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Applying behavioral science to promote pro-environmental behavior: Experimental insights on determinants and interventions

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Abstract (English)

To mitigate the effects of climate change, behavioral changes are essential. However, despite some progress, significant behavioral changes are lacking, and people continue to struggle with translating their pro-environmental values into actions – a phenomenon known as the value-action gap. Given that human behavior and decision-making considerably contribute to climate change, behavioral science as an interdisciplinary field investigating human behavior emerges as a crucial tool for informing mitigation strategies. In this cumulative dissertation, I draw on the conceptual foundations of behavioral science, with an emphasis on behavioral economics, to identify determinants of pro-environmental behavior – particularly the perceived impact of behavior and knowledge – and to test the effectiveness of various behavioral interventions across different contexts. These contexts include collective decision-making to mitigate climate change, donation decisions to environmental organizations, sustainable investments, and the reduction of littering. Empirically, this thesis consists of a series of lab, online, and field experiments, with each chapter forming a peer-reviewed publication or submitted manuscript. Chapter 1 examines the role of three behavioral barriers – such as when individuals are not immediately affected by the consequences of their actions, when the impacts of their actions are uncertain, and when their contributions are perceived as only marginal. These barriers significantly hinder pro-environmental behavior and widen the value-action gap, as shown through a combination of an interactive lab experiment (N = 800) and a vignette experiment involving incentivized donation decisions (N = 658). Chapter 2 evaluates targeted, reflective information interventions on sustainable investments. It shows that providing information about both financial returns and the impact on Environmental, Social, and Governance (ESG) factors, as well as combined information covering both aspects, effectively promotes ESG investments in an incentivized investment decision (N = 2,254). Chapter 3 develops a measurement instrument to quantify sustainable finance literacy, defined as knowledge about sustainable finance, employing a sample of 1,047 participants in Study 1. The chapter further demonstrates that higher levels of sustainable finance literacy are predictive of more sustainable investments, an improved ability to identify greenwashing, and increased stock market investments, as evidenced in an incentivized investment experiment with another sample in Study 2 (N = 1,510). Chapter 4 tests an implicit intervention aimed at promoting pro-environmental behavior and reducing littering within 182 social housing waste disposal areas through a field experiment conducted over 13 months. The intervention involved displaying a nature poster. The findings indicate that while the nature poster intervention does not increase objective cleanness, it significantly improves the residents' subjective cleanness ratings (N = 739) one month post-intervention. Overall, this dissertation enhances our understanding of how behavioral science can be applied to promote pro-environmental behavior by empirically identifying key determinants and evaluating targeted interventions across different contexts. The research contributes to multiple strands of the behavioral science literature and provides practical insights for applying behavioral science findings to environmental policy design. By addressing the need for continuous innovation of behavioral science and by extending beyond standard economic models, this work offers valuable insights into promoting sustainable behavior and contributes to advancing the field.

Zusammenfassung (Deutsch)

Um die Auswirkungen des Klimawandels zu verringern, sind Verhaltensänderungen entscheidend. Trotz einiger Fortschritte bleiben jedoch tiefgreifende Verhaltensänderungen aus und viele Menschen haben Schwierigkeiten, ihre umweltfreundlichen Werte in konkrete Taten umzusetzen – ein Phänomen, das als „Value-Action Gap" bekannt ist. Da menschliches Verhalten und Entscheidungen erheblich zum Klimawandel beitragen, bietet die Verhaltenswissenschaft als interdisziplinäres Forschungsfeld wertvolle Ansätze, um wirksame Strategien zur Bekämpfung des Klimawandels zu entwickeln. Die kumulative Dissertation stützt sich auf die konzeptionellen Grundlagen der Verhaltenswissenschaft, insbesondere der Verhaltensökonomik, um die Determinanten umweltfreundlichen Verhaltens zu identifizieren – wie die wahrgenommene Wirksamkeit von Verhalten sowie Wissen – und um die Effektivität verschiedener Verhaltensinterventionen in unterschiedlichen Kontexten zu testen. Diese umfassen kollektive Entscheidungsprozesse zur Bekämpfung des Klimawandels, Spenden an Umweltorganisationen, nachhaltige Geldanlagen sowie das nicht fachgerechte Entsorgen von Abfällen. Empirisch basiert die Dissertation auf einer Reihe von Labor-, Online- und Feldexperimenten, wobei jedes Kapitel eine im Peer-Review begutachtete Veröffentlichung in einer Fachzeitschrift oder ein dort eingereichtes Manuskript darstellt. Kapitel 1 untersucht die Rolle von drei Verhaltensbarrieren – wenn Individuen nicht unmittelbar von den Folgen ihres Handelns betroffen sind, die Auswirkungen ihrer Handlungen unsicher sind oder sie ihre Beiträge nur als geringfügig wahrnehmen. Diese Barrieren behindern umweltfreundliches Verhalten erheblich und verstärken das Value-Action Gap, wie durch eine Kombination eines interaktiven Laborexperiments (N = 800) und eines Vignettenexperiments mit incentivierten Spendenentscheidungen (N = 658) gezeigt wird. Kapitel 2 evaluiert gezielte, explizite Informationsmaßnahmen zu nachhaltigen Investitionen. Die Ergebnisse zeigen, dass Informationen über finanzielle Renditen und die Auswirkungen auf Umwelt-, Sozial-, und Governance-Faktoren (ESG), sowie kombinierte Informationen über beide Aspekte, nachhaltige Investitionen in einer incentivierten Investitionsentscheidung wirksam erhöhen (N = 2.254). Kapitel 3 entwickelt ein Instrument zur Messung von Sustainable Finance Literacy, also des Wissens über nachhaltige Finanzen, basierend auf einer Stichprobe von 1.047 Teilnehmern (Studie 1). Zudem wird in einem incentivierten Investitionsexperiment mit einer weiteren Stichprobe (N = 1.510) gezeigt, dass ein höheres Niveau an Sustainable Finance Literacy mit nachhaltigeren Investitionen, einer verbesserten Fähigkeit zur Erkennung von Greenwashing und einer erhöhten Aktienmarktteilnahme einhergeht (Studie 2). Kapitel 4 testet eine implizite Intervention zur Förderung umweltfreundlichen Verhaltens und zur Reduzierung von unsachgemäß entsorgten Abfällen in 182 Müllbereichen von Gemeindebauten im Rahmen eines 13-monatigen Feldexperiments. Die Installation bestand aus der Platzierung eines Naturposters. Die Ergebnisse zeigen, dass die Intervention zwar keine objektive Sauberkeitssteigerung bewirkt, jedoch die subjektiven Sauberkeitseinschätzungen der befragten Bewohner:innen (N = 739) einen Monat nach der Intervention deutlich verbessert. Insgesamt erweitert diese Dissertation unser Verständnis darüber, wie die Verhaltenswissenschaft zur Förderung umweltfreundlichen Verhaltens eingesetzt werden kann, indem sie zentrale Determinanten empirisch

identifiziert und gezielte Interventionen in verschiedenen Kontexten evaluiert. Die Arbeit leistet einen Beitrag zu mehreren Bereichen der verhaltenswissenschaftlichen Literatur und bietet praktische Erkenntnisse für die Anwendung verhaltenswissenschaftlicher Erkenntnisse auf die Gestaltung von Umweltpolitik. Durch die Berücksichtigung des Bedarfs an kontinuierlicher Weiterentwicklung der Verhaltenswissenschaft und durch den Blick über standardökonomische Modelle hinaus liefert diese Arbeit wertvolle Einblicke in die Förderung nachhaltigen Verhaltens und trägt zur Weiterentwicklung des Forschungsfeldes bei.

Preamble

What you do makes a difference,
and you have to decide what kind of difference you want to make.

Dr. Jane Goodall, Scientist and Activist

1. Background and motivation

How can we promote behavior change towards a sustainable future? For decades, thousands of scientists have warned about the climate emergency and the profound impacts of human behavior (IPCC, 2021; Ripple et al., 2020). Despite some progress, such as climate emergency declarations and climate strikes, significant behavioral change is still needed (Creutzig et al., 2018; Swim et al., 2011; Whitmarsh et al., 2021). Although many express environmental concerns and willingness to take action, few consistently adopt environmentally friendly behaviors (Babutsidze & Chai, 2018; Kollmuss & Agyeman, 2002).

The determinants of pro-environmental behavior are diverse and multifaceted. Meta-analyses indicate that factors such as the perceived effectiveness of actions (outcome efficacy), knowledge about climate change or about specific behaviors, beliefs about climate change, perceived risk, and social norms play significant roles (Albarracín et al., 2024; van Valkengoed & Steg, 2019). Conversely, pro-environmental behavior can be hindered by various barriers, ranging from structural issues, such as inadequate infrastructure, to behavioral or cognitive challenges, such as uncertainty about the impact of an action or a lack of knowledge (van der Linden & Weber, 2021; van Valkengoed et al., 2022). Understanding these determinants is crucial for designing interventions that effectively promote pro-environmental behavior (Nielsen et al., 2020; van Valkengoed et al., 2022). In essence, knowing *why* individuals do or do not engage in pro-environmental behavior is critical for understanding *what can be done* to encourage further sustainable action.

Given the significant role of human behavior and decision-making in contributing to climate change, it can be argued that behavioral science – particularly the use of behavioral insights and related frameworks (Hallsworth & Kirkman, 2020; Steg & Vlek, 2009) – can play a vital role in mitigating these impacts. This dissertation focuses on two main areas: understanding determinants of pro-environmental behavior (i.e., *why*) as well as developing behavioral interventions and assessing their effectiveness. Both are examined across different contexts, including collective decision-making, donation decisions, sustainable investments, and littering (i.e., *what can be done*).

To achieve meaningful outcomes in promoting pro-environmental behavior, however, it is essential to continuously refine approaches within behavioral science. This refinement involves not only developing innovative interventions but also addressing key methodological challenges within the field. These challenges include the limited impact of some interventions, the context dependency and lack of external validity, participant heterogeneity, and the absence of (evaluating) long-lasting effects (Hallsworth, 2023).

Furthermore, a broader range of behaviors should be studied, the complexity of determinants addressed, and the variety of methods and populations considered (Nielsen et al., 2024).

This dissertation aims to address these challenges to not only enhance the impact of behavioral interventions but also to advance the field of behavioral science while upholding scientific rigor. By empirically identifying determinants of pro-environmental behavior – including knowledge and outcome efficacy as well as barriers – and evaluating the effectiveness of targeted behavioral interventions across diverse contexts, this thesis significantly contributes to the behavioral science literature. Furthermore, it underscores the nuanced application of behavioral science principles in designing environmental policies.

In the following sections, I outline the conceptual foundations of my dissertation, focusing on behavioral science with an emphasis on behavioral economics as the primary theoretical framework. I also discuss applied behavioral science, determinants of pro-environmental behavior, behavioral interventions, and criticism of behavioral science. Next, I introduce the research questions, the methodology, and the empirical approach, followed by a summary of the four chapters and their main results. I then discuss the findings to conclude with a reflection on the benefits and limitations of applying insights from behavioral science to promote pro-environmental behavior, along with an outlook on the future of the field.

2. Conceptual foundations of behavioral science

Behavioral science is a discipline that investigates individual and group behavior by generating and testing theories to predict human actions (Hallsworth, 2023; Nielsen et al., 2024).[1] As an inherently interdisciplinary field, it draws on methods, theories, and principles from various fields such as anthropology, behavioral economics, psychology, sociology, and cognitive science. This interdisciplinary approach enables a deeper understanding of the underlying factors that influence decision-making, preferences, and actions, allowing to make more accurate predictions and design effective interventions.

A significant strand within behavioral science is behavioral economics, which has gained prominence in recent decades for its ability to explain economic behavior that deviates from standard economic theory (Camerer & Loewenstein, 2004; Dhami, 2016; Thaler, 2015). Standard economic theory rests on two key assumptions (Camerer & Fehr, 2006). The first assumption is that individuals are rational decision-makers who can retrieve and process all information relevant for decision-making, aiming to maximize their own utility. The second assumption is that individuals have purely self-regarding preferences, focusing on their own outcomes rather than those of others. These assumptions form the basis of the economic agent known as *homo economicus*, which has been used to explain and model a plethora of phenomena. For example, the assumption of rational agents in competitive markets not only helps to explain interactions between supply and demand as well as price determination, but also informs game theory, such as the prisoner's dilemma, to analyze strategic interactions and predict equilibrium outcomes (Mas-Colell et al., 1995; Varian, 1992).

[1] Note that 'behavioral science' should not be confused with 'the behavioral sciences', which is a broader category that includes various scientific disciplines focused on the study of behavior (Hallsworth, 2023).

Additionally, scholars like Gary Becker have extended these assumptions to non-market behaviors, applying traditional economic theory to social behaviors such as family decisions, marriage markets, and crime analyses (Becker, 1968, 1973, 1974).

However, real-world behavior – particularly in the context of pro-environmental decision-making – is often multi-faceted, complex, and influenced by heuristics, biases, and emotions, as well as social and other factors (Tversky & Kahneman, 1974; van der Linden & Weber, 2021). Behavioral economics emphasizes that decision-making is affected by i) fairness and social norm concerns aside from material payoffs, ii) the social context and dimensions of social approval and status, and iii) cognitive limitations – which, in some cases, can lead to seemingly irrational decisions (Carlsson & Johansson-Stenman, 2012).

A substantial body of literature documents deviations from the rational, self-interested *homo economicus* model (Croson & Treich, 2014; van der Linden & Weber, 2021). In other words, humans often do not behave as rationally as some models suggest or assume. Theories from multiple disciplines, including psychology and economics, have sought to address the complexities of human decision-making. For instance, the concept of bounded rationality, introduced by Hebert A. Simon in the 1950s, suggests that although individuals strive to make rational choices, they are constrained by several factors: limitations in information (they do not possess all information needed to make a decision), cognitive limitations (they cannot process all available information, often leading to simplifying complex decisions), time constraints (i.e., the time frame for decision-making is are limited) and the complexity of an environment, which is often unpredictable (Simon, 1955, 1990). This leads to simplified decision-making processes, such as satisficing – settling for a satisfactory option rather than the optimal one.

Psychologists have proposed the dual process theory of behavior, which describes two distinct processes of thinking and decision-making: System 1 and System 2 (Evans, 2008; Kahneman, 2012; Lieberman, 2007). System 1 is characterized by automatic, intuitive, implicit, and non-cognitive thinking, such as recognizing a familiar face. In contrast, System 2 involves deliberate, analytical, explicit, and reflective processes, such as solving difficult problems. While System 1 is faster, more efficient, and energy-saving, it is also more prone to biases and errors due to its reliance on heuristics. System 2, although slower, more deliberate, and resource-intensive, is less susceptible to such biases.

Research across psychology and other disciplines has shown that people frequently rely on heuristics – mental shortcuts that reduce the complexity of a task, allowing for simpler and faster judgments (Gilovich et al., 2002). Various heuristics have been identified in the literature, beginning with the foundational work of Tversky and Kahneman (1974). For instance, the availability heuristic leads people to base judgments on how easily information can be retrieved from the mind (Tversky & Kahneman, 1973). If an individual can quickly recall recent negative news about greenwashing in sustainable investments, they may overestimate the prevalence of greenwashed products on the market and become overly skeptical about all sustainable funds, basing their judgment on memorable events rather than a balanced assessment of available data.

Another example for such a shortcut is the representative heuristic, where likelihood judgments are based on how closely the situation matches a certain prototype or stereotype (Tversky & Kahneman, 1974). For instance, if a person encounters a sustainable investment option that fits their stereotype of what a 'green' investment is, they might judge it to be more sustainable than it actually is, simply because it matches their mental picture of sustainable investments. An additional example is the anchoring heuristic, where individuals make estimates based on initial starting points, which are potentially irrelevant or random (Kahneman, 2003; Tversky & Kahneman, 1974). This might involve using a salient reference point, random numbers, or recent information about investments when making financial decisions. Additionally, the recognition heuristic suggests that people make decisions based on familiarity, often considering more familiar options as better (Goldstein & Gigerenzer, 2002). This heuristic can explain why investment products are perceived as less risky when they are more familiar to an individual (Wang et al., 2011).

The reliance on heuristics can lead to cognitive biases, where individuals systematically deviate from rational judgment and behavior (Gilovich et al., 2002). One such bias is the status quo bias, where individuals prefer options that maintain the current situation and avoid changes, even when beneficial alternatives are available (Samuelson & Zeckhauser, 1988). This bias is particularly relevant in the context of pro-environmental behavior, where individuals may resist innovations or adaptions and prefer to retain the status quo (Handgraaf et al., 2017; Tam & McDaniels, 2013). Similarly, present bias refers to the preference for immediate, smaller rewards over delayed, larger ones, even if this results in a less optimal long-term outcome (O'Donoghue & Rabin, 2015). Unlike general time preferences, which remain consistent regardless of timing, present bias causes a shift in preferences toward immediate rewards when the decisions involve the present, causing inconsistencies in decision-making. For example, one might prefer 100 euros in a year over 90 euros in 11 months, but they would choose to take 100 euros now instead of waiting for 110 euros in a week.

Another bias, known as the framing effect, occurs when decisions are influenced by how a choice situation is presented. For example, individuals display a preference for avoiding losses rather than for achieving gains, even if the outcome in terms of monetary payoff is objectively identical (Tversky & Kahneman, 1981). Many of these biases can be explained by prospect theory, which describes how decisions are made under risk and why individuals are risk-seeking when facing losses and risk-averse when considering gains (Kahneman & Tversky, 1979).

Furthermore, with regards to self-interest, numerous studies (Fehr & Fischbacher, 2002; Fehr et al., 2002) demonstrate voluntary cooperation and the existence of social preferences, such as fairness, reciprocity, and altruism, which contradict the purely self-interested behavior suggested by standard economic theory. These behaviors challenge the concept of *homo economicus*, who is presumed to free-ride or disregard fairness considerations in the pursuit of utility maximization.

Experimental findings from dictator and ultimatum games further illustrate these deviations. In the dictator game, one participant (the 'dictator') receives an amount of money and must decide how much to share with a second participant, who has no power over the outcome. Contrary to the predictions of pure self-interest, which would suggest the dictators would keep the entire amount, empirical results consistently show that many individuals choose to share a portion of the money, reflecting altruistic motives and/or a preference for fairness (Eckel & Grossman, 1996; Forsythe et al., 1994). This willingness to give, even when there is no strategic incentive, indicates a concern for the well-being of others, at least to some degree.

In the ultimatum game, one player proposes how to divide a certain amount of money while the second player can either accept or reject the offer. If the offer is rejected, both players receive nothing. According to standard economics theory, the second player should accept any positive offer, as receiving something is better than receiving nothing. However, findings consistently show that low offers are often rejected, indicating that individuals are willing to forgo monetary gains to punish what they perceive as unfair behavior (Güth & Tietz, 1990; Thaler, 1988). This rejection of low offers demonstrates a preference for fairness and willingness to incur personal costs to uphold social norms. Similarly, in public goods games, individuals frequently contribute more than predicted by models that assume purely self-interested agents, showing a willingness to incur personal costs to punish unfair behavior or reward cooperation (Fehr & Gächter, 2000, 2002). While strategic considerations may partly drive behavior in ultimatum games, this does not apply to dictator games where the receiving player has no influence (Eckel & Grossman, 1996; Roth, 1995).

Moreover, experimental findings reveal cultural variations in the outcomes of these games, suggesting that fairness norms and social preferences are influenced by societal context and varying across different groups (Henrich et al., 2001). While offers were above zero in all societies, more generous offers and higher rejection rates of unfair offers were observed in some cultures, underscoring the role of social norms and collective values.

Deviations from self-interest are also evident in other pro-environmental and pro-social behaviors, where individuals prioritize collective well-being over their personal interest. For instance, in pro-environmental behavior, individuals may engage in actions like recycling, even when such behavior involves higher costs or inconvenience, motivated by a desire to contribute to the environmental sustainability and a collective concern that extends beyond personal gain (Evans et al., 2013). Altruistic actions such as charitable giving further challenge the assumption of self-interest. Individuals often donate money or resources to support causes that provide no direct personal (financial) return, such as funding for disaster relief or education in underserved areas (Andreoni, 1990). Similarly, volunteering for community service or participation in social activism, such as campaigning for human rights, demonstrates motivational drive rooted in a sense of duty, moral obligation, or social justice rather than the pursuit of direct personal gain (Unger, 1991).

In summary, deviations from the *homo economicus* model extend beyond bounded rationality to include a range of pro-social and other-regarding behaviors, as demonstrated by experimental settings such as dictator, ultimatum, and public goods games. These findings underscore the complexity and richness of human decision-making, where information limitations, cognitive constraints, biases and heuristics, social preferences, fairness concerns, and emotions play significant roles in shaping choices, including those related to pro-environmental behavior.

Beyond behavioral economics, other disciplines and theories have further contributed to the development of behavioral science, particularly in the context of pro-environmental decision- and policy-making. In addition to the more general contributions previously discussed, psychology has also been instrumental in providing informed solutions to increase pro-environmental behavior (Steg & Vlek, 2009; Van Lange et al., 2018) and understanding the psychological determinants of consumption, which form the foundation for targeted interventions (Swim et al., 2011). Research in environmental psychology has grown rapidly (Gifford, 2007), proposing and investigating barriers to pro-environmental behavior, such as limited cognition, ideologies, as well as social norms and comparisons (Gifford, 2011; Gifford et al., 2011; Gifford & Chen, 2017).

Emerging research fields such as behavioral environmental economics, behavioral finance (Croson & Treich, 2014), or neuroeconomics (Fehr & Krajbich, 2014; Sawe & Chawla, 2021) have expanded the principles of behavioral economics and behavioral science to explore how cognitive biases, social preferences, and neurological factors influence decisions related to environmental sustainability. Furthermore, connections between behavioral science, social sciences, and evolutionary biology have been established, focusing on human behavior and decision-making, biases, and adaptive behaviors (Machery & Cohen, 2012; Nelson & Winter, 2002; van den Bergh, 2007). These fields aim to provide realistic representations of human behavior and a more accurate understanding of it, both of which are crucial for informing policymakers and for designing effective interventions to enhance environmental sustainability.

While this overview is not exhaustive and the contributions to behavioral science extend beyond the scope of this thesis focusing on behavioral economics, these fields share a common denominator: understanding and predicting human behavior, particularly in the context of environmental sustainability, and providing policy recommendations. Interdisciplinary fields such as human ecology or ecological economics also contribute to these efforts (Kastenhofer et al., 2011). Although integrating knowledge, principles, and methods from diverse disciplines has enriched our understanding of human behavior and informed policy recommendations, this process remains far from perfect, and interdisciplinary work presents unique challenges (see Gifford et al., 2011 for a more detailed discussion). Despite these difficulties, there is a critical need to further interdisciplinary approaches in behavioral science to advance climate change mitigation (Nielsen et al., 2024).

3. Applied behavioral science and behavioral interventions

Behavioral science research has lately received increased attention around the world for its role in promoting pro-environmental behavior and sustainable lifestyles (Nielsen et al., 2021), for example in areas such as conservation behavior (Cinner, 2018). The application of behavioral science findings to address practical problems and inform policy is commonly known as 'behavioral insights', a term often used interchangeably with 'applied behavioral science' (Hallsworth, 2023; Mukherjee & Giest, 2020). In recent years, there has been a growing focus on behavioral economics (Angner, 2019; Geiger, 2017), including its influence on policy-making. This is exemplified by the advisory role Cass Sunstein – a behavioral economics pioneer – held with the Obama administration (Sunstein, 2013). Furthermore, this attention has extended to the broader field of (applied) behavioral science, which has gained significant traction.

Over the past two decades, Behavioral Insights Teams have been established all over the world, with both academics and practitioners applying these principles across various sectors, and boasting an audience comprised of governments, policy makers, and the private sector (Hallsworth, 2023; Hallsworth & Kirkman, 2020). The behavioral insights approach has been globally adopted in a wide range of fields and interventions to promote pro-environmental behavior have been tested in numerous contexts. Examples include initiatives to reduce energy consumption by providing customers with real-time feedback on the current energy consumption or using peer comparisons to encourage water conservation (OECD, 2017, 2019a, 2019b).[2]

Behavioral science and, based on it, the behavioral insights approach play a crucial role in understanding *why* individuals engage – or fail to engage – in pro-environmental behavior, and in determining *what can be done* to promote such behavior. Addressing both aspects simultaneously is essential, as interventions are more effective when they target the underlying determinants of a certain behavior (van Valkengoed et al., 2022). This aligns with frameworks such as the one by Steg and Vlek (2009), which recommend first

[2] During my PhD studies, I contributed to several applied behavioral science projects that complement this dissertation. These projects were conducted within the Behavioral Economics Research Group at the Institute for Advanced Studies, which employs behavioral insights and the principles of behavioral science. For instance, one project involved a field experiment, published as a working paper (Bechtold et al., 2024), that tested different invitation letters to recruit citizens for a citizen assembly in Austria (N = 14,999). This citizen assembly, initiated in the autumn of 2023 by the Austrian government to account for the Covid-19 pandemic, involved about 360 participants, with scientific support from the Austrian Academy of Sciences and the Institute for Advanced Studies. The results show that an invitation letter emphasizing the importance of personal experience and different opinions was more effective in increasing participation than an invitation focused on bringing own ideas. These findings can not only inform future initiatives related to the Covid-19 pandemic, but can also provide insights for citizen assemblies on environmental topics. In addition to this, I contributed to a policy brief on energy saving based on behavioral science research (Gangl, Abstiens, et al., 2022). To enhance science communication with the general public, we also published a blog post summarizing the policy brief's key points, available at: https://www.ihs.ac.at/de/publications-hub/blog/was-uns-am-energiesparen-hindert/.

identifying a target behavior, then analyzing the underlying determinants, designing and applying interventions to change behavior, and finally evaluating their effects.[3]

Regarding the first point – i.e., *why* – behavioral science examines determinants of pro-environmental behavior. Albarracín et al. (2024) summarize these determinants in their review of meta-analyses, identifying factors such as general skills, beliefs, knowledge, emotions, general attitudes, behavioral skills, behavioral attitudes, and habits (in ascending order of importance). Similarly, van Valkengoed et al. (2022) identify 13 determinants of pro-environmental behavior and their underlying theoretical frameworks. Among those are, for example, knowledge (understanding the causes and impacts of environmental issues) and outcome efficacy or perceived behavioral control (the belief than one can have an effective impact on environmental problems).

3.1. Determinants of pro-environmental behavior: Knowledge and outcome efficacy

In this dissertation, I focus on these two key determinants – knowledge and outcome efficacy – as they form the foundation of the interventions developed and evaluated here. While knowledge about environmental issues, as well as their causes and impacts is recognized a positive determinant – or driver – of pro-environmental behavior (van Valkengoed et al., 2022), it is not among the strongest predictors (Albarracín et al., 2024; van Valkengoed et al., 2022; van Valkengoed & Steg, 2019). Interventions that include information provision to fill knowledge gaps about environmental issues may not be the most effective (Albarracín et al., 2024), as many barriers are rooted in psychological, cultural, and ideological factors such as perceptions and beliefs rather than a lack of information (Weber, 2018). However, specific types of knowledge, often referred to as 'literacy', can significantly influence behavior. A popular example is financial literacy – a person's understanding of financial concepts – which relates to more sound financial

[3] While this dissertation's chapters consider target behaviors as given, it is crucial to carefully select these behaviors. Behavioral science can be instrumental in identifying effective target behaviors. In a recent working paper that complements this dissertation (Gangl, Seifert et al., 2022), we combined a behavioral insights approach with stakeholder analysis, involving 89 experts in sustainability transition. These experts assessed the power and interest of Austrian stakeholders (e.g., political parties) regarding a sustainable transition in mobility and renewable energy provision and suggested necessary target behaviors. Additionally, the experts, along with a representative sample of 1,000 citizens, ranked the most significant barriers concerning these transitions. This approach helped to pinpoint key stakeholders, essential target behaviors, and major barriers for sustainability transitions. More generally, research shows that many commonly promoted actions to reduce greenhouse gas emissions, such as recycling, have a low impact, whereas high-impact actions, such as living without a car, minimizing air travel, or adopting a plant-based diet, are rarely emphasized among the recommended actions (Wynes & Nicholas, 2017). Shifting towards those high-impact target behaviors might be advisable, but this must be guided by behavioral science, as high-cost situations involve different determinants and barriers. For instance, in high-cost scenarios, the value-action gap – the difference between people's values and actions – is typically larger than in low-cost behaviors (Farjam et al., 2019). Future research should prioritize interventions in these high-cost domains and examine their behavioral implications.

decision-making (Kaiser et al., 2022; Lusardi & Mitchell, 2008; van Rooij et al., 2011). Similarly, sustainable finance literacy is highly predictive of sustainable investments (Degryse et al., 2023; Filippini et al., 2024; see Chapter 3). Knowledge can also influence behavior by helping individuals understand the consequences of specific actions rather than just the causes and impacts of environmental issues. This understanding can also shift attitudes towards pro-environmental behavior, which is another key determinant of pro-environmental behavior (Bolderdijk, Gorsira, et al., 2013; van Valkengoed et al., 2022).

The second determinant, outcome efficacy, broadly refers to the belief in the effectiveness or impact of one's action and is a critical determinant of pro-environmental behavior (Albarracín et al., 2024; van Valkengoed et al., 2022), for instance in adaptive behaviors (van Valkengoed & Steg, 2019). In the context of investments, perceived impact – or perceived consumer effectiveness – is a determinant of sustainable investing (Brunen & Laubach, 2022; Nilsson, 2008). Recent experiments suggest that while investors do care about impact, they may not prioritize the extent of it (Heeb et al., 2023). Importantly, determinants are often interrelated and can influence each other (Nielsen et al., 2024). For example, a knowledge intervention might alter beliefs or increase awareness to environmental issues and the impacts of individual behavior (Bolderdijk, Gorsira, et al., 2013; Steg & Vlek, 2009).

In addition to knowledge and outcome efficacy, other significant determinants of pro-environmental behavior may interact with the effectiveness of interventions and should be considered as control or interacting variables in the statistical analysis. Among these factors are normative values (Steg, 2016; Stern, 2000). For example, biospheric value orientation – whether people consider preventing pollution or protecting the environment as important in their lives – can drive pro-environmental behavior (De Groot & Steg, 2007, 2008, 2016; Steg, 2016). However, while these values determine behavior to a certain degree, they do not always entirely translate into corresponding pro-environmental behaviors – a phenomenon known as the value-action gap (Babutsidze & Chai, 2018; Kollmuss & Agyeman, 2002).

Another important determinant of pro-environmental behavior is made up of sociocultural factors, such as social norms, which also significantly influence pro-environmental behavior. Descriptive norms, which refer to the behavior of others, are particularly influential (Albarracín et al., 2024; van Valkengoed et al., 2022). Peer effects and reciprocity, influenced by the actions of others, also shape group behavior (Babutsidze & Chai, 2018; Fehr et al., 2002).

In contrast, negative determinants, commonly referred to as barriers, hinder pro-environmental behavior and contribute to the value-action gap. These barriers can be broadly divided into two larger domains: structural barriers, which are typically beyond an individual's control (e.g., lack of infrastructure), and psychological barriers (Gaspar, 2013; Gaspar et al., 2010; Gifford, 2011; Nguyen et al., 2019). Psychological barriers, closely linked to boundaries in individual decision-making, are often intertwined and can be categorized as cognitive, affective, social, political, motivational, and behavioral (van der Linden & Weber, 2021). Behavioral science, as shown in this dissertation, has the potential to address all these barriers,

particularly behavioral ones, such as uncertainty about the impact on one's action, which hinder pro-environmental behavior and exacerbate the value-action gap.

3.2. Behavioral interventions

Once the first point – i.e., *why* individuals do or do not engage in pro-environmental behavior – has been established, the second point – i.e., *what can be done* – can be addressed by designing behavioral interventions that consider how determinants and biases influence decision-making and by building on these insights (Albarracín et al., 2024; Nielsen et al., 2020). Interventions to promote pro-environmental behavior can be summarized in different broad categories, though these are neither exhaustive nor mutually exclusive: information provision (e.g., energy-saving tips), social comparison (e.g., highlighting social norms), commitments (e.g., private or public pledges), feedback (e.g., on past consumption), engagement (e.g., goal setting), as well as appeals (e.g., requests to change behavior), and changes in the choice architecture (e.g., modifying the decision environment) (Nisa et al., 2019; van Valkengoed et al., 2022).

One prominent category of interventions related to changes in the choice architecture called 'nudges'. Rooted in nudge theory, these interventions aim to facilitate predefined behaviors without restricting choices or using incentives (Thaler & Sunstein, 2009). Nudges encompass strategies such as setting default options, employing framing effects, and emphasizing social norms, all of which are designed to subtly influence decision-making. They are among the most prominent examples of behavioral science, being widely recognized in both academia and practical applications (Barton & Grüne-Yanoff, 2015; Thaler & Sunstein, 2009). Nudges have been applied to optimize financial decisions and promote sustainable investments (Gajewski et al., 2024). These interventions can also address biases, such as the status quo bias. For example, default nudges, which set a target behavior as the default option, significantly increase adoption. This has been demonstrated in contexts like pension plan enrollment, where the status quo (or current default) is non-participation and changing the default to automatic enrollment has increased participation rates (Thaler & Benartzi, 2004). Similarly, in the realm of pro-environmental behavior, setting sustainable investment products as the default choice rather than conventional options encourages more people to opt for sustainable options (Gajewski et al., 2022; Isler et al., 2022).

More broadly, behavioral interventions – those that do not rely on economic (dis)incentives and regulations, but focus on methods such as information provision (Nisa et al., 2019; Stern, 2020) – can, to some extent, effectively promote climate action. A recent review of interventions to change behavior found that the behavioral interventions are generally effective, though their success varies depending on the target behavior (Albarracín et al., 2024). The review emphasizes that interventions targeting specific behaviors by developing habits, changing attitudes towards those behaviors, and building behavioral skills to execute a target behavior are more effective than those that provide general knowledge about climate change, train

broad skills such as self-control, or alter general attitudes, such as one's views on cars.[4] Also, earlier meta-analyses noted that, for example, interventions addressing cognitive dissonance or goal setting had the largest effect sizes, but also that the effectiveness depends on the target behavior (Osbaldiston & Schott, 2012).

Similarly, a meta-analysis of 83 randomized control trials (RCTs) with more than three million observations found that individuals in an intervention group are 6.6% more likely to engage in climate action than individuals in the control group (Nisa et al., 2019). Stern (2020) expanded on this meta-analysis and highlighted that combining behavioral interventions with other intervention types could enhance their effectiveness. Follow-up analyses of the work of Nisa et al. (2019) further emphasized the importance of applying behavioral interventions appropriately, considering the context of the implementation, and integrating them with other strategies, such as policy tools, to achieve greater effects (Nielsen et al., 2020). A recent second-order meta-analysis of 10 meta-analyses concluded that while behavioral interventions can increase pro-environmental behavior, financial incentives are most effective (Bergquist et al., 2023).

3.3. Criticism of behavioral science and the behavioral insights approach

Despite its potential, the behavioral insights approach, as extensively summarized by Hallsworth (2023) as well as Nielsen et al. (2024), has faced several points of criticism, including limited impact of interventions and context dependency as well as lacking external validity, heterogeneity of participants, and long-lasting effects.

First, interventions sometimes yield limited or negligible impact, especially after correcting for publication bias, which is the tendency to publish only positive or significant results. This bias means that the observed effects in meta-analyses may only reflect a few effective interventions, while numerous null results likely remained unpublished (Maier et al., 2022; Mertens et al., 2022). Additionally, research often focuses on commonly studied consumer behaviors and low-impact interventions, even though other behaviors, such as financial investments, should also be considered (Nielsen et al., 2024).

Second, the outcomes of interventions are often highly context-dependent, may lack external validity, and may not fully translate from laboratory settings to real-world applications in the field, complicating the successful scaling of interventions (DellaVigna & Linos, 2022). In the same vein, van Valkengoed et al. (2022) argue that ignoring contextual factors results in unclear conclusions about whether and why interventions are effective. Moreover, Nielsen et al. (2024) recommended replacing analyses of self-reported behavior with measures of actual behavior or incentivized decisions-making to obtain more accurate data. Research on pro-environmental behavior has been largely based on self-reported behavior, often in hypothetical scenarios (Osbaldiston & Schott, 2012; Peattie, 2010; Ropret Homar & Knežević Cvelbar,

[4] It is important to note that some meta-analyses (e.g., Albarracín et al., 2024; Bergquist et al., 2023) also take into account interventions that include financial incentives, even though these are often not considered behavioral interventions in the narrower sense (e.g., Nisa et al., 2019).

2021), which can be biased toward overstatement and lead to an overestimation of actual pro-environmental behavior and the effectiveness of behavioral interventions (Koller et al., 2023).[5]

Third and related to the previous point, the social context of interventions and participant heterogeneity are frequently overlooked (Bryan et al., 2021). For instance, a large crowd-sourced study with nearly 60,000 participants from 63 countries found that the effectiveness of behavioral interventions varies greatly depending on the target behaviors and the target groups (Vlasceanu et al., 2024). Furthermore, the complexity of interactions between individual characteristics and other factors (e.g., social, physical, and systemics factors) is often ignored (Nielsen et al., 2024). In this regard, studies have documented heterogeneous effects of interventions. For example, providing environmental knowledge is more effective in changing behavior among participants with stronger biospheric value orientation (Bolderdijk, Gorsira, et al., 2013).

Fourth, interventions may not produce long-lasting effects and few studies assess their long-term impact (Marchiori et al., 2017). More longitudinal data is needed to assess effects and changes in behavior over time (Nielsen et al., 2024).

These critiques highlight the need for continuous innovation and rigorous testing of behavioral interventions to ensure their effectiveness across different populations and contexts. Thus, in each chapter of this dissertation, I tackle the points of criticism and recommendations regarding behavioral science and interventions.

To address the critique of limited impact, this dissertation investigates high-impact behaviors such as financial investments (Nielsen et al., 2024) and finds that behavioral interventions significantly increase sustainable investments, with effects comparable to those found on knowledge interventions in large meta-analyses (Bergquist et al., 2023; Nisa et al., 2019). Additionally, this dissertation examines pro-environmental behaviors beyond the usual focus areas, such as littering, contrasting with more commonly studied behaviors like energy use reduction, water conversation, or recycling. Rather than solely generating and testing behavioral interventions in each chapter, the dissertation also identifies determinants of pro-environmental behavior that can ultimately impact the design of interventions. Scholars have emphasized that understanding these determinants is crucial for developing effective interventions (Steg & Vlek, 2009; van Valkengoed et al., 2022).

To address concerns about context dependency, external validity, and scalability (DellaVigna & Linos, 2022), this dissertation employs different measurement approaches to quantify relevant outcome variables across different settings. Distinctively, experimental approaches and incentivized or observed behavioral data are incorporated, ensuring that all outcome variables reflect observed, actual (incentivized) behavior.

[5] However, recent studies have reported no significant differences in behavior between participants receiving monetary incentives and those receiving no incentives (Hackethal et al., 2023).

Observing real behavior rather than relying on self-reported behavior is essential for studying the determinants of pro-environmental behavior and developing effective interventions. For instance, each chapter compares an objective, often incentivized outcome (except for the field experiment in Chapter 4, where incentives from the experimenters do not apply) to a self-reported outcome measured through surveys. By using multiple outcome variables in each chapter, the dissertation aims to increase the robustness and the external validity of our findings. Moreover, this approach allows us to examine the stability of behavior and understand the effect of determinants and interventions across different modes of measurement. It also contributes to the literature by providing insights regarding the differences between objective and subjective ratings (Koller et al., 2023; Osbaldiston & Schott, 2012; Peattie, 2010; Ropret Homar & Knežević Cvelbar, 2021).

Participant heterogeneity is also addressed throughout this dissertation. Most chapters include broad, diverse, or representative samples of the target population. Different characteristics are analyzed by forming subgroups and testing whether sociodemographic factors such as gender, age, or education interact with treatment effects or relate to varying levels of pro-environmental behavior. These approaches represent a significant step forward in understanding the varied impacts of behavioral interventions across different sociodemographic groups. Moreover, the complexity of interactions is taken into account, both among different interventions and between interventions and individual or contextual factors such as social, physical, and systemic factors. Chapters that manipulate multiple variables, such as barriers to behavior or behavioral interventions, simultaneously test different combinations of these manipulations. Additionally, most chapters examine heterogeneous (treatment) effects, investigating whether treatment effects differ depending on individual characteristics. Numerous variables, both self-reported and infrastructural-related, are collected to control for these factors and increase the robustness of our findings, thereby ruling out alternative explanations for the observed effects.

Finally, in response to the critique of insufficiently testing long-term effects (Hallsworth, 2023; Marchiori et al., 2017), this dissertation includes representations of long-term behavior in each chapter. This is done either by observing actual behavior over more than a year in the field, by simulating group interactions over ten rounds, or by including hypothetical revisions of initial decisions in response to changes in the decision environment, such as receiving additional information about outcomes.

This dissertation contributes to the advancement of behavioral science by addressing these challenges through empirical research. These efforts aim to provide more reliable and applicable insights to promote sustainable behavior beyond the scope of usual consumer behavior. Additionally, this work makes several significant contributions to the broader field of behavioral science, particularly in exploring the determinants of pro-environmental behavior and the effectiveness of behavioral interventions to promote pro-environmental behavior (Albarracín et al., 2024; Bergquist et al., 2023; Hallsworth, 2023; van der Linden & Weber, 2021; van Valkengoed et al., 2022).

4. Research questions and objectives

This cumulative dissertation comprises four empirical chapters, each grounded in the conceptual foundations of behavioral science with a focus on behavioral economics. The primary goal is to identify determinants of pro-environmental behavior and to evaluate the effectiveness of targeted behavioral interventions across various contexts. Collectively, these chapters address one overarching research question: What are the key determinants of pro-environmental behavior and how can targeted behavioral interventions be designed and implemented to effectively address these determinants across diverse environmental contexts?

This central research question is further divided into several specific subquestions related to different domains of pro-environmental behavior: How do behavioral barriers related to outcome efficacy reduce pro-environmental behavior in both collective decision-making (e.g., contributions to a group goal to combat climate change) and individual decision-making (e.g., individual donation decisions)? Can a reflective intervention focused on information provision effectively promote sustainable investments? Is specific knowledge about sustainable finance, or sustainable finance literacy, a determinant of sustainable investment decisions? Can implicit behavioral interventions, such as a nature poster intervention, reduce littering and improve cleanness in waste disposal areas over a longer period?

To address these research questions, this dissertation employs a series of online, lab, and field experiments. Chapter 1 examines behavioral barriers to pro-environmental decision-making, using insights from behavioral science to understand their impact on both collective decision-making and individual donation decisions. Chapter 2 investigates reflective interventions that provide information and specific knowledge about ESG investments, studied at the concrete example of individual sustainable investment decisions. Chapter 3 identifies sustainable finance literacy – the knowledge about sustainable finance and ESG investments – as a key determinant of not only more sustainable investments but also fewer greenwashed investments and increased stock market investments. Chapter 4 evaluates an implicit behavioral intervention using a nature poster to reduce littering and enhance cleanness in a long-term field experiment in Viennese social housing buildings.

This dissertation adheres to the frameworks for applying behavioral insights (Hallsworth & Kirkman, 2020; Steg & Vlek, 2009), which involve: 1) identifying the behavior to be changed and defining a target behavior, 2) examining the underlying determinants of behavior, 3) developing and implementing interventions, and 4) evaluating the interventions. Across all chapters, the target behavior is pro-environmental behavior – or the lack thereof – in contexts such as public goods contributions, donations, sustainable investments, and littering. Chapters 1 and 3 primarily investigate determinants, while Chapters 2 and 4 develop and evaluate different interventions based on knowledge and outcome efficacy, taking these determinants into account.

The targeted behaviors in this dissertation are inherently pro-environmental. In Chapter 1, contributions to the public good are aimed at mitigating climate change, and the vignette experiment's donation decisions

can lead to actual tree planting, both of which are considered pro-environmental actions (Milinski et al., 2008; Whitburn et al., 2019). In Chapters 2 and 3, sustainable investments are considered a pro-environmental behavior, as the financial sector and the mobilization of private capital through ESG investments, i.e., investments that consider Environmental, Social, and Governance (ESG) factors, are crucial for reaching environmental goals and the United Nation's Sustainable Development Goals (Bauer et al., 2021; Eurosif, 2018; Hartzmark & Sussman, 2019; UNDP, 2023; UNFCCC, 2018). Finally, Chapter 4 addresses the topic of littering as a pro-environmental behavior, with the reduction of littering and the promotion of proper recycling being essential for mitigating environmental issues and climate change (Wijkman & Skånberg, 2015). These behaviors share a common feature: they require some investment to avoid negative consequences, such as the loss of money due to climate change. This may include a tradeoff between (monetary) investments and benefits, such as a positive impact on environmental factors, or avoiding negative consequences, like financial losses from climate change occurrence – discussed in Chapter 1 – or increased cleaning costs due to littering – discussed in Chapter 4.

The chapters focus on two related determinants: outcome efficacy and knowledge. Based on these determinants, various interventions were developed and tested. Chapter 1 examines outcome efficacy as a determinant of contributions to public goods and donations, focusing on how behavioral barriers reduce the perceived impact of actions on the outcomes in both collective decision-making and in the donation for environmental projects.

Chapter 2 uses a reflective intervention, targeting the explicit and reflective System 2, aiming to increase outcome efficacy through information provision about the impact on Environmental, Social, and Governance (ESG) factors (i.e., promoting literacy regarding sustainable investments). This intervention is, among others, compared to a standard intervention focusing on financial aspects, which has typically been found to be effective (Døskeland & Pedersen, 2016, 2021). Such interventions are sometimes referred to as educative nudges (Kaiser et al., 2022).

Chapter 3 focuses on knowledge, specifically sustainable finance literacy, as a determinant of sustainable investing. Greater knowledge is associated with increased sustainable investments, often motivated by the desire to impact ESG factors rather than purely financial reasons (Degryse et al., 2023; Riedl & Smeets, 2017).

Chapter 4 employs an implicit intervention, targeting the implicit and automatic System 1 by installing large nature posters in waste disposal areas. This approach considers that explicit reminders may not always be effective. Previous research (Gangl, Walter, et al., 2022) demonstrated that an explicit intervention using pictograms to convey knowledge on monetary consequences of littering behavior did not significantly change littering behavior compared to a control group without an intervention. Instead, the nature poster intervention acts as a nudging stimulus – related to nudge theory (Thaler & Sunstein, 2009) – altering the choice architecture to implicitly address thoughts, feelings, and behavior relevant to nature conservation, thereby potentially enhancing outcome efficacy (Van Lange, 2021).

The findings gained from this dissertation enhance our understanding of how behavioral science can be applied to foster pro-environmental behavior by empirically identifying determinants of such behavior and evaluating the effectiveness of targeted interventions in promoting pro-environmental behavior across different contexts. The separate chapters contribute to the behavioral science literature by addressing existing points of critique and areas for improvement (Hallsworth, 2023; Nielsen et al., 2024). Thereby, this dissertation offers critical insights for informing policy design aimed at achieving behavioral changes necessary to comply with the limits for anthropogenic greenhouse gas emissions adopted in the Paris Agreement (IPCC, 2021).

5. Methodology and empirical approach

This dissertation's empirical approach relies on a series of online, lab, and field experiments to draw conclusions about determinants of pro-environmental behavior and the impact of behavioral interventions. As a form of scientific experiments, randomized control trials (RCTs) have emerged as the gold standard for evaluating the impact of different interventions, because they allow for causal inference (Barrett & Carter, 2010), providing a significant advantage over correlational studies. RCTs are a core method in behavioral science and can be adapted to different contexts (Hallsworth, 2023). They are particularly valuable in economic research for testing assumptions while controlling for alternative explanations, such as transaction costs, imperfect information, and the effects of anonymity, through careful experimental design and control (Weber & Camerer, 2006). Examples include the aforementioned studies on dictator and ultimatum games (Eckel & Grossman, 1996; Forsythe et al., 1994; Güth & Tietz, 1990).

RCTs involve the random assignment of participants to an intervention or a control group. The intervention group is exposed to the treatment, while the control group is not, with all other conditions kept constant (ceteris paribus). This setup allows for drawing causal conclusions about the effect of the intervention.

Chapters 1, 2, and 4 use RCTs with different treatments randomly assigned to participants. Chapter 3 employs a framed field experiment without treatment allocation, but including an incentivized experimental investment decision and a subsequent revision of this decision after learning about greenwashing allegations against one of the investment options.[6]

[6] I refer to Chapter 3 (Study 2) as an experiment, even though it is not a traditional randomized control trial (Levitt & List, 2009). This designation is justified for several reasons: the study involves participants making investment decisions within a controlled framework that simulates real-world conditions using financial incentives. The inclusion of an investment product with a greenwashing allegation among different options, along with the provision of specific information about these allegations, introduces an experimental element. Although Chapter 3 does not employ random assignments, its structured approach, control of variables, and use of incentives to generate empirical evidence and test predefined hypotheses allow it to be considered an experimental study in the broader sense.

To incentivize participation and to ensure realistic behavior, the experiments in this dissertation involve monetary or non-monetary rewards depending on the participants' decisions. This approach aligns with standard practices in behavioral and experimental economics, aiming to motivate participants to reveal their true preferences in the face of salient monetary consequences, thereby increasing the external validity of the results (Kleinlercher & Stöckl, 2018; Smith, 1976). Additionally, this approach more closely mirrors real-world decision-making environments.

Each experimental setting – online, lab, and field – offers unique advantages and disadvantages. Laboratory experiments provide high internal validity due to controlled environments, allowing for precise manipulation of variables. Conversely, field experiments offer greater external validity by testing interventions in natural and realistic settings, thereby enhancing the generalizability of the findings (Levitt & List, 2007). Online experiments combine elements of both settings by allowing large and diverse samples at a lower cost while still permitting some control over the variables. However, they may face limitations, for example, in ensuring participant attention and avoiding dropouts (Arechar et al., 2018). Balancing these trade-offs between internal and external validity is crucial when designing experiments and interpreting the results.

Despite their strengths, experiments, particularly RCTs, present several potential issues and limitations that must be carefully considered for the study design. As discussed in Section 3.3 on the criticism of behavioral science, a significant concern, that also applies to experiments, is that their findings are often highly context-dependent, may lack external validity, and may not fully translate from laboratory settings to real-world applications. Other concerns include experimenter demand effects (Zizzo, 2010), the use of windfall gains rather than self-earned money (Hoffmann et al., 2019; Li et al., 2018), and ethical considerations, such as unintended consequences of experimental designs or challenges in obtaining truly informed consent (Barrett & Carter, 2010). I address these issues in the relevant chapters. Additionally, randomization can sometimes result in unequal baselines, which can be addressed through balance checks, as discussed in several chapters.

Furthermore, interventions and materials may be overly complex, posing challenges for their evaluation through RCTs. To mitigate these issues, simpler interventions were chosen. All experimental materials were refined through iterative feedback from colleagues (all chapters) and external samples (Chapter 2 and Chapter 3) to ensure clarity.

The risk of small and underpowered samples is another limitation. To address this, I conducted power analyses across all chapters to determine appropriate sample sizes, ensuring the experiments were well-powered to detect small to medium effect sizes, with a power of at least 0.8 (0.9 in most cases) and an alpha-level of 0.05, in line with established literature (Cohen, 1988; Cowles & Davis, 1982).

The chapters of this dissertation consider a wide range of participants, aligning the sample design with relevant variables of interest. The population sample in Chapter 2 and the full sample in Chapter 3 were

representative of the Austrian population over 18 years – who are potential investors – thereby enhancing the generalizability of the findings. However, the subsample of retail investors in Chapter 2 was self-selected based on those who accepted the invitation and comparisons to the general population and the population of investors are provided in the chapter. The sample in Chapter 4 included particularly littered waste disposal areas, as these were most relevant for the interventions (see Gangl, Walter, et al., 2022). In the survey among residents in the social housing buildings, we used a door-to-door approach, but participation remained self-selected. The sample in Chapter 1, while not representative, included a diverse range of participants, which is further discussed there.

The data analysis in this dissertation primarily relies on regression analysis, a common method in economics, psychology, and sociology (Cohen et al., 2002). This approach allows the quantification of the direction and strength of relationships between variables – such as determinants, interventions, and outcomes – while controlling for other individual or contextual factors that might influence the results. Different types of regressions (e.g., linear, logistic, probit) were applied depending on the nature of the outcome data, and interaction terms were included to test interactions between various factors, such as interventions and individual characteristics. Regression analyses also facilitate hypothesis testing and confidence interval estimation, enabling statistically valid inferences. Additionally, we conducted robustness checks and sensitivity analyses to assess the robustness and reliability of the findings. These checks included alternative model specifications, subgroup analyses, and the use of different operationalizations of outcome variables.

Data collection for all chapters adhered to strict ethical guidelines and open science standards. Participants voluntarily participated in the studies, and they were provided with an overview of the study topics. We informed them about their rights concerning data protection under the European General Data Protection Regulation (GDPR) and obtained their informed consent. Participants' payment was at or above the usual standards (e.g., on Prolific or through market research agencies). In the spirit of open science, links to the online data and replication codes are provided directly within each chapter. The procedures, hypotheses, and analyses of Chapters 2, 3, and 4 were preregistered with the Open Science Framework (OSF), approved by the Ethics Committee of the Institute for Advanced Studies (IHS) and audited for GDPR compliance by the IHS data protection officer. The procedures of Chapter 1 were presented and discussed with senior representatives of the International Institute for Applied Systems Analysis (IIASA), the Austrian Academy of Sciences (OeAW), the Vienna University of Economics and Business (WU), and the University of Vienna. The StartClim initiative by the Austrian Ministry of Climate Action and Energy, the Ministry of Education, Science, and Research, the Climate and Energy Fund, and the State of Upper Austria provided further oversight.

While preparing the preamble for this dissertation, I used OpenAI ChatGPT-4o for initial proofreading and editing the text. Subsequently, I thoroughly reviewed and refined the content, ensuring its accuracy and integrity. I take full responsibility for the final version.

6. Summary of chapters

This cumulative dissertation comprises four empirical chapters. Each chapter is a separate peer-reviewed publication or manuscript submitted to a peer-reviewed journal. The chapters collectively aim to identify determinants of pro-environmental behavior and evaluate the effectiveness of targeted behavioral interventions. They also take into account the limitations of behavioral science, addressing the potential and challenges of implementing behavioral interventions in different contexts. This dissertation not only advances the field of behavioral science, but also makes notable contributions to specific areas of study and fields of literature, enhancing our understanding of pro-environmental behavior in diverse settings. The chapters address policy-relevant research questions and offer practical insights, both for external partners and stakeholders such as StartClim, the Financial Market Authority, several Austrian experts in sustainable investments, banks, and Vienna's public housing company Wiener Wohnen, as well as for a broader range of stakeholders.

Chapter 1 – Behavioral barriers impede pro-environmental decision-making: Experimental evidence from incentivized laboratory and vignette studies. Although a majority of people across 19 countries around the world recognize climate change as a major threat (Pew Research Center, 2022), the vast population is slow to adapt pro-environmental behaviors. This disconnect between values, concerns, and attitudes on the one hand and behavior on the other hand is referred to as the value-action gap and has been documented in different areas of pro-environmental behavior (Blake, 1999; Kollmuss & Agyeman, 2002), for example, in using public transportation (Haider et al., 2019). Behavioral barriers contribute to this gap, making it more challenging for individuals to translate their values into actions by increasing the psychological distance between actions and outcomes, as explained by construal level theory (Brügger et al., 2015; McDonald et al., 2015; Schuldt et al., 2018; Spence et al., 2012).

Chapter 1 investigates the role of central behavioral barriers in the emergence of the value-action gap and as determinants of pro-environmental behavior. Two online experiments examined how three behavioral barriers related to the uncertainty, immediacy, and marginality of the consequences of an action affect pro-environmental behavior. The first experiment, involving a sample of N = 800 participants for the United Kingdom and the United States recruited via a crowdsourcing platform, investigated these barriers in a collective action context using an interactive online experiment. Participants in several groups contributed to their group's climate account over multiple periods of time to mitigate climate change, based on Milinski et al. (2008). The barriers were operationalized through varying the probability with which a contribution was effective in avoiding climate change (70% vs. 100%; *uncertainty* treatment), through varying the consequences of not reaching the threshold (own or other group directly affected; *immediacy* treatment), and through varying the group size (three vs. six participants; *marginality* treatment). Two months later, participants were invited to take part in a second experiment (N = 658). This vignette experiment tested the effect of the barriers on individual incentivized donation decisions in a realistic vignette setting. In the vignette setting, the barriers were operationalized through changing the descriptions, varying the probability

of success of the environmental projects (70% vs. 100%; *uncertainty* treatment), the benefits of the projects (own country vs. other country; *immediacy* treatment), and varying different marginal impacts on the success of the project (confirmation of individual donation vs. confirmation of group donation; *marginality* treatment). Additionally, a survey measured the value-action gap based on self-reported behavioral intentions and behaviors.

The results indicate that all three behavioral barriers impede pro-environmental decision-making and exacerbate the value-action gap in the laboratory.[7] Participants exhibited less pro-environmental behavior and a larger value-action gap when the impacts of their actions were uncertain, when they were not directly affected by the consequences, and when they perceived their contribution to the outcome as marginal. In the vignette design, uncertainty and immediacy significantly increased the value-action gap, while the effect of marginality was positive but not significant. The effect of immediacy – being unaffected by the consequences – was particularly pronounced across both lab and vignette settings. Additionally, many individuals chose to contribute to the climate account to avoid climate change rather than free-ride. However, reduced reciprocity and peer effects were identified as mechanism through which behavioral barriers indirectly undermine contributions. The results also underscore the importance of perceived effectiveness or impact of a behavior (outcome efficacy) and suggest that the value-action gap remains relatively constant across different modes of measurement (experiment, donation decision, and survey).

Chapter 1 advances the behavioral science literature (Hallsworth, 2023; Nielsen et al., 2024) by addressing concerns about context dependency and lacking external validity. It combines data from incentivized lab experiments, realistic incentivized donation decisions, and surveys to provide a more comprehensive assessment and understanding of pro-environmental behavior. This combination of measures is novel in the literature. Additionally, the chapter investigates the heterogeneity of participants and simulates long-term behavior across multiple rounds in a stylized laboratory setting.

This chapter also extends the behavioral ecological economics literature and the long-standing environmental psychology literature regarding the value-action gap, from foundational studies (Blake, 1999; Kollmuss & Agyeman, 2002) to recent research (Haider et al., 2019). It uniquely investigates the simultaneous impact of three different behavior barriers in experimental settings. By this, it provides new insights into the barriers' effects on the value-action gap and on pro-environmental behavior across various decision contexts, including collective decisions and donations. The peer-reviewed publication is featured in a special issue on *Behavioral Ecological Economics* in the journal *Ecological Economics*, highlighting its relevance to ongoing debates in this field.

From a policy perspective, the findings suggest that effective climate communication and educational interventions must go beyond simply providing knowledge about environmental issues. The perceived impact of outcomes, both in terms of marginality and uncertainty and particularly in terms of not being

[7] Based on the results of Chapter 1, we published a German research report (Hoffmann et al., 2021).

affected by negative outcomes, is crucial for encouraging pro-environmental behavior. It is therefore essential to understand the underlying psychological and behavioral mechanisms and to emphasize the direct, interpersonal consequences of environmental actions as well as the significance of individual contributions to climate change mitigation.

Chapter 2 – Can information provision and preference elicitation promote ESG investments? Evidence from a large, incentivized online experiment. The financial sector and the shift of private financial investments towards sustainable companies and funds are detrimental to achieving a green transition and the United Nation's sustainable development goals (UNFCCC, 2018). In this regard, sustainable investments that consider Environmental, Social, and Governance criteria (i.e., ESG investments) made by private investors assume a central role (Eurosif, 2018). However, a lack of knowledge and awareness about ESG investments presents a significant barrier for (potential) investors (Gutsche & Zwergel, 2020; Meunier & Ohadi, 2022; Wins & Zwergel, 2016). To address this and to raise awareness, the European Union (EU) introduced regulation (EU) 2021/2616, which requires financial institutions to elicit their ESG preferences from investors – essentially asking investors whether and to what extent they wish to invest sustainably. Implicitly, the regulation also suggests providing investors with information about ESG investments.

Building on the findings in Chapter 1, which highlighted the importance of outcome efficacy (i.e., perceived impact) of pro-environmental behavior, we conducted an incentivized online experiment (RCT) with a sample consisting of investors and non-investors (N = 2,254). The experiment, designed in close cooperation with the Austrian Financial Market Authority (FMA), developed and evaluated different behavioral interventions to promote ESG investments. In the *basic information* treatment, participants were informed about the concept of ESG investments. In the *financial return information* treatment, participants were additionally provided with information about the financial benefits of ESG investments; in the *ESG impact information* treatment, participants were furthermore provided with information about the potential impact on ESG factors; in the *combined information* treatment, both sets of information were provided. After the interventions, participants allocated 600 euros to four different funds (two conventional, two sustainable). The investment decisions of 15 randomly selected participants were actually implemented at the stock market, with the resulting amount being paid out after one year.

The results indicated that ESG investments increased by about five percentage points in the financial return treatment and by about seven percentage points in the ESG impact treatment, with similar effects observed in the combined information treatment. Additionally, we also tested different modes of eliciting ESG preferences: firstly, a general and easier mode, simply asking for the preferred amount of sustainable investments, and secondly, a more specific mode, additionally inquiring about the preferred focus of the ESG investments. The results showed no marked differences between these methods. Furthermore, we found that financial literacy is a central predictor of sustainable investments.

The findings from this chapter offer two key insights. First, under the assumption that an individual is completely rational and fully informed, one would not expect strong effects from the treatments, as such knowledge should already be available to the decision-maker. Second, the comparable results from the ESG impact and financial return treatments suggest that individuals are not purely self-oriented and profit-maximizing. Related to this, recent research shows, for example, that investors might invest sustainably not only for ESG impact but because it makes them feel good and gives them a 'feeling of a warm glow' (Heeb et al., 2023).

Chapter 2 advances the behavioral science literature (Hallsworth, 2023; Nielsen et al., 2024) as follows: Regarding the limited impact of interventions, the chapter addresses impactful behaviors, i.e., financial investments, and finds considerable effects of the information treatments. To address concerns regarding context dependency and lacking external validity, the chapter is aimed at measuring outcome variables in multiple ways, including sustainable investment choices in the incentivized investment decision and ESG preferences. Chapter 2 also features designs realistically mimicking the participants' payoffs as closely as possible. The design was informed by the Austrian Financial Market Authority to keep the setting as close to real life as possible and to avoid studying the relevant behaviors outside of context (Nielsen et al., 2021). Moreover, the effect of information treatments in combination, simultaneously with different modes of ESG preference elicitation, is considered as well. Tests for heterogenous effects of the interventions related to characteristics such as education, biospheric value orientation, altruistic value orientation, and financial literacy are also being conducted. By including both investors and non-investors, the study chapter extends beyond typical investment experiments that exclusively focus on one group (e.g., Degryse et al., 2023; Gutsche et al., 2023). This approach includes non-investors, who could potentially contribute to the green transition of the financial sector when they start investing. To explore long-term effects, participants were asked to revise their investment decisions based on the hypothetical over- or underperformance of sustainable investments compared to conventional investments after six months.

Additionally, Chapter 2 serves an applied example of using insights into determinants to build effective interventions. The chapter draws on literature identifying both financial (returns) and non-financial factors, such as ESG impact, and the knowledge about them, as significant determinants for sustainable investing (Riedl & Smeets, 2017). Based on these insights, we designed information interventions that specifically addressed either financial aspects or ESG impacts of sustainable investments. Using different manipulations highlights the importance of accounting for heterogeneity in preferences.

Chapter 2 enriches the behavioral finance and the sustainable finance literature on information provision (e.g., Døskeland & Pedersen, 2016, 2021) and on knowledge in sustainable financial decision-making (Meunier & Ohadi, 2022; Wins & Zwergel, 2016). This relatively novel approach (except for, e.g., Gutsche et al., 2023) of incentivizing the investment decisions by executing real stock market investments for randomly selected participants and paying out the resulting portfolio value after one year presents a methodological advancement over previous studies, which often lack such realistic representations of

investors' payoffs and used unincentivized experiments or surveys (Degryse et al., 2023; Wins & Zwergel, 2016).

The chapter has practical implications, particularly in view of recent EU regulations. It demonstrates that providing information about sustainable investments can effectively promote these investments. Moreover, the mode of ESG preference elicitation does not significantly impede more sustainable investments.

Chapter 3 – Sustainable finance literacy predicts investment behavior beyond general financial literacy: Evidence from two representative samples. ESG considerations add an additional layer of complexity to investment decisions (Löfgren & Nordblom, 2024; Pedersen et al., 2021). Chapter 2 demonstrated that providing investors with targeted information about ESG investments (i.e., financial return information and ESG impact information) increases such investments. Furthermore, the results showed that financial literacy is a predictor of sustainable investments. Thus far, however, most studies on financial literacy and investment behavior (Lusardi & Mitchell, 2008; van Rooij et al., 2011) have not explicitly considered knowledge about sustainable finance and ESG investments, referred to as sustainable finance literacy. This aspect and the role of sustainable finance literacy in investment decisions have largely been overlooked in the literature, with only a few exceptions (Filippini et al., 2024). To address this gap, we examined the relationship between sustainable finance literacy and investment behavior.

The first study in this chapter involved developing an inventory for sustainable finance literacy using a sample of N = 1,047 participants and items developed through an expert-based approach (twelve experts from nine different Austrian institutions). This inventory allows for assessing an individual's knowledge on sustainable finance.[8] The second study investigated the role of sustainable finance literacy as determinant of investment behavior, using a sample of N = 1,510 participants, representative of the Austrian population with regards to gender, age, and education. We conducted a framed field experiment featuring an incentivized investment decision, where participants could allocate money to four different funds (two conventional funds, one truly sustainable fund, and one fund that was marketed as sustainable but faced greenwashing allegations and changed its marketing message as a result) and a savings account. The investment decisions of five randomly selected participants were implemented in the stock market, with the resulting amount being paid out after one year. Additionally, we also surveyed participants on their real-life investment behaviors, such as holding stocks or ESG assets.

The results indicated that, on average, participants correctly answered half of the seven sustainable finance literacy questions. In the incentivized investment decision, sustainable finance literacy related to higher participation in the stock market (i.e., a greater share invested in funds rather than savings accounts),

[8] Parts of these results are published in German policy briefs (Gangl, Seifert, et al., 2023; Gangl & Seifert, 2024). In the spirit of science communication, we published a blog post based on this Chapter's first study, available in German at: https://www.ihs.ac.at/publications-hub/blog/nachhaltiges-finanzwissen/.

increased investment in sustainable funds, and reduced investments in the greenwashed fund. Participants with high sustainable finance literacy were four times more likely to correctly identify the greenwashed fund. These findings are robust to the separate analysis of investors and non-investors without previous investment experience, indicating that prior investment experience is not a major driver of these findings (Hastings et al., 2013; Lusardi & Mitchell, 2014). Across all outcome variables, sustainable finance literacy explained investment behavior beyond previously established concepts, such as advanced financial literacy. Similar results were obtained with self-reported investment behavior outside the experiment, supporting the external validity of our findings.

Thus, based on the results, we concluded that sustainable finance literacy is a complementary concept to existing concepts such as general financial literacy. It is crucial for investment decisions in an environment where ESG investments have recently gained prominence. Conversely, a lack of this knowledge poses a cognitive barrier to sustainable investing and stands in contrast with assumptions of unbounded rationality (van der Linden & Weber, 2021). Some of these results may also be explained by the recognition heuristic, where greater sustainable finance literacy leads to sustainable investments being perceived as more familiar and therefore better and less risky (Goldstein & Gigerenzer, 2002; Wang et al., 2011).

Chapter 3 contributes to advancing behavioral science literature (Hallsworth, 2023; Nielsen et al., 2024) through several key aspects. To address concerns about context dependency and lacking external validity, we measured sustainable investments through incentivized investment decisions that realistically mimic participant behaviors, as well as through self-reported ownership of financial market products and sustainable investment products. We also controlled for variables potentially influencing investment decision-making, such as sociodemographic characteristics (e.g., age, gender, and education), attitudes towards sustainable investments, investment experience, biospheric value orientation, and risk preference. Regarding heterogeneity, as in Chapter 2, both investors and non-investors were included. To observe long-term behavior, we allowed participants to revise their investment decisions at a later point in time, after learning about the greenwashing allegations, i.e., after receiving new information about the potential sustainability of the investment.

Chapter 3 advances the literature on financial literacy in investment decision-making and the field of behavioral finance. The development of a seven-question inventory to measure sustainable finance literacy and demonstrating its relevance relative to other concepts enriches the existing literature on sustainable finance literacy (Degryse et al., 2023; Filippini et al., 2024) and extends findings on traditional metrics such as basic financial literacy (Lusardi & Mitchell, 2008) or advanced financial literacy (van Rooij et al., 2011). Additionally, using a historical example of a fund accused of greenwashing to simulate a greenwashed investment situation is novel in the literature and extends the literature on greenwashing in finance (Gatti et al., 2021; Kleffel & Muck, 2023). As in Chapter 2, investment decisions are incentivized by realizing and paying out the choices of randomly selected participants after one year. However, Chapter 3 extends this decision space by including a savings account option, allowing for a measurement of stock market

investments. Chapters 2 and 3 also identify determinants of sustainable investment behavior, such as biospheric value orientation.

From a policy perspective, Chapter 3 demonstrates that sustainable finance literacy is a strong determinant of investment behavior. In line with the findings of Chapter 2, which show that knowledge interventions can promote more sustainable investments, these results support the Austrian National Financial Literacy Strategy's current initiative to include knowledge on sustainable finance and investments in educational programs and public awareness initiatives.[9] More specifically, the results indicate that increasing the sustainable finance literacy of the population could not only boost broader societal welfare by mobilizing private capital for the green transition of the financial sector but also enhance individual financial well-being by fostering informed investment decisions that align with personal preferences. These findings were of immediate interest for the Austrian Financial Market Authority.

Chapter 4 – Nature posters enhance subjective but not objective cleanness in public housing: Evidence from a field experiment. Littering, defined as the improper disposal of waste, leads to negative environmental, social, and financial consequences for residents using waste disposal areas in social housing buildings (Bucci et al., 2020; Ramos & Torgler, 2012). To reduce littering and thereby increase pro-environmental behavior, posters and signs are commonly employed tools (Almosa et al., 2017). A field experiment in Viennese social housing buildings by Gangl, Walter, et al. (2022) found that posters with explicit messages highlighting the financial consequences of littering or the injunctive norms of correct disposal behavior were less effective than posters with implicit messages, such as images of watching eyes or a nature poster. This suggests that non-financial appeals, such as emphasizing individuals' feeling of being connected to nature – a concept known as nature connectedness – may be more effective in fostering pro-environmental behavior (Arendt & Matthes, 2016; Barbaro & Pickett, 2016).

Building on the work of Gangl, Walter, et al. (2022), Chapter 4 reports on a field experiment in municipal housing complexes in cooperation with Vienna's social housing company, Wiener Wohnen. This field experiment aimed to evaluate the impact of a behavioral intervention – specifically a nature poster intervention – on reducing littering in 182 waste disposal areas used by approximately 13,000 inhabitants over 13 months, compared to a control group without the intervention.[10] To measure objective cleanness in the waste disposal areas, photographs of the floor were taken at four different time (before installing the intervention, after one month, after three months, and after 13 months), which were then rated by two

[9] The financial literacy strategy is documented at the website of the Austrian Federal Ministry of Finance: https://www.bmf.gv.at/en/the-ministry/National-Financial-Literacy-Strategy.html.

[10] Based on this field experiment, we published a German research report (Gangl, Knaub, et al., 2023). Additionally, a second manuscript on the role of other-managing-behavior in maintaining cleanness is currently being prepared for submission to a peer-reviewed journal.

independent research assistants. Subjective cleanness was assessed through a door-to-door survey of inhabitants (N = 739) conducted one month after the installation of the intervention.

The results revealed a discrepancy between objective and subjective cleanness. We found no significant effect of the nature poster intervention on objective cleanness at any of the measured intervals (one, three, or 13 months) compared to the control group. However, the nature posters did increase subjective cleanness in indoor waste disposal areas by about 16%. The survey data suggested that this increase in subjective cleanness could be causally linked to making residents' nature connectedness more salient. The findings indicate that non-financial incentives, such as nature posters, which do not objectively increase an individual's utility, can still promote pro-environmental behavior and cooperation. However, their effectiveness varies depending on how outcomes are measured. The gap between subjective and objective cleanness may be explained by the availability heuristic (Tversky & Kahneman, 1973), where residents might more readily recall extreme instances of littering than more frequent, relatively clean environments.

Chapter 4 contributes to the advancement of the behavioral science literature (Hallsworth, 2023; Nielsen et al., 2024). It addresses the limited impact of the intervention by highlighting the differing effects of the nature poster intervention, which significantly increased subjective but not objective cleanness. To ensure external validity and address context dependency, this chapter evaluates interventions in real-world settings and measures both objective cleanness via photo-ratings and subjective cleanness via resident surveys. Moreover, in terms of the context of the interventions, we collected numerous control variables, either self-reported by survey participants, observed by researchers and staff from the Viennese social housing company, or from their databases. These variables provide a comprehensive understanding of drivers of littering and the effectiveness of the intervention. Chapter 4, conducted as a field experiment, includes all inhabitants of the relevant parts of the social housing buildings that use the waste disposal areas, offering a diverse sample. Regarding long-term effects, this chapter stands out by observing the impact of an intervention to reduce littering for a time period longer than a year, making it one of the longest studies in this field (Bateson et al., 2015; Ernest-Jones et al., 2011; Gangl, Walter, et al., 2022).

Chapter 4 extends beyond typical incentive-based interventions or highlighting financial consequences (Bolderdijk, Steg, et al., 2013) by testing an ecology-based intervention designed to make nature connectedness more salient, thereby promoting pro-environmental behavior, such as reducing littering and increasing cleanness of waste disposal areas. The chapter is among the first to examine the differences between the effects of interventions on objective and subjective cleanness ratings, highlighting potential biases that influence these perceptions. In doing so, it contributes to the environment psychology literature on how nature cues or exposure to nature can affect cleanness perceptions and pro-environmental behaviors (Zelenski et al., 2015). It also adds to environmental psychology and the behavioral economics literature on the effects of implicit versus explicit cues on behavior (Evans, 2008; Gangl, Walter, et al., 2022; Kahneman, 2012).

In terms of practical implications, Chapter 4 suggests that while a nature poster intervention might not enhance objective cleanness, it can improve subjective cleanness. Additionally, the chapter offers practical recommendations for increasing cleanness based on the identified determinants, such as social norms and removing litter left by other inhabitants.

7. Discussion

In summary, this dissertation identifies determinants of pro-environmental behavior and evaluates the effectiveness of different behavioral interventions across various contexts, including collective decision-making, donation decisions, sustainable investments, and littering. This work contributes to multiple strands of the behavioral science literature and informs the practical application of behavioral science in environmental policy design.

The chapters illustrate the diversity of determinants that influence pro-environmental behavior. A key insight from this dissertation is the significant role of both the perceived impact on environmental aspects (outcome efficacy) and specific knowledge in driving pro-environmental behavior. Whether in collective climate action and individual donations (Chapter 1) or in interventions providing information about the impact of sustainable investments on ESG factors before investment decisions (Chapter 2), the belief that one's actions can have a tangible impact was a consistent predictor of pro-environmental behavior. These findings align with the previous literature and meta-analyses showing that outcome efficacy is a key driver for sustainable behaviors (Albarracín et al., 2024; van Valkengoed et al., 2022; van Valkengoed & Steg, 2019). Outcome efficacy might also be enhanced by modifying the choice architecture, for example, through installing nature poster interventions that enhance feelings related to nature conservation, e.g., nature connectedness (Van Lange, 2021) (Chapter 4). Future research could test this conjecture more explicitly by conducting targeted studies.

The dissertation emphasizes the critical role of specific knowledge rather than general knowledge about climate issues, in fostering pro-environmental behavior, particularly in investment decisions. Targeted informational interventions effectively promote such behaviors by providing information about the impact of a specific behavior and making outcome efficacy more salient (Chapter 2). Moreover, sustainable finance literacy – a specific form of knowledge – is a pivotal determinant of sustainable investments (Chapter 3). These findings support earlier findings that environmental knowledge, including knowledge on the perceived effectiveness of actions, is a strong predictor of pro-environmental behavior (Vicente-Molina et al., 2013). Interestingly, Chapter 3 reveals that sustainable finance literacy is more influential than biospheric value orientation, a determinant deemed significant in Chapter 2 and in previous studies (De Groot & Steg, 2007, 2008, 2016). Specifically, Chapter 2 shows that knowledge interventions and basic financial literacy are similarly predictive of sustainable investments as biospheric value orientation. Chapter 1 shows that higher pro-environmental values foster pro-environmental behavior in the form of contributions to the climate account and donations, although the translation of values to action is hindered by barriers, resulting in the value-action gap.

However, information interventions are most effective when they meet certain criteria. First, they should align with the individual's values or address them accordingly (Bolderdijk, Gorsira, et al., 2013). For instance, people motivated by financial considerations to behave pro-environmentally (e.g., reducing energy consumption to save money) may not respond to environmental appeals (e.g., to protect the environment), and vice versa. That means that information interventions should align with identified determinants of pro-environmental behavior such as individual values. Other interventions could incorporate multiple determinants, addressing financial and non-financial aspects, such as the combined information in Chapter 2. However, Chapter 2 also shows that combining information does not necessarily improve the overall effectiveness compared to single-focus interventions. Second, knowledge interventions may be less effective when they address knowledge about general climate change issues rather than knowledge about specific behavioral implications, such as the impact of sustainable investing (Weber, 2018). This aligns with the results of Chapter 3, which show that general knowledge and awareness about climate change – in contrast to specific knowledge about sustainable investments and sustainable finance – do not predict sustainable investing.

This dissertation emphasizes the importance of several factors, such as the context in which interventions are implemented and the measurement methods used to assess outcomes, both of which can greatly influence the results on specific behaviors being studied. Chapter 1, for example, shows that the uncertainty and marginality barrier increase the value-action gap across both lab and realistic vignette settings, but the impact of the marginality treatment is only significant in the lab setting. Additionally, the effects may vary depending on how the behavioral outcome is measured. Chapter 4 reveals that, while the nature poster intervention influenced subjective perceptions of cleanness, it did not significantly improve objective cleanness measures. Moreover, Chapter 1 demonstrates variability in the extent of the value-action gap across different settings and modes of measurement. These findings highlight the importance of evaluating multiple outcomes to fully understand the effectiveness of environmental behavior interventions.

The findings also underscore the diversity of effective interventions. Some studies show that environmental campaigns using economic appeals are less effective than environmental or neutral appeals, as evidenced in the case of encouraging car tire checks to reduce harmful emissions and fuel consumption (Bolderdijk, Steg, et al., 2013). Conversely, other studies find that financial interventions are most effective in investment decisions (Døskeland & Pedersen, 2016, 2021). In Chapter 2, both reflective financial return and ESG impact interventions are found to be similarly effective. Additionally, non-financial and ecology-based cooperation incentives such as an implicit nature poster can address emotions, concerns, and nature connectedness and thus improve pro-environmental behavior (Chapter 4), sometimes even better than financial appeals (Gangl, Walter, et al., 2022).

To foster pro-environmental behavior and design effective interventions, it is essential to understand the mechanisms underlying treatment effects and behaviors. This understanding helps to clarify which interventions work, under which conditions, and for which reasons. This is in addition to analyzing the

determinants *why* individuals behave pro-environmentally. Understanding mechanisms requires examining the potential channels through which an intervention can change specific behaviors. Chapter 3 explores these mechanisms, but future research is needed to explicitly test outcome efficacy as a mediator between sustainable finance literacy and ESG investing. In Chapter 4, more salient nature connectedness is identified as a mechanism that partly explains the increase in subjective cleanness. Chapter 1 identifies reciprocity and peer effects as mechanisms through which the behavioral barriers indirectly impede pro-environmental behavior. Gaining such a nuanced understanding is vital for designing more effective behavioral interventions and policies while reflecting the complex realities of human decision-making and pro-environmental behavior.

Importantly, the choice of intervention should also account for suitability and cost. While a recent review article finds that interventions targeting knowledge and beliefs are less effective than other interventions, such as addressing habits (Albarracín et al., 2024), it is important to consider the cost-benefit-ratio. Chapter 2 shows that brief, cost-efficient information provided at the time of decision-making ('just-in-time'; Fernandes et al., 2014; Kaiser & Menkhoff, 2017) can increase sustainable investing by 5 to 7 percentage points and may be a more cost-efficient alternative to long-term, costly courses ('just-in-case education'). Additionally, interventions should not only focus on positive determinants but also help individuals to overcome barriers that prevent them from pro-environmental behavior (Albarracín et al., 2024). Chapter 1 exemplifies how strong barriers can be and how understanding barriers is a starting point for designing suitable and effective interventions.

8. Conclusion

With this dissertation, I significantly advance the understanding of determinants of pro-environmental behavior and the effectiveness of targeted behavioral interventions. I demonstrate that a behavioral science perspective provides valuable insights for understanding *why* people do not always act sustainably and *what can be done* to promote pro-environmental behavior. Unlike standard economic models, which often assume rational decision-making based on self-interest, I build on the conceptual foundations of behavioral science to investigate the complex influences of cognitive biases, heuristics, social dynamics, individual characteristics, and contextual factors on behavior. This thesis not only extends beyond the confines of standard economic models and theories, but it also addresses criticisms of behavioral science, expanding both its theoretical foundations and its practical implications in environmental policy.

The findings across the four empirical chapters reveal that the determinants of pro-environmental behavior are multi-faceted. Two factors consistently emerge as particularly significant: the perceived impact of individual actions (outcome efficacy) and specific knowledge relevant to the behavior in question. These determinants are crucial for designing effective interventions. While behavioral interventions have the potential to enhance pro-environmental behavior, this dissertation also addresses critical challenges and limitations in behavioral science, such as the potentially limited impact of interventions, context dependency and lack of external validity, heterogeneity of participants, and long-lasting effects (Hallsworth, 2023;

Nielsen et al., 2024). These insights are critical for designing effective policy measures that account for the complexity and limitations of behavioral interventions, underscoring the importance of grounding policy recommendations in behavioral science rather than relying solely on traditional economic theory.

Combining different interventions is recommended to create the strongest effect. Within behavioral science, using financial and non-financial incentives in parallel has been suggested as the most effective strategy (Croson & Treich, 2014; Stern, 2011). However, to maximize impact, behavioral interventions should extend beyond simple nudges and changes in the choice architecture (Barton & Grüne-Yanoff, 2015). They should be combined with other policy measures, technical solutions, and structural changes that interact synergistically (Nielsen et al., 2020; Stern, 2020). When designing interventions, it is crucial to move beyond merely listing and applying biases, instead considering the decision-making context (Hallsworth, 2023; van Valkengoed et al., 2022). Additionally, consulting recent reviews and meta-analyses that investigate the circumstances, determinants of behavior, and the effectiveness of different types of behavioral interventions in different contexts is critical (e.g., Albarracín et al., 2024; Bergquist et al., 2023). Thorough evaluation of the interventions' effectiveness is also essential (Steg & Vlek, 2009). This evaluation helps to identify the limitations of interventions, as seen with the combined information on sustainable investment in Chapter 2, where the effect size did not exceed that of single-focus interventions.

Despite the promising impact of behavioral science research and behavioral interventions that build on understanding determinants as well as heuristics, biases, norms, and values, public policies often overlook these insights (Nielsen et al., 2020; van der Linden & Weber, 2021). To enhance the practical relevance of behavioral science, it is essential to foster a stronger dialogue between science and policy. This could be achieved, for instance, through publishing policy briefs and reports that translate scientific findings into actionable insights. Behavioral science should not be used in isolation (van der Linden & Weber, 2021), but should be integrated with policy-making and other disciplines, such as climate science (Fischhoff, 2021). Ideally, applied behavioral science should be embedded in the core activities of organizations and governments, not just used as a specialist tool in specific circumstances or to design interventions. Thus, it should be integrated as a foundational element in all activities and also looking backwards to reassess current policies and actions (Hallsworth, 2023).

Looking ahead, behavioral science should continue to evolve over the next years (Hallsworth, 2023; Nielsen et al., 2024) and integrate with other initiatives such as meta-science approaches, including many-analyst or many-lab studies (Huber et al., 2023; Kirchler & Weitzel, 2023). Such a procedure would also be particularly beneficial in light of the replication crisis, which raises concerns about the replicability of scientific findings (Camerer et al., 2016). Notable efforts in this direction, such as those by Vlasceanu et al. (2024), who tested different behavioral interventions across multiple labs in over 60 countries, reveal that the effectiveness of interventions varies based on target audience and behavior. On a smaller scale, other measures to address the replication crisis should be adapted, for example, adequate sample size, preregistrations, and open materials and data (Asendorpf et al., 2013).

In terms of external validity and sample composition, all chapters strive to recruit broad samples and mimic realistic decision environments. However, while all chapters focus on developed, wealthy nations – primarily responsible for historical greenhouse gas emissions (Ripple et al., 2020) – they do not account for the disproportionate impact of high-net-worth-individuals or include participants from less developed countries. For future research, addressing these gaps by conducting field experiments in various and diverse countries, populations, or situations would be beneficial (Abrahamse & Steg, 2013; Henrich et al., 2010).

It is important to note that tackling pressing societal issues may require moving beyond focusing solely on the individual level (i-frame). Systemic changes (s-frame) that involve altering rules, norms, and institutions that shape behavior are also crucial (Chater & Loewenstein, 2023). Additionally, it is essential to acknowledge that not only individuals, but also policy-makers, organizations, and governments responsible for s-frame changes are themselves subject to heuristics and bounded rationality (Carlsson & Johansson-Stenman, 2012). Thus, adopting a transdisciplinary agenda and including citizens, experts, and stakeholders, as well as using other, more participatory methods, could and should be considered (Gudowsky et al., 2017).

Behavioral science alone cannot resolve all of the challenges associated with climate change and environmental threats. However, its insights are vital for promoting pro-environmental behavior at the individual level and can inform a major leap in this direction (Hallsworth, 2023; Nielsen et al., 2024; van der Linden & Weber, 2021). In this dissertation, I examine the determinants of behavior and evaluate the effectiveness of different behavioral interventions, providing a substantial contribution to the literature and advancing the field. My research opens avenues for future studies aimed at promoting pro-environmental behavior across different domains and illustrates how behavioral science can foster behavior change toward a sustainable future.

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Chapter 1: Behavioral barriers impede pro-environmental decision-making: Experimental evidence from incentivized laboratory and vignette studies (Published in: *Ecological Economics*)

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Behavioral barriers impede pro-environmental decision-making: Experimental evidence from incentivized laboratory and vignette studies

Abstract

Despite increasing concerns about climate change, many people struggle to translate their pro-environmental values into action. Here, we explore the origins of this value-action gap focusing on the role of behavioral barriers that are characteristic for many environmentally relevant decisions. Using incentivized online laboratory and vignette experiments, we find that individuals are less likely to behave in accordance with their environmental values if they are not immediately affected by the consequences of their actions, if the impacts of their actions are uncertain, and if they contribute only marginally to the outcome. The behavioral barriers also exert an indirect effect on environmental behavior by undermining reciprocity and positive peer effects. The value-action gaps are correlated across the different experimental settings with men and younger participants showing a particularly large gap. These insights are important for climate communication and education, highlighting the important role of the perceived relevance and potential consequences of personal behaviors in collective action.

Keywords: Environmental behavior, value-action gap, behavioral barriers, laboratory experiment, vignette experiment

Code availability: The anonymized experimental data generated and analyzed in the current study as well as scripts that generate and visualize the results reported in this study are fully available at the Harvard Dataverse repository at: https://dataverse.harvard.edu/privateurl.xhtml?token=3881c3b6-396e-4cf3-83d5-c2368fe15721.

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CRediT authorship contribution statement: Roman Hoffmann: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Georg Kanitsar**: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Marcel Seifert**: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Indication of own contribution: Chapter 1 is based on a joint project with Roman Hoffmann (IIASA, Laxenburg) and Georg Kanitsar (IHS Vienna, WU Vienna). I have been involved in this project from the outset, building upon my master's thesis with the addition of new data and expanding the scope of research. Together with my two coauthors, I reviewed the relevant literature, assisted with the grant proposal, and developed the research design. I was primarily responsible for programming and implementing the online and vignette experiments on Lioness Lab, a platform designed for interactive online experiments. Additionally, I managed participant recruitment through the crowdsourcing platform Prolific. In collaboration with Roman Hoffmann, I provided support with statistical techniques and procedures for the data analysis, a task that was primarily overseen by Georg Kanitsar. I contributed to writing the German research report as well as the manuscript and to addressing the comments from editors and reviewers during the revise and resubmit process.

1. Introduction

To mitigate the impacts of anthropogenic climate change on natural and human systems, a rapid reduction of greenhouse gas emissions is urgently needed (IPCC, 2022; Schleussner et al., 2016). In a recent poll by the Pew Research Center (2022), 75% of respondents across 19 countries globally named climate change as a major threat. Apart from engaging in national and international mitigation efforts, personal actions and a shift towards more sustainable behaviors and lifestyles play a vital role in curbing global warming and achieving the ecological transition (Creutzig et al., 2018; Mundaca et al., 2019; Swim et al., 2011).

Although an increasing number of people worldwide are concerned about climate change and share pro-environmental values, sustainable consumption and living patterns are adopted only very slowly (Hedlund-de Witt, 2012). As a result, global emissions continue to grow and have now rebounded to the levels prior to the Covid-19 pandemic (Jackson et al., 2022). The divide between concerns and values on one side and actions on the other, commonly referred to as value-action gap (Kollmuss & Agyeman, 2002; Poortinga et al., 2004), has been documented in several areas, including consumption (Nguyen et al., 2019; Peattie, 2010; Wang, 2017; Young et al., 2010), energy use (Momsen & Stoerk, 2014), dietary choices (Gifford & Chen, 2017; Haider et al., 2019; Vermeir & Verbeke, 2006), transportation (Anable et al., 2006; Haider et al., 2019), and investment decisions (Paetzold & Busch, 2014; Wins & Zwergel, 2016). In addition, value-action gaps have been identified in a wide range of non-environmental behaviors, such as physical activity, gambling, voting, or smoking (Sheeran, 2002).

Here, we examine some of the root causes of the value-action gap by studying behavioral barriers to pro-environmental decision-making using an innovative integration of an online laboratory and vignette experiment. While structural and economic barriers, such as the unavailability of affordable and accessible green alternatives, have been shown to be highly relevant (Diekmann & Preisendörfer, 2003; Farjam et al., 2019; Steg & Vlek, 2009), also psychological and behavioral factors related to the decision-making contexts and the processing of information can represent important behavioral constraints. These factors may increase the psychological distance between a person's decisions and their outcomes, making it more challenging for individuals to align their actions with their pro-environmental values (Brügger et al., 2015; McDonald et al., 2015; Schuldt et al., 2018; Spence et al., 2012).

We test for the role of three behavioral barriers in the two experiments, the first one representing a stylized and controlled laboratory setting (N = 800) and the second one a realistic setting (N = 658). In different treatment conditions, we vary (1) the extent to which participants' actions affect them personally versus others (immediacy treatment), (2) the probability with which these actions can have an impact (uncertainty treatment), and (3) the (perceived) importance of the individual actions for the overall outcome (marginality treatment).

All of these potential barriers are characteristic for many environmentally relevant behaviors and their consequences, which are often not immediately observable and do not have a direct effect on the individual,

come with a high level of uncertainty, and depend not only on one person but on the decisions of many (Gifford, 2011). By raising the abstractness and complexity of the social dilemma underlying climate change (Van Lange et al., 2018; Van Lange & Rand, 2022), these barriers can thus provide an explanation for why in certain contexts humans do not act in a way corresponding to their own environmental values (Dawes, 1980; Koletsou & Mancy, 2011; Kollock, 1998; Newell et al., 2014; Weber et al., 2004).

In the laboratory setting, we employ collective-risk social dilemma games (Barrett & Dannenberg, 2012; Dannenberg et al., 2015; Hauser et al., 2014; Milinski et al., 2008; Szekely et al., 2021; Tavoni et al., 2011), which confront participants with a conflict between individual short-term interests and the risk of collective damage due to climatic change. Participants play in groups and can contribute to climate change protection as a collective good. Climate change can only be prevented if contributions exceed a certain climate protection threshold. While passing the threshold is beneficial for all, participants may decide to free ride on the contributions of others and behave in an environmentally unfriendly way (Bicchieri, 2006; Cialdini et al., 1990).

To study the role of the barriers in a realistic vignette experiment, participants were invited to a second follow-up online study after two months. In this experiment, the participants were shown 12 randomly varied descriptions of environmental protection projects (Atzmüller & Steiner, 2010; Laury, 2006). They were informed that they could donate a certain amount of a monetary endowment to these projects, knowing that at the end of the experiment one of the presented projects would be randomly selected to receive the individual donation (Wyss et al., 2022).

The behavioral barriers were implemented in different ways in the laboratory and vignette setting. In the laboratory context, the immediacy barrier was varied by having the consequences of not reaching the climate protection threshold either directly affect the participant's group or another group. In the vignette setting, the environmental projects benefited either the participant's country directly or another country. To implement the uncertainty treatment in the laboratory, we experimentally varied the probability (100% vs. 70%) with which a participant's contributions were effective in protecting the collective good reflecting the experienced uncertainty of making an impact with one's pro-environmental actions. In the vignette study, the descriptions of the environmental projects were changed to suggest differential chances of success of the environmental projects. Finally, the marginality of one's decisions was varied by changing the size of the groups in the laboratory setting (three vs. six players) with the perceived importance of one's decisions being lower in larger groups. In the vignette setting, the descriptions were changed to suggest different marginal impacts of one's contributions on the success of the environmental projects.

To determine the value-action gap, we compare participant's actual behavior with their answers to normative questions of how much one ought to contribute to the collective-risk social dilemma game or how much one ought to donate to an environmental project, respectively (Bicchieri, 2006; Cialdini et al., 1990). Participants were asked to reveal their values in the laboratory and vignette settings prior to the start of the actual experiments using a neutral framing comparable to our baseline treatments. Decisions in both

the laboratory and vignette experimental study had real consequences for the participants as well as for other participants in the interactive game or an actual environmental protection organization who received all donations made by the participants.

Our study makes three contributions to the literature. First, we provide experimental evidence on the value-action gap complementing the rich survey-based literature which has largely relied on self-reported behaviors and hypothetical scenarios (Blake, 1999; Kollmuss & Agyeman, 2002; Peattie, 2010). Also, by explicitly measuring and examining the difference between values and actually realized actions, we complement studies that focus primarily on behavioral outcomes (e.g., in form of pro-environmental behaviors or contributions to collective goods). Second, while previous experimental studies have typically considered the role of the different barriers in isolation, e.g., by varying the group size in social dilemma games (Barcelo & Capraro, 2015; Isaac & Walker, 1988), we simultaneously test for the impact of all three barriers and study accumulation effects of increasing barriers on behaviors and the emergence of the value-action gap (Dawes, 1980; Koletsou & Mancy, 2011; Kollock, 1998; Newell et al., 2014; Weber et al., 2004). Moreover, our design allows us to investigate the role of peer influences and reciprocity under conditions with more or less behavioral barriers. Third, we combine laboratory and vignette experimental methods to account for concerns about the external validity of our experimental findings (Levitt & List, 2007). Our integrated approach sheds light on the drivers of environmental behaviors and value-action gaps from two complementary vantage points, ultimately increasing the robustness and validity of our findings.

2. Theoretical framework and previous literature

An individual's environmental behavior is influenced by a number of psychological (internal) and structural (external) determinants (Figure 1). Internal factors, such as values, preferences, and beliefs, and external factors, such as social and cultural influences or the economic conditions, can shape a person's awareness and concerns about environmental issues (Bamberg & Möser, 2007; Inglehart, 1995; Steg et al., 2014).

Normative values are an important factor preceding and affecting pro-environmental behaviors (Hitlin & Piliavin, 2004; Stern, 2000). They can be defined as "*desirable goals that transcend situations and serve as guiding principles in people's lives in general*", shaping perceptions of what is considered good and fair in different contexts (Steg, 2016, p. 279). Whether and to what extent values translate into behavioral intentions and ultimately environmental behaviors depends on the perceived efficacy, costs, and consequences of the behavior (Ajzen, 2002; Kaiser et al., 1999; Miller et al., 2022; Tabernero & Hernández, 2010).

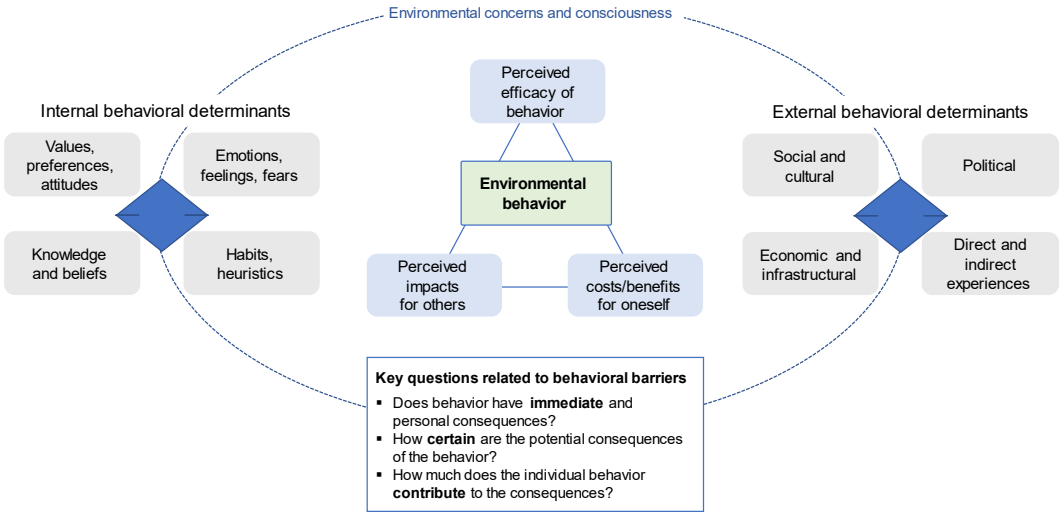

Figure 1. Conceptual model of the determinants of pro-environmental behaviors and the role of behavioral barriers. Behaviors are determined by internal, psychological (left panel) and external, structural (right panel) determinants, which shape a person's environmental concerns and consciousness (blue ellipse). The center of the graph illustrates mediating processes that are influenced by the different determinants and shape environmental decision-making. Related to these, the textbox at the bottom highlights the relevance of the behavioral barriers examined in this study. The conceptual figure was adapted from Blake (1999), Clayton et al. (2015), and Kollmuss & Agyeman (2002).

The behavioral barriers examined in this study shape these mediating processes and perceptions by influencing whether a behavior has direct and immediate consequences for a person, how effective the behavior is perceived, and how marginal the individual's contribution to the consequences is. All of these can discourage acting in a pro-environmental way and increase the psychological distance between one's decisions and their potential impacts (Brügger et al., 2015; McDonald et al., 2015; Schuldt et al., 2018; Spence et al., 2012). Despite being environmentally concerned and conscious, many people may therefore not adopt pro-environmental behaviors, constituting a gap between their values and actions (Blake, 1999; Kollmuss & Agyeman, 2002).

The immediacy barrier can be conceptually understood in two different ways: (i) intra-personal immediacy, which refers to whether consequences of an action impact an individual's well-being immediately in the present or in the future (Jacquet et al., 2013; Tiezzi & Xiao, 2016); and (ii) inter-personal or inter-generational immediacy, which refers to whether consequences affect one's own well-being or that of others, either in the present or in the future (Jacquet et al., 2013; Miller et al., 2022; Van Lange et al., 2018). This study specifically focuses on the latter form of immediacy, investigating whether individuals alter their behavior if they are not personally affected by potential negative consequences of their actions. If a behavior does not result in adverse consequences for a person, but affects spatially distant regions, other social groups, or future generations, then this can represent an incentive to not act in a pro-environmental way and increase the spatial, social, and temporal psychological distance (Jones & Rachlin, 2009; Spence et al., 2012).

Also, the uncertainty surrounding the effectiveness and consequences of one's decisions can widen the perceived gap between behaviors and outcomes (Spence et al., 2012). With regards to climate change, three types of uncertainty can influence people's willingness to take action: (i) Uncertainty about whether and when climate change will lead to damages; (ii) uncertainty about the magnitude of the potential damages; and (iii) uncertainty about the effectiveness of one's actions in mitigating these damages. Studies have shown that the first two forms of uncertainty about the potential occurrence and magnitude of damages can reduce the willingness to take pro-environmental action and be harmful for cooperation (Barrett & Dannenberg, 2012; Milinski et al., 2008). Also, uncertainty regarding critical thresholds and tipping points beyond which damages may occur can result in reduced contributions in collective risk games (Dannenberg et al., 2015). In this study, we focus on the third form of uncertainty related to the efficacy of one's actions in preventing negative consequences, which has received less attention in the previous literature. A recent meta-analysis on household-level climate change adaptation has shown that the perceived outcome efficacy of adaptive behaviors is strongly associated with the adoption of such behaviors (van Valkengoed & Steg, 2019). If people are uncertain about the effectiveness of their actions, then this can lead to an underestimation of potential impacts and discourage taking actions (Nielsen et al., 2021; Wynes & Nicholas, 2017).

Finally, greater marginality can likewise lead to a lower perceived efficacy of behaviors as well as the diffusion of responsibility, and thus counteract environmental behavior. In social dilemmas, specifically the collective-risk social dilemma, the marginal effect of individual contributions decreases with increasing number of participants (Powers et al., 2021). Thus, in larger groups, the (perceived) marginality of each contribution is higher than in smaller groups, which can in turn reduce the belief that pro-environmental behaviors matter (Isaac & Walker, 1988; Van Lange et al., 2018). As individuals perceive their own contribution as less pivotal for the overall outcome, they may react with reduced personal engagement and may fail to do their part in reaching a cooperative outcome (Barcelo & Capraro, 2015; Weimann et al., 2022).

The behavioral barriers related to immediacy, uncertainty, and marginality are characteristic for many environmental behaviors, especially with respect to climate change (Gifford, 2011). The negative consequences of changing climatic conditions are often not experienced directly by those who have contributed the most to them. For many, climate change is an abstract and complex phenomenon that is associated with high levels of uncertainty. Furthermore, grasping the impact of one's actions is challenging, given that they appear marginal when viewed against the global scale of the challenge.

3. Methods

This study combines an online laboratory experiment studying environmental behavior in the collective-risk social dilemma game (N = 800) and a vignette experiment validating measures in a realistic decision scenario (N = 658). While the laboratory experiment identifies the causal effects of the three behavioral barriers under stylized and controlled conditions, the vignette experiment analyzes the effects in a realistic environmental decision context.

3.1. Participants and procedures

Participants for the experiments were recruited using the crowdsourcing platform Prolific.co, which was specifically designed for scientific data collection purposes (Palan & Schitter, 2018). The experiments were programmed using the experimental platform Lioness (Giamattei et al., 2020). The data collection for the laboratory study was organized in 23 sessions from 4th of December 2020 to 28th of February 2021. Only residents of the United Kingdom (UK) or the United States (US), who were above 18 years at the time of the study, were eligible to participate. In total, 800 participants completed the online laboratory study and filled in an attached questionnaire. Although not representative, Prolific provides a more diverse and heterogeneous sample than most laboratory studies with participants coming from a wide array of socioeconomic backgrounds (Appendix A, Tables G.1, G.2, and G.3).

Before the start of the laboratory experiments, all eligible participants saw a short introductory text on Prolific informing them about the interactive nature and expected duration of the study. Furthermore, participants learned about the payment structure of the experiments. They received a fixed payment of £2.50 and a bonus payment depending on their own decisions and the decisions of other participants. Those who registered for the study received a link to the experiment with further instructions. In particular, they were informed that their participation was fully anonymous, implying that other participants were not able to link their behavior in the interactive game to their personal identities. At this stage, all participants provided informed consent. To qualify for the study, participants had to answer seven control questions in order to ensure that all participants correctly understood the experimental instructions (Appendix B).

Each participant in the experiment was equipped with an endowment which they could contribute to climate protection efforts and interacted with other participants in groups over ten rounds. At the start, the participants received full information about the size of their group, their endowment, and the climate protection threshold, i.e., the total sum of contributions needed to be reached to prevent dangerous climate change. After each period, the participants were informed about their contribution and whether their contribution was added to the climate account or not (in the high uncertainty treatments), about the total contributions in their group, about the points missing to reach the threshold, and about the points left in their endowment.

All participants were paid for their participation depending on the outcome of the game. In total, the final payments received by the participants ranged from £2.50 to £8.88 with an average payment of £5.26 (SD = £1.38). Participants took, on average, 33 minutes to complete the entire interactive study. At the end of the study, participants filled in a questionnaire assessing their sociodemographic characteristics, their environmental attitudes and stated behaviors, as well as their time, risk, and social preferences (Falk et al., 2022).

Two months after completion of the laboratory experiment, participants were invited to participate in the second vignette experiment (Appendix C). Of the 800 initial participants, 658 also took part in the vignette study. Again, respondents were first informed about the nature of the study and gave their informed consent

to participate (Appendix D). The average time to complete the second study was 24 minutes and participants earned on average £2.25.

3.2. Laboratory experiment: the collective-risk social dilemma

The laboratory experiment was characterized by two features: First, the participants interacted directly with other participants, and second, all decisions in the game had real consequences in terms of possible financial gains or losses for both the participants themselves and their fellow participants. While responses in surveys typically remain without real-world consequences for participants, actions in our experiments were associated with actual payoffs.

At the beginning of the interactive laboratory experiment, participants were randomly sorted into groups and endowed with 40 tokens which they could contribute to reaching an exogenously imposed climate protection threshold (Milinski et al., 2008). The tokens had a real monetary value and were translated into £ at the end of the experiment at an exchange rate of 8 tokens for £1. We use tokens instead of real money in the laboratory setting as they allow creating a psychological distance from real-world financial consequences and to abstract from absolute monetary values, while still providing a basis for a clear incentive structure. This can help participants focus on the decisions within the experimental setting rather than external financial implications.

The game was played for ten rounds keeping the groups of participants constant. In each of the ten rounds, participants could decide to contribute either 0, 1, 2, 3, or 4 tokens from their endowment to a climate account. Those tokens that were not invested into climate protection in a round could not be contributed to the climate account at a later stage. With this feature we mimic in a stylized way that insufficient environmental protection today may result in irreversible consequences in the future that cannot be mitigated or reversed, even with substantial efforts or investments.

At the end of the game, the remaining token endowment was paid out to the participants if their total contributions to the climate account exceeded a prespecified threshold amount, representing the climate protection target. If the group failed to reach the exogenous threshold, the tokens left in the personal endowment of the participants were destroyed with a 90% probability. While contributing to the collective good was socially beneficial, it came at a cost for the participants in the form of foregone earnings, reflecting efforts an individual has to undertake to protect the environment. The climate protection threshold was varied depending on the treatment conditions (Table 1). Importantly, in all treatments, the threshold was adjusted such that if all players on average invested half of their endowment, that is, 2 of 4 tokens per period, the threshold would be reached. The objective difficulty of reaching the threshold was thus kept identical across all treatment conditions.

Before the first period of the collective-risk social dilemma, the participants had to indicate how much they think participants should contribute to the climate account every round to measure participants' normative values. Here, we used the baseline condition without barriers (No Uncertainty, High Immediacy, Low

Marginality). To measure participants' actual behavior, we calculated their contributions to the climate account in the ten periods. The difference between the two is conceptualized as the value-action gap, with positive values indicating that participants' stated values were above their actual contributions.

Because social norms might prescribe pro-environmental behavior, environmentally harmful forms of action are often perceived as negative. To counteract this effect, decisions in the studies were deliberately presented in a neutral and standardized manner, and behaviors were not given labels with negative or positive connotations. Neither the experimenter nor the participants were informed about the background and personal characteristics of the participants, who remained anonymous throughout the interactive game and the vignette study.

While the neutral framing aimed to minimize external biases and influences on decision-making processes, it comes at the expense of reduced real-world applicability by abstracting away from the social and moral complexities that typically influence behavior. However, the goal of our research is not to explain differences in values and behaviors between different contexts but to test for the relevance of the three behavioral barriers within each experimental setting in an internally valid way. By combining and comparing insights from different settings, we aim to identify underlying patterns and principles that are consistent across contexts, thereby enhancing the generalizability of our findings and contributing to a broader understanding of how the behavioral barriers operate.

3.3. Treatment conditions in the laboratory experiment

In the laboratory experiment, the three behavioral barriers were varied in a 2 x 2 x 3 factorial design between subjects, resulting in 12 treatments (Table 1). The different treatments were implemented in the following way:

(1) Marginality: In the Low Marginality treatment participants played in groups of 3 participants, whereas in the High Marginality treatment they played in groups of 6 participants. Increasing the number of participants reduced the perceived importance of each persons' contribution. As described above, the climate protection threshold was varied to reflect the changes in the group size keeping the objective difficulty of reaching the threshold identical over the treatment conditions.

(2) Uncertainty: In the No Uncertainty treatment, participants' contributions were added to the climate account with certainty (100% probability). In the High Uncertainty treatments, contributions were added to the climate account only with a probability of 70% mirroring a reduced perceived effectiveness of one's actions in reaching a desired outcome. Again, the climate protection threshold was varied to reflect this change in the likelihood of making a meaningful contribution keeping the objective difficulty of reaching the threshold identical over the treatment conditions.

(3) Immediacy: In the Low Immediacy treatment, groups were not directly affected by missing the exogenous threshold. Instead, their failure to reach the climate target affected another randomly selected group, which lost their personal endowments with a probability of 90% (Dependency Treatment). These

dependent groups did not only need to reach their own threshold to avoid climate change but were also dependent on the success of the other randomly selected group from the low immediacy treatment. The High Immediacy treatment reflected the baseline condition where groups were independent of other groups and responsible for reaching their own threshold to avert climate change.

Table 1. Treatment conditions in the laboratory (2 x 2 x 3 factorial design).

		Uncertainty					
		No			High		
		Immediacy			**Immediacy**		
		High Immediacy	Low Immediacy	Dependency	High Immediacy	Low Immediacy	Dependency
Marg-inality	Low	12 groups TH=60	12 groups TH=60	12 groups TH=60	12 groups TH=42	12 groups TH=42	12 groups TH=42
	High	12 groups TH=120	12 groups TH=120	12 groups TH=120	12 groups TH=84	12 groups TH=84	12 groups TH=84

Note. The value TH indicates the climate protection threshold to be reached by each group to avert climate change. The value was adjusted in order to keep the objective difficulty of reaching the threshold identical over the treatment conditions.

3.4. Vignette experiment: donations for charity

In the vignette study, which took place two months after the laboratory experiment, participants were shown vignette descriptions of 12 environmental forest protection and reforestation projects in random order (Atzmüller & Steiner, 2010). For each vignette, they could decide how much of £1 they wanted to invest in the project. The investments determined the likelihood that a donation of £1 was made to the environmental project on behalf of the participant (Becker et al., 1964).

For each additional 10 Pence invested in a project, the probability of a £1 donation increased by 10%. For example, if a participant invested £1 in a project, a donation of £1 was certain to be made (100% probability); if £0.5 were invested, a donation of £1 was made with 50% probability; and if nothing was invested (£0), no donation was made (0% probability). Having participants' investments influence the likelihood that a project is selected for funding is a commonly used, incentive-compatible strategy to assess a person's willingness to pay or donate (Becker et al., 1964; Schmidt & Bijmolt, 2020). It helps abstracting from the actual monetary value of the donation, which is held constant at £1 in our case, and makes participants base their choice solely on the comparable likelihood with which they would like a project to receive a donation which is bound between 0% and 100%.

At the end of the experiment, one of the 12 projects was randomly selected and the participant's investment influenced the probability that the respective project received a donation. Participants received detailed briefings on the project selection process and were shown exemplary test cases to ensure that they understood the employed selection and payout procedures. As final payment, the participants received the amount not invested into the selected project plus a fixed participation fee of £1.5.

Like in the laboratory study, decisions had real financial consequences for the participants and individual incentives stood in contrast with the support for the environmental projects. After the data collection, donations of £519 were given to real environmental projects of "One Tree Planted" (https://onetreeplanted.org/), a non-profit organization that supports (re)forestation projects worldwide, including in the UK and in the US, the home countries of the study participants. Participants received a donation confirmation after the data collection was finished.

Also in the vignette setting, participants were asked at the beginning of the experiment in a hypothetical decision situation to indicate how much they thought should be invested in the environmental project, using the baseline treatment without barriers as a reference. Like in the laboratory setting, the value-action gap was determined by taking the difference between the actual decisions and the values elicited in the hypothetical scenario.

3.5. Treatment conditions in the vignette experiment

The behavioral barriers were varied by changing the descriptions of the environmental projects. All descriptions were fictitious and did not contain detailed information about the respective projects (Figure 2). In the treatments, the project descriptions varied a) one's own benefit or affectedness by the donation to the environmental project (immediacy barrier), b) the likelihood of survival of the trees in the respective location (uncertainty barrier), and c) the relative importance of the individual donation for the environmental project (marginality barrier). The final project description again represented a combination of the individual treatments in form of a 2 x 2 x 3 design (Appendix E).

Project A
The project plants trees in [your country]. The forestation will benefit people **in your country directly by improving air quality and restoring bio-diversity**. It is critical for the success of the project to ensure that trees survive and grow. Whether trees survive depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive.** Each pound donated allows the project to plant one additional tree. Your donation **directly contributes** to the planting of this tree and you will receive a confirmation of your individual donation to this project at the end of this study.

Figure 2. Exemplary structure of a vignette. The vignette depicts the baseline treatment condition of an environmental project (High Immediacy, No Uncertainty, Low Marginality). The placeholder [your country] was replaced with the name of the participant's home country (UK or US). Appendix F shows the complete list of vignettes.

Even though both the laboratory and vignette experiments considered the effects of barriers on environmental behavior and the value-action gap, the two settings were distinct in their experimental designs. In the laboratory experiment, we employed a between-subject design where participants were exposed to only one combination of the three barriers as treatment. In the vignette experiment, the participants were shown 12 vignettes representing different combinations of barriers in random order following a within-subject design. Importantly, both the between and within treatment allocations were completely random and thus, by design, uncorrelated between the two settings. Hence, the exposure to

specific treatment conditions in the first experiment could not have systematically affected decision-making in the second experiment, for example in the form of priming. Also, since participation in the laboratory experiment was a requirement for participation in the vignette study, all participants were exposed to the same prior conditions which could hence not bias the estimation of average treatment effects, which is the primary focus of our study.

3.6. Measurement of the value-action gap using survey items

At the conclusion of the laboratory experiment, participants completed a questionnaire aimed at gathering survey-based data on their personal characteristics, including their general environmental attitudes and tendency to show environmentally friendly behaviors. The questionnaire primarily served two purposes: first, to collect additional information on the participants which we use as control and interaction variables in our analysis; and second, to show the replicability of our experimental findings through survey-based methods. The measurement of the primary behavioral outcomes, the calculation of the value-action gap, and the implementation of the behavioral barriers in the experiments were independent of the survey administration process.

Aside of collecting basic demographic and socioeconomic information about the participants, their environmental values were assessed in the questionnaire by asking for agreement to two statements (Oreg & Katz-Gerro, 2006): "We worry too much about the future of the environment and not enough about prices and jobs today" and "People worry too much about human progress harming the environment" (five-point agreement scale from fully disagree to fully agree).

Participants were also asked about their environmental behaviors across different private and public domains (Babutsidze & Chai, 2018), including efforts to recycle, use less pesticides, drive less, consume less energy, save water, and avoid buying new products or consuming meat (five-point frequency scale from never to regular) as well as signing a petition, donating money, taking part in a protest, or being a member of an environmental organization (yes/no). The items were aggregated into an index and normalized to a scale from 0 to 1.

By subtracting the self-reported environmental value and the actual behaviors, we calculated a survey-based value-action gap. Please note that this value-action gap is different from the ones calculated in the laboratory and vignette experimental settings and serves mainly to compare our experimental results on the role of the three behavioral barriers using survey-based measures. For this, we collected information on the participants' perception of the three barriers in their everyday environmental orientation and behavior. They were asked in the survey if they agree that a) environmental problems have a direct effect on their everyday life (immediacy), b) it is hard to know whether the way they live is helpful or harmful to the environment (uncertainty), and c) personal actions can contribute to preventing climate change (marginality). All items were measured on a five-point agreement scale and recoded to dummy variables. Using these measures, we tested to what extent we find relationships between the barriers and the survey-based value-action gap and whether these relationships are consistent with our experimental findings. The results showcase the usability

of survey items to study the relevance of behavioral barriers, including using larger and more representative samples as the one used in our experimental study.

The participation in the laboratory experiment prior to answering the questionnaire may have influenced participants' response behavior. Our decision to administer the experiment before the questionnaire was guided by several considerations. First, we wanted to ensure that the exposure to the survey items could not influence behavior in the game which could have had very detrimental consequences for our experimental design. Second, since the experimental treatments in the laboratory were assigned randomly, we do not anticipate any systematic bias in the measurement of the survey variables. Indeed, additional analyses (results not reported) investigating the impact of the experimental conditions to which participants were exposed on their survey responses revealed no significant relationships. Also, the variables measured in the questionnaire served mainly as control and interaction variables, and to showcase the replicability of our main experimental findings using self-reported survey items.

4. Results

4.1. Values shape pro-environmental behaviors

Figure 3 shows how environmental values shape individual actions in the laboratory and vignette study. Overall, values and actions are strongly correlated. Participants who considered it morally right to contribute more to climate change protection in the collective-risk social dilemma game also contributed on average more to the common good. Likewise, in the vignette study, participants' views on how much one should donate to an environmental project correlated with their actual donation behavior (Figure 3a).

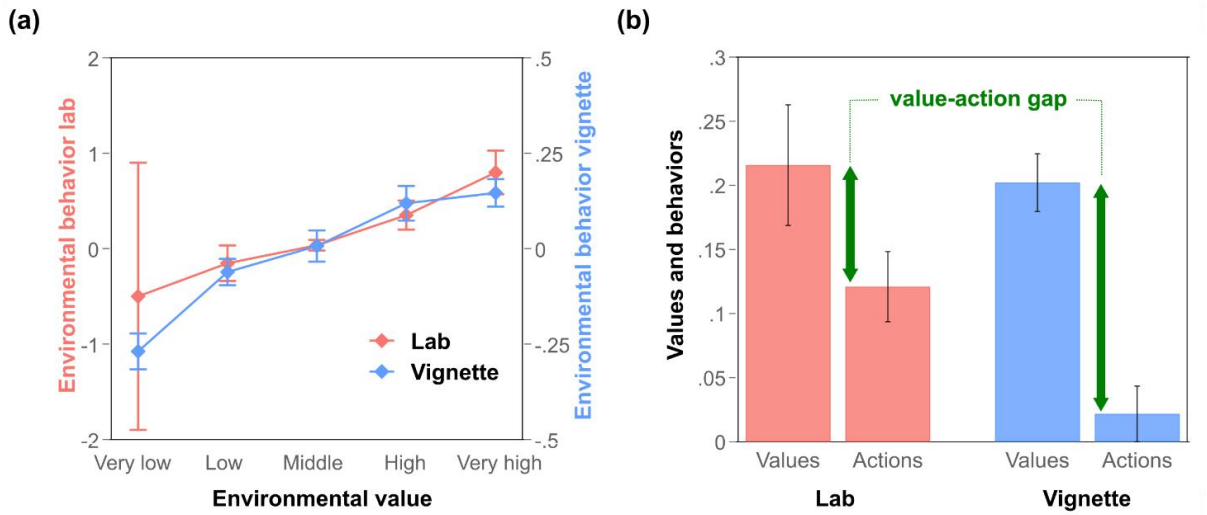

Figure 3. Environmental values and behaviors in the lab and vignette experiment. Panel (a) shows the association of environmental values and actions in the lab (contributions, left axis) and the vignette study (donations, right axis). Environmental values are classified from very low to very high according to responses in the lab (0; 1; 2; 3; 4) and the vignette experiment (0–0.3; 0.4–0.5; 0.6–0.7; 0.8–0.9; 1). Panel (b) shows the value-action gap calculated at the period-level (lab) and decision-level (vignette). Variables are centered at the focal scale midpoint of 2 (lab) and 0.5 (vignette). 95% CIs are calculated using the standard errors of the mean.

Despite this positive correlation, a considerable gap between values and actions is observable both in the laboratory and vignette setting (Figure 3b). In the lab, values stated in advance of the interactive game exceeded actions significantly by 0.09 points (95% CI: 0.01, 0.18; scale from 0 to 4). In the vignette study, actual donations were on average 0.18 points (95% CI: 0.15, 0.21; scale from 0 to 1) lower than what participants stated as morally appropriate before the experiment.[11]

4.2. Behavioral barriers drive a wedge between values and actions

The behavioral barriers substantially contributed to widening the gap between values and actions. Both in the laboratory and in the vignette setting, people deviated more strongly from their environmental values the higher the number of barriers they faced. While in the laboratory, the effect of one barrier on the value-action gap was positive but not statistically different from zero, two barriers significantly increased the value-action gap by 0.13 (95% CI: 0.02; 0.23) and three barriers by 0.17 (95% CI: 0.07; 0.28) standard deviations (Figure 4, Model 1), on average. A similar pattern was discernable in the vignette study, where one barrier increased the gap by 0.22 (95% CI: 0.18; 0.25), two barriers by 0.38 (95% CI: 0.34; 0.43), and three barriers by 0.52 (95% CI: 0.47; 0.57) standard deviations.

Besides the observed cumulative effects, several of the behavioral barriers also affected the value-action gap individually (Figure 4, Model 2). In the laboratory setting, a high marginality due to a larger group size increased the value-action gap by 0.08 (95% CI: 0.01; 0.15) standard deviations compared to treatments with smaller groups, where the perceived importance of the individual contributions was lower. While we also observe a widening of the gap in the vignette study with a higher marginality, this effect is not statistically significant from zero.

Similarly, uncertainty about the impact of one's actions was an important barrier, leading to an increase in the discrepancy between values and actions by 0.06 (95% CI: 0.01; 0.11) standard deviations in the laboratory and by 0.20 (95% CI: 0.18; 0.23) standard deviations in the vignette experimental setting. If it was uncertain whether environmental actions and donations had a lasting impact for climate protection, people more strongly deviated from their values.

Across settings, the strongest and most consistent effects were observed for changes in the immediacy treatments. In decision contexts in the laboratory where the consequences of the actions did not affect the participants themselves but others, the value-action gap increased by 0.09 (95% CI: 0.01; 0.18) compared to settings with a high immediacy. Likewise, if the environmental projects were not benefiting the country

[11] Due to differences in the experimental designs and protocols the estimated size of the value-action gaps cannot be directly compared across the laboratory and vignette settings. For example, while the outcome derived from the laboratory experiment resulted from the interaction between participants, this was not the case in the vignette experiment. The goal of our study is not to compare value-action gaps across settings, but to study the impacts of the behavioral barriers, which were introduced as distinct treatments in experiments, and to explore whether these exert a consistent effect across settings.

of the participant but another country (Low Immediacy), the value-action gap in the vignette study widened by 0.34 (95% CI: 0.30; 0.39) standard deviations compared to a treatment where the benefits of the pro-environmental action accrued in the direct vicinity of the participants.

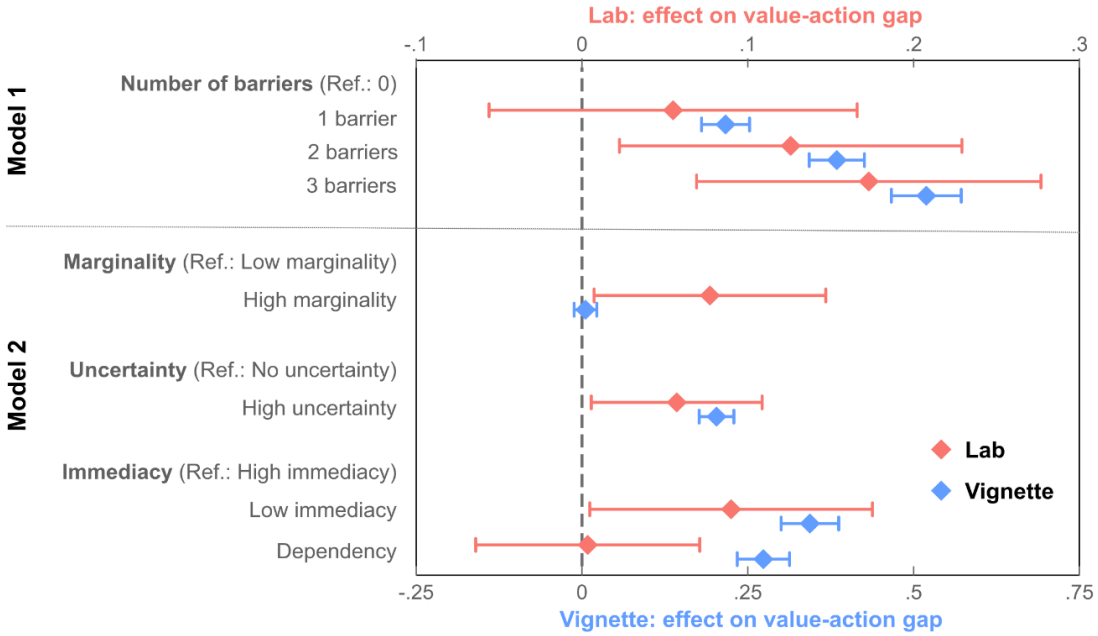

Figure 4. The effects of the behavioral barriers on the value-action gap. Coefficient plots show the effect of the treatment variables on the standardized value-action gap in the laboratory (red, upper axis) and in the experimental vignette study (blue, lower axis). The coefficients are derived from the models in Table H.1 in the Appendix. Robustness checks are reported in Tables I.1 and I.2.

In additional treatments, we studied the impact of being dependent on others' contributions for participants' willingness to act in a pro-environmental way (Dependency Treatment). If the success of environmental projects were additionally dependent on the benevolence of others in the vignette setting, the value-action gap grew compared to the High Immediacy treatment by 0.27 (95% CI: 0.23; 0.31) standard deviations. In the laboratory setting, on the other hand, no significant differences were found for groups that were directly affected by the consequences of their actions and those that additionally depended on others. This suggests that the dependency from other groups did not discourage participants from reaching the climate protection threshold.

4.3. Behavioral barriers relevant for survey responses

Using survey items collected in the post-experimental questionnaire, we measure participants' general perceptions of how much they think climate change would affect them directly as opposed to others (immediacy), the expected likelihood of experiencing an impact (uncertainty), and the importance of own behavior for climate action (marginality). Combining this information with participants' environmental values and actual behaviors as measured using a range of standard survey items, we find results in line with our experimental findings (Table 2).

Respondents who were unconvinced that personal actions contribute to preventing climate change had a higher disconnect between environmental values and actions (High Marginality). Those who find it hard to know if their lifestyle is harmful to the environment display greater value-action gaps (High Uncertainty). And if experimental subjects indicated that environmental problems have no direct effect on their personal life, they were less successful in translating their values into environmental actions (Low Immediacy).

Table 2. Linear regressions on the importance of the three barriers using survey data.

	Value-action gap (survey)
	(1)
Marginality	
Personal Actions Contribute to Prevent Climate Change	-0.0974***
	(0.0147)
Uncertainty (reversed)	
Hard to know if way of life is harmful or hurtful to environment	0.0215**
	(0.00930)
Immediacy	
Environmental problems have a direct impact on my life	-0.103***
	(0.0170)
Observations	800
R^2	0.614

Note: Regression coefficients with session-clustered standard errors in parentheses. Clustering at session level. Dependent variable: standardized Value-Action Gap in the survey. Not Reported: Constant, Values. 2 Participants were dropped from analysis, as they did not complete the questionnaire. P-values: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Surveys have been extensively used in the empirical literature to explore drivers of pro-environmental actions (Swim et al., 2011). Our findings show the usability of these instruments to complement the experimental evidence on behavioral barriers as presented here. A stronger emphasis on items addressing the perceptions of the immediacy, uncertainty, and marginality of environmental behaviors in large-scale surveys can be beneficial and further enhance our understanding of these barriers for large and representative samples.

4.4. Barriers undermine reciprocity and peer effects

Decisions are often interdependent as people react to the behavior of others. This is also the case for environmental behaviors, where studies have shown that own actions are related to the visible actions undertaken by others (Babutsidze & Chai, 2018). Even though people often underappreciate their own susceptibility to social influence, group norms strongly influence and guide behavior, including in social dilemma games (Simpson & Willer, 2015) and environmental decision-making processes (Culiberg & Elgaaied-Gambier, 2016; Keizer & Schultz, 2018).

Here, we test to what extent participants' behaviors were influenced by the behaviors of other group members in the interactive laboratory experimental setting. We find that participants deviated less from their environmental values in the collective-risk game if others contributed more to environmental protection in the previous round (Table J.1 in the Appendix). Hence, if everyone behaved in a more pro-environmental way, participants acted in a reciprocal way and were more successful in realizing their values.

However, this positive peer effect was attenuated the higher the number of barriers in the game (Figure 5a). The behavioral barriers hence undermined the reciprocity and positive influence of others making it harder for participants to live up to their own values. This suggests that the considered barriers can have both a direct and an indirect effect on behavior. Directly by influencing individual decision-making processes and the perception of expected outcomes, and indirectly by undermining the otherwise positive peer effects. This can result in a vicious cycle where barriers can lead to a breakdown of cooperation and pro-environmental action in a group, with potentially highly destructive consequences for all.

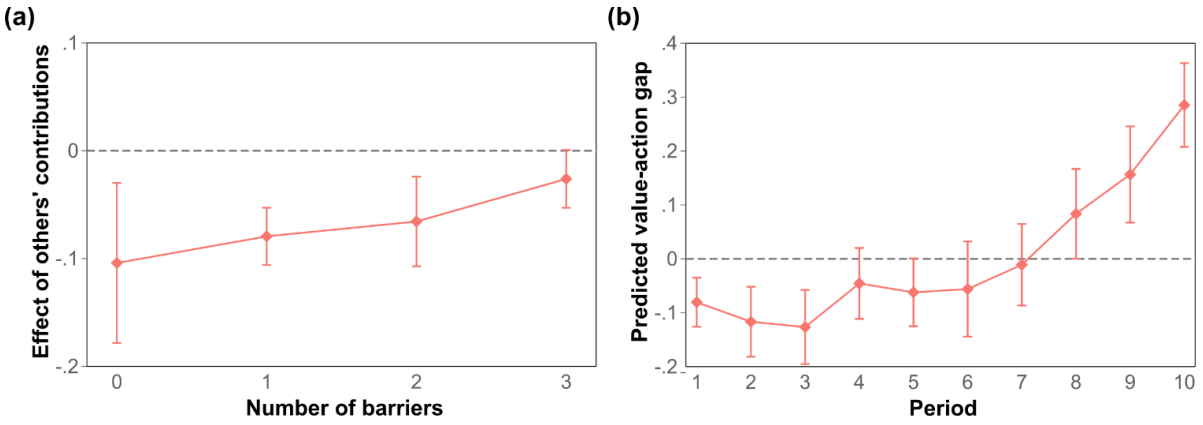

Figure 5. The social and temporal dimensions of the value-action gap in the laboratory experiment. Panel (a) shows the average marginal effect of others' contributions on the standardized value-action gap for different numbers of barriers. The displayed estimates are calculated holding all other variables constant at the mean (Table J.1 in the Appendix). Increasing contributions have a dampening effect on the value-action gap, but this peer influence is reduced the higher the number of barriers. Panel (b) shows the predicted value-action gap over the course of the experimental game demonstrating increases in the gap over time.

Indeed, in line with the notion of deteriorating cooperation, we find that the value-action gap inflates over time. Typically, participants behaved more in line with their values at the beginning of the game, but increasingly deviated from them towards the game's end. This effect also holds when controlling for whether or not the groups have already reached the climate protection target in previous rounds, suggesting that it is not driven by groups having succeeded in preventing climate change towards the end of the game (Figure 5b).

The post-experimental survey provides further evidence of these social and temporal underpinnings of the value-action gap (Franco & Ghisetti, 2022) (Table J.1). Participants who had an overall stronger altruistic orientation in the survey and were more inclined to reciprocate a favor showed overall a smaller value-action gap in the laboratory experiment, emphasizing the social dimension underlying contributions to

environmental protection. Also, larger value-action gaps were observed for those participants with a stronger orientation towards the presence. Those who indicated in the survey that they were less willing to give up something today in order to benefit in the future showed larger differences between their values and actions, accentuating the temporal dilemma posed by climate change.

4.5. Value-action gaps are correlated across settings

The value-action gap measures in the laboratory and vignette setting are correlated at the individual level (Figure 6). The more individuals deviated from their normative response in the laboratory experiments, the more likely they were to also deviate in the vignette study. More precisely, a one-point increase in the value-action gap measured in the interactive laboratory experiment (scale 0-4) resulted in a 0.06 (95% CI: 0.03; 0.09) point increase in the value-action gap in the vignette setting (scale 0-1).

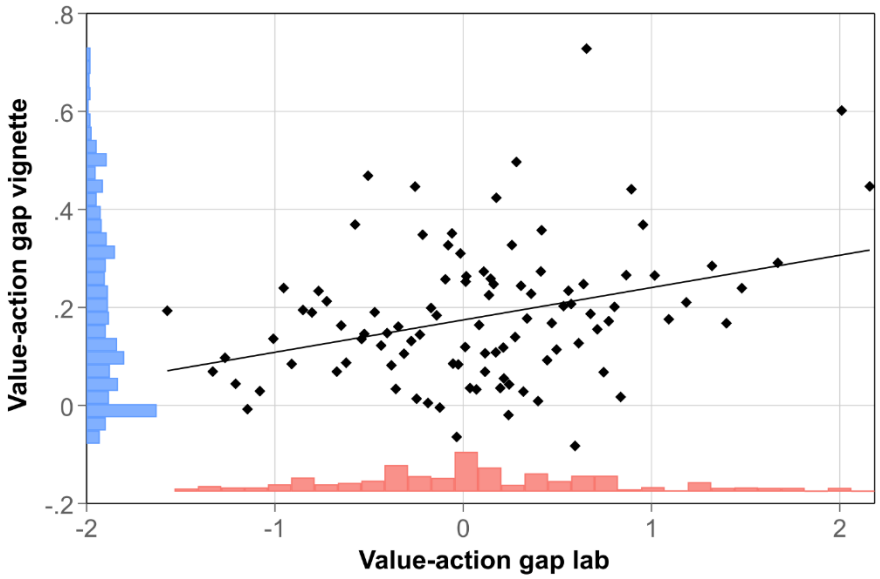

Figure 6. Scatterplot and histograms for value-action gaps in the laboratory and vignette experiment. The gaps are displayed here in an unstandardized way reflecting differences between participants' behaviors and stated values. Variables are centered at the focal scale midpoint of 2 (lab) and 0.5 (vignette).

This finding does not only show the high degree of robustness across the different measures used to assess the value-action gap in our study, but it also reveals a tendency for some individuals to more strongly deviate from their personal values than others. This suggests the existence of stable traits leading to increased value-action gaps for some individuals in different experimental settings and across a range of environmental domains (Barr, 2006b; Kollmuss & Agyeman, 2002). In the next step of our analysis, we explore different underlying drivers of this heterogeneity.

4.6. Age and gender explain differences in the value-action gap

Making use of the diverse composition of the participant sample, we explore the heterogeneity in the value-action gap by participants' background characteristics. The goal is to show how variations in demographic and socioeconomic factors influence the discrepancy between stated values and actual behaviors. The analysis carried out here is explorative and cannot be directly generalized to the broader population given

the selectiveness of our samples. However, it offers valuable insights into patterns and tendencies that can inform future research and interventions aimed at addressing environmental decision-making processes.

Table 3 shows models that regress the value-action gaps in the laboratory (1) and vignette (2) setting on different demographic and socioeconomic characteristics. Here, we are particularly interested in exploring the effects of participants' gender, age, and socioeconomic status, which we proxy with participants' education and income level. The latter two variables were measured in three categories ranging from low to high education and income levels.

Table 3. Testing for the heterogeneity in value-action gaps in the laboratory and vignette experiment.

	Value-action gap (Lab)	**Value-action gap (Vignette)**
	(1)	**(2)**
Gender (Ref.: female)		
Male	0.218***	0.267***
	(0.0655)	(0.0715)
Age (in decades)	-0.135***	-0.121***
	(0.0394)	(0.0346)
Education (Ref.: low)		
Medium	-0.0131	-0.0688
	(0.0836)	(0.0893)
High	0.0323	-0.0644
	(0.0569)	(0.0877)
Income (Ref.: low)		
Medium	0.0452	0.0818
	(0.0570)	(0.0798)
High	0.0469	-0.0226
	(0.0872)	(0.107)
Country (Ref.: UK)		
USA	-0.0355	0.221**
	(0.0782)	(0.109)
Observations	796	654
R^2	0.326	0.326

Notes: Models (1) and (2) show regression coefficients with robust standard errors in parentheses. The dependent variables are standardized. Not Reported: Values, Constant, "Other"/No Response for Education and Income, Treatment (Model (1)), Finished Dummy (Model (1)). P-values: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The results are highly consistent across the different settings, suggesting similar drivers of heterogeneity in the observed value-action gaps. In both experiments, men showed a greater value-action gap compared to women, as did younger participants compared to older ones. These findings confirm past work using more representative samples (Babutsidze & Chai, 2018; Barr, 2006; Moser & Kleinhückelkotten, 2017).

Compared to women, men had on average a 0.22 (95% CI: 0.08; 0.35) and 0.27 (95% CI: 0.12; 0.41) standard deviations larger gap in the laboratory and vignette setting, respectively. The gaps decreased by 0.13 (95% CI: 0.04; 0.22) and 0.12 (95% CI: 0.05; 0.19) standard deviations with every 10 years of participant's age, on average. In extended analyses considering age as a continuous measure, we find evidence for non-linearities in the age effects on contributions in the laboratory experiment. According to these estimates, marginal reductions in the value-action gap with age are larger the younger the participants and decrease for older age groups (Table K.1).

Considering differences by participants' country of residence, we find larger value-action gaps in the vignette study among participants residing in the US compared to residents of the UK. We do not find any significant differences in the value-action gaps for participants with different socioeconomic status, suggesting a more important role of the demographic factors in shaping the observed differences.

5. Discussion and conclusion

Despite growing concerns regarding climate change, many individuals do not translate their pro-environmental values into actions. This paper delves into the root causes of this value-action gap, with a particular focus on three behavioral barriers that are relevant for many environmental decisions. By conducting online laboratory and vignette experiments, we show that people are less likely to engage in environmentally-friendly behavior and deviate from their values if they are not immediately and personally affected by the consequences of their actions, if the impacts of the actions are uncertain, or if their contributions to the outcomes are only minimal.

These behavioral barriers affect behaviors not only directly but also indirectly by undermining reciprocity and positive peer influences. Observing others contributing to a public good serves as motivator encouraging higher contributions. At the same time, the absence of contributions and reciprocity in a group can undermine the motivation for individuals to engage in pro-environmental behaviors (Berg et al., 1995; Falk & Fischbacher, 2006). Participants' failure to contribute can adversely influence group dynamics and create a ripple effect threatening the achievement of the common environmental goal (Koletsou & Mancy, 2011).

Our exploratory analyses further demonstrate a persistence in the value-action gap across different settings. Despite variations in the level of the value-action gap stemming from differences in the employed experimental designs and protocols, there exists a clear correlation. This suggests that the success or failure of translating values into actions depends on relatively stable individual characteristics. In particular, men and younger people show larger gaps between their values and actions (Hunter et al., 2004; Vicente-Molina et al., 2018). These findings highlight the importance of looking beyond averages when examining the role of behavioral barriers and value-action gaps and in the development of policies to effectively target specific groups characterized by larger gaps.

Our findings add to a growing body of literature highlighting the important role of behavioral barriers in influencing decision-making processes (Kollmuss & Agyeman, 2002; Van Lange et al., 2018). In particular, expanding beyond previous research, we show how the accumulation of barriers can hinder pro-environmental behaviors and increase the value-action gap. The behavioral barriers identified as relevant can interact with structural barriers that are outside of an individual's control, such as factors and infrastructures shaping available response options (Gifford, 2011; Nguyen et al., 2019). Further research is needed to fully understand how structural and behavioral barriers jointly contribute to the emergence of the value-action gap in individuals' decisions in everyday life.

The experimental approaches and methods used in this study have different limitations that are important for the interpretation of the results. For our laboratory and vignette experiments, we created an artificial decision situation that masks out contextual influences. While this allows us to investigate the causal effects of the three behavioral barriers in controlled settings, it comes at the expense of a loss of external validity and a reduced transferability of our findings to other environmental decision contexts (Reindl et al., 2019; Sturm & Weimann, 2006). In our approach, we follow established procedures (Atzmüller & Steiner, 2010; Jacquet et al., 2013; Milinski et al., 2008) to complement other experimental and non-experimental research and to provide novel theoretical and empirical insights into the underlying determinants of value-action gaps.

Combining insights from a highly stylized laboratory experiment, a realistic vignette study, and a general questionnaire, we increase the external validity of our findings and demonstrate the relevance of behavioral barriers across diverse settings and measurement approaches. In this context, Levitt & List (2007) point out that both laboratory and non-laboratory data have strengths and weaknesses that, when combined, can enhance each other to derive a more comprehensive understanding. The measures of the value-action gaps observed across the different settings (laboratory, vignette, survey) are inherently different due to differences in the structure and research design employed in each setting, but they allow for a comprehensive analysis of the influence of the three barriers on decision-making processes and the importance of individual characteristics in shaping value-action gaps in different decision situations.

Our study focuses on a selected set of behavioral barriers related to the immediacy, uncertainty, and marginality of environmental decisions. There are aspects related to these barriers as well as other types of barriers that were not considered. For example, our design focuses on the uncertainty in the effectiveness of one's actions and not on the uncertainty related to the occurrence and extent of the consequences of actions or critical thresholds, which have been previously investigated (Barrett & Dannenberg, 2012; Dannenberg et al., 2015; Milinski et al., 2008). Also, we primarily focus on the effects of interpersonal immediacy rather than intrapersonal immediacy, with the latter referring to consequences of actions that affect a person with a delay. Through its focus on a diverse set of barriers, our study provides insights into how different types of barriers operate and how these jointly influence the emergence of value-action gaps.

The data collection was carried out online among a sample of participants from the UK and US who were recruited via Prolific (Henrich et al., 2010; Palan & Schitter, 2018; Peer et al., 2017). Collecting data online meant we had limited control over the data collection process and the circumstances under which participants responded. To address this issue, we implemented monitoring steps and included a number of test questions to ensure a high level of engagement of the participants. Only if the control questions were correctly answered, participants were allowed to participate in the study. Prolific furthermore implements a number of quality standards to ensure high commitment and engagement of participants in the research activities.

While the online data collection allowed us to obtain information from highly diverse respondents, our sample is not representative and results can therefore not be generalized (Appendix G). Compared to the general population in the countries, our sample has on average a lower age, lower income, higher education, and is mostly female. Despite this, the experimental design employed ensures that the results on the role of the barriers are valid, and the major diversity in participants' key characteristics allows us to explore heterogeneity in value-action gaps across the experimental settings. Despite the sample comprising participants from just two countries, our findings on the factors influencing environmental behaviors and value-action gaps hold relevance beyond these specific country contexts. They also complement previous studies on the value-action gap, which have employed cross-national perspectives based on surveys and hypothetical settings, or laboratory studies utilizing more restrictive samples, such as student samples.

Our findings have important policy implications for the design of effective climate communication and education interventions aimed at closing value-action gaps and promoting pro-environmental behavior. In line with other studies (Weber, 2016), our results show that knowledge and environmental concerns are often not sufficient to induce behavioral changes, but that it is important to also address underlying psychological and behavioral mechanisms and constraints. While our research shows that all barriers have a relevant influence on behavior, the immediacy barrier exerts the most consistent effects. If people are not directly affected by the consequences of an action or perceive to not be affected, they are less likely to act in accordance with their values.

Furthermore, our results indicate that increased marginality in the laboratory experiment adversely affects behavior. Although our experimental setup does not mirror real-world conditions with thousands of contributors, it underscores the significance of marginality. If an increase from 3 to 6 participants reduces the likelihood of achieving climate targets, larger groups may face even more considerable difficulties and an even larger experienced marginality of individual decisions (Milinski et al., 2008). Thus, we consider it likely that incorporating larger groups would have amplified the observed treatment effect, suggesting that our results represent a conservative estimate of the impact of marginality. Previous research has also confirmed that qualitatively participants' behaviors and collective outcomes are very similar in public good social dilemma situations even if these involve larger groups of up to 1000 participants (Pereda et al., 2019; Weimann et al., 2022).

This is particularly relevant in the context of climate change, which is a global phenomenon that requires global action. For many people it may be difficult to grasp the relevance of their individual contributions, which can impose an uncertainty barrier (Marx et al., 2007). Highlighting the direct, inter-personal consequences of climate change for oneself and the community, and the relevance of individual actions is hence critical in achieving behavioral change. Indeed, increasing evidence shows that (direct and indirect) experiences with climate change can be a strong driver of changes in perceptions and the adaptation of more sustainable behavior (Broomell et al., 2015; Herrnstadt & Muehlegger, 2014; Hoffmann et al., 2022).

At the same time, studies have emphasized that highlighting proximal impacts of climate change might not be sufficient to increase individuals' willingness to behave more sustainably and to support climate mitigation and adaptation policies (Brügger, 2020; Brügger et al., 2015; McDonald et al., 2015). To effectively overcome barriers and promote climate action, there is a need for holistic approaches that involve integrated and comprehensive measures targeting not only individuals, but also their communities and civil society, the private and public sector, as well as structural barriers. Only through the use of integrated measures can we effectively induce change and bridge value-action gaps in a sustainable manner, thereby promoting the ecological transition.

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Chapter 2: Can information provision and preference elicitation promote ESG investments? Evidence from a large, incentivized online experiment (Published in: *Journal of Banking & Finance*)

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Can information provision and preference elicitation promote ESG investments? Evidence from a large, incentivized online experiment

Abstract

Sustainable investing is characterized by considerations of both financial returns and ESG (Environmental, Social and Governance) impacts. We investigate how information about these two aspects, individually and in combination, affects investors' decision to invest sustainably and their satisfaction with the information they received. We also test whether different ESG preference elicitation modes affect these investment decisions and investors' satisfaction. We conduct an incentivized online experiment with two samples, experienced retail investors and a representative sample of the Austrian population in terms of age and gender (N = 2,254 in total). We find that both financial return information and ESG impact information stimulate ESG investment. Providing both types of information does not have a greater effect than presenting either one alone. Finally, we find no effect on satisfaction and the ESG preference elicitation mode significantly affects neither investment decisions nor satisfaction.

JEL Classification: D90, G11, M14, G53

Keywords: ESG investments; sustainable investments; financial advice; investor behavior; financial return information; ESG impact information; incentivized experiment; preregistered

Code availability: The anonymized experimental data generated and analyzed in the current study as well as scripts that generate and visualize the results reported in this study are fully available at the Mendeley Data repository at: https://data.mendeley.com/datasets/shn4g4vksb/1.

Declaration of competing interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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CRediT authorship contribution statement: Marcel Seifert: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration. **Florian Spitzer**: Conceptualization, Methodology, Writing – review & editing, Funding acquisition. **Simone Haeckl**: Conceptualization, Methodology, Formal analysis, Writing – review & editing. **Alexia Gaudeul**: Conceptualization, Methodology, Writing – review & editing. **Erich Kirchler**: Conceptualization, Methodology, Writing – review & editing. **Stefan Palan**: Conceptualization, Methodology, Writing – review & editing. **Katharina Gangl**: Conceptualization, Methodology, Validation, Investigation, Resources, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition.

Indication of own contribution: Chapter 2 is based on a project on financial advice at the Institute for Advanced Studies (IHS). I was involved from the project's inception, contributing to the formulation of research questions based on a comprehensive literature review I conducted and interviews with practitioners. Together with my coauthors, we developed the experimental design, and I was responsible for preregistrations, obtaining approvals from the Ethics Committee and the data protection officer, implementing the study, programming the experiment, and recruiting participants. During this process, I designed the post-experimental survey with input from Katharina Gangl, and identified the actual funds used in the incentivized investment decision. I was also in charge of the formal analysis, including the selection of appropriate statistical tests, conducting analyses, and preparing the replication code. I drafted the original manuscript, with Katharina Gangl providing support on its structure and writing style. Additionally, I coordinated communication among all coauthors during the review and editing stages and integrated their suggestions and feedback into the manuscript. As the first and corresponding author, I was responsible for the submission process, addressing the reviewer's comments, and preparing the response letters to the editor and reviewers through three rounds of reviews, with my coauthors providing valuable input on these letters.

1. Introduction

Sustainable investments that consider Environmental, Social and Governance criteria ("ESG investments") arguably have great potential to mitigate climate change by promoting a more sustainable economy (Eurosif, 2018; IPCC, 2018). Despite the remarkable growth of such investments in the recent past (GSIA, 2021), challenges such as a lack of investor awareness are slowing their even faster adoption (Gutsche and Zwergel, 2020; Meunier and Ohadi, 2022; Wins and Zwergel, 2016; The World Bank, 2020). To address this problem, the European Union (EU) passed regulation (EU) 2021/2616, requiring financial institutions to inform their clients about ESG investments and to elicit their ESG sustainability preferences, starting from August 2022 (see Appendix A). However, financial institutions may fear that the already complex advisory process will become even more complex due to the new regulation, which in turn could affect investor satisfaction and customer loyalty (Seiler et al., 2013). If investors are dissatisfied with the information overload associated with eliciting ESG preferences, this could also affect ESG investments.

Motivated by the new regulation, we aim to answer two pivotal research questions in the context of ESG investments. For this purpose, we collaborate with eight Austrian banks and with the Austrian Financial Market Authority (FMA) which is responsible for implementing EU regulations regarding investments in Austria. We answer two questions: First, do ESG investments and investor satisfaction increase when financial advisors provide investors with information about the financial returns and ESG impacts (i.e., impact on Environmental, Social and Governance factors) of investment products? Second, are ESG investments and investor satisfaction affected by the mode of eliciting investors' ESG preferences (i.e., using either a general or a more detailed elicitation mode)? Answering these questions is crucial to understanding how effective information provision and ESG preference elicitation can promote ESG investments and increase investor satisfaction, as intended by the new EU regulation and similar initiatives, e.g., by the World Bank.

We answer our research questions through a preregistered, incentivized, online experiment with 871 retail investors and 1,383 members of a representative sample for Austria. We test different ways of conducting an investment consultation, ensuring compliance with the new EU regulation. Participants receive 600 euros to invest in four randomly assigned treatments that vary in the information the participants receive about ESG investments. In the *basic information treatment*, we provide them with only the basic, legally required definition of ESG. In the *financial return information treatment*, we additionally inform them about financial benefits of ESG investments, in the *ESG impact information treatment* about the ESG impact, and in the *combined information treatment* about both. In addition, we randomly assign participants to either the general preference elicitation mode, which asks for the minimum ESG investment amount, or to the specific elicitation mode, which additionally asks for the focus of the ESG investment. Based on their ESG preferences, participants receive a recommendation involving up to four different equity mutual funds, which they can either accept or modify according to their wishes. To incentivize these choices, we really

implement the investment decisions and pay out the final portfolio values one year later to 15 randomly selected participants (as in Gutsche et al., 2023).

We elicit participant satisfaction as well as individual characteristics (biospheric and social value orientation, household income, financial literacy) through a post-experiment questionnaire. We explore heterogeneous effects of the financial return and ESG impact information treatments, how the treatments affect the stability of investors' investment decisions in the face of underperformance, and what drives deviations from the investment recommendation.

We find that both financial return and ESG impact information promote ESG investments compared to the basic information treatment. Combining financial return and ESG impact information yields similar effect sizes as providing either type of information alone. Neither of the information treatments notably affects investor satisfaction. The general and the specific sustainability preference elicitation modes do not markedly differ in their effect on ESG investments and satisfaction. Participants with stronger biospheric values, higher financial literacy, education, and income levels tend to invest more sustainably. We find no evidence of interaction effects between the treatments and participant characteristics. Finally, the treatments do not materially affect the stability of the investment decisions, and the deviations from the investment recommendation.

This paper makes two conceptual contributions. Our first conceptual contribution is to demonstrate the impact of combining financial return and ESG impact information on ESG investments and investor satisfaction. Previous studies have tested how financial, environmental, social, or moral information in isolation impacts green investments or socially responsible investments (Barreda-Tarrazona et al., 2011; Døskeland and Pedersen, 2016, 2021; Heeb et al., 2023; Lagerkvist et al., 2020; Siemroth and Hornuf, 2023). Our second conceptual contribution is to extend the literature on the elicitation of ESG preferences and its effect on ESG investments and investor satisfaction. Prior research on eliciting sustainability preferences and how this elicitation translates into actual investment decisions is sparse (Bauer et al., 2021 is a notable recent exception). We fill this gap by experimentally comparing two versions of an ESG sustainability preference elicitation mechanism that were debated by EU legislators: asking only generally about ESG sustainability preferences, or asking investors to further specify the focus of their ESG investments. The present study is also among the first to provide up-front information about ESG investments, as mandated by the new EU regulation, instead of varying the fund characteristics used in the investment decisions (Gutsche et al., 2023; Heeb et al., 2023; Lagerkvist et al., 2020).

Our study also makes a methodological contribution in that we incentivize participants' investment decisions by actually realizing them in the stock market. This approach is relatively novel in the literature (with a few exceptions, see, e.g., Gutsche et al., 2023), yet offers a more realistic representation of investors' payoffs compared to other incentivization modes (Barreda-Tarrazona et al., 2011; Riedl and Smeets, 2017) and in particular to the large majority of unincentivized experiments (e.g., Degryse et al., 2023) or survey studies (e.g., Wins and Zwergel, 2016). Our recruitment of two distinct samples – experienced investors

and a representative, general population sample – further differentiates our study from studies that either investigate retail investors (e.g., Gutsche et al., 2023) *or* the general population (e.g., Degryse et al., 2023), often with smaller samples (Engler et al., 2023 is a rare counterexample).

Finally, our study yields practical contributions. The design, developed in close cooperation with the Austrian Financial Market Authority and eight banks, ensured a realistic and legally compliant test of the EU regulation. Previous studies (e.g., Døskeland and Pedersen 2016, 2021) use strong manipulation texts (e.g., concerning profitability) that would not be permissible in practice. Thus, our information treatments and preference elicitation modes are ready to be used by banks. Also, the results alleviate concerns among banks that excessively granular questions regarding an investor's specific ESG preferences might lead to lower ESG investments and investor dissatisfaction. This aspect is particularly relevant given that the specific elicitation mode we model was ultimately mandated by EU regulation (EU) 2021/2616.

The remainder of this paper is organized as follows. Section 2 derives the hypotheses. Section 3 describes the experimental design, sample, and outcome variables. Section 4 presents the empirical results and Section 5 discusses them. Section 6 concludes, with cautious policy recommendations.

2. Hypothesis development

Based on the literature, we derive hypotheses how ESG information and preference elicitation may affect ESG investments and investor satisfaction. In the following, we only discuss our main hypotheses. The Appendix provides a detailed presentation and analysis of all preregistered hypotheses.

Hypothesis 1: Information impacts ESG investments (i.e., the amount that is invested considering Environmental, Social and Governance criteria) and investor satisfaction. A rich body of literature finds that investors consider financial and non-financial (e.g., moral) aspects of sustainable investments (Degryse et al., 2023; Gutsche et al., 2023; Riedl & Smeets, 2017). Informing investors about these aspects might enhance their understanding of potential benefits, break down knowledge barriers, and rectify misperceptions (Meunier and Ohadi, 2022; Wins and Zwergel, 2016). For instance, those investors initially linking ESG investments with morality might find ESG investments more appealing upon realizing that these instruments offer comparable financial returns to traditional investments. Conversely, those viewing ESG investments as profit-driven greenwashing might reconsider learning about the moral implications of ESG investments. Survey studies (e.g., Nilsson, 2008) and non-incentivized experiments show that financial return information stimulates sustainable investments (Døskeland and Pedersen, 2016, 2021), as does information regarding moral aspects (Barreda-Tarrazona et al., 2011; Bassen et al., 2019; Glac, 2009). However, rather than just relying on creating a feeling of moral obligation, this latter effect might be driven by creating a belief in the chance to have an environmental or social impact (van Valkengoed and Steg, 2019). This conjecture is supported both by survey studies (Nilsson, 2008; Wins and Zwergel, 2016; Palacios-González and Chamorro-Mera, 2018) and experiments (Heeb et al., 2023; Siemroth and Hornuf, 2023). Hence, we expect the provision of ESG information to stimulate ESG investments.

With regard to satisfaction, quantitative surveys show that both information on financial performance and information on environmental impact positively relate to satisfaction (Nilsson et al., 2014). Thus, we conjecture that both sets of information will increase satisfaction. This satisfaction might furthermore spill over and also increase the willingness to invest in ESG products. Since both financial and ESG impact information are potentially important for sustainable investments (Gutsche and Ziegler, 2019; Hartzmark and Sussman, 2019; Hong and Kostovetsky, 2012; Riedl and Smeets, 2017) and satisfaction (Nilsson et al., 2014), their combination may be even more effective. Conversely, overemphasizing ESG investments could fuel doubts and lead to dissatisfaction (e.g., Agnew and Szykman, 2005), crowding out motivation. Similarly, highlighting financial rewards could reduce the intrinsic motivation to invest in ESG. Yet, investors who are not convinced by one argument may be convinced by the other so that more recipients end up convinced and satisfied overall. We thus expect more information to result in greater ESG investments and satisfaction. We test the following hypotheses:

H1.1. Both information on financial return and information on ESG impact increase ESG investments compared to a treatment with only basic, legally required information about ESG.

H1.2. The combination of financial return information and ESG impact information increases ESG investments more than either does on its own.

H1.3. Both information on financial return and information on ESG impact increase investor satisfaction with the information received compared to a treatment with only basic, legally required information about ESG.

H1.4. The combination of financial return information and ESG impact information increases investor satisfaction with the information received more than either does on its own.

Hypothesis 2: The elicitation of ESG preferences itself impacts ESG investments and satisfaction. Few studies investigate how the way in which financial advisors elicit investors' preferences regarding investment into ESG assets affects investment decisions (see Bauer et al., 2021 for a recent exception) or satisfaction. The literature sends mixed signals, such that predictions for the effects of different elicitation modes could go in either direction. The general mode of preference elicitation might be perceived as straightforward and easy to understand, thus increasing ESG investments and satisfaction (Yoon, 2010). It could, however, also be perceived as overly simplistic or less transparent, thus negatively affecting trust, satisfaction and the willingness to invest. The specific mode of preference elicitation gives investors more control over their investment and may yield a better fit between investors' preferences and the resulting investments (Johnson et al., 2012), thus increasing ESG investments and satisfaction. Conversely, investors might not care about the more subtle differences between different ESG investments or become confused due to information overload (Scheibehenne et al., 2010), leading to reduced ESG investments and satisfaction. In conclusion, we posit the following, non-directional hypotheses:

H2.1. The ESG preference elicitation mode affects the amount invested into ESG assets.

H2.2. The ESG preference elicitation mode affects investor satisfaction.

Hypothesis 3: Individual investor characteristics affect ESG investments. Previous research indicates that a greater regard for biospheric and social values (i.e., caring for an intact environment and for others' utility) correlates positively with sustainable investments (Bassen et al., 2019; Bauer et al., 2021; Gutsche et al., 2023). So do higher household income (Cheah et al., 2011; Escrig-Olmedo et al., 2013; Gutsche et al., 2023) and financial literacy (Bauer and Smeets, 2015; Gutsche et al., 2021, 2023; Riedl and Smeets, 2017). We thus test the following hypothesis:

H3. Investors who care more about biospheric and altruistic values and who have greater household income and financial literacy invest more sustainably.

3. Experimental design

We conducted two waves of an incentivized online experiment in Austria, with the first wave targeting experienced retail investors and the second targeting a sample that was representative of the general population in terms of age and gender. We used the same treatments in both, and followed the analysis plan outlined in the preregistration of the population sample wave.[12]

3.1. Treatment manipulations

Table 4 presents our 4 × 2 design of information and preference elicitation modes.

Table 4. Treatment conditions and number of participants.

		Wave			
		Retail		Population	
		Elicitation mode			
		General	Specific	General	Specific
Information	Basic information	116	105	170	172
	Financial return	103	106	171	172
	ESG impact	111	111	172	178
	Combined	109	110	172	176

Information. In the *basic information* treatment, we provide the participants with basic information about ESG (see Section 3.4., Procedure). In the *financial return information* treatment, we follow up the basic information with a headline ("Earning returns with ESG investments") and a short text informing participants about ESG investments as a promising financial investment in future technologies with reduced

[12] Preregistered at Open Science Framework (OSF): https://osf.io/pe4g2 (retail investor sample) and https://osf.io/3zymq (population sample). We made the following adaptations between the two waves: Based on a power analysis of the preliminary results of the retail investor sample, we increased the sample size of the population sample to N = 1,400. Participants were informed that the lottery would have five winners. The attention check was adapted to suit non-investors.

risks related to ESG factors. In the *ESG impact information* treatment, we follow up the basic information with a headline ("Promoting sustainability with ESG investments") and a short text informed participants that ESG investments can be promising with regard to ESG impact and the promotion of companies that fulfill ESG criteria. In the *combined information* treatment, we follow up the basic information with both, the financial and the impact information texts (see Section 3.4., Procedure).[13] We include the English translation of all manipulations in Appendix K. Furthermore, Table B.1 in the Appendix shows that the randomization with regards to the information treatments was successful for most variables, except for *biospheric values* ($p = 0.045$) and *trust in ESG products* ($p = 0.023$).

Sustainability preference elicitation. Both the *general sustainability preference elicitation* and the *specific sustainability preference elicitation* ask participants for the minimum percentage of their investments that should meet ESG criteria (*What is the minimum amount of your investment that should go into investment products that meet ESG sustainability criteria*?; 1 = *0 % - no sustainable products*; 2 = *up to 25%*; 3 = *up to 50%*; 4 = *up to 75%*, and 5 = *100% - only sustainable products*). The *specific sustainability preference elicitation* follows up on this first question with a second question about the preferred focus of the investment (*If you choose an ESG investment, you can choose one or both of the following two product categories*; 1 = *Investment products that avoid important negative impacts on ESG factors*; 2 = *Investment products that invest in activities that are considered sustainable according to legal requirements (Disclosure Regulation, Taxonomy Regulation)*). In the specific elicitation, the second question is not asked if participants had indicated no interest in sustainable investment in the first question. Table B.2 in the Appendix shows that the randomization concerning to the sustainability preference elicitation mode was successful (all $p > 0.05$).

3.2. Measured variables

3.2.1. Outcome variables

Participants make investment decisions by allocating their endowments of 600 euros to four equity mutual funds (as per Gutsche et al., 2023). They can do so by accepting the non-binding recommendation based on their stated ESG preferences or by allocating their money themselves. Our most important outcome variable, *sustainable ESG investments*, is the percentage of the 600 euros that they invest into sustainable funds.

[13] A pretest with 58 participants in September 2021 showed that the information has the intended effect. Participants were randomly presented with the information and asked for their agreement on three items (*With sustainable ESG investments I can … earn money; have an impact; follow my values*), answered on a 7-point Likert scale (1 = *I totally disagree* / 7 = *I totally agree*). The results of *t*-tests show that the financial information ($M = 5.46$, $SD = 0.98$) received significantly ($p = 0.03$) higher ratings for "earn money" than did the ESG impact information ($M = 4.65$, $SD = 1.70$). The ESG impact information was rated higher ($p < 0.01$) on "have an impact" ($M = 5.62$, $SD = 1.10$) than the financial information ($M = 4.50$, $SD = 1.38$). ESG impact information ($M = 5.74$, $SD = -1.44$) and financial information ($M = 5.16$ $SD = 1.45$) were rated comparably high on "follow my values" ($p = 0.14$).

The four funds, two conventional and two sustainable, are identical in terms of risk and performance but vary regarding ESG criteria and the economic sectors they invest in (see Figure 7). The choice set of funds is held constant across all treatments. Participants did not learn the actual fund names to ensure that they would base their decisions solely based on the information provided.[14] Consistent with similar experiments (Gutsche et al., 2023; Gutsche and Zwergel, 2020; Heeb et al., 2023; Lagerkvist et al., 2020), we limit the information provided about the funds to avoid information overload, to ensure the experiment would not take too long (median duration: 10.87 minutes), and to ensure that the fund information differed primarily regarding their sustainability aspects.

Our second outcome variable assesses *satisfaction with the information on ESG investments,* using the average response to four items (*The information I received at the beginning about ESG investing was ... understandable, simple, informative, helpful*; standardized Cronbach's $\alpha = 0.91$), elicited on a 7-point Likert scale (1 = *I totally disagree* / 7 = *I totally agree*). The third outcome variable, *satisfaction with the sustainability preference elicitation*, is also assessed using the average of four items (*The way I was asked how much I would like to invest in ESG investment products was ... understandable, simple, informative, helpful*; standardized Cronbach's $\alpha = 0.92$), elicited on the same 7-point Likert scale. We display screenshots of the initial information and the sustainability preference elicitation question(s) during the satisfaction assessment.

We also elicit an exploratory outcome variable, the *stability of investment decisions* (see Appendix J.1), using two hypothetical, non-payoff-relevant scenarios (scenario 1 [2]: after 6 months, conventional funds have performed 5% better [worse] than sustainable funds). Participants had to indicate how they would revise the amount initially invested in sustainable funds in each of these two scenarios on a 5-point Likert scale (*1 = significantly reduce* / 3 = *neither reduce nor increase* / 5 = *significantly increase*). We aggregate the responses to a binary variable indicating whether a participant would have adjusted their ESG investments in at least one scenario (stability = 0) or not (stability = 1).

As a second exploratory outcome variable, we compute the *deviation from the recommendation* for ESG investments, defined as the total amount invested in sustainable funds minus the recommended amount for sustainable funds (see Appendix J.2). Positive values indicate that participants invest more sustainably than recommended, while negative values indicate that participants invest less.

[14] We nevertheless ensured that the funds were similar in terms of assets under management (AUM), volatility and costs. Their ISINs, names and characteristics (as of August 2021) are: Fund A: AT0000805460 "Raiffeisen Osteuropa Aktien T", AUM: 264.09 million euros, 3-year volatility: 29.53%, ongoing charges: 2.33%; Fund B: AT0000764758 "Raiffeisen US Aktien R T", AUM: 442,47 million euros, 3-year volatility: 18.78%, ongoing charges: 1.72%; Fund C: AT000UMWELT5 "Kepler Umwelt Aktienfonds T", AUM: 119.70 million euros, 3-year volatility: 13.59%, ongoing charges: 1.48%; Fund D: LU2257980289 "Mandarine Global Transition R", AUM: 135.2 million euros, 1-year volatility: 18.60%, ongoing charges: 2.25%. Note that performance in the preceding year was relatively high, reflecting the recovery after COVID-19, yet it was identical across all funds and thus unlikely to have affected the amounts allocated to the different funds.

Fund	Fund A	Fund B	Fund C	Fund D
Orientation	Conventional		Sustainable	
Type	Fund with focus on energy and finance	Fund with focus on information technology and healthcare	Fund that avoids negative impacts on ESG factors	Fund that invests in activities that are considered sustainable by law
Risk and return profile	6	6	6	6
Performance in the last year	Greater than 30 %	Greater than 30 %	Greater than 30 %	Greater than 30 %
Largest shares by sector	Finance, Oil, Gas	Microelectronics, Semiconductors, Agricultural products	Insulation technology, Metal recycling, Electricity	Plant engineering, Wind energy, Semiconductors

Figure 7. Equity mutual funds used in the investment decision. The figure shows the information about the four equity mutual funds as presented to the participants (English translation).

3.2.2. Explanatory variables

We calculate both the *biospheric* and the *altruistic value orientation* as the average response to four items (based on De Groot and Steg, 2007, 2008). Participants indicated how important four concepts of biospheric values (*preventing pollution*, *respecting the earth*, *unity with nature*, *protecting the environment*, Cronbach's $\alpha = 0.93$) and four concepts of altruistic values (*equality*, *a world at peace*, *social justice*, *helpfulness*, Cronbach's $\alpha = 0.89$) were as guiding principles of their lives (7-point Likert scales with 1 = *Opposed to my values* / 7 = *Extremely important*).

We calculate *household income* by dividing the income of all household members by household size, weighting adults by 1 and minors under 18 years by 0.5. The total income of all household members was measured with a single-choice question, answered in 1,000 euro-increments from *less than 1,000 euros* to *more than 8,000 euros*.[15]

We measure *financial literacy* using the percentage of correct answers to the three-item scale by Lusardi and Mitchell (2008), consisting of questions on interest rates, inflation, and risk (e.g., *Suppose you have 100 euros credit balance in your savings account. This balance earns interest at 2% per year and you leave it in this account for 5 years. What do you think: How much will your balance be after 5 years?* 1 = *higher than 102 euros, 2 = exactly 102 euros, 3 = lower than 102 euros, 4 = do not know).*

[15] As preregistered, we used multiple imputation by chained equations (van Buuren and Groothuis-Oudshoom, 2011) in the R statistical package "MICE" to impute missing data in the two covariates income (10.3%) and number of minors in the household (3.5%). This method, recommended for handling missing data (Hanss and Böhm, 2013; Tabachnick et al., 2007), involves an iterative algorithm which generates 10 datasets with plausible imputed values for these covariates. Our regression analyses are pooled regressions over these imputed datasets.

3.2.3. Control variables and other variables

We assess *gender*, *age*, *education*, *risk preference*, *experience in investing*, *trust in ESG products*, *trust in the information and the elicitation*, and *perceived relevance of the incentives* as control variables (see experimental material in Section K in the Appendix). We additionally add dummy variables for the provision of the email address (pre-requisite to participate in the incentive lottery), the experiment wave, and a correct answer on an attention check question.

3.3. Participants

We recruited 2,254 participants in two waves.[16] The retail investor sample was collected between October 12, 2021, and November 9, 2021, the population sample between February 2, 2022, and February 11, 2022. The overall sample consisted of 56.7% men, with an average age of 48.2 years (SD = 15.5), which is minimally lower than the average of Austrians aged 18 years or above (M = 49.9 years).[17] Table B.3 in the Appendix provides details for both samples.

We invited the first wave participants (retail investor sample) directly through eight Austrian banks (N = 871).[18] We compare the demographics of this first wave to that of Austrian investors more generally, using 2023 data from the Vienna Stock Exchange.[19] Compared to the 63% in the stock exchange data, male investors were, at 69.6%, slightly overrepresented in our first wave. The average age of Austrian investors of 47.5 years closely aligns with our first wave's 47.7 years.

We invited the second wave participants through a market research agency ("Talk Online Panel"). The second wave (N = 1,383) was representative of the Austrian population concerning age and gender by adding quotas for age (categories: 18-29 years: 17.3%; 30-39 years: 16.6%; 40-49 years: 16.0%; 50-59 years: 18.9%; above 60 years: 31.2%) and gender (51.2% female and 48.8% male).

Across both samples, 31.4% of the participants held a university degree, which is higher than in the general Austrian population (19.7% in 2021). Moreover, more of the participants in our retail investor sample held a university degree (38.7%) than did in our population sample (26.8%) and in the population of retail investors in Austria in 2023 (26%). The majority of participants reported monthly incomes between 2,001

[16] We followed our two preregistrations for the retail investor sample and the population sample. Applying the preregistered criteria of the population sample led to the exclusion of 7 participants from the first and 18 participants from the second wave due to repeated participation.

[17] Official Austrian population statistics in 2021 (time of the first wave) from Statistics Austria.

[18] Our recruitment strategy targeted them via investor-specific newsletters, website postings and online banking portals. Since our eventual sample size fell short of projections, we supplemented this sample with a second, newly preregistered wave, the population sample.

[19] Data collected in the "Aktienbarometer 2023" survey (N = 2000; telephone/online interviews in January 2023 among the Austrian population above 16 years). Note that these data were collected one year after our data collection and income data here corresponds to individual income, not household income.

euros and 5,000 euros. The median income in our first wave (3,001 to 5,000 euros) surpassed the Austrian median household income (2,484 euros), and the individual income in the Austrian population of investors (2,000 to 2,999 euros). The median income of our second wave (2,001 to 3,000 euros) aligns with the Austrian average in 2021. In the retail investor sample, 10.0% report less than one year of investment experience, while 51.4% indicated more than 11 years of experience. In the population sample, 52.2% report no investment experience and only 16.1% indicate more than 11 years of experience. Average financial literacy was 0.80 (*SD* = 0.28), or 2.4 out of 3 questions answered correctly (retail investor sample: *M* = 0.90, *SD* = 0.20; population sample: *M* = 0.74, *SD* = 0.31). These results align with results from a German study (Gutsche et al., 2023) reporting 2.46 correctly answered questions on average, and are slightly higher than those reported by an Austrian survey using similar questions (about 1.9 correctly answered; Fessler et al., 2020). Participants considered the biosphere (*M* = 6.00, *SD* = 1.07) and altruism (*M* = 5.88, *SD* = 1.04) to be highly important.

3.4. Procedure

Participants were invited to a study on investment decisions. The link in the invitation brought them to the survey platform Qualtrics, where they found general instructions, terms of participation, and privacy statements.[20] We furthermore informed participants about the lottery incentives, through which 15 participants (10 in wave 1 and 5 in wave 2) were randomly selected. For these, we invested the amount allocated to each mutual fund, sold the funds after one year and paid out the resulting ending values to the participants (cp. Gutsche et al., 2023).

To mimic a financial advice setting, we asked participants to imagine themselves asking for financial advice in a bank about how to invest 600 euros. In this setting, their advisor would provide basic investment information, including that, besides liquidity, returns and risk, they could also consider ESG factors in their investment choices (see Appendix K).

Depending on the randomly chosen treatment, we then presented only basic information on ESG (*basic information* treatment), the basic information plus information on financial returns (*financial return information* treatment), the basic information plus information on ESG impact (*ESG impact information* treatment), or the basic information plus financial and ESG impact information combined (*combined information* treatment). We followed up the information provision with the sustainability preference elicitation (see Figure 8). We informed the participants that their stated sustainability preferences would be used to prepare a non-binding investment recommendation (e.g., a choice of 75% ESG investment in the general preference elicitation resulted in a recommendation to invest 225 euros into each of the two sustainable funds and 75 euros into each of the two conventional funds). Participants then made their investment decisions by accepting the

[20] The procedure was approved by the Ethics Committee of the Institute for Advanced Studies, Austria, and a representative of the interests for investors of the Austrian Chamber of Labor. Compliance with the EU's General Data Protection Regulation (GDPR) was audited by the data protection officer of the Institute for Advanced Studies.

non-binding investment recommendation or by manually choosing their allocations to the four funds. At this stage, we reminded the participants of the incentives, i.e., the lottery procedure.

The participants then filled in the post-experimental questionnaire (see Section 3.2. for details). At the end, participants could leave their email address to participate in the lottery and/or receive information about the study's results. Finally, we thanked them for their participation.

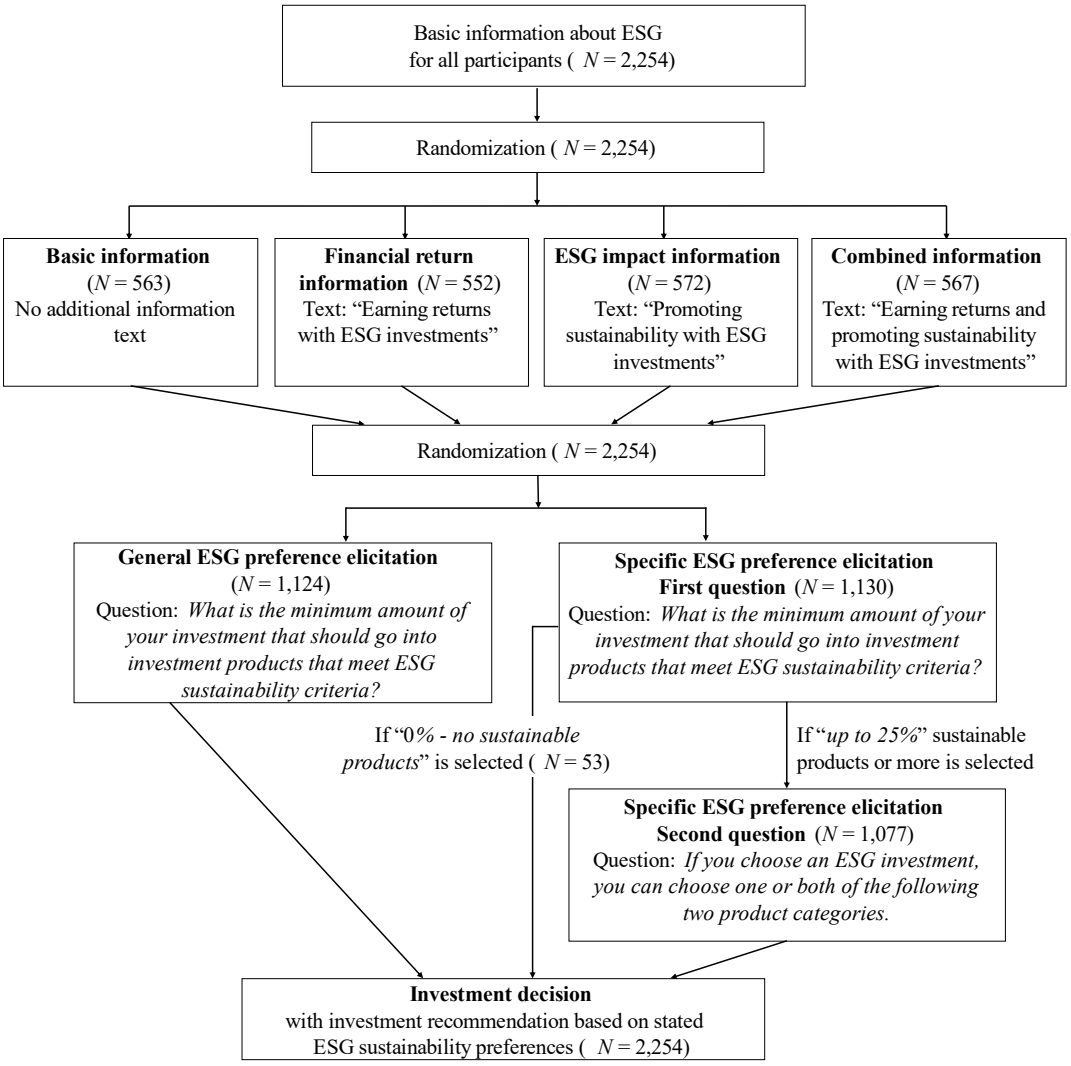

Figure 8. Flow chart of the main task in the experiment. All participants receive basic information about ESG investments and are then randomly assigned to four information treatments (*basic*, *financial return*, *ESG impact*, or *combined information*) and to two different modes of ESG preference elicitation (*general* or *specific*) before making their investment decision.

4. Results

We start by presenting descriptive statistics of the outcome variables, followed by the main results, followed by exploratory analyses. Our results are based on the total sample, including a dummy for the wave, since both waves yielded qualitatively comparable results (i.e., effects pointing in the same direction) and since pooling the samples increases the statistical power and internal validity of the results. Additionally, since the new EU regulation targets both investors and non-investors, our approach ensures relevance for both

groups. Nevertheless, we also provide the main results separately for each sample to allow our readers to judge the external validity for themselves. We control for multiple hypothesis testing by applying the Benjamini-Hochberg procedure (Benjamini and Hochberg, 1995) to the results of the total sample. All results reported in the paper regarding hypotheses *H1 – H3* remain significant after controlling for multiple hypothesis testing (see Table C.1 in the Appendix).

Participants invest an average of 394.39 out of 600 euros into ESG funds (i.e., 65.73%, *SD* = 27.94%; see Table B.4 in the Appendix for details on the total sample and both waves separately). This investment level is 94.93 euros higher than suggested by the 1/n or naïve-diversification strategy ($p < 0.001$), which would prescribe investing equal amounts into each fund (Benartzi and Thaler, 2001). ESG investments are higher in the retail investor sample (*M* = 68.65%, *SD* = 25.75) than in the population sample (*M* = 63.89%, *SD* = 29.10; $p < 0.001$). The participants favor Fund D, which invests in activities considered sustainable by the "EU taxonomy for sustainable activities" (EU Regulation (EU) 2020/852), while they least favor Fund A, which invests in oil and gas (see Table B.4 for average allocations to each fund).

Satisfaction with the information (*M* = 5.60, *SD* = 1.13) and with the mode of sustainability preference elicitation (*M* = 5.64, *SD* = 1.16), both rated on a 7-point Likert scale, are relatively high and correlate positively with ESG investments ($r = 0.28$ and $r = 0.26$, respectively; $p < 0.001$ for both). In the first (general) sustainability preference question that all participants answer, 3.86% indicate a preference for 0% sustainable products and 26.31% a preference for 100% sustainable products. The share of participants who choose 0% in the first question is not significantly lower ($p > 0.1$) in the general (34 out of 1,124 participants, 3.0%) than in the specific elicitation mode (53 out of 1,130 participants, 4.7%). Moreover, there is no overall difference in the stated preferences between the general and the specific elicitation modes (Chi-square test: $\chi^2(4) = 6.02$, $p = 0.197$). In the second question of the *specific sustainability preference elicitation* treatment, answered only by those who did not select "*0% - no sustainable products"* in the first question, 48.93% profess a preference for products that are sustainable according to the law (i.e., the EU taxonomy). Avoiding a negative impact was the preferred focus for 32.59% of the participants and 18.48% selected investments that focus on both, i.e., products that are sustainable according to the law *and* avoid negative impact.

4.1. Financial return and ESG impact information

Figure 9 shows that the average investment in sustainable ESG products amounts to 362.90 euros (*SD* = 172.69) in the basic information treatment. This number increases to 395.80 euros (*SD* = 160.57) in the financial return information and to 411.90 euros (*SD* = 167.25) in the ESG impact information treatments. Finally, the average investment amounts to 406.60 euros (*SD* = 165.93) in the combined information treatment.

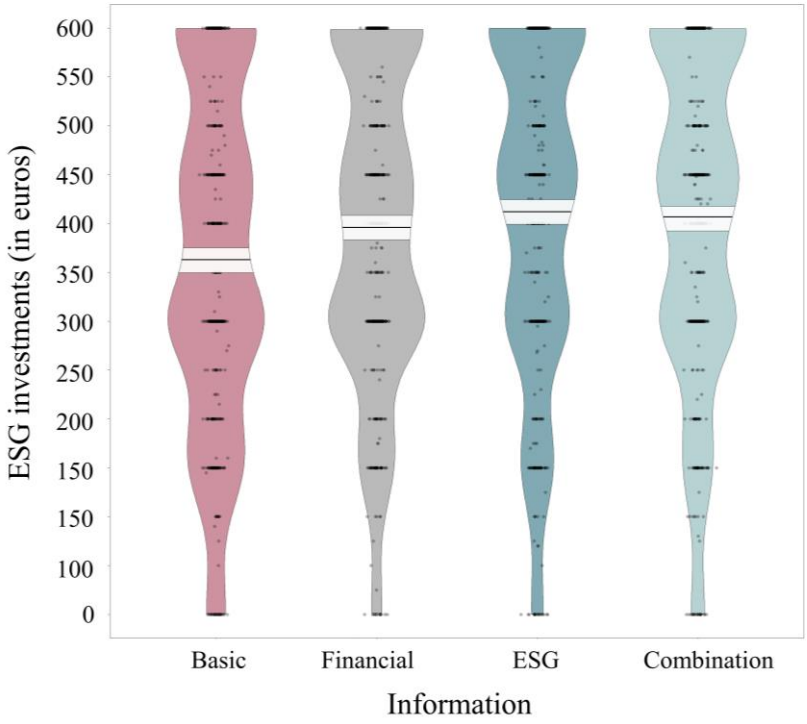

Figure 9. ESG investments in euros by information treatment. The figure shows the mean amounts of ESG investments (in euros, displayed by bold line in center) and 95% confidence intervals (displayed by white bands) for each information treatment (basic : N = 563; financial return: N = 552; ESG impact: N = 572; combined : N = 567). The black dots represent the raw data points of the variable *ESG investments* (0 to 600 euros), the colored shapes plot the density of the data distribution for each treatment.

Table 5 presents the OLS regressions we use to test our hypotheses on the effect of financial and/or ESG impact information on ESG investments (*H1.1* and *H1.2*). Model (1) regresses sustainable ESG investment (the percentage of the total endowment that is invested in sustainable funds) on dummies indicating whether financial return and/or ESG impact information was presented. Model (2) adds the elicitation mode dummy, household income, biospheric and altruistic value orientation, financial literacy variables, and other control variables. Models (3) and (4) present separate results for the retail investor sample (N = 871), and Models (5) and (6) for the population sample (N = 1,383). We use the same control variables throughout the remainder of the paper.

Models (1) and (2) show that financial return information increases ESG investments by a statistically significant margin of 5 percentage points (pp) compared to the basic information treatment. ESG impact information increases ESG investments by statistically significant 7pp (in Model (1), this, for example, corresponds to an increase of 13.48% relative to the basic information treatment). The difference between the effects of the financial return and ESG impact information treatments is not significant (Wald test for coefficient equality, $\chi^2(1) = 2.04$, $p = 0.153$). Providing both types of information yields similar effect sizes as providing one type of information alone (Wald tests, both $p > 0.27$). The negative interaction effect of the combined financial return and ESG impact information indicates that the two types of information are substitutes rather than complements.

Table 5. OLS models: Impact of information on ESG investments.

	(1)	(2)	(3)	(4)	(5)	(6)
Financial return	0.055***	0.041**	0.037	0.025	0.067**	0.053**
	(0.017)	(0.015)	(0.025)	(0.023)	(0.022)	(0.020)
ESG impact	0.082***	0.063***	0.052*	0.037	0.101***	0.080***
	(0.016)	(0.015)	(0.024)	(0.023)	(0.022)	(0.020)
Financial * impact	-0.064**	-0.045*	-0.037	-0.024	-0.082**	-0.063*
	(0.023)	(0.022)	(0.035)	(0.033)	(0.031)	(0.028)
Specific elicitation mode		0.005		-0.011		0.015
		(0.011)		(0.017)		(0.014)
Biospheric values		0.063***		0.070***		0.061***
		(0.009)		(0.014)		(0.011)
Altruistic values		-0.014		-0.014		-0.015
		(0.009)		(0.015)		(0.011)
Household income		0.024**		0.004		0.040***
		(0.007)		(0.009)		(0.010)
Financial literacy		0.074***		0.046		0.083**
		(0.022)		(0.044)		(0.026)
Constant	0.605***	0.001	0.651***	0.095	0.575***	-0.040
	(0.012)	(0.058)	(0.017)	(0.097)	(0.016)	(0.063)
Control variables	NO	YES	NO	YES	NO	YES
N	2254	2254	871	871	1383	1383
Adjusted R^2	0.012	0.172	0.004	0.100	0.015	0.154
F	9.797	24.338	2.048	6.357	8.173	15.768
p	0.000	0.000	0.106	0.000	0.000	0.000
Mean (SD)	0.66 (0.28)	0.66 (0.28)	0.69 (0.26)	0.69 (0.26)	0.64 (0.29)	0.64 (0.29)

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. In Models (1) and (2) use the full sample, Models (3) and (4) the retail investor sample, and Models (5) and (6) the population sample. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and the same for ESG impact information). Control variables: age, gender, education, children, experience, risk preference, trust in ESG products, relevance of the incentive, email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), sample dummy in Model (2) (1 = retail investor sample, 2 = population sample); see Tables D.1 and F.1 in the Appendix for the regression coefficients of the control variables. F and p indicate the overall significance of the regression model. Mean (SD) is the mean (standard deviation) of the dependent variable. In the Appendix we show that the results are qualitatively robust to stratifying standard errors by age and gender (Table I.1) and to month-year fixed effects (Table I.4).

Studying each wave separately, the treatment coefficients are significant in the population sample (Models (5) and (6)) but smaller and not significant in the retail investor sample (Models (3) and (4)). We calculate the interaction coefficients of the information treatments with the sample but find no significant

interaction effects (max. $b = 0.048$, min. p-value = 0.152), suggesting that the information treatments have a similar effect size across samples whether or not we control for other, participant-specific characteristics.[21]

To test whether financial and ESG impact information affect satisfaction with the information (*H1.3* and *H.1.4*), Table 6 replicates the OLS regression analyses from Table 5, but using satisfaction with the information as the dependent variable.

Table 6. OLS models: Impact of information on satisfaction with the information.

	(1)	(2)	(3)	(4)	(5)	(6)
Financial return	0.088	0.008	0.185*	0.074	0.034	-0.040
	(0.068)	(0.055)	(0.092)	(0.085)	(0.092)	(0.072)
ESG impact	0.140*	0.047	0.292**	0.210*	0.045	-0.062
	(0.067)	(0.055)	(0.091)	(0.084)	(0.092)	(0.072)
Financial * impact	-0.089	0.009	-0.192	-0.069	-0.030	0.062
	(0.095)	(0.078)	(0.130)	(0.119)	(0.130)	(0.101)
Specific elicitation mode		0.005		0.026		-0.012
		(0.039)		(0.060)		(0.050)
Biospheric values		0.156***		0.093+		0.179***
		(0.031)		(0.051)		(0.039)
Altruistic values		0.129***		0.128*		0.120**
		(0.031)		(0.053)		(0.039)
Household income		0.058*		0.038		0.073*
		(0.024)		(0.034)		(0.034)
Financial literacy		0.697***		0.415*		0.735***
		(0.079)		(0.161)		(0.092)
Constant	5.507***	1.187***	5.638***	1.949***	5.423***	1.277***
	(0.048)	(0.209)	(0.064)	(0.353)	(0.065)	(0.224)
Control variables	NO	YES	NO	YES	NO	YES
N	2254	2254	871	871	1383	1383
Adjusted R^2	0.012	0.139	0.004	0.100	0.015	0.154
F	9.797	20.202	2.048	6.357	8.173	15.768
p	0.000	0.000	0.106	0.000	0.000	0.000
Mean (SD)	5.60 (1.13)	5.60 (1.13)	5.83 (0.96)	5.83 (0.96)	5.45 (1.21)	5.45 (1.21)

Note. $^+ p < 0.1$, $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$. Robust standard errors in parentheses. Models (1) and (2) use the full sample, Models (3) and (4) the retail investor sample, in Models (5) and (6) the population sample. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and the same for ESG impact information). Control variables are identical to Table 5; for full models, see Tables E.1 and F.2 in the Appendix. F and p indicate the overall significance of the regression model. Mean (SD) is the mean (standard deviation) of the dependent variable. In the Appendix, we show that the results are qualitatively robust to stratifying standard errors by age and gender (Table I.2) and to month-year fixed effects (Table I.4).

[21] The corresponding estimation results are omitted to conserve space, but are available upon request.

After controlling for multiple hypothesis testing, we find no significant effect of information on satisfaction with the information. Our point estimates for the effect of information on satisfaction are slightly higher in the retail investor sample than in the population sample, yet this difference too is not statistically significant (max. b = -0.248, min. p-value = 0.069). Bivariate t-tests reveal a significant increase in trust compared to the basic information treatment for the ESG impact information treatment (p = 0.032) and the combination of information treatment (p = 0.015), yet not for the financial return information treatment (p = 0.147).

4.2. Elicitation of ESG sustainability preferences

Table 7 analyzes the relationship between the sustainability preference elicitation mode and ESG investments and satisfaction (*H2*) using OLS models with ESG investments and satisfaction with the elicitation, respectively, as the outcome variables (further details in Appendix G). We include only the elicitation mode as a predictor in Model (1), while Model (2) includes the same predictors (in different order) as the model reported for ESG investments (Table 5, Model (2)). The results yield no evidence that the elicitation mode affects ESG investments. The point estimates are close to zero and not statistically significant.[22] The same holds for satisfaction with the elicitation mode (Models (3) and (4)). We find similar null results when including the mode of elicitation in the models for each wave separately (see coefficients for mode of elicitation in Tables 2 and 3). Moreover, there is no significant interaction between information and sample (ESG investments: max. b = 0.025, min. p-value = 0.294; satisfaction with the elicitation: b = -0.002, min. p-value = 0.982). Bivariate t-tests additionally detect no significant difference between the general and the specific sustainability preference elicitation modes regarding trust in the preference elicitation (p = 0.122). We also find no significant interaction between the information and the ESG preference elicitation mode (see Table D.2 in the Appendix).

4.3. Differences in personal values, income, and financial literacy as determinants for ESG investments

Model (2) in Table 5 examines which participant-level differences determine ESG investments. Our results show that participants who care more about biospheric values, who have greater household income and who are more financially literate invest significantly more sustainably, while altruistic values do not seem to play a role. These results remain significant after controlling for multiple hypothesis testing. Additionally, the exploratory results in Table D.1. in the Appendix show that greater trust in ESG (b = 0.043, p < 0.001) and higher education (b = 0.017, p < 0.001) are associated with greater ESG investments. Greater preferences for risk-taking (b = -0.011, p < 0.001) are related to lower ESG investments. Men invest less sustainably than do women (b = -0.038, p < 0.01). Table H.1 in the Appendix reports the results for treatment heterogeneity, testing whether the information provided has different effects on different

[22] Excluding those participants (N = 87) who selected "*0% - no sustainable investments*" from the analyses in Table 5 and Table 7 does not change the results.

subgroups. Except for one positive effect (financial return, ESG impact, and above-median altruistic values), no results regarding treatment heterogeneity remain significant after controlling for multiple hypothesis testing.

Table 7. OLS models: Impact of elicitation mode on ESG investments (Models (1) & (2)) and on satisfaction with the information (Models (3) & (4)).

	ESG investments		Satisfaction with elicitation	
	(1)	(2)	(3)	(4)
Specific elicitation mode	0.002	0.005	-0.044	-0.053
	(0.012)	(0.011)	(0.049)	(0.040)
Financial return		0.041**		0.058
		(0.015)		(0.057)
ESG impact		0.063***		0.028
		(0.015)		(0.056)
Financial * impact		-0.045*		0.044
		(0.022)		(0.080)
Biospheric values		0.063***		0.149***
		(0.009)		(0.031)
Altruistic values		-0.014		0.127***
		(0.009)		(0.032)
Household income		0.024**		0.058*
		(0.007)		(0.025)
Financial literacy		0.074***		0.743***
		(0.022)		(0.081)
Constant	0.656***	0.001	5.663***	1.027***
	(0.008)	(0.058)	(0.035)	(0.215)
Control variables	No	Yes	No	Yes
N	2254	2254	2254	2254
Adjusted R^2	0.000	0.172	0.000	0.347
F	0.032	24.338	0.823	60.907
p	0.858	0.000	0.364	0.000
Mean (SD)	0.66 (0.28)	0.66 (0.28)	5.64 (1.16)	5.64 (1.16)

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Control variables: age, gender, education, children, experience, risk preference, trust in ESG products, relevance of the incentive, email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), sample dummy (1 = retail investor sample, 2 = population sample); see Table G.1 in the Appendix for the regression coefficients of the control variables. F and p indicate the overall significance of the regression model. Mean (SD) is the mean (standard deviation) of the dependent variable. We also show that the results are qualitatively robust to stratifying standard errors by age and gender in Table I.3 in the Appendix.

4.4. Exploratory analyses: ESG sustainability preferences, stability of investment decisions, and deviation from recommendations

ESG sustainability preferences. ESG investments could be affected by the selection of mutual funds that we present in the experiment. ESG preferences, as elicited in the general elicitation mode, are less context-dependent and hence interesting in their own right. Table 8 presents the ordered probit models we use to explore whether financial and ESG impact information affect participants' ESG sustainability preferences in the general elicitation mode. The models in the table mirror our models for ESG investments (Table 5), yet use the ordinal sustainability preference score from the general elicitation as their outcome variable (1 = *0 % - no sustainable products*; 2 = *up to 25%*; 3 = *up to 50%*; 4 = *up to 75%*, and 5 = *100% - only sustainable products*). The rightmost five columns in Table 8 provide the average marginal effects based on Model (2). The results show that both financial return and ESG impact information significantly increase the indicated sustainability preference in the general elicitation mode. A Wald test shows that the coefficient for the ESG impact information is significantly greater than that for the financial return information in Model (1) ($\chi^2(1) = 5.51$, $p = 0.019$). The large and negative interaction coefficient of financial return and ESG impact information again indicates that presenting the two information sets in combination does not yield greater effects than presenting either one in isolation. The average marginal effects indicate that ESG impact information as well as the combination of the information sets reduce (increase) the probability of participants selecting lower (higher) percentages of sustainable investments in the preference elicitation. For example, the probability of selecting "*100% - only sustainable products*" increases by 7.5 percentage points in the ESG impact information treatment compared to the basic information treatment. Finally, a Chi-square test does not indicate a significant influence of financial and ESG impact information on choices in the specific preference elicitation mode ($\chi^2(9) = 6.12$, $p = 0.728$).

Stability of investment decisions. We asked participants whether they would want to revise their initial investment decision in two hypothetical scenarios of investment performance by either decreasing, keeping constant, or increasing the amount invested in sustainable funds. We use logit models with stability of investment (SOI) as the binary outcome variable to explore whether financial and/or ESG impact information increase the stability of investments (i.e., the investors indicate no intent to revise their investments) compared to the basic information treatment (0 = no stability of investments, 1 = stability of investments, $M = 0.33$, $SD = 0.47$). We find no significant impact of financial return or ESG impact information on stability (minimum $p > 0.1$, see Appendix J.1 for the full results).

We do, however, identify other determinants for the stability of investment decisions. When asked what they would do if, six months later, the sustainable funds had outperformed the conventional funds by 5 percentage points, 39.49% of the participants reply that they would maintain their ESG investment, 55.10% would increase it and only 5.41% would decrease it (5-point Likert scale, *1 = significantly reduce* / 5 = *significantly increase*, *Median* = 4). In the scenario where conventional funds outperform, 67.30% reply they would maintain their ESG investment, 17.84% would increase it, and only 14.86% would decrease it

(*Median* = 3). We furthermore explore whether participants whose investment amounts are below the median ESG investment amount differ from those at/above the median in their revision choices in the scenario where conventional investments perform better than ESG investments, yet find no significant difference (Mann–Whitney *U* test; *Median* = 3 for both groups, $p = 0.290$). However, participants with investments at or above the median increased their ESG investments significantly more ($p < 0.001$) in the hypothetical scenario (*Median* = 4) where ESG investments performed better than participants with lower ESG investments (*Median* = 3).

Table 8. Ordered probit models and average marginal effects: Impact of information on stated preferences for ESG investments.

	Coefficients		Marginal Effects				
	(1)	(2)	0%	Up to 25%	Up to 50%	Up to 75%	100%
Financial return	0.169***	0.135*	-0.009	-0.019	-0.012	0.008	0.031
	(0.063)	(0.064)	(0.005)	(0.012)	(0.007)	(0.005)	(0.020)
ESG impact	0.318***	0.274***	-0.018***	-0.043***	-0.030***	0.016***	0.075***
	(0.063)	(0.064)	(0.005)	(0.012)	(0.008)	(0.005)	(0.020)
Financial * impact	-0.207*	-0.164+	-0.017***	-0.041***	-0.028***	0.015**	0.071***
	(0.089)	(0.091)	(0.005)	(0.012)	(0.008)	(0.005)	(0.020)
Biospheric values		0.287***					
		(0.036)					
Altruistic values		-0.027					
		(0.036)					
Household income		0.068*					
		(0.030)					
Financial literacy		0.233*					
		(0.092)					
Control variables	NO	YES					
N	2254	2254					
Nagelkerke Pseudo R^2	0.014	0.204					

Note. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses for Models (1) and (2). Marginal effects are based on Model (2), shown with standard errors. The dependent variable is the outcome of the general sustainability preference elicitation (*What is the minimum amount of your investment that should go into investment products that meet ESG sustainability criteria?*, 1 = 0 % - *no sustainable products*; 2 = *up to 25%*; 3 = *up to 50%*; 4 = *up to 75%*, 5 = *100% - only sustainable products*). Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Control variables: age, gender, education, children, experience, risk preference, trust in ESG products, relevance of the incentive, email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), sample dummy (1 = retail investor sample, 2 = population sample).

Deviation from the recommendation. We find that 34.43% of the participants accept the non-binding recommendation. For the others, the deviation from the recommended amount is on average positive

(M = 15.00, SD = 109.41), indicating that participants invest about 15 euros more in sustainable funds than recommended based on the preference elicitation. The results (Table J.2) yield no convincing evidence of financial and ESG impact information affecting the deviation from the recommended ESG investment amount.

5. Discussion

Understanding which information financial advisors should provide about ESG investments and how investors' ESG sustainability preferences should be elicited is crucial to increase ESG investments and investor satisfaction. Both, information provision and preference elicitation by financial institutes are mandatory under EU Regulation (EU) 2021/2616, and, outside of the EU too, promoting ESG investments is a key topic in current discussion about financial advisory (The World Bank, 2020).

5.1. Financial return and ESG impact information

In line with *Hypothesis 1.1*, we find that providing information about financial returns and ESG impact increases ESG investments by about 5 and 7 percentage points, respectively. While these effects are qualitatively similar in our retail investor population samples, the overall effect seems to be driven by the population sample. One reason for this result might be that the retail investors have greater ESG sustainability preferences and thus choose higher ESG investment amounts irrespective of the information. Another might be that a greater proportion of retail investors are already aware of ESG investments, such that our information provision has less of an effect. Both reasons would leave less room for a further increase among retail investors due to ceiling effects.

Contrary to *Hypothesis 1.2*, however, the combination of financial return and ESG impact information does not increase ESG investments more than each type of information does alone. This could be driven by an individual upper bound in ESG investments that both types of information independently push investors to, leaving no room for additional increases when the information is combined. Another explanation could be motivational crowding out (Frey and Jegen, 2001). Investors might lose their intrinsic desire to support ESG goals when financial rewards are highlighted. Conversely, those motivated by financial considerations might not derive additional utility from ESG appeals and would thus not increase their ESG investments when provided with ESG impact information.

Our results challenge the claim that financial considerations are a more important driver of sustainable investments than other considerations (Døskeland and Pedersen, 2016, 2021). We show that both aspects are similarly important as compared to previous studies that have emphasized either financial returns (Døskeland and Pedersen, 2016, 2021) or other single aspects as key drivers (Barreda-Tarrazona et al., 2011; Bassen et al., 2019; Heeb et al., 2023; Siemroth and Hornuf, 2023). Moreover, we show that the combination of both sets of information does not affect ESG investments beyond the effect of each type of information alone. Finally, with one exception, we find no significant heterogeneous treatment effects when controlling for individual characteristics after multiple hypothesis testing.

Our financial return and ESG impact information treatments increase investments over and above any effect of the basic, legally required (in the EU) information regarding ESG. In the basic information treatment, ESG investments constitute 60.49% of the total investment amount, significantly exceeding the 1/n heuristic's prediction of 50% or 300 euros (Benartzi and Thaler, 2001). This finding suggests that participants actively choose to invest sustainably rather than merely seeking diversification. The overall high level of ESG investments may of course have been caused by the limited set of information we provided about the funds, which could have made sustainability issues more salient relative to other parameters (i.e., risk and return). Nevertheless, since we kept the fund-related information set constant, our treatment effects would be unaffected by such a level shift. As a final observation regarding the investment amounts, note that the financial return information resulted in a less robust increase in ESG investments than the ESG impact information in both samples. Hence, when uncertain, financial advisors who aim to increase sustainable investments might be better off providing information on ESG impact.

Contrary to *H1.3* and *H1.4*, we do not find that information increases satisfaction. The reasons could be the layout, or the length of the text provided. However, overall satisfaction correlates positively with ESG investments. Thus, financial advisors in banks can confidently provide information and highlight reasons for ESG investing without fearing counteracting effects (Agnew and Szykman, 2005).

5.2. Modes of preference elicitation

Contrary to *H2*, the results suggest that the two sustainability preference elicitation modes do not differ in their effects on ESG investments and satisfaction. Thus far, limited comparable research exists on how investment advisors should assess ESG sustainability preferences (Bauer et al., 2021, is a notable exception). We fill this gap in the literature and provide practical evidence to understand whether a general or a specific elicitation mechanism increases ESG investments more effectively. Consistent with the new EU regulation, the results suggest that the newly mandatory, specific elicitation mode of sustainability preferences has no disadvantages (such as causing choice overload; cp. Scheibehenne et al., 2010) compared to a simpler format.

5.3. Individual differences in ESG investment

In line with *H3,* the results reveal that investors with greater biospheric value orientation, greater financial literacy, and higher income, invest more sustainably. When controlling for multiple hypothesis testing, these results are significant and align with previous research (Cheah et al., 2011; Escrig-Olmedo et al., 2013; Gutsche et al., 2023). In contrast to what we hypothesized in *H3*, however, altruistic value orientation does not seem to relate significantly to ESG investments.

Our exploratory analyses support the widespread notion that sustainable investors tend to be female and educated, but we find no support for the notion that these investors are typically younger (Dorfleitner and Nguyen, 2016; Nilsson, 2008). Trust in ESG is a determinant of ESG investing in our data, consistent with other studies (Gutsche et al., 2023; Gutsche and Zwergel, 2020; Nilsson, 2008). Interestingly, greater risk

aversion relates to an increase of 1.1 pp in ESG investments. Both of these latter findings might reflect the view that sustainable investments are typically perceived as less risky (Scholtens and van't Klooster, 2019; Verheyden et al., 2016).

5.4. Limitations

Our study of course is subject to some limitations. First, participants made investment decisions with windfall gains, as opposed to self-earned money. Prior research has found that windfall gains may increase the willingness to invest sustainably (Hoffmann et al., 2019), which may have inflated our overall level of ESG investments. Given that every treatment is subject to this limitation, however, we would expect qualitatively similar treatment effects for the case of investing self-earned money. Specifically, we would expect future experiments to find lower ESG investments on average, but to find our treatment variables to have a comparable impact as observed in the present study. Furthermore, windfall gains are a common occurrence in practice, such as in the form of inheritances, gifts, surprise bonuses, or lottery gains.

A second potential limitation is that our design does not include control groups who did not receive any ESG information or did not participate in any sustainability preference elicitation. Instead, we used a basic information treatment reflecting the mandatory legal practice regarding financial advice in the EU. We decided not to include a control group without any sustainability preference elicitation in favor of greater external validity and practical relevance. This approach also ensured participants' understanding of basic ESG information when we elicited their ESG sustainability preferences and may be seen as a conservative benchmark for the effect of ESG information on ESG investments. Likely, our information treatments would show larger effects when compared to a control condition with no ESG information at all.

Third, our study did not include the possibility of ESG investment products being more costly. While the interaction of higher fees for sustainable investments with our information treatments cannot be completely disregarded, the existing literature indicates a willingness to pay higher fees for funds with a sustainability mandate (Engler et al., 2023; Heeb et al., 2023; Riedl and Smeets, 2017). At the same time, sustainable investors seem to be more sensitive to paying higher fees when funds lack an explicit sustainability mandate (Sjuve, 2022). Future research should therefore evaluate how fees and information interact in shaping investors' decisions to invest in ESG products.

A fourth potential limitation is that we observe investments not in actual capital markets, but in a controlled experimental context with self-selected retail investors and a sample reflecting the Austrian general population. To enhance external validity, we designed our experiment in close cooperation with eight banks and the Austrian Financial Market Authority to ensure that it closely simulates a real investment decision. Our incentivized design, involving actual investments in the stock market, represents a methodological advancement over studies without such realistic incentives, again aimed at closely mimicking investors' potential payoffs. Finally, our study used a comparatively large and diverse sample of investors and non-investors, all of whom are potentially affected by the new EU regulation.

6. Conclusion and policy implications

The present research was conducted in collaboration with the Austrian Financial Market Authority and Austrian banks, and examines different legally possible implementations of EU regulation (EU) 2021/2616, designed to foster ESG investments. Our results show that providing retail investors with information regarding the financial returns *or* the ESG impact of sustainable investment products will likely increase ESG investments. We find that combining both information sets has no additional effect. Contrary to worries sometimes advanced by banks and investment advisors, a specific and more complex mode of eliciting ESG preferences does not influence ESG investments or investor satisfaction compared to a general, simpler mode.

Our results also indicate that more ESG information affects the general population more strongly than it does experienced investors. Without more information, many (potential) investors with sustainability preferences might remain unaware of sustainable investment options (Gutsche and Zwergel, 2020; Wins and Zwergel, 2016) causing the value-action gap observed in some investment decisions (Brunen and Laubach, 2022; Kollmuss and Agyeman, 2002).

The present results allow the conclusion that investors prefer ESG funds with a legally based definition of sustainability (mutual funds adhering to the EU Taxonomy; EU Regulation (EU) 2020/852) compared to other such definitions. Clear legal ESG definitions (maybe communicated with labels, Degryse et al., 2023; Gutsche et al., 2023) allow investors with less knowledge about sustainable finance to feel protected from greenwashing or cheap talk (UNCTAD, 2021). We believe that future research and practice should develop and apply measures to increase investors' knowledge about ESG investments and sustainable finance, in other words, promote "sustainable finance literacy". Greater sustainable finance literacy could improve the understanding of ESG investments which could in turn increasing investors' general appetite for stocks over less profitable traditional savings options.

Although our research presents an optimistic view of the effectiveness of new ESG regulations, we wish to note several pitfalls. Investors seem to prefer clear (legal) ESG definitions. At present, a large variety of (un-)standardized ESG ratings exist, and especially for small investment managers, obtaining a trustworthy rating for their products may be prohibitively expensive. Due to a lack of clear definitions and maybe also due to a lack of knowledge, financial advisors might thus be hesitant to suggest ESG investments. Studies show, however, that ESG indices not only outperform benchmark indices concerning their impact in relation to the UN's Sustainable Development Goals (SDGs), but also offer at least similar financial performance (Bekaert et al., 2023; Pastor et al., 2021). Yet, advisors might not be aware of these studies or might not trust the examined ESG definitions and products, causing them to perceive a possible conflict with their fiduciary duties (i.e., to offer their clients the "best" investment advice), making them reluctant to recommend ESG investments. The establishment of a clear ESG definition (system) and further education of financial advisors concerning ESG investment options thus seems to be crucial.

The present study shows that more information may increase investors' readiness to invest in ESG products. The materials used in this study comply with regulation (EU) 2021/2616, making them suitable for financial advisors' use. Nonetheless, greater regulatory effort and research are necessary to fully harness the potential of ESG investments in environmental protection and the combat against climate change.

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Chapter 3: Sustainable finance literacy predicts investment behavior beyond general financial literacy: Evidence from two representative samples (Submitted to: *The Review of Financial Studies*)

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Sustainable finance literacy predicts investment behavior beyond general financial literacy: Evidence from two representative samples

Abstract

We investigate sustainable finance literacy (SFL) as a complementary concept to general financial literacy. Study 1 uses a representative sample (N = 1,047) to develop a well-founded SFL inventory and confirms a relationship to self-reported sustainable investments. Study 2 uses an incentivized, framed field experiment (N = 1,510) to demonstrate that SFL is related to greater stock market investments and sustainable investments, and lower potentially greenwashed investments. SFL has more explanatory power than does general financial literacy. This is true for both experienced investors and non-investors. Our results underscore the pivotal theoretical and practical role of SFL for informed investments.

JEL Classification: G11, G41, G53

Keywords: Sustainable finance literacy; inventory; ESG investments; sustainable investments; stock market investments; greenwashing; incentivized; framed field experiment; preregistered;

Code availability: The anonymized experimental data generated and analyzed in the current study as well as scripts that generate and visualize the results reported in this study are fully available at the Harvard Dataverse repository at: https://doi.org/10.7910/dvn/u6thkg.

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Indication of own contribution: Chapter 3 builds on the same project on financial advice at the Institute for Advanced Studies (IHS) discussed in Chapter 2. I coined this chapter with its focus on sustainable finance literacy and greenwashing, topics in which I have a strong interest. In Study 1, I led the development of items to measure sustainable finance literacy through an iterative process with Aja Ropret Homar and Katharina Gangl. I was responsible for recruiting twelve experts, coordinating the feedback rounds on the items, and implementing the suggested improvements. I drafted the initial version of the preregistration, which was subsequently reviewed by Aja Ropret Homar. Katharina Gangl supported the selection of factor analysis models, while I was responsible for the formal analysis. For Study 2, I was primarily responsible for designing the survey, with input from Katharina Gangl and Stefan Palan. This process involved selecting the funds for the incentivized investment decision using Refinitiv EIKON, discussing ethical considerations with colleagues from the Vienna University of Economics and Economics, and writing the applications for approval by the Ethics Committee and the data protection officer, as well as the preregistration. I independently handled the formal analyses, which included selecting statistical tests, conducting analyses and interpreting the results. I wrote the original draft of the manuscript, which was later edited by my coauthors. As first and corresponding author, I prepared the replication codes for OSF, wrote the letter to the editor, and submitted the manuscript to the journal.

1. Introduction

Financial literacy is crucial for sound financial decision-making. Extensive research underscores the importance of both basic financial literacy (understanding of fundamental financial and economic principles) and advanced financial literacy (understanding of financial markets) in guiding financial decisions and stock market participation (Almenberg & Dreber, 2015; Lusardi & Mitchell, 2014; Van Rooij et al., 2011). Recently, sustainable investments that integrate Environmental, Social, and Governance (ESG) dimensions have gained relevance and have come to play a central role in achieving the United Nations' Sustainable Development Goals and the Paris Agreement (Bauer et al., 2021; Eurosif, 2018; Hartzmark & Sussman, 2019; UNDP, 2023; UNFCCC, 2018). From an investor's perspective, however, the integration of ESG considerations introduces a new layer of complexity, potentially requiring new knowledge – or literacy (Filippini et al., 2024; Löfgren & Nordblom, 2024; Pedersen et al., 2021). This raises a crucial question: Is sustainable finance literacy (SFL) already captured by existing literacy measures or does it complement them?

SFL encompasses an adept understanding of sustainable finance, including its fundamental terms, regulatory frameworks, products, investment strategies and performance, and potential impact on ESG factors and the economy. While widely used concepts and therefore inventories for basic financial literacy by Lusardi and Mitchell (2008) and for advanced financial literacy by Van Rooij et al. (2011) exist, they do not encompass SFL. Among the available definitions and measures of SFL (Degryse et al., 2023; Strauß et al., 2023; Yucel et al., 2023), only few were developed using a stringent scientific approach (Filippini et al., 2024, for example the one from Filippini et al. (2024), in which SFL is assessed with a set of multiple-choice questions. Consequently, there are few empirical studies on SFL, and the theoretical and practical relevance of SFL as a complement to general financial literacy remains unclear.

Significant gaps also prevail in our understanding of the relationship between SFL and broader financial behaviors, including not only sustainable or greenwashed investments, but also stock market participation more generally. Research has found greater SFL to be associated with more sustainable investments, because SFL reduces information barriers (Filippini et al., 2024; Gutsche et al., 2023; Wins & Zwergel, 2016), misperceptions (Meunier & Ohadi, 2022) and perceived information costs, which are significant factors in investment behavior (Balloch et al., 2015; Campbell, 2006; Meunier & Ohadi, 2022). A lack of SFL might impair the translation of sustainability preferences into investment decisions, especially for individuals with lower financial literacy (Anderson & Robinson, 2022). However, the empirical evidence on the relationship between SFL and sustainable investments is not unequivocal. While two studies, based on data from the US and UK (Meunier & Ohadi, 2022) and from Switzerland (Filippini et al., 2024), respectively, find that SFL is related to self-reported sustainable investments, a study based on Eurobarometer data reports no significant relationship between participants' SFL and their intention to invest in sustainable products (Olumekor & Oke, 2024).

Greater SFL can also be expected to be associated with fewer potentially greenwashed investments and a greater ability to distinguish between truly green investments and assets that are only marketed as being green (i.e., "greenwashed" assets, cf. Gatti et al., 2021; Kleffel & Muck, 2023). In the investment domain, prior research suggests that product names can be used to mislead investors (Anderson & Robinson, 2022; Cooper et al., 2005), a practice that could be countered by SFL. By raising awareness for potential greenwashing issues, SFL could allow investors to recognize misleading information. Studies in non-investment related domains show that literacy interventions enable consumers to differentiate between genuinely green and greenwashed products (Fernandes et al., 2020).

Greater SFL may also be related to higher stock market participation, since better knowledge about the availability of ESG investments, which allow investors to pursue non-financial goals, may help overcome negative perceptions of the stock market (Dobni & Racine, 2015, 2016) and of stockholders (Henkel & Zimpelmann, 2023). Similarly, SFL could mitigate stock market aversion (Kaur & Vohra, 2012; Kaustia & Torstila, 2011; Keller & Siegrist, 2006) and attract ethically-minded individuals who would otherwise shy away from the market (Brunen & Laubach, 2022). In concordant evidence, Briere and Ramelli (2021) report that offering sustainable investment options in French employee savings plans increases equity investments.

This paper addresses two research questions arising from the gaps in the literature. First, how does SFL relate to financial decisions, such as stock market investments in general, sustainable investments, and greenwashed investments? Second, is SFL already subsumed by, or does it rather complement existing measures of basic and advanced financial literacy? Answering these questions will allow us to determine the theoretical and practical importance of the emerging concept of SFL on its own as well as relative to other financial literacy concepts. To study our questions, we deliberately chose Austria. As a member country of the European Union, Austria offers a rich context of established sustainability regulations and frameworks, such as the EU Taxonomy and Austria's state-issued sustainability label for financial products, the Austrian Eco-Label (UZ49). Additionally, this setting facilitates the development of an SFL inventory that can be adapted and expanded for use in different international contexts.

To address our research questions, we conducted two preregistered and ethics approved survey studies.[23] In Study 1, we developed a brief inventory to measure SFL. Our choice of items was based on the literature, existing measures, three rounds of systematic consultations with 12 financial experts, and on statistical analyses (exploratory and confirmatory factor analyses, analysis of discrimination, difficulty, homogeneity)

[23] Preregistered at Open Science Framework (OSF): https://osf.io/ycu3x (Study 1) and https://osf.io/ejzr7 (Study 2). We marginally deviate from the preregistrations. In Study 1, we keep participants who passed two of three attention checks in the sample and exclude those who answered *I don't know* on all 30 SFL questions. Both in Study 1 and 2, we include household income as a binary variable using a median split (low vs. high) to allow for easier interpretation. The procedures were approved by the Ethics Committee of the Institute for Advanced Studies (Case 05, 05.06.2023; Case 12, 09.10.2023).

of data from a representative sample (N = 1,047). We furthermore used Study 1 to replicate previous studies that show that SFL is related to self-reported sustainable investments. We find that SFL and advanced financial literacy are two relevant but distinct predictors of participants' self-reported investments in financial markets in general and in sustainable assets in particular.

In Study 2, we investigate whether SFL is predictive of stock market investments, sustainable investments, and potentially greenwashed investments in a framed field experiment involving an incentivized investment decision (based on Gutsche et al., 2023 and Seifert et al., 2024). Using another representative sample of the Austrian population (N = 1,510), we asked participants to allocate 500 euros across a savings account and four different mutual funds – two traditional funds, one sustainable fund, and one fund that is marketed as sustainable but faced greenwashing allegations and changed its marketing messaging as a result. By contrasting the effect sizes and explained variance of SFL with advanced financial literacy (Balloch et al., 2015; Van Rooij et al., 2011), we sought to determine SFL's unique explanatory power in shaping investment decisions. We did so while controlling for several other variables that may be related to investment decisions, e.g., biospheric value orientation, risk preferences, investment experience, income, and education. At the end of the experiment, we debriefed the participants on the greenwashing allegations regarding one fund and allowed them to revise their investment decision, which then determined their final pay-off.

Study 2 shows that SFL is robustly associated with higher stock market investments, more sustainable investments, and less potentially greenwashed investments in a German-speaking sample. While SFL and advanced financial literacy correlate, SFL is associated with greater effect sizes and additional variance explained in the three incentivized outcome variables. We show that these results are robust to several specifications, and remain qualitatively similar when replicated with self-reported investment behavior outside of the experiment. We furthermore find similar effects of SFL among financial market participants and non-participants, indicating that investment experience is not a major driver of our findings (Hastings et al., 2013; Lusardi & Mitchell, 2014). Participants with high SFL are four times as likely to correctly identify the allegedly greenwashed fund in a follow-up question. Interestingly, after learning about the greenwashing allegations, a majority of participants do not adjust their investments. Those who do shift investments towards the genuinely sustainable fund and the savings account but not towards conventional funds.

Our findings contribute to several strands of literature. First, we complement prior research on the measurement of financial literacy which to date has rarely included ESG aspects (Balloch et al., 2015; Lusardi & Mitchell, 2008; Van Rooij et al., 2011). Additionally, we enrich the emerging literature on sustainable finance and on financial literacy by developing an inventory to measure an individual's level of SFL that is well-founded in theoretical, statistical and practical terms (Degryse et al., 2023; Filippini et al., 2024). Our inventory provides a reliable tool for use in future studies, either as a stand-alone instrument or integrated into advanced financial literacy instruments, allowing researchers to identify potential relationships between SFL and, e.g., pro-environmental or financial behaviors.

Second, our findings add to the literature on the interplay between financial literacy and broader investment behavior. We identify SFL as a key determinant of stock market investments and sustainable investments. Particularly, we go beyond previous studies that investigated the relationship between SFL and sustainable investments using self-reported investment behavior or hypothetical decisions (Degryse et al., 2023; Filippini et al., 2024). To the best of our knowledge, our study is the first to study the effects of SFL on incentivized investment decisions, controlling for conventional advanced financial literacy.

Third, we contribute to the growing literature on greenwashing (Fernandes et al., 2020), including its manifestation in financial products (Gatti et al., 2021; Kleffel & Muck, 2023; Klein et al., 2022), which has recently received increased attention among regulators (see, e.g., European Banking Authority, 2023). As a novelty compared to related studies (Degryse et al., 2023; Filippini et al., 2024), we are the first to show that greater SFL is associated with lower potentially greenwashed investments. Giving investors the choice of investing, as one option, into a fund that has actually faced greenwashing allegations, represents a methodological contribution to the literature. The lack of revision in investment decisions despite greenwashing allegations aligns with other studies indicating that the willingness to pay for the impact of ESG investments does not scale with the absolute level of impact (Heeb et al., 2023). These findings suggest that investors may be driven by warm glow more than by actual ESG impact.

In terms of practical implications, our results show that SFL, through its association with investment behavior, might be a prominent factor to study when aiming to increase individual and societal welfare. In particular, stock market participation is linked to financial well-being and retirement provision (Bucher-Koenen et al., 2021; Lusardi & Mitchell, 2014), and sustainable investments are relevant for societal welfare (Hong et al., 2023) and the sustainability transition (e.g., European Commission, 2024, Eurosif, 2018). Being able to identify greenwashing, finally, is important for informed financial decision-making, since it reduces an investor's vulnerability to being misled, allowing them to avoid products that do not align with their sustainability preferences or that in the future may face greenwashing allegations, which could lead to lower resale values (Du, 2015; Gatti et al., 2021). Measuring SFL with a brief inventory will allow practitioners (e.g., financial advisors) to tailor their advice to investors' SFL levels. In addition, measuring SFL provides policymakers with the possibility to evaluate and inform financial literacy strategies.

2. Measuring SFL and predictions of self-reported investment behavior (Study 1)

The goal of our first study is twofold. First, we develop a short inventory to measure SFL. Second, we investigate its relationship with the self-reported ownership of (sustainable) investment products. We particularly focus on assessing SFL's importance relative to other concepts such as basic and advanced financial literacy as well as sustainability literacy, i.e., knowledge about sustainability in general. This section starts by discussing how we developed our SFL questionnaire. We proceed by describing all items we elicited. Appendix C presents the questionnaire.

2.1. Method

We undertook several steps to develop and select SFL questions that cover the topic of sustainable finance comprehensively and are relevant for practice. These steps included consulting the literature and 12 experienced experts, as well as conducting qualitative pre-tests and a quantitative data collection, as detailed in the following sections.

2.1.1. Development of the SFL question pool

We base our questions on the previous literature and on existing SFL measures used in sustainable finance (Degryse et al., 2023; Filippini et al., 2024; Klein et al., 2022; Meunier & Ohadi, 2022), on industry reports (HSBC, 2020), on various learning materials from the Austrian Federal Ministry for Climate Action, and on questions used in online quizzes on sustainable finance (e.g., by UBS). Three co-authors of the paper independently developed questions taking the form of true or false statements to measure SFL, resulting in 73 different questions (in German). Through an iterative process, the question set was refined from 73 to 30 question by eliminating duplicates, consolidating similar questions, and discussing the relevance of the questions among the researchers, aiming to produce questions that evoke neither positive nor negative feelings or beliefs about the topic. These questions address diverse dimensions such as definitions, regulation, greenwashing, investment strategies, financial market products, ESG impact, financial performance, and sustainable financial products.[24] The set of 30 questions was then presented to 12 experienced experts from 9 institutions, including the Austrian Financial Market Authority and the Green Finance Department of the Environment Agency Austria, who rated the questions on relevance (1 = not relevant, 5 = very relevant), and commented on their comprehensibility, content, and precision (Table A.1 in the Appendix provides an overview of all institutions and review rounds). The expert feedback ensured the relevance, robustness and correctness of the concepts covered, as well as the near- to mid-term validity of the statements in the context of forthcoming regulations or changes in regulations. We used a pretest, based on ratings of 10 researchers in economics and economic psychology to make small refinements concerning clarity and comprehensibility. The statements presented in the questions were true in 20 questions and false in 10 questions. The predominance of true questions increases comprehensibility, whereas the inclusion of false questions ensures necessary variation in answering patterns. We provide detailed information about the 30 questions, including English translations and the description of the translation process in Table A.2 in the Appendix.

2.1.2. Measured variables

SFL, basic and advanced financial literacy, and sustainability literacy. We included our 30 SFL questions in the survey with the aim of developing a shorter inventory with a reduced number of questions. To allow for factor analyses later in the data collection process, all 30 questions shared the same scale, i.e., responses to the question "How likely is this statement true or false", collected on a 5-point Likert-scale,

[24] Our design considers all three ESG factors. However, to simplify the terminology, we use the term "greenwashing", as it is more commonly used than, e.g., "bluewashing", which focuses on social aspects.

with the labels 1 = *definitely false*, 2 = *likely false*, 3 = *undecided*, 4 = *likely true*, 5 = *definitely true*, plus the option of answering "*I do not know*". The ten false statements were recoded for data analysis. To compare SFL to other concepts, we measured basic financial literacy (three questions; Lusardi and Mitchell, 2008), advanced financial literacy (three questions, van Rooij et al., 2011), and sustainability literacy (three questions, based on Filippini et al., 2024). We then mapped the correct number of correct answers relative to the number of questions to a range from 0 to 1 all four literacy measures. We also measured subjective basic and advanced financial literacy, subjective SFL, and subjective sustainability literacy (Brunen & Laubach, 2022; Dobni & Racine, 2015; Gutsche et al., 2023).

Self-reported investment behavior. We asked participants to indicate what type of investments they own (e.g., savings accounts, cash, stocks, bonds, funds). Participants who owned stocks, bonds, or funds were categorized as financial market participants (0 = *no*, 1 = *yes*). We assessed self-reported sustainable investments by asking participants whether they hold sustainable investments and categorized those holding sustainable stocks, bonds, or funds as sustainable financial market participants.

Explanatory and other variables. As further control variables analyzing the determinants of (sustainable) investment behavior, we measured the hassle factor, i.e., the perception that (sustainable) investing is complicated (Sivaramakrishnan et al., 2016), financial experiences and behaviors, environmental attitudes (derived from van der Werff et al., 2013 and behaviors (Heeb et al., 2023), and sociodemographic characteristics (gender, age, income).

2.1.3. Participants

We commissioned an international market research agency (TalkOnline Panel GmbH) to collect data from a representative sample for Austria with quotas for age (above 18 years) and gender in March 2023. This sample (N = 1,047) consisted of 51.00% women and had an average age of 49.38 years (SD = 17.09). Overall, 32.95% of the respondents reported having a university degree, which is higher than the Austrian average of 15.30%. The median net household income (*Median* = 4.0, corresponding to 3,001 to 4,000 euros) was slightly higher than the median net household income of 2,879 euros in Austria in 2022 (Statistics Austria, 2023). A total of 43.84% of the participants were financial market participants, defined by current ownership of funds, stocks, or bonds, and about 25% of the full sample also owned sustainable financial market products. The sample covered a wide range of investment experiences, ranging from no experience (40.69%) to our top category of more than eleven years of experience (19.58%). The sample size of 33 participants per question exceeds even the most conservative rule of thumb for scale development, which is 20:1 participants per question of the inventory (Morgado et al., 2017).

2.1.4. Procedure

Participants who accepted our invitation to a study on investment decisions were directed to the online survey (in German) on the survey platform *Limesurvey*, where they first received general instructions and accepted the terms of participation and the privacy policy. The survey consisted of nine sections. We presented the questions on (sustainable) finance literacy and sustainability literacy in random order.

Participants received a standard participation fee through the market research agency and the median participant took 11.9 minutes to complete the survey.

2.2. Results

2.2.1. Development of the SFL inventory (Study 1)

To assess the suitability of our items, we analyze the discrimination index (i.e., how well the item can discriminate between participants with low and high literacy) and the difficulty index (also called item easiness, i.e., how challenging an item is for the participants) of all questions (Ebel & Frisbie, 1972; Gronlund & Linn, 1990). Of the 30 SFL questions (more details in Appendix A.2, Table A.3), three questions (Q9, Q21, Q23) have a discrimination index below 0.19. Scores below 0.20 indicate that questions do not reliably discriminate between high and low overall scores, i.e., between participants with low and high SFL. These three questions furthermore had low difficulty indices (i.e., too low item easiness), suggesting that they are too difficult to answer, thus making them candidates for deletion. The remaining 27 questions are suitably discriminative, with an appropriate difficulty level.

To develop a shorter version of the inventory (Table 9), we selected the three "true" questions (5, 16, 12) and the two "false" questions (26, 19) with the highest discrimination indices, and added two additional questions (3, 4) that were considered important by the external experts (expert ratings are shown in Table A.3. in the Appendix). We further grounded the selection of questions for the short inventory in the exploratory factor analysis by including questions with high factor loadings (Appendix A.3). The seven-question inventory includes two country-specific questions regarding regulations within the European Union and the Austrian Eco-Label for use in Austria. We would recommend adapting these two questions to local circumstances when the short inventory is used in other locales (Q4 is Austria-specific and Q5 is EU-specific).[25]

The reliability of this seven-item inventory, with two items reverse-coded and recoded for all analyses, is Cronbach $\alpha = 0.62$ (the five "true" questions have a reliability of $\alpha = 0.72$). The descriptive characteristics ($M = 3.68$; $SD = 1.11$; Median = 4.00, Kurtosis = -0.34) indicate that the instrument is suitable for reliably assessing SFL. The seven-item inventory also provides a comparably good measurement of SFL as the 27-item version, since the correlation between the results of both inventories is very high (Spearman's Rho $r_s = 0.87$, $p < 0.001$).

[25] For international use (i.e., outside of Austria / the European Union), we additionally provide a 5-question measure omitting two country-specific questions. These could, alternatively, be adapted to the local context, e.g., by replacing the Austrian Ecolabel in Q4 with a label used in the target country. Table B.10 in the Appendix presents the primary analyses from Study 2 using the 5-question inventory, revealing comparable effect sizes to those observed with the 7-question inventory.

Table 9. German original and English translation of the short SFL inventory questions.

	German	English	True /false
Q3	Greenwashing bedeutet, dass ein Finanzprodukt beispielsweise als umweltfreundlich beworben wird, obwohl Umweltaspekte bei der Veranlagungsstrategie kaum oder nicht berücksichtigt werden.	Greenwashing means that a financial product is, for example, advertised as environmentally friendly, even though environmental aspects are hardly or not at all considered in the investment strategy.	true
Q4	Qualitätssiegel (Labels) wie das Österreichische Umweltzeichen (UZ49) sollen sicherstellen, dass ein Anlageprodukt festgelegten Nachhaltigkeitskriterien entspricht.	Quality labels such as the Austrian Eco-Label (UZ49) aim to ensure that an investment product complies with defined sustainability criteria.	true
Q5	Die EU-Taxonomie ist ein Klassifikationssystem, das festlegt, welche wirtschaftlichen Tätigkeiten als ökologisch nachhaltig (= grün) angesehen werden.	The EU Taxonomy is a classification system that defines which economic activities are considered environmentally sustainable (= green).	true
Q12	Durch Ausschlusskriterien können Staaten, Branchen bzw. Unternehmen, die bestimmte ESG-Kriterien nicht erfüllen, von der persönlichen Veranlagung ausgeschlossen werden.	Exclusion criteria can be used to exclude countries, sectors or companies that do not fulfill certain ESG criteria from personal investments.	true
Q16	Nachhaltige Anlageprodukte können neben Einzelaktien auch Anleihen, Investmentfonds oder Indexfonds bzw. ETFs (Exchange Traded Funds) sein.	Besides individual shares, also bonds, investment funds, or index funds and ETFs (Exchange Traded Funds) can be sustainable investment products.	true
Q19	Die Gebühren für nachhaltige Anlageprodukte sind immer deutlich höher als für konventionelle Anlageprodukte.	The fees for sustainable investment products are always significantly higher than those for conventional investment products.	false
Q26	Die Gewinne sind bei nachhaltigen ESG-Finanzprodukten deutlich geringer als bei konventionellen Finanzprodukten.	The returns are significantly lower for sustainable ESG financial products than for conventional financial products.	false

Note. This table shows the German original and translated versions of the seven questions included in the short version of the inventory.

Participants on average answered 3.5 out of 7 (*Median* = 4) SFL questions correctly ($M = 0.51$, $SD = 0.27$, i.e., 51% of the 7 questions). Table A.5 reports the share of correct responses to each of the 30 questions; Table B.2 shows the number of correct responses in Study 1 and Study 2 for the short inventory. Of the basic financial literacy questions, participants answer an average of 2.11 out of 3 correctly (*Median* = 2; in percentage terms: $M = 0.70$, $SD = 0.30$), of the advanced financial literacy questions 2.2 out of 3 (*Median* = 2; $M = 0.72$, $SD = 0.32$), and of the sustainability literacy questions 1.17 out of 3 (*Median* = 1; $M = 0.39$, $SD = 0.25$). SFL correlates positively with basic financial literacy ($r_s = 0.33$, $p < 0.001$), advanced financial literacy ($r_s = 0.39$, $p < 0.001$), and sustainability literacy ($r_s = 0.25$, $p < 0.001$).

Regarding construct reliability, Table 10 shows that the results of the 7-item inventory are positively correlated with basic and advanced financial literacy (both subjective and objective), sustainability literacy, investment experience, education in economics, and ownership of (sustainable) investment products.

Table 10. Correlation of SFL with related concepts.

	M (SD)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1.SFL (7 questions)	0.51 (0.27)															
2.SFL (27 questions)	0.50 (0.22)	0.87														
3.SFL (5 questions)	0.48 (0.28)	0.92	0.78													
4.Basic FL	0.70 (0.30)	0.33	0.35	0.34												
5.Advanced FL	0.72 (0.32)	0.39	0.41	0.41	0.48											
6. Sustaina-bility literacy	0.39 (0.25)	0.25	0.27	0.24	0.24	0.27										
7.Subjective SFL	0.40 (0.24)	0.30	0.35	0.26	0.21	0.23	0.12									
8.Subjective basic FL	0.55 (0.22)	0.31	0.37	0.28	0.26	0.28	0.12	0.64								
9.Subjective advanced FL	0.44 (0.22)	0.33	0.38	0.30	0.25	0.29	0.09	0.76	0.74							
10.Subjective sustainability literacy	0.54 (0.22)	0.28	0.32	0.25	0.18	0.19	0.22	0.54	0.50	0.44						
11. Investment experience	2.65 (2.75)	0.27	0.33	0.27	0.28	0.34	0.07	0.38	0.36	0.49	0.16					
12. Education	4.75 (1.96)	0.18	0.20	0.19	0.12	0.15	0.20	0.17	0.21	0.21	0.24	0.16				
13. Education in economics	2.65 (1.08)	0.21	0.24	0.20	0.22	0.21	0.09	0.32	0.42	0.42	0.22	0.28	0.21			
14. Financial market participant	0.44 (0.50)	0.28	0.29	0.29	0.31	0.33	0.14	0.32	0.30	0.41	0.15	0.61	0.16	0.19		
15. Sustainable financial market participant	0.25 (0.43)	0.22	0.25	0.22	0.17	0.20	0.13	0.34	0.20	0.31	0.19	0.41	0.10	0.14	0.58	

Note. This table presents the correlations between measures of SFL and related concepts of financial literacy (FL). *M* = mean, *SD* = standard deviation. All correlations computed using Spearman's Rho. Correlations with $r_s > 0.10$ are significant at $p < 0.001$, correlations below this threshold are significant at least at $p < 0.05$.

2.2.2. Confirmatory factor analysis

A confirmatory factor analysis (CFA) using the data collected in Study 2 reveals that all items consistently measure a single underlying concept, confirming SFL as a homogeneous construct. The CFA indicates an acceptable fit (Hu & Bentler, 1999), with a Root Mean Square Error of Approximation (RMSEA = 0.07) and a Standard Root Mean Residual (SRMR = 0.04) that remain below the recommended cut-off of 0.08. The Comparative Fit Index (CFI = 0.91) is above the acceptable cut-off of 0.90, while the Tucker-Lewis-

Index (TLI = 0.86) falls slightly short of the acceptable cut-off of 0.90. The model's Chi-Square test is significant (Chi-square(14) = 120.19; $p < 0.001$), which, however, is common with larger samples. Modeling the true and false questions as two separate factors to account for the factor structure found in the exploratory factor analysis (Table A.4) results in a good fit (RMSEA = 0.04, SRMR = 0.03, CFI = 0.97, TLI = 0.95), except for the Chi-square(13) = 49.60, $p < 0.001$.

2.2.3. Sustainable finance literacy and self-reported investment behavior

To test for the relationship of SFL with self-reported investment behavior, we calculated logistic regression analyses (Table A.6 in the Appendix) based on the sample of Study 1. The results show that both SFL and advanced financial literacy increase the likelihoods of being a financial market participant and of holding sustainable investments. Basic financial literacy relates only to financial market investments, but not strongly to holding ESG investments. Sustainability literacy does not significantly relate to either outcome variable. Thus, to determine the relative relevance of SFL for investment behavior, it should be compared to advanced financial literacy.

2.3. Discussion

Study 1 aimed at developing an inventory to assess SFL and to investigate its relevance relative to other concepts of financial literacy in self-reported investment behavior. Our analyses suggest a 7-question short inventory to assess SFL. However, as all questions load on one factor (except for the "false" questions) and have sufficient discriminatory power, the 27-question long measure or other short versions such as the 5-question inventory could similarly be used to measure SFL. The results indicate that SFL correlates highly with self-reported ownership of (sustainable) investment products. Overall, among the other concepts, advanced financial literacy correlates with these outcome variables to a similar degree, while basic financial literacy and sustainability literacy displayed less explanatory power. Thus, in Study 2 we focus on the effect sizes of SFL and advanced financial literacy.

3. The importance of SFL for investment behavior (Study 2)

Study 2 investigates whether SFL drives stock market investments, sustainable investments, and potentially greenwashed investments, with the aim of studying the relevance of SFL relative to that of advanced financial literacy, both in incentivized and in self-reported investment decisions. To this end, we conducted a framed field experiment including an incentivized investment decision (as per Gutsche et al., 2023). The questionnaire is reproduced in Appendix D.

3.1. Method

3.1.1. Measured variables

Incentivized investment decision. Our three main outcome variables related to the initial investment decision were stock market investments (percentage of the endowment allocated to four funds as opposed to the savings account), sustainable investments (percentage of stock market investments allocated to the

two funds marketed as sustainable) and potentially greenwashed investments (percentage of sustainable investments allocated to the allegedly greenwashed fund).[26]

Participants allocated 500 euros to four funds and a savings account. This design extends the decision space of previous studies like Gutsche et al. (2023) and Seifert et al. (2024) by allowing investments in a risk-free savings account (as in Kleffel and Muck, 2023). Figure 10 shows the options: two conventional funds without a sustainability objective (Funds A and B), one sustainable fund (Fund D), one sustainably marketed but potentially greenwashed fund (Fund C) and a savings account. Fund C was a historical example of documented greenwashing allegations against an investment fund.[27] We discussed this procedure and the fund selection (Appendix B.1) with the Austrian Financial Market Authority (FMA) and the Consumer Advocacy Austria (VKI). The funds were identical in terms of the risk and performance information we provided to the participants, but differed in ESG considerations and economic sectors (as per Seifert et al., 2024). Most sustainability ratings of the allegedly greenwashed fund are similar to those of the conventional funds. Fund names were not made explicit to ensure that decisions were based solely on the provided information. In line with other experiments (Gutsche et al., 2023; Heeb et al., 2023; Lagerkvist et al., 2020), we limited information to avoid overload and to keep the experiment reasonably short. We used information that is usually accessible to retail investors (e.g., MSCI or Cleanvest ratings), rather than non-public rating sources (like the Refinitiv EIKON ESG rating), which are typically available only to institutional investors.

Revised investment decision. After debriefing participants about the greenwashing allegations against Fund C towards the end of the survey, we allowed them to revise their investment decision. Presenting them again with the funds in Figure 10, we measured stock market investments, sustainable investments and potentially greenwashed investments in the revised decision. This procedure allowed us to calculate the

[26] We assigned a value of zero to sustainable investments for participants who did not invest in the stock market to avoid divisions by zero. We adopted this procedure because we focus on sustainable investments among all potential investors who could contribute to the sustainability transition. Notably, 85.36% of all participants invested a positive amount in the funds.

[27] In 2022, the Baden-Württemberg Consumer Center, a German non-profit consumer protection organization, levelled greenwashing allegations against Fund C, leading the fund's issuer to sign a cease-and-desist declaration and to change the fund's marketing material, while not admitting to any misconduct. The allegations involved non-transparent advertising and excessive claims, e.g., that investors in the fund were investing "specifically in the achievement of climate goals" and they would "help counteract climate change through targeted investment". Original statement in German: https://www.verbraucherzentrale-bawue.de/pressemeldungen/presse-bw/klage-gegen-dws-wegen-greenwashing-78104. German report on cease-and-desist declaration: https://www.ecoreporter.de/artikel/greenwashing-verdacht-dws-unterschreibt-unterlassungserkl%C3%A4rung/. Reuters report in English: https://www.reuters.com/business/finance/deutsche-banks-dws-sued-by-consumer-group-over-alleged-greenwashing-2022-10-24/.

differences in the three outcome variables as well as in the amounts allocated to each of the products before and after learning about the greenwashing allegations.

Self-reported investment behavior. We elicited self-reported investment behavior for financial market investments, sustainable investments, and potentially greenwashed investments. For self-reported financial market investments, participants indicated whether they own financial assets such as stocks, bonds or funds and the total amount of financial products relative to their overall wealth (1 = *1 to 24%*, up to 5 = *100% - I only own financial assets such as stocks or funds*). Non-owners were coded 0 = *0% - I do not have stocks, bonds, funds* in this question. For self-reported sustainable investments, participants reported the percent share of sustainable assets among their financial assets (stocks, bonds, funds) in a single choice question (1 = *0% - I do not own sustainable assets*, 2 = *1 to 24%*, 3 = *51 – 75%*, 4 = *76 – 99%*, 5 = *100% - I only own sustainable assets*). For self-reported greenwashed investments, we used a proxy question, since investors are likely often unaware of owning a greenwashed product (*When purchasing a sustainable investment, I seek additional information (e.g., eco-labels, sustainability ratings, independent reports) to ensure that the environmental promises are true);* anchored at 1 = *always*, 5 = *never* (reversed)).

Fund	Fund A	Fund B	Fund C	Fund D	Savings account
Short description	This fund invests in equity and equity-related securities of small and mid-cap companies in the energy sector and seeks capital growth.	This fund invests in companies in the oil & gas, service, power, gas, and other sectors of the energy industry.	This fund invests in companies through which investors make targeted investments to achieve climate goals and help counteract climate change through targeted investing.	This fund invests in companies that seek to reduce energy-related greenhouse gases and/or are sustainable according to ESG criteria.	This savings account offers the opportunity to invest money for one year tied at a fixed rate of interest.
Sustainability-related disclosure according to SFDR	Article 6 - Fund without consideration of sustainability criteria	Article 6 - Fund without consideration of sustainability criteria	Article 8 - Fund that promotes environmental or social characteristics	Article 9 - Fund that has a sustainable investment objective	-
Sustainability label	none	none	none	Austrian Eco-Label (UZ49), FNG-Label	-
Cumulative performance over the last 3 years	more than 12%	more than 12%	more than 12%	more than 12%	2% interest per year
Risk and return profile	Medium risk	Medium risk	Medium risk	Medium risk	-
Fund volume (in euros)	> 136 million	> 136 million	> 136 million	> 136 million	-
Fees	ca. 2% per year	ca. 2% per year	ca. 2% per year	ca. 2% per year	none
Geographical orientation	global	global	global	global	not specified
Compliance with EU-taxonomy	0% taxonomy-compliant	0% taxonomy-compliant	0% taxonomy-compliant	31% taxonomy-compliant, 50% taxonomy-able	not specified
Cleanvest ESG-Rating (1 = low, 10 = high)	5,6 out of 10	5,2 out of 10	7,0 out of 10	8,2 out of 10	not specified
Carbon intensity (per million US-Dollars invested)	327.3 tons	199.8 tons	241.1 tons	163.3 tons	not specified
Top 10 holdings (share of fond volume in %)	Galp Energia (6,5%) USD Cash (4,38%) Ovinitiv Inc (3,87%) Harbour Energy (3,63%) Shell (3,49%) Marathon Oil (3,45%) Drax Group (3,35%) Baker Hughes (3,21%) Equinor Asa (3,21%) John Wood Group (2,99%)	Baker Hughes (5,27%) Equinor Asa (4,97%) Totalenergies (4,71%) Shell (4,66%) Respol (4,37%) Eni Spa (4,19%) Edp Renovaveis (3,82%) Galp Energia (3,71%) OMV (3,71%) Inpex (3,37%)	Darling Ingredients (3,63%) Republic Services (3,41%) Schneider Electric (2,89%) Marsh & McLennan (2,58%) Veolia Environment (2,53%) Owens Corning (2,47%) Nomad Foods (2,39%) Microsoft (2,36%) L'Air Liquide Societe (2,35%) Solaredge Techno (2,34%)	ON Semiconductor (5,42%) EUR Cash (4,65%) Wolfspeed (4,22%) Solaredge Tech (4,19%) Orsted (4,01%) Schneider Electric (3,76%) Infineon Tech (3,76%) Quanta Services (3,67%) First Solar (3,47%) Itron (3,01%)	-

Figure 10. Incentivized investment decision, as presented to the participants. This figure shows the four equity mutual funds, and the savings account used in the investment decision (English translation).

Follow-up questions and attention check. We included two follow-up questions concerning the investment products' properties. The first question measured participants' sustainability rating of each product (7-point Likert scale, anchored at 1 = *not at all sustainable*, 7 = *very sustainable*). The second question asked which of the funds they thought was most likely to be engaging in greenwashing, providing answer options for each fund and a "none" choice. This generated a binary variable for correctly identifying the

potentially greenwashed product.[28] An attention check was randomly included among the SFL questions ("*Please choose "false" here*). Participants failing the check were excluded and replaced (N = 134).

SFL, advanced financial literacy, and other explanatory variables. In the postexperiment survey, we measured our main explanatory variable SFL using the 7-question inventory developed in Study 1 with a true/false answer format plus an "*I don't know*" answer option. SFL is the sum of correct responses to the seven questions, mapped to a range from 0 to 1. We include advanced financial literacy, measured by three questions, with the total number of correct answers again mapped to a range from 0 to 1, as the second most important explanatory variable (Balloch et al., 2015; Lusardi & Mitchell, 2014; Van Rooij et al., 2011). We collected further control variables that are related to investment decisions: stock market image (i.e., what views participants have about the stock market in terms of wealth creating capacity, immorality, and the importance of ESG factors; Dobni & Racine, 2015, 2016; Jeong et al., 2014), stockholder image (i.e., whether participants view stockholders as greedy, selfish, or gambler-like; Henkel & Zimpelmann, 2023), hassle factor (i.e., the perception that investing sustainably is complicated; Sivaramakrishnan et al., 2016), beliefs that sustainable investments constitute greenwashing (Degryse et al., 2023), biospheric and altruistic value orientation (i.e., caring for an intact environment and for others' utility; De Groot & Steg, 2007, 2008), risk taking (Dohmen et al., 2011; Henkel & Zimpelmann, 2023), patience (Falk et al., 2018; Gutsche et al., 2023), general trust (Balloch et al., 2015; Guiso et al., 2008; Nilsson, 2008), political orientation (Kaustia & Torstila, 2011) as well as socio-demographics (gender, age, household income, education). We furthermore gathered data on whether participants invested in ESG funds for financial or non-financial reasons and asked about their subjective ability to identify greenwashing (inspired by Degryse et al., 2023).

3.1.2. Participants

We recruited a sample of 1,510 participants, representative of the Austrian population in terms of age above 18 years, gender, and university degree, via an internationally operating market research agency (TalkOnline Panel GmbH) between 25.10.2023 and 08.11.2023.[29] The sample consisted of 51.20% women and had an average age of 49.03 years (SD = 16.92). 15.30% reported having a university degree. Our sample's median net household income (*Median* = 4.0, equal to 3,001 to 4,000 euros) was slightly higher than Austria's median net household income of 2,879 euros in 2022 (Statistics Austria, 2023). 43.31% of the participants reported being financial market participants, defined by ownership of funds, stocks, or bonds, with 30.72% of the total sample owning sustainable investments. Investment-related experience ranged from none (50.20%) to our top category of more than eleven years (15.96%).

[28] Answering the second follow-up question was mistakenly not mandatory in our survey software. Thus, we have 13 missing values in this outcome variable, of which nine are among the participants who invested sustainably, reducing the sample size for analyses regarding the identification of potentially greenwashed investments.

[29] We implemented quotas for participants with university degree, as the sample in Study 1 included a higher proportion of participants with a university degree compared to the Austrian population. We excluded three of the initially 1,513 complete responses due to repeated participation.

3.1.3. Procedure and incentives

We started the framed field experiment by informing participants about the monetary incentives. Five participants were to be randomly selected in a lottery draw. For these participants, we invested the amount allocated to each fund or the savings account and promised them to sell the funds after one year and pay out to them the resulting ending values (as in Gutsche et al., 2023 and Seifert et al., 2024). The first part of the experiment mimicked a financial advisory setting. Participants were asked to imagine themselves going to a bank to invest 500 euros and then make the incentivized investment decision. In the next part of the experiment, we measured SFL, advanced financial literacy, further control variables and other investment-related variables. We asked follow-up questions concerning the properties of the investment products towards the end to avoid unwanted spillover effects affecting other questions, in particular the perception of greenwashing. In the final part, we debriefed the participants about the greenwashing allegations against Fund C and that these had led to changes in its marketing claims. They then had the option of revising their investment decision. Their revised allocation formed the basis of what will be paid out to the winners of the draw.[30] The participants received a link to SFL training materials and were asked to leave their email for the lottery. They received a standard participation fee from the market research agency. The median participant spent 12.24 minutes on the experiment.

3.2. Results

The descriptive results in Table 11 show that participants invest an average of 354.65 euros of their total endowment of 500 euros (i.e., 70.9%) in the stock market and save the remaining 145.35 euros (i.e., 29.1%). Investments in the funds marketed as sustainable account for 48.1% of the amount invested in all funds. Participants who invested in the sustainably marketed funds (N = 1,081) invested 43.5% into the fund confronted with greenwashing allegations. Participants invested significantly more into Fund D ($p < 0.001$) than would be predicted by a 1/n or naïve-diversification strategy, which would entail investing equal amounts into each fund or product (Benartzi & Thaler, 2001). These results point towards a preference for sustainable investments. The first follow-up question shows that participants were able to identify Fund D as the most sustainable among the funds. 27.59% correctly identified the potentially greenwashed product in the second follow-up question, while 26.65% indicated that none of the products was likely to have been greenwashed.[31]

[30] After consulting with other experimental researchers, we concluded that the procedure does not amount to deception. Participants faced no negative consequences, and they were allowed to revise the decision after being debriefed, or to stick with their initial decision. The descriptions, including that of the allegedly greenwashed fund, furthermore stemmed from existing funds, which participants could have encountered in real-world investment decisions. We anticipate no negative impacts on the participant pool.

[31] Although the percentage of correct identification is relatively low, we argue that it was not due to chance. First, participants were aware of the meaning of greenwashing, as we defined it in the question text of the second follow up question. Second, the ability to correctly identify the potentially greenwashed fund is related to higher SFL (Table 15).

After the debriefing and thus after learning about the greenwashing allegations against one fund, a majority of participants (67.90%) who had invested into the sustainably marketed funds (N = 1,081) did not revise their investment decisions, even though 72.75% of them had allocated a positive amount to Fund C. Those who revised their allocations reduced their investment in the allegedly greenwashed fund by approximately 70%. They shifted their investments towards the genuinely sustainable fund, increasing their initial investment in this fund by 51.07%, and, to a lesser extent, to the savings account increasing their initial investment by 22.04%. Appendix B.8. presents a more detailed analysis of the revised investment decisions and the determinants of revising the decision.

Participants on average answered 49.09% (SD = 27.89%; $Median$ = 4) of the seven SFL questions correctly, which aligns with the average of Study 1 (U-test, p = 0.168). Table B.2 in the Appendix presents a detailed comparison of correct responses per SFL question between Studies 1 and 2. On average, participants answered 2 out of 3 advanced financial literacy questions correctly ($Median$ = 2; M = 0.66, SD = 0.33; U-test; p < 0.001). As in Study 1, SFL correlates with advanced financial literacy (r_s = 0.46, p < 0.001). Table B.3 in the Appendix relates SFL and answering each of the seven SFL items correctly with investment behavior and with the identification of potential greenwashing. Participants who correctly answered the question on the meaning of greenwashing (Q3) were, for example, more likely to correctly identify the allegedly greenwashed fund in the follow-up question, and less likely to state that none of the funds represented a case of greenwashing. We present the descriptive statistics of all explanatory variables included in the subsequent regression models in Table B.4.

SFL is significantly lower (U-test, p < 0.001) among women (M = 3.04, SD = 1.46) than among men (M = 3.64, SD = 1.52). Also, confidence in correctly answering the questions is lower (U-test, p < 0.001) among women (M = 0.45, SD = 0.28) than among men (M = 0.53, SD = 0.28).

3.2.1. SFL is associated with greater stock market investment

To test whether SFL predicts stock market investment (*H1*), we use an econometric model regressing stock market investment on SFL (Table 12). We successively add control variables, yielding four hierarchical models. Model (1) regresses stock market investments on advanced financial literacy, Model (2) regresses on SFL, Model (3) regresses on both, and Model (4) adds further control variables. The full hierarchical models are in Table B.5 in the Appendix; gender-specific analyses are in Table B.11.

Third, identification was more prevalent among participants with a university degree (r_s = 0.11, p < 0.001), among those with a greater belief that "green" assets are usually greenwashed (r_s = 0.07, p < 0.01), and those experiencing a lower hassle factor (r_s = -0.08, p < 0.01). Of all participants, 18.23% indicated that the sustainable Fund was likely greenwashed, while 12.36% and 17.17%, respectively, selected Funds A or B. One explanation for the moderate identification rate might be the complexity of the task, particularly for those with low SFL.

Table 11. Descriptive statistics of incentivized investment behavior and the follow-up questions.

Outcome variable	*N*	*M*	*SD*	*Min*	*Max*
Stock market investments (% of endowment)	1,510	70.9%	35.0%	0%	100%
ESG investments (% of stock market investment)	1,510	48.1%	37.7%	0%	100%
Potentially greenwashed investment (% of ESG)	1,081	43.5%	30.3%	0%	100%
Investment Fund A	1,510	€81.76	€113.44	€0	€500
Investment Fund B	1,510	€74.39	€107.18	€0	€500
Investment Fund C	1,510	€83.20	€104.08	€0	€500
Investment Fund D	1,510	€115.30	€132.90	€0	€500
Investment savings account	1,510	€145.35	€174.93	€0	€500
Sustainability rating Fund A	1,510	3.16	1.50	1	7
Sustainability rating Fund B	1,510	2.96	1.51	1	7
Sustainability rating Fund C	1,510	4.43	1.47	1	7
Sustainability rating Fund D	1,510	4.88	1.36	1	7
Sustainability rating savings account	1,510	3.98	1.68	1	7
Greenwashing correctly identified	1,497	27.6%	44.7%	0	100%

Note. This table reports the descriptive statistics of the outcome variables included in the econometric analyses of the incentivized investment decision as well as of the follow-up questions. *N* = number of observations, *M* = mean, *SD* = standard deviation. Since we exclude participants who did not invest sustainably (*N* = 429) from the analyses of potentially greenwashed investment in Table 14, we report data for this subsample only (*N* = 1,081). The greenwashing identification question was mistakenly not mandatory in our survey software. Thus, we miss *N* = 13 responses. Note that participants judged the sustainability ratings of the funds while seeing all fund details (Figure 10) which might have affected their ratings. Percentages of the outcome variables on investments do not always perfectly align with the values in euros, since we record zero sustainable investments for participants who did not invest in the stock market, as described in Section 3.1.1.

We find that SFL relates to an increase in stock market investments of 36.61 percentage points [95% CI: 0.31; 0.43] in Model (2), and to one of 18.7 percentage points [95% CI: 0.12; 0.26] in Model (4). Advanced financial literacy relates to an increase in stock market investments of 24.31 percentage points [95% CI: 0.19; 0.29] in Model (1), and one of 8.4 percentage points [95% CI: 0.03; 0.14] in Model (4). Wald tests show that the coefficients for SFL are significantly higher than those for advanced financial literacy in Model (3) ($F(1507, 1) = 9.27$, $p = 0.002$), whereas the difference is only weakly significant in Model (4) ($F(1507, 1) = 3.70$, $p = 0.054$). Hierarchical regression analyses show that Model (1) accounts for $R^2 = 0.053$ of total variance, and Model (3) accounts for $R^2 = 0.087$, which is a significant increase due to the inclusion of SFL (ΔR^2: $F(1507,1) = 2.139$, $p < 0.001$).

Overall, the results show that SFL is more important than advanced financial literacy in explaining stock market investments and explains this behavior even after controlling for advanced financial literacy. Similar to Cronqvist et al. (2015), we investigate potential mechanisms via a mediation analysis (see Appendix B.4. for a detailed analysis). We find that the relationship between SFL and stock market investments is weakly mediated by a more positive image both of the stock market (i.e., in terms of morality and wealth creating capacity) and of stockholder characteristics (i.e., greedy, selfish, gambler-like).

Table 12. OLS-regression of stock market investments on SFL.

	(1)	(2)	(3)	(4)
Sustainable finance literacy		0.366***	0.294***	0.187***
		(0.031)	(0.035)	(0.035)
Advanced financial literacy	0.243***		0.128***	0.084**
	(0.026)		(0.029)	(0.030)
Female (Ref.: male)				-0.037*
				(0.018)
Age in years				-0.0003
				(0.0006)
University degree (Ref.: no)				-0.013
				(0.024)
High household income				0.006
				(0.020)
Household income not reported				-0.016
				(0.023)
Investment experience in years				-0.006
				(0.004)
Constant	0.548***	0.530***	0.480***	0.462***
	(0.019)	(0.017)	(0.021)	(0.081)
Additional control variables	NO	NO	NO	YES
N	1510	1510	1510	1510
R2	0.054	0.085	0.097	0.186
R2 adj.	0.053	0.085	0.096	0.175

Note. This table presents the results of the hierarchical models regressing stock market investments on SFL, successively adding control variables. Additional control variables in Model (4): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. Standard errors are shown in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.2.2. SFL is associated with greater sustainable investment

To test whether SFL predicts sustainable investment (*H2*), we use the same model specifications as in Table 12, with sustainable investments as the outcome variable, and report the results in Table 13. Full stepwise models are presented in Table B.6 in the Appendix. SFL accounts for an increase in sustainable investments of 32.80 percentage points [95% CI: 0.26; 0.39] in Model (2), and one of 25.1 percentage points [95% CI: 0.17; 0.33] in Model (4). Advanced financial literacy relates to a significant increase of 15.49 percentage points [95% CI: 0.10; 0.21] in Model (1) and a non-significant increase of 4.52 percentage points [95% CI: -0.02; 0.11] in Model (4). Wald-tests for coefficient equality show that the estimates for SFL are significantly higher in Models (3) and (4), with $p < 0.001$ for both tests. Two-step regression analyses show that Model (1) accounts for $R^2 = 0.018$ of total variance and Model (3) accounts for $R^2 = 0.059$, which is a significant increase in additional variance explained due to the inclusion of SFL (ΔR^2: $F(1507,1) = 8.767$,

$p < 0.001$). The results thus show that SFL explains sustainable investment better than does advanced financial literacy. Investigating the potential mechanism, we find that a modest proportion of the relationship between SFL and sustainable investments is mediated by reduced perceptions of ESG investments as greenwashing (Appendix B.4).

Table 13. OLS-regression of sustainable investments on SFL.

	(1)	(2)	(3)	(4)
Sustainable finance literacy		0.328***	0.309***	0.251***
		(0.034)	(0.038)	(0.039)
Advanced financial literacy	0.155***		0.034	0.045
	(0.029)		(0.032)	(0.032)
Female (Ref.: male)				0.021
				(0.020)
Age in years				-0.001*
				(0.0006)
University degree (Ref.: no)				-0.021
				(0.026)
High household income				-0.007
				(0.022)
Household income not reported				0.033
				(0.025)
Investment experience in years				-0.004
				(0.004)
Constant	0.378***	0.320***	0.307***	-0.067
	(0.021)	(0.019)	(0.023)	(0.088)
Additional control variables	NO	NO	NO	YES
N	1510	1510	1510	1510
R2	0.019	0.059	0.060	0.162
R2 Adj.	0.018	0.058	0.059	0.150

Note. This table presents the results of the hierarchical models regressing sustainable investments on SFL, successively adding control variables. Additional control variables in Model (4): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. Standard errors are shown in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.2.3. SFL is associated with lower potentially greenwashed investment

To test whether greater SFL predicts fewer potentially greenwashed investments (*H3*), we re-run the models from Table 13 but using potentially greenwashed investments as the outcome variable, and report the results in Table 14. By definition, only participants who have invested sustainably are included in these analyses (N = 1,081). The full stepwise models are shown in Table B.7 in the Appendix. We find that SFL relates to a reduction in potentially greenwashed investment by 17.70 percentage points [95% CI: -0.24; -0.11] in Model (2), and to one of 13.4 percentage points [95% CI: -0.21; -0.05] in Model (4). Advanced

financial literacy relates to a reduction in potentially greenwashed investment by 10.70 percentage points [95% CI: -0.16; -0.05] in Model (1); however, the estimate becomes insignificant once SFL and other variables are controlled for. Wald-tests show that the coefficient estimates for SFL are marginally higher than those for advanced financial literacy in Model (4) ($F(1060, 1) = 3.69$, $p = 0.055$), while they are insignificant in Model (3) ($F(1078, 1) = 2.50$, $p = 0.114$). Furthermore, two-step regression analyses show that Model (1) accounts for $R^2 = 0.012$ of total variance and Model (3) for $R^2 = 0.025$, which is a significant increase in variance explained that is due to the inclusion of SFL (ΔR^2: $F(1078,1) = 14.808$, $p < 0.001$).

Table 14. OLS-regression of potentially greenwashed investments on SFL.

	(1)	(2)	(3)	(4)
Sustainable finance literacy		-0.177***	-0.148***	-0.134**
		(0.034)	(0.038)	(0.041)
Advanced financial literacy	-0.107***		-0.054+	-0.018
	(0.028)		(0.031)	(0.033)
Female (Ref.: male)				0.002
				(0.020)
Age in years				-0.0006
				(0.0006)
University degree (Ref.: no)				-0.025
				(0.026)
High household income				-0.023
				(0.023)
Household income not reported				-0.0004
				(0.026)
Investment experience in years				-0.008+
				(0.004)
Constant	0.508***	0.529***	0.550***	0.698***
	(0.021)	(0.020)	(0.024)	(0.091)
Additional control variables	NO	NO	NO	YES
N	1081	1081	1081	1081
R2	0.013	0.024	0.027	0.050
R2 Adj.	0.012	0.023	0.025	0.032

Note. This table presents the results of the hierarchical models regressing potentially greenwashed investments on SFL, successively adding control variables. Additional control variables in Model (4): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. Standard errors are shown in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Testing the potential mechanism, we do not find any significant indirect effect of our proposed mediators (i.e., the subjective ability to identify greenwashing, and the belief that "green" assets are usually greenwashed) in explaining potentially greenwashed investments in the incentivized decision (Appendix B.4).

Logit regressions (Table 15) show that with higher SFL, the probability of correctly identifying the product that faced greenwashing allegations increases. When calculating the odds ratios, the results show that with perfect SFL, the odds for correctly identifying that fund are about four times higher than with no SFL (odds ratio Model (3) = 4.72, $p < 0.001$; odds ratio Model (4) = 4.29, $p < 0.001$). The odds ratios for advanced financial literacy remain below 1 and are not significant (odds ratio Model (3) = 0.93, $p = 0.753$; odds ratio Model (4) = 0.90, $p = 0.678$). Testing for coefficient equality, we find that the estimates for SFL are significantly higher in Models (3) and (4), with $p < 0.002$ in both Wald-tests. These results support the previous result that high SFL is related to less potentially greenwashed investment, since participants with high SFL are substantially more likely to be able to correctly identify the fund that faced greenwashing allegations. Advanced financial literacy, by contrast, does not explain these results.

Table 15. Logistic regression of greenwashing identification on SFL.

	(1)	(2)	(3)	(4)
Sustainable finance literacy		1.512***	1.552***	1.456***
		(0.270)	(0.298)	(0.323)
Advanced financial literacy	0.468*		-0.075	-0.106
	(0.212)		(0.237)	(0.255)
Female (Ref.: male)				-0.071
				(0.153)
Age in years				-0.006
				(0.005)
University degree (Ref.: no)				0.388*
				(0.187)
High household income				0.055
				(0.173)
Household income not reported				0.097
				(0.200)
Investment experience in years				-0.017
				(0.033)
Constant	-1.204***	-1.714***	-1.684***	-2.109**
	(0.163)	(0.169)	(0.193)	(0.718)
Additional control variables	NO	NO	NO	YES
N	1072	1072	1072	1072
Nagelkerke pseudo R2	0.007	0.044	0.044	0.089

Note. This table presents the results of the hierarchical logistic models regressing the correct identification of the allegedly greenwashed fund on SFL, successively adding control variables. Additional control variables in Model (4): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. Standard errors are shown in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.2.4. Robustness checks and external validation with self-reported investment behavior

Robustness checks in Appendix B.5 show that the results of our hypothesis tests (Table 12, Table 13, Table 14) are qualitatively robust to excluding all participants who did not provide an email address, who answered "*I don't know"* on all literacy questions, and who spent less than 30 seconds on the SFL questions or the investment decision. Applying these exclusion criteria as a robustness check shows that the main results are robust even if we exclude participants who potentially did not engage thoughtfully with the study materials, thereby also enhancing the reliability and validity of our findings.

We conducted additional robustness checks to address potential effects of previous investment experience – specifically, the possibility that real-world financial market investments or owning sustainable investments might drive SFL and the effects of SFL on behavior. We split our sample into financial market participants (N = 654) and non-participants (N = 856), excluding investment experience as a control variable in the latter group. We then replicate the analyses we ran for our three outcome variables, and report the outcomes in more detail in Appendix B.5. This approach allows us to isolate the relationship between SFL and investment behavior in each subgroup separately.

The estimates for SFL are robust for stock market investments (Table B.12), sustainable investments (Table B.13) and potentially greenwashed investments (Table. B.14), with the coefficients often being qualitatively larger among non-participants than among financial market participants. In summary, these findings alleviate investment experience as a main driver for the results, since non-financial market participants, by definition, lack investment experience that could have influenced their SFL, suggesting that the direction of the effect is most likely from SFL to behavior rather than the reverse.

To test the external validity of our results, we replicate the analyses regarding the relationship between SFL and, respectively, financial market investments, sustainable investments, as well as the potentially greenwashed investment, using similar self-reported behaviors as in Study 1 as the outcome variable in ordered probit regressions. The results in Appendix B.7. show that with regards to financial market investments, the estimates for SFL are significant and the odds of holding higher amounts in stock market products are about 4 times higher when SFL is high in Model (3). With the introduction of additional control variables in the subsequent models, estimates of SFL turn insignificant and the odds ratio in Model (4) is 1.03. Our results on the relationship between the share of sustainable investments owned and SFL (Table B.15) are robust to these specifications: individuals with high SFL are on average about 3.5 times as likely to hold more sustainable investments. Also, as SFL increases, so does the likelihood of seeking additional information in order to avoid greenwashing.

3.3. Discussion

3.3.1. Causality and correlates of SFL

Study 2 aimed to show how SFL is predictive of downstream investment behaviors and to determine its importance in investment decisions, on its own and relative to other concepts of financial literacy. Prior research considers the role of basic and advanced financial literacy (Filippini et al., 2024; Rossi et al., 2019)

as well as environmental literacy (Anderson & Robinson, 2022; Bethlendi et al., 2022; Filippini et al., 2024) in sustainable investments, finding weak to modest effects. Our results show that SFL robustly relates to greater stock market investments (*H1*), greater sustainable investments (*H2*), and fewer potentially greenwashed investments (*H3*). Comparing SFL with advanced financial literacy to gauge their relative levels of importance, our results show that SFL not only competes effectively with advanced financial literacy but often explains more variance and has larger effect sizes. Thus, SFL emerges as a key correlate of investment behavior and should be considered in future research on investment decision-making.

The causality of our findings, however, is difficult to pin down. Participants who report and display high proportions of sustainable investments might do so not because of high SFL. Instead, the reverse may be the case: their literacy could be a result of prior (sustainable) investment experience (Hastings et al., 2013; Lusardi & Mitchell, 2014), a key source of financial knowledge (Hilgert et al., 2003). If so, experienced investors should predominantly drive our main results. However, robustness checks reveal that the effect sizes and differences between advanced financial literacy and SFL are even more pronounced for non-financial market participants than for experienced financial market participants. These results suggest that the observed effects are not principally driven by prior investment experience. On the contrary, the similar results among investors and non-investors as well as in self-reported investment behavior support the conjecture that SFL is driving investment behavior. We acknowledge that some participants who currently do not hold stock market products may have past investment experience. Nevertheless, we expect this subset to be relatively small and to not significantly affect the results.

We observe smaller effect sizes and smaller differences in the explanatory power of SFL and advanced financial literacy when looking at experienced investors or when using self-reported financial market investments as the outcome variable. These differences could be attributed to several factors. One possible explanation may be the timing of real-life investments. Many investors may acquire most of their investment knowledge when they start investing. If active financial market participants gained their knowledge at a time where sustainable finance and ESG investments were less prominent, this may render SFL less important for their decisions, with general financial literacy playing a more prominent role. In contrast, for individuals who do not own stocks or are just beginning to invest, both SFL and general financial literacy are likely to be relevant, thus lending more weight to SFL. This aligns with our finding of larger effect sizes among non-financial market participants. Future research, however, would need to test these conjectures.

Why should SFL be predictive of investment behavior? Inadequate knowledge is a pertinent barrier to greater sustainable investments (Gutsche & Zwergel, 2020; Meunier & Ohadi, 2022; Wins & Zwergel, 2016). Financial literacy is related to the propensity for owning stocks (Lusardi & Mitchell, 2014), potentially due to its impact on the image individuals have of the stock market (Dobni & Racine, 2015, 2016). Our findings support and expand upon this idea, demonstrating that SFL also relates to a more favorable view of the stock market (i.e., to perceiving the stock market as less immoral) and of stockholders (i.e., to not seeing them as greedy, selfish, or gambler-like; Henkel and Zimpelmann, 2023). Although the mediation

effects are modest, we find that these views in turn relate to greater stock market investments, both in the incentivized decisions and in the self-reported financial market investments. Thus, SFL may help overcome barriers such as stock market aversion, ambiguity, and financial disengagement (Anderson & Robinson, 2022; Antoniou et al., 2015; Kaustia & Torstila, 2011; Keller & Siegrist, 2006).

Regarding sustainable investments, barriers such as information costs (Balloch et al., 2015; Campbell, 2006), and the belief that "green" assets are usually greenwashed ("greenwashing beliefs", in short) (Degryse et al., 2023) can act as deterrents. Our findings indicate that SFL alleviates these issues, which also mediates the relationship with sustainable investments in both the incentivized and reported sustainable investments. The hassle factor – the belief that sustainable investing is complicated and needs substantial time and effort – mediates the relationship only in reported investments, likely because the hassle factor is more relevant in real-world scenarios than in our stylized and simplified incentivized decision. SFL may thus, to some extent, promote sustainable investments. Another channel to be investigated in future research is beliefs about risks and expected returns, as better knowledge of a specific investment product may reduce the perception of risk associated with it (Wang et al., 2011).

Regarding greenwashed investments, we conjectured that greater SFL would lead to lower potentially greenwashed investments by increasing individuals' ability to identify greenwashed products and by reducing greenwashing beliefs. Our results provide indications that the effect of SFL is marginally mediated by the subjective ability to identify greenwashing, but only in self-reported behavior. Thus, the proposed mediators can explain the decrease in potentially greenwashed investments with higher SFL only to a limited extent. Nevertheless, considering the direct effects observed, increasing SFL could still enable investors to make more informed decisions and to reduce their susceptibility to greenwashing, a noted obstacle in sustainable investing (Degryse et al., 2023; Klein et al., 2022).

The participants' response to information about greenwashing allegations against one of the funds merits further discussion. When informed about greenwashing concerns during the debriefing, a majority of the participants who invested in the sustainably marketed funds, including the fund that faced greenwashing allegations, did not revise their initial investment decision. The reasons for this might be varied. First, investors might be engaging in information avoidance, since reassessing their decision and considering the greenwashing information requires additional effort (Golman et al., 2017). Second, their sustainable investments might be driven by warm glow rather than by actual impact (Heeb et al., 2023). Third, participants might not believe the accusations presented or might not care about greenwashing. All of these reasons could result in a lower willingness to revise the decision. However, our results show that those participants who reported that they primarily invest sustainably in order to make an ESG impact are more inclined to change their decisions. Partially aligned with expectations that learning about greenwashing might lead to disengagement from the stock market due to disappointment, skepticism, frustration, or lowered trust, we observe that the participants who revised their decision reduced the amount allocated to the greenwashed product by an average of about 70% compared to the initial investment decision. They

redirected some of these funds to the savings account but, to a greater extent, to the genuinely sustainable Fund D.

3.3.2. Limitations

The following limitations should be considered when interpreting our results. First, in the incentivized investment decision in Study 2, we define potentially greenwashed investment as the proportion of total investments in the funds marketed as sustainable (Funds C and D) that are allocated to the fund that faced greenwashing allegations (Fund C). We infer that greater SFL predicts lower potentially greenwashed investments because high-SFL investors are more likely to recognize and aim to avoid greenwashing. However, we cannot entirely rule out the possibility that these effects might be partially driven by a preference for investments in a fund that has a sustainability label (Fund D), rather than the explicit intent to avoid greenwashing. Nonetheless, our data show that participants who accurately identified greenwashing concerns also invested less in the fund facing greenwashing allegations. Importantly, individuals with greater SFL allocated a larger proportion of their endowment to the genuinely sustainable Fund D.

A second limitation to consider is the critique by Bethlendi et al. (2022), who argue that it may be too early to introduce the concept of SFL, as neither sustainable finance nor the EU Taxonomy are fully developed and established yet, leading to limited investor experience. We counter this argument by highlighting the recent surge of sustainable investments across the globe, for instance in the United States (Hartzmark & Sussman, 2019), which has indeed exposed investors to the practical aspects of sustainable finance and ESG investments. Furthermore, in some large economic areas such as the European Union, financial advisors are now mandated to elicit clients' sustainability preferences in financial advisory, directly involving investors in sustainable finance considerations (Seifert et al., 2024). Additionally, the involvement of experts in developing our inventory of SFL also addresses this critique. Their input strengthens our belief that all statements in the measure are robust and will remain valid in the context of both current and forthcoming regulations in the near- to medium-term future, thereby reinforcing the relevance and applicability of the SFL concept despite the evolving nature of the field.

A third limitation involves the use of windfall gains for investment decisions in our study, which might have inflated the percentage of sustainable investments (see Hoffmann et al., 2019; but note that this concern extends to stock market investments as well; see, e.g., Briggs et al., 2021). Additionally, experimenter demand effects may have led participants to feel an implicit expectation to invest in the (sustainable) funds rather than the savings account. Both are valid concerns. However, our focus was on the relationship between SFL and investment behavior rather than on the absolute level of (sustainable) investments, and we would expect level effects to cancel out. Moreover, we observe consistent relationships between SFL and investment outcomes also in self-reported investments, where the influence of windfall gains effects is less likely. Furthermore, our use of an incentivized investment decision, designed to closely simulate investors' payoffs after one year, encourages participants to align their investment decisions and

revisions with their genuine preferences rather than with perceived experimenter expectations. Finally, we did not explicitly focus the instructions on sustainable investments before participants made their investment decisions, reducing the likelihood that their decisions were influenced by the study's objectives.

4. Conclusion

Is sustainable finance literacy essential to understanding investment behavior, or are basic and advanced financial literacy measures (Lusardi & Mitchell, 2008; Van Rooij et al., 2011) sufficient, even if they do not explicitly account for sustainable finance and ESG investments? To answer these questions, in Study 1 we developed a short, 7-question, and a long, 27-question inventory for sustainable finance literacy and find positive relationships with owning (sustainable) investments. In Study 2, we confirm these findings in an incentivized experiment and find that SFL is associated with more stock market investment, more sustainable investment, and fewer potentially greenwashed investments. Notably, SFL explains substantial variance in these three investment behaviors even after controlling for other concepts, such as advanced financial literacy. These findings are robust to splitting the sample into financial market participants and non-participants, thus partially addressing potential effects of previous investment experience, and to analyzing self-reported investment behavior, increasing the external validity of our findings. SFL therefore emerges as an important concept, complementary to general financial literacy and other factors that help us understand investment decisions. Given the strong political and regulatory interest in sustainable finance as well as the imperative to address climate change, we believe that SFL needs to receive greater attention in the research and discussion regarding sustainable finance and financial literacy. Our results offer valuable insights to both researchers and practitioners on the pivotal role of SFL in investment behaviors that can, ultimately, contribute to a successful transition towards sustainable finance.

Participants correctly answer about half of the SFL questions, highlighting a significant potential for improvement. Enhancing SFL in the general population is important for several reasons. First, SFL may help direct financial flows towards genuinely sustainable investments that do not entail greenwashing. Second, it can increase stock market investments in general, aiding the sustainability transition by mobilizing the necessary private capital. Third, increases in sustainable investments may improve individual financial outcomes, since stock market engagement for many is beneficial for retirement savings and planning (Lusardi et al., 2017), and sustainable investments can offer both financial return and ESG impact (Bekaert et al., 2023; Pástor et al., 2021; Von Wallis & Klein, 2015). Moreover, increased SFL might help better align investors' (sustainability) preferences with their investment choices and might make them less susceptible to misleading marketing, or missing sustainability standards (Filippini et al., 2024), which is especially important for individuals with low literacy levels (Anderson & Robinson, 2022). Our results also show that greater SFL may be associated with less potentially greenwashed investment. Avoiding such investment is critical for avoiding potential negative impacts on resale values due to greenwashing accusations (Du, 2015; Gatti et al., 2021) and for fostering a genuine transition towards a sustainable financial system.

Policymakers should therefore prioritize enhancing SFL among the general population, as suggested for example by the OECD in a recent policy paper (OECD, 2023). In line with this recommendation, we propose that financial education should be broadened to encompass SFL. A potential point of entry could be financial advisors. The majority of retail investors' investment decisions involve financial advisors (Paetzold et al., 2015), who play a pivotal role in the decision-making process and support particularly individuals with low SFL levels (Stolper & Walter, 2017). Advisors could also play a central role in elevating SFL, and ought to be incentivized to do so despite potential additional costs (e.g., additional training). SFL may positively influence (potential) investors' perceptions of and attitudes towards the stock market, both of which are crucial for engaging in complex financial activities such as investing (Carpena & Zia, 2020). Advisors are uniquely positioned to attract individuals otherwise hesitant about the stock market, thereby expanding stock market investments and tapping into new customer segments. Importantly, firsthand experience in sustainable investing emerges as a key method for boosting literacy (Hilgert et al., 2003). Potentially, the effectiveness could be further enhanced by providing financial incentives to investors for completing a training, e.g., by offering a few large prizes among all participants (Bauer et al., 2022).

Our study highlights avenues for future research, demonstrating that SFL robustly relates to higher stock market investments, more sustainable investments, and better identification of a fund that faced greenwashing allegations, even among non-investors, and relative to advanced financial literacy. We suggest that future research on investment behavior should consider SFL as a control variable and as a determinant for investment behavior. Future research could also seek to establish causal relationships between SFL and investment behavior and disentangle the underlying mechanisms in greater detail. An important unanswered question from our work is what the most effective methods for enhancing SFL are. Subsequent research could evaluate the impact of different just-in-time interventions at the point of investment decision-making (Fernandes et al., 2014), such as educational materials in different formats (videos, information brochures, quizzes with feedback) aimed at improving literacy and downstream financial behaviors that contribute to individual and societal welfare. This study lays the groundwork by elucidating the connection between SFL and investment behavior, offering valuable insights for further inquiry.

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Chapter 4: Nature posters enhance subjective but not objective cleanness in public housing: Evidence from a field experiment (Submitted to: *Journal of Environmental Psychology*)

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Nature posters enhance subjective but not objective cleanness in public housing: Evidence from a field experiment

Abstract

Littering has negative effects on the environment and is seen as a sign of social disorder. A previous field experiment in public housing buildings showed that implicit posters using eyes and nature posters were more effective in reducing litter than explicit posters using norms and financial costs. The aim of the present field experiment was to test the effects of the nature picture against a control group assessing "objective" (based on ratings of posters) and "subjective" cleanness (based on residents' reports) and explore the role of connectedness to nature. Results from 182 waste disposal areas and 739 residents show that nature posters did not increase objective cleanness but did increase subjective cleanness after one month. This effect was partly accounted for by increased feelings of connectedness to nature in residents. In addition, objective cleanness ratings were higher overall than were subjective cleanness ratings. We conclude that nature posters had little impact on objective cleanness, but enhanced subjective experiences of cleanness – which is presumably an important driving force behind feelings of social disorder and discomfort.

Keywords: Implicit, explicit, pro-environmental behavior, social housing, nature connectedness

Code availability: The anonymized experimental data generated and analyzed in the current study as well as scripts that generate and visualize the results reported are available at the OSF at: https://osf.io/vfmd4/.

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CRediT authorship contribution statement: Katharina Gangl: Conceptualization, Methodology, Investigation, Validation, Funding, Writing-original draft, Supervision, Project administration. **Marcel Seifert**: Formal analysis, Validation, Resources, Data curation, Writing-original draft. **Paul van Lange**: Conceptualization, Methodology, Writing-original draft. **Sabine Pahl**: Conceptualization, Methodology, Writing-original draft

Indication of own contribution: Chapter 4 is based on a project conducted at the IHS, expanding upon previous work (Gangl, Walter, et al., 2022). The field experiment was designed to test the effect of a nature poster while addressing the limitations identified in the earlier study. My involvement in the design process focused on overseeing various data sources (photo-ratings, the resident survey, data reported by the employees of Wiener Wohnen or retrieved from their database), as I was responsible for merging, curating, and conducting formal analyses of the data. Additionally, I performed the randomization and stratification of waste disposal areas into the treatment and control groups based on 31 pre-measured variables, using an R-package in cooperation with its developer. I also prepared the preregistrations for the baseline measure, the field experiment, and the resident survey, and developed the replication codes for OSF. Furthermore, I contributed to writing the original draft of the manuscript and the German research report.

1. Introduction

Littering is a widespread problem in many societies, undermining environmental quality, and cleanup costs are substantial. Moreover, litter in public spaces is also perceived as a sign of social disorder (Ramos & Torgler, 2012), negatively affecting residents' well-being, for example in the public housing context. Consequently, political stakeholders and researchers aim to identify cost-effective measures to foster the correct disposal of waste (e.g., Chaudhary et al., 2021; Almosa et al., 2017).

Posters and signs are classic tools used to reduce littering (Almosa et al., 2017). A previous field experiment in public housing buildings in Vienna, Austria examined the effect of four different posters using either explicit or implicit messages on littering, assessed by analysing photos taken of the floor (Gangl et al., 2022). The explicit messages aimed at increasing awareness and knowledge by presenting either the injunctive norm of correct waste disposal behavior or the monetary costs of cleaning needed because of littering. In contrast, the implicit messages attempted to promote behavior change in more indirect (and subtle) ways by presenting either watching eyes or posters of nature. The watching eyes are a frequently used image to increase norm-compliant behavior by enhancing feelings of surveillance and reputation-based cooperation (e.g., Manesi et al., 2016; Wu et al., 2016). Nature posters are a novel approach to examine thoughts, feelings, and behavior relevant to nature conservation (Van Lange, 2021).

In a recent study, Gangl et al. (2022) showed that implicit messages were more effective in reducing litter than were explicit messages, however, no difference to the control group was observed. One explanation for the lack of effect between intervention and control group might have been the overall high cleanness of the waste disposal areas (M = 2.12, SD = 1.09) on a scale from 1 = totally clean to 7 = totally dirty. This finding contrasts with stereotypical reports of low cleanness in public housing in the media (e.g., Kronen Zeitung, 2023) and resident complaints, indicating that subjective ratings and objective conditions might differ.

The aim of this paper is to test the effect of a nature picture intervention against a control group because of growing interest in nature exposure as a potential driver of pro-environmental behavior (Martin et al., 2020; Luo et al., 2022, Stöckli et al., 2016) and because we learned that children in the present context (public housing in Vienna) reported being scared of the watching eyes. Extending earlier research, we included both subjective and objective indicators of cleanness, and examined the role of connectedness to nature. The study was preregistered (https://osf.io/s47b8; https://osf.io/6p9yt; https://osf.io/eavmh).

2. Method

2.1. Experimental design

We conducted a field experiment in the waste-disposal areas of public housing buildings in Vienna, Austria, with one intervention group (nature posters) and one control group (no change of set-up). We assessed objective and subjective cleanness after one month (T2) and objective cleanness also after three (T3) and 13 months (T4).

2.2. Sample of waste disposal areas

Within 26 different buildings (with a total population of 37,901), 182 waste disposal areas were selected. The disposal areas were used by 13,569 residents, whereas 83 (45.6%) were situated outdoors and 99 (54.4%) were indoors.

2.3. Sample of residents

The initial sample consisted of 739 residents who took part in door-surveys (i.e. a survey at the door of their apartment; 53,18% female, M_{age} = 33.08, SD = 19.86). As preregistered, we excluded participants who were not able to see the intervention because the posters (either at the wall or door) were missing at Time 2 (N = 215), because they had not visited the waste-disposal area since the installation of the posters (N = 9) or because they were not able to indicate the waste-disposal area they used (N = 25). Thus, for the main hypothesis testing on the effect of the nature posters, the final sample consisted of 494 residents (109, thus 22.1 % were in the intervention group with nature posters and the others were in the control group).

2.4. Randomization

The 182 waste-disposal areas were randomly assigned to the intervention (N = 90) or control group (N = 92) with the aim to reach a similar sample size as in the previous study (Gangl et al., 2022) using the R-package minMSE (Schneider & Schlather, 2021). Randomization was stratified (i.e., controlled) for 31 variables (e.g., objective cleanness at Time 1, indoor/outdoor location, number of small and large items on the floor; see Appendix A for the full list of variables).

3. Materials

3.1. Experimental manipulation of intervention and control group

In the intervention groups, an implicit reminder of nature was applied by fixing posters of nature on the wall and door of the waste disposal area. As depicted in Figure 11, three A0 format posters were fixed on the wall (fewer in 3.3% of cases due to space constraints). In addition, one A3 poster was fixed on each side of the entrance door of each waste disposal area in the intervention group. After Time 2, all missing posters were replaced (22 wall posters, 37 door posters).

Figure 11. Implicit reminders of nature via posters.

3.2. Measures

In the following, we present the main variables of the study. All assessed variables can be found in Appendix A.

3.2.1. Objective cleanness

To assess objective cleanness, two photos of the floor of the waste disposal areas were taken on two consecutive Saturdays. The first picture covered the whole floor, and the second picture covered only the part of the floor, that contained litter. Trained employees of the city of Vienna took the photos and also ensured that only the identifying area number via a sheet of paper on the floor but no information of the wall or door was included in the picture. Two trained research assistants rated each of the photos on several categories. In addition to assessing details (e.g., the number of small or large items, see Appendix B), they rated objective cleanness on a 7-point Likert scale (1 = totally clean; 7 = extremely dirty). In total, objective cleanness was assessed four times: one month (T1: 25.06.22 and 02.07.22) prior to the intervention (30.08.2022), one month (T2: 24.09.22 and 01.10.22), three months (T3: 26.11.22 and 03.12.22) and 13 months (T4: 30.09.23 and 07.10.23) after the intervention. Pearson correlations between the two ratings were at least 0.84. Interrater reliability measured via Cohen's Kappa was higher than 0.45 (except on two days with 0.40 and 0.35).

3.2.2. Subjective cleanness

Residents were asked to recall the last time they visited the waste disposal area, and to rate its cleanness on a 7-point Likert scale (1 = totally clean, 7 = extremely dirty). Seven trained research assistants documented the answers on a tablet (see original questionnaire in Appendix C) in a period between three and six weeks after the intervention (17.09.2022 to 12.10.2022).

3.2.3. Control and moderating variables

Surveys assessed subjective smell, nature connectedness, and last visit. Research assistants asked residents to rate the smell when they last visited the waste disposal area on a 7-point Likert-type scale (1 = very good; 7 = very bad) and to state their agreement with three statements concerning their connectedness with nature, woods, and living creatures on a 7-point scale (1 = totally agree, 7 = totally disagree, adapted from Mayer & McPherson Frantz, 2004). Residents were also asked when they last visited the waste disposal area (before or after August 30, which was the day of the poster assembly).

Employees assessed cleanness, smell, and missing posters. They took photos of the floor to assess objective cleanness and also assessed the cleanness on a 7-point scale (1 = totally clean, 7 = extremely dirty). And from Time 2 onwards they also assessed the smell at that moment (1 = very good; 7 = very bad). Moreover, they assessed the presence or absence of posters on the wall and on the door.

3.2.4. Salience check

Residents were asked whether they had noticed a change in their waste disposal area. Without sharing possible answers, research assistants assessed responses to one of three options: (a) yes - a poster, (b) yes - something else, (c) no. After that, all residents in the intervention group who had not indicated to have seen a poster were asked whether they had seen a poster with a nature picture (response options: yes, no).

Out of the 109 residents who were part of the intervention group, 26 (23.9%) indicated to have seen a poster on the wall, 21 (19.3%) indicated to have noticed a change without being able to tell what exactly had changed, and 62 (56.9%) indicated to have noticed no change. The explicit question, whether residents of the intervention group had noticed a nature poster, was agreed by 25 (22.9%) out of the 109 residents.

Of the 385 residents in the control group, 2 (0.01%) participants reported having seen a poster on the wall and 85 (22.1%) indicated to have noticed a change without being able to tell what. 77.4% reported to have noticed no change. Differences between treatment and control groups are significant (Chi-square (2) = 86.82, $p < 0.001$).

4. Analytical approach

To test whether the nature poster increased objective cleanness over time (Hypothesis 1), we used panel data regression with fixed effects for timing and waste disposal area. These models compare the effect of the treatment to the control group, distinguishing between periods before and after the poster was installed. We employed OLS-regressions to test whether the nature poster increased subjective cleanness compared to the control group at Time 2 (Hypothesis 2), where fixed effects were not applicable due to a single time point. Both fixed effects and the OLS-regressions included additional models to assess heterogeneous effects based on the location of the waste disposal area (indoor/outdoor). To explore whether nature connectedness played a role in potential effects of the nature poster on objective or subjective cleanness, a moderation analysis was used via a median split of nature connectedness interacted with a dummy for the nature poster in an OLS regression (Hypothesis 3). In addition, we explored with a mediation analysis using the "mediation" function from the psych package in R whether the effect of the nature poster was mediated via nature connectedness. Chi-square tests and *t*-tests were used to test differences between outdoor and indoor areas. Finally, we used *t*-tests to explore the difference between objective and subjective cleanness.

5. Results

For clarity, we only present results of the main preregistered hypothesis including possible heterogeneous effects for indoor and outdoor areas and an investigation of nature connectedness as a mechanism that explains the effect of the nature picture. A previous version of the results can be found in a project report (Gangl et al., 2024 [in German]).

5.1. Effects of nature posters on objective cleanness (preregistered Hypothesis 1)

Fixed-effect regression results showed no difference between nature posters and control for objective cleanness at T2, T3 (Models 1 and 2 in Table 16) or T4 (Models 3 and 4). Specifically, *t*-tests showed no

difference between intervention group and control group for T2 (M_I = 2.67, SD_I = 1.10, M_K = 2.61, SD_K=1.19, t(179.5) = -0.33 p = 0.75, Cohen's d = -0.05[-0.34, 0.24]), T3 (M_I = 2.83 SD_I = 1.40, M_K = 2.63 SD_K= 1.17, t(173.1) = -1.10, p = 0.31, Cohen's d = -0.15[-0.44, 0.14]) or T4 (M_I = 2.80 SD_I = 1.16, M_K = 2.74, SD_K= 1.17, t(180) = -0.37, p = 0.71, Cohen's d = -0.05[-0.35, 0.24]). Also, no differences emerged if only indoor (all p > 0.19) or outdoor areas (all p > 0.16) were considered, as preregistered. The regression results only showed that over all measurement times, littering increased (post-treatment in Models 1-4 in Table 16), particularly in outdoor waste disposal areas (post-treatment x location in Models 2 and 4).[32]

Table 16. Fixed-effect regression Models 1-4 on the effect of the nature posters on objective cleanness.

	(1)		(2)		(3)		(4)	
	Estimate (SE)	95% CI	Estimate (SE)	95% CI	Estimate (SE)	95% CI	Estimate (SE)	95% CI
Post-treatment	0.31**	[0.09, 0.53]	0.63***	[0.30, 0.95]	0.35***	[0.14, 0.55]	0.59***	[0.28, 0.89]
	(0.11)		(0.17)		(0.10)		(0.16)	
Post-treatment x nature poster	0.19	[-0.13, 0.50]	0.27	[-0.19, 0.73]	0.17	[-0.13, 0.46]	0.29	[-0.14, 0.72]
	(0.16)		(0.23)		(0.15)		(0.22)	
Post-treatment x location			-0.58**	[-1.01, -0.14]			-0.43*	[-0.84, -0.02]
			(0.22)				(0.21)	
Post-treatment x location x nature poster			-0.18	[-0.80, 0.44]			-0.25	[-0.84, 0.33]
			(0.31)				(0.30)	
N	182		182		182		182	
R2	0.07		0.11		0.06		0.09	

Note. * p < 0.05; ** p < 0.01; *** p < 0.001. Fixed effects for timing and waste disposal area.

[32] If all areas without a poster are excluded, the three-way interaction has a tendency to reach significance (p = 0.081). Post-hoc t-tests show no significant (p = 0.09) difference between outdoor areas with a poster (N = 21) and outdoor areas of the control group (N = 92).

5.2. Effects of nature posters on subjective cleanness (preregistered Hypothesis 2)

Results show (Table 17, Model 1) that nature posters increased subjective cleanness. Independent *t*-tests indicate that residents in the intervention group (M = 4.08; SD = 1.97) rated cleanness as higher than did residents in the control group (M = 4.80; SD = 2.11; $t(184.1) = 3.29$, $p = 0.001$, Cohen's $d = 0.34$[0.13, 0.56]).

Table 17. OLS regression Models 1-2 on the effect of the nature posters on subjective cleanness.

	(1)		(2)	
	Estimate (SE)	95% CI	Estimate (SE)	95% CI
Intervention: Nature poster	-0.71**	[-1.16, -0.27]	0.18	[-0.45, 0.81]
	(0.23)		(0.32)	
Location (outdoor = 0, indoor = 1)			1.51***	[1.06, 1.96]
			(0.22)	
Nature poster * location			-1.02*	[-1.90, -0.13]
			(0.45)	
Constant	4.80***	[4.59, 5.01]	3.69***	[3.31, 4.08]
	(0.11)		(0.20)	
N	494		494	
R2	0.02		0.10	

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

As preregistered, we also examined possible differences between indoor and outdoor areas. Subjective cleanness only increased in indoor areas, but not in outdoor areas (Table 17, Model 2, Figure 12). The difference in subjective cleanness between indoor areas with (M = 4.37, SD = 1.90) and without a poster (M = 5.21, SD = 2.02; $t(62.91) = 2.74$, $p = 0.008$, Cohen's d = 0.42[0.10, 0.73]) shows that subjective cleanness increased by approximately 15 percent. An exploration in Appendix D shows, that the posters on the door but likely not the wall impacted subjective cleanness.

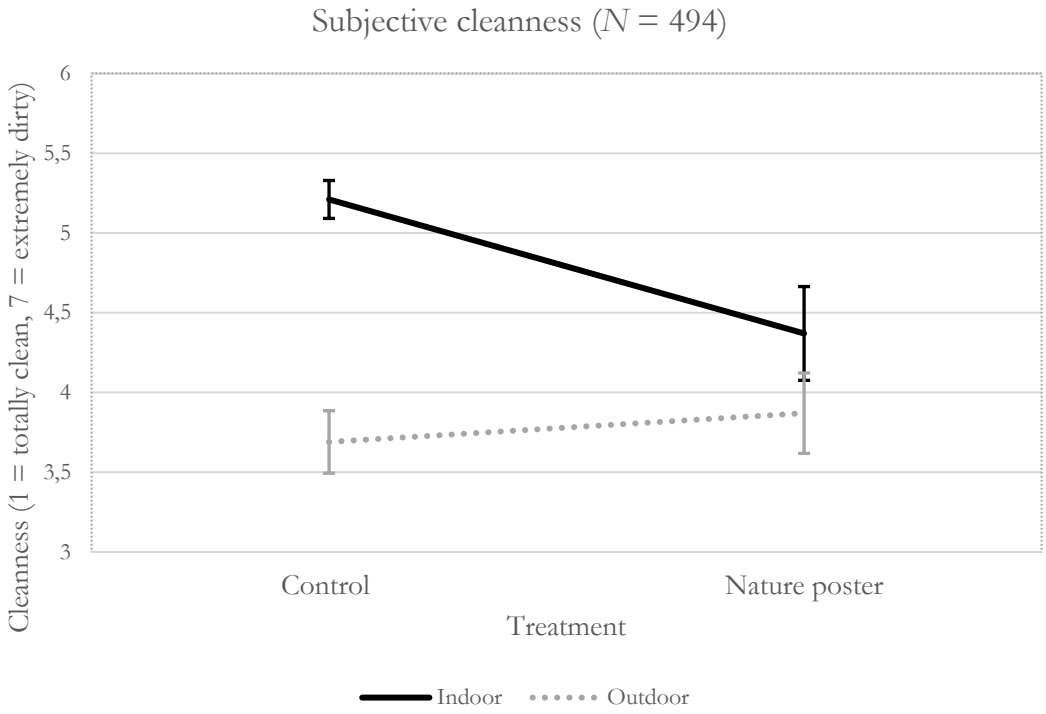

Figure 12. Effect of nature posters on subjective cleanness in indoor versus outdoor areas.

5.3. Nature connectedness as potential moderator (preregistered Hypothesis 3)

In our OLS regression (Table 18) which included an interaction term for the nature poster and the median split of nature connectedness (*Median* = 6.33), we again observed a significant main effect of the nature poster on subjective cleanness. However, neither nature connectedness nor the interaction term were significant, indicating that the effect of the nature poster was not moderated by nature connectedness.

Table 18. OLS regression model on the effect of the nature posters on subjective cleanness.

	(1)	
	Estimate (SE)	95% CI
Intervention: Nature poster	-0.83*	[-1.50, -0.16]
	(0.23)	
Nature connectedness equal to or above median	-0.28	[-0.70, 0.14]
	(0.21)	
Nature poster * nature connectedness	0.24	[-0.66, 1.13]
	0.46	
Constant	4.94***	[4.64, 5.23]
	(0.15)	
N	494	
R2	0.02	

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5.4. Nature connectedness as potential mediator (exploratory analysis)

A mediation analysis shows that the nature poster increased nature connectedness, which in turn increased subjective cleanness (total effect: $t(492) = -3.16$, $d = -0.71$, $p = 0.002$, mediated effect $t(491) = -3.77$, $d = -0.18$, $p < 0.001$). Figure 13 displays the direct and indirect relationship between the nature picture, reported nature connectedness and subjective cleanness.

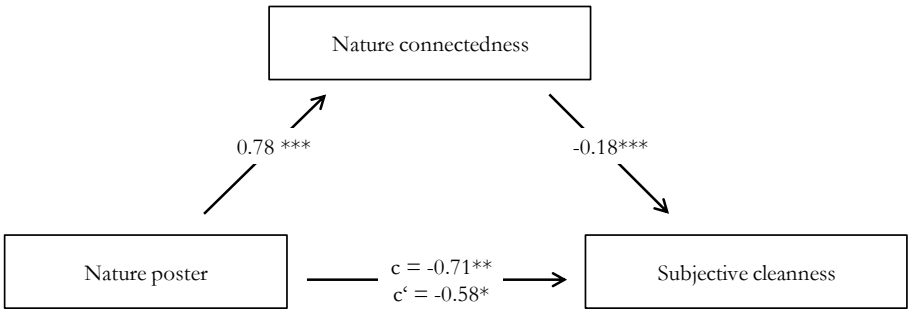

Figure 13. Mediated effect of the nature picture on subjective cleanness via nature connectedness. Note: c is the regression estimate for the direct effect of the treatment. c' is the regression estimate for the indirect effect of the treatment * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5.5. Difference between objective and subjective cleanness (exploratory analysis)

At Time 2 in the control group, objective cleanness ($M = 2.61$, $SD = 1.19$; $N = 92$) was rated higher than subjective cleanness at the level of waste disposal areas ($M = 4.31$, $SD = 1.48$; $N = 67$; $t(122,7) = -7.76$, $p < 0.001$, Cohen's $d = -1.29$[-1.63, -0.94]).[33] In addition, also employee assessments of cleanness ($M = 2.90$, $SD = 1.57$, $N = 92$) were higher than subjective cleanness by residents ($t(147,1) = -5.77$, $p < 0.001$, Cohen's $d = -0.92$[-1.25, -0.59]). These findings indicate that the difference between objective and subjective cleanness was not attributable to different assessment styles by residents and employees compared to (non-trained) photo-raters. Moreover, at Time 2 in the control group, residents also rated the smell ($M = 4.71$; $SD = 1.51$, $N = 67$) worse than the employees ($M = 3.01$; $SD = 1.57$, $N = 92$, $t(145,3) = 6.88$, $p < 0.001$, Cohen's $d = 1.10$[0.76, 1.43]). Objective and subjective cleanness were weakly correlated ($r_s = 0.23$, $p = 0.06$). Subjective cleanness by residents and employees were moderately correlated ($r_s = 0.66$, $p < 0.001$).

6. Discussion

The aim of the present field experiment was to examine the impact of nature posters on objective and subjective cleanness compared to a control condition in the context of public housing in Vienna, Austria. Results showed that whereas nature posters (versus no posters) had no significant impact on objective cleanness (in the short or long run), they did increase subjective cleanness. In indoor waste disposal areas especially, nature posters increased the subjective perception of cleanness by 15 percent. Supplementary analysis showed that in particular posters on doors rather than walls were effective. Connectedness to nature

[33] In total, 739 residents rated the cleanness of 125 waste disposal areas, of which 67 were in the control group and 58 in the treatment group.

did not moderate the effect of the posters. Instead, explorative mediation results show that nature posters appeared to increase the salience of nature connectedness, which, in turn, partly explained the effect of nature pictures on subjective cleanness ratings.

Why did nature posters have no large effect on objective cleanness? One reason is that the descriptive norm of visible cleanness exerts a stronger influence on people's perception and behavior than nature posters. In the present study, the general increase of litter over time might have had a stronger impact on objective cleanness compared to the nature posters (Schultz et al., 2013). For instance, a field experiment showed that if there was already a fair amount of litter, a prohibition sign on littering caused even more rather than less littering (Keizer et al., 2011). Indeed, cleaning up is the most important preventive measure to enhance correct disposal of waste in the future (Cialdini et al., 1990; Finnie, 1973). Future experimental research needs to examine the combined impact of poster-interventions and descriptive norms to allow targeted implementation of posters depending on the prevailing level of cleanness.

The differences between objective and subjective cleanness seem rather intriguing. One explanation could be derived from the availability heuristic (Tversky & Kahneman, 1973), suggesting that residents might recall extreme events of litter more easily than the rather clean environments that tend to be more common. Similarly, media reports about supposedly dirty waste disposal areas might also increase awareness and selective attention and retrieval from memory which can lead to an overestimation of litter. Taken together, while the present findings highlight the importance of subjective experiences of cleanness, it is up to future research to assess the determinants and consequences of such ratings. After all, relative to objective aspects of the environment, subjective experiences of the environment may be at least as important a predictor of behavior.[34]

7. Conclusion

In previous research, nature posters as a more implicit message were more effective than posters with explicit messages (Gangl et al., 2022). The present research shows that nature posters increased subjective cleanness, while objective cleanness was mostly unaffected. At present, it is not clear how subjective experiences might drive human behavior, especially when clean environments are the rule and littered environments the exception. However, it is plausible that reminders of nature do have an impact, and, as the present findings suggest, this might work through increasing salience of connectedness to nature.

[34] In Appendix E, we explored determinants of objective and subjective cleanness and found that only the presence of bulky waste is related to objective cleanness on the floor.

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Appendices

Appendix Chapter 1

Appendix A: Experimental procedures and protocols in the laboratory

For our studies, participants were pre-selected on Prolific (Palan & Schitter, 2018; Peer et al., 2017) using the following criteria: United Kingdom or United States as current country of residence; 18 years or older; PC or tablet as device used. We excluded players who had previously participated in more than 100 studies and only invited those with a completion rate of more than 90%. Based on these pre-screeners approximately 40,000 participants were eligible on Prolific.

In each session of the lab experiment, we implemented 6 of the 12 treatments. Once participants entered the experiment, they were randomly assigned to a treatment. After that, players received detailed instructions, went through a set of control questions, and indicated their values in a hypothetical baseline scenario. Thereupon, they were sent to a waiting room (lobby). Access to this waiting room was conditional on correctly answering all control questions to ensure that participants properly understood the decision situation. Once six players with the same treatment variable reached the waiting room, the interactive game began. Participants in treatments with a group size of three also had to wait until six players with their treatment variable reached the waiting room. Doing so ensured that all treatments had the same expected waiting time, and prevented some treatments from moving faster through the experiment than others.

For each treatment, we invited 8 players (6 per matching group plus 2 extra players), such that each session hosted 48 players. We chose to recruit two extra players to account for the possibility that subjects might drop out during the instructions and to shorten waiting time until a sufficient number of players reached the waiting room. In case one or two of the extra players also reached the waiting room, the program automatically assigned them to another treatment and filled up groups that were still short on players. If participants stayed in the waiting room for 13 minutes without a group being formed, they were assigned to another treatment and had to wait for two additional minutes. If they were again unable to join a group, participants were forwarded to the end of the study and received a fixed participation fee.

At the start of the collective-risk social dilemma game, participants were informed about the exact parameters of their treatment. After each round, the players received feedback on the sum of the contributions in their group and the cumulative sum over all rounds, and on the number of points that were still required in order to pass the climate protection threshold. In each round of the game, participants had 60 seconds to make a decision. If a player did not respond within time, the contribution was automatically set to zero.

If participants dropped out during the game (less than 5% of the participants), groups continued with a reduced size and the contributions of the dropouts were set to zero in the following rounds. The authors sought to prevent dropouts by keeping instructions as simple as possible and authorizing payment to

participants only after full completion of the experiment. All results presented in the study remain fully robust upon controlling for a dummy indicating if groups experienced a dropout in the game.

Several further measures were taken to prevent repeated participation in the game. First, we recruited participants via their Prolific ID (Palan & Schitter, 2018), a unique identifier. Importantly, participants who had registered for previous sessions were blocked from taking part in any subsequent session. Second, the experimental platform Lioness (Giamattei et al., 2020) checks IP addresses and cookies in the browser to prevent repeated participation with the same IP address.

After the game, participants filled in a questionnaire containing items on environmental concern and behavior, social, risk, and time preferences, a cognitive reflection test, and questions on sociodemographic variables. After that, they were shown a summary of the outcomes of the game, and learned their combined payment from the main interactive part, the show-up fee, and further incentivized tasks. The participants already had information about the game's outcomes prior to this final step, which served mainly to summarize the payoffs derived from the different parts of the experiment. For payment, the participants were linked back to Prolific. Through the platform we matched the final earnings to the respective Prolific IDs and transferred the money to their accounts anonymously.

Participants received a show-up fee if they completed the instructions, the test questions, the hypothetical scenario, and passed the waiting room. If they could not be assigned to a group within 15 minutes, they received a compensation of £2.00. For those players who were successfully matched into groups, the fixed payment was increased to £2.50 to encourage them to also complete the remainder of the survey. In addition to this fixed payment, participants could earn points in the interactive game and in further incentivized tasks, including a memory test to measure cognitive abilities. In the game, participants decided on the allocation of "token" to minimize the external influence of money. At the end of the study, tokens were converted back to real money. The conversion rate between tokens and Pounds was 8:1. A maximum of 40 tokens (£5.00) could be earned in the collective risk social dilemma game and an additional £1.5 in further incentivized tasks.

In total, 829 participants played at least one round in the interactive climate game, of which 802 completed the interactive part and 800 completed the full questionnaire. 658 of those also took part in the second vignette study which took place approximately two months after the laboratory study. This corresponds to an attrition rate of 17.8% between the two studies.

Appendix B: Experimental instructions of the lab experiment

This section includes the study description on Prolific and the experimental instructions of the lab experiment. We removed questionnaire items that were not used in the final analysis.

Study description on Prolific

Interactive Game: 2.50 – 9.00 £ for Completion

In this study, you will play an interactive game with other Prolific participants. Because the study involves live interaction among real participants, it is highly important that you are able to complete the survey without interruptions and with a stable internet connection. If you join the study, you will go through the instructions of the game and you have to answer to test questions on the instructions. Afterwards, you will be sent to a waiting room until you are assigned to a group.

If there are not enough participants to form a group for 15 minutes, you are redirected to a final screen and receive a **payment of £ 2**. If there are enough participants to form a group, the interactive game starts, and you will be able to earn a variable **bonus payment of up to £ 5.00** in addition to a **fixed amount of £ 2.50**. Your bonus payment depends on your decisions and the decisions of other participants. Throughout the survey, there will be further possibilities to earn **additional payments of up to £ 1.50** in form of mini tasks. If you exit the study at any other point during the instructions, the waiting stage, or the interactive game **we will not be able to pay you.** This study is scheduled to last about **25 to 30 minutes**. Since you will be playing live with other Prolific participants, you will regularly have to wait for others to take their Decisions.

The task will only be available on **PC and tablet**, not on smartphones and does not support the browser 'Internet Explorer'. Please **start the study immediately after reserving a place**. The link expires shortly after the study has been published. If you reserve a place but do not enter the study in time, you cannot participate, and we will not be able to pay you.

Experimental Instructions - Welcome Stage 1

Before the survey starts, please enter your **Prolific-ID** (24 alphanumeric characters). Please remember that we will only be able to pay you if you finish the entire survey. [enter ID] **Please make your decisions within the time limit shown on your screen. If you do not continue with the time limit, you will be redirected to a final page and we are not able to pay you.**

Information about data protection

- Your participation is voluntary.
- Your responses are anonymous and cannot be linked to your person.
- The data will be treated confidentially.
- The European General Data Protection Regulation (GDPR) applies.

If you have any questions about the survey, please use the „Contact Researcher" Button in Prolific. Thank you for your participation!

Welcome Stage 2

In this survey, you will be playing an **interactive game** in a group together with other real people who are completing this survey at the same time as you. Overall, completing this survey will take about **25 to 30 minutes**. During the survey, **please do not close this window** or leave the survey web pages in any other way. If you do close your browser or leave the survey, you will not be able to re-enter the survey and we will not be able to pay you!

Since you are playing in a group, it is important that you complete the game without interruptions. Please make your decisions within the time limit shown on your screen. Because participants progress through the game with varying speed, occasionally you might have to wait for others to take their decisions.

Before starting the game, you will be shown detailed instructions and test questions. Afterwards, you will be sent to a waiting room until you are assigned a group. If there are not enough participants to form a group for 15 minutes, you will be redirected to a final screen and receive a **payment of £ 2.00**. If you exit the waiting room before the 15 minutes are over, we will also not be able to pay you!

If there are enough participants to form a group, the interactive game starts and you will be able to earn a variable **bonus payment of up to £ 5.00** in addition to a fixed amount of £ 2.50. Your bonus payment depends on your decisions and the decisions of other participants. Throughout the survey, there will be further possibilities to earn **additional payments of up to £ 1.50** in form of mini tasks.

During the experiment we do not speak of Pounds, but of Points. At the end of the experiment, the Points earned will be converted according to the following exchange rate: **8 Points = 1 Pound (£).** Please take your time when reading the instructions and making your decisions. At no time during the game will your identity and your payment be revealed to other participants. Your anonymity towards the researchers and the other participants is guaranteed.

Instructions

Today, you will participate in a game that simulates **climate change**, which is a real environmental problem faced by humankind. Humanity significantly contributes to climate change by producing CO2 as part of industrial processes or energy production as well as when using internal combustion engines in automobiles.

During the game, you will interact with the same participants in a group for **10 climate rounds**. The decision situation is the same for each player. At the beginning, an initial endowment of **40 Points will be credited to your personal account**. All the Points left in your personal account at the end of the game will be paid out to you as your bonus payment.

In each climate round, you can use your endowment to invest into a **climate account** in an attempt to avoid dangerous climate change. Among other things, climate change leads to serious economic

consequences, which are simulated in this game through the loss of the Points in your personal account. Also, the other group members can invest Points from their personal account into the Climate Account.

At the end of the game, after 10 climate rounds, the Points invested into the climate account by all group members are compared to a **fixed threshold amount**. If the Points in the climate account do not reach the threshold amount, dangerous climate change occurs with 90% probability, that is in 9 out of 10 cases. If climate change occurs, participants lose all their endowment kept in the personal account. Your investments in the climate account can help to avert climate change and the economic loss, but the success of the prevention also depends on the contributions of other participants. Players can either keep their Points in their personal account to receive higher payouts, if no climate change occurs, or invest in the public climate account to support the group in preventing climate change.

In each round all participants will be asked at the same time: "How many Points do you want to invest into climate protection?". The possible answers are 0, 1, 2, 3 or 4 Points. As soon as every group member has made a decision, you will be informed about the total investments into the climate account and a new round will begin. Please note: If a participant happens to drop out from the online survey, their investments to the climate account will be set to 0 for the remainder of the game.

Control Questions

To continue with the experiment, you have to answer the 7 test questions correctly.

1. How many rounds does the game last?

- 10 climate rounds
- 14 climate rounds
- 18 climate rounds
- 20 climate rounds

2. How can participants prevent dangerous climate change?

- By keeping Points in the personal account
- By investing Points into the climate account
- By keeping Points in the climate account
- By investing Points into the personal account

3. How many Points does each participant receive as an initial endowment?

- 20 Points
- 40 Points
- 60 Points
- 80 Points

4. What happens if the investments in the climate account do not exceed the threshold amount? Participants earn the Points in the personal account...

- ...with a probability of 90% or lose everything with a probability of 10%
- ...with a probability of 10% or lose everything with a probability of 90%
- ...with a probability of 90% or 40 Points with a probability of 10%
- ...with a probability of 10% or 40 Points with a probability of 90%

5. You are playing in a group of 3 players. The threshold amount needed to prevent climate change is 60 Points. Climate change can be prevented if…

- All three players contribute 1 Point each round to the climate account
- All three players contribute 2 Points each round to the climate account
- One player contributes 3 Points each round to the climate account and the other two players contribute nothing
- None of the players contributes to the climate account in any of the rounds

6. You are playing in a group of 3 players. The threshold amount needed to prevent climate change is 60. Imagine one player never contributes anything to the climate account. How much do the other two players have to invest at least each round to prevent climate change?

- 1 Point
- 2 Points
- 3 Points
- Climate change cannot be prevented

7. You are playing in a group of 6 players. The threshold amount needed to prevent climate change is 120 Points. Climate change can be prevented if…

- None of the six players contributes to the climate account in any of the rounds
- All six players contribute 1 Point each round to the climate account
- All six players contribute 2 Points each round to the climate account
- One player contributes 3 Points each round to the climate account and the other five players contribute nothing

Hypothetical Scenario

Before the actual game, we are interested in your personal opinion in a hypothetical situation. Please note: There are no true or false answers to the following questions. None of your answers on this page will affect your bonus payment. Imagine you are playing in a **group of 3 people**, this is you and two other players. The threshold amount is 60 Points. Remember that all group members have an endowment of **40 Points** and can invest from **0 to 4 Points** into the climate account each round.

- How many Points would you invest in climate protection in each round? [0 to 4 points]

- How many Points do you think someone ought to invest in climate protection in each round? [0 to 4 points]

For the next two questions we are interested in what you think your group members replied to the previous questions. If you are in the range of -0.3 to +0.3 of the actual average in your group for both questions, we will add 2 extra Points to your final payment at the end of the survey. You will be informed about the average in your group and your extra payment at the end of the game.

Imagine you are playing in a **group of 3 people**, this is you and two other players. The threshold amount is 60 Points. Remember that all group members have an endowment of **40 Points** and can invest from **0 to 4 Points** into the climate account each round.

What do you think your group members replied on average to the following question:

"How many Points would you invest in climate protection in each round?" [slider from 0 to 4 in 0.1 increments]

What do you think your group members replied on average to the following question:

"How many Points do you think someone ought to invest in climate protection in each round?" [slider from 0 to 4 in 0.1 increments]

Please Continue

By clicking "Continue" you are sent to the waiting room. The game will start once the waiting room hosts enough participants to form a group.

Waiting room

You will now be assigned to your group. This might take some minutes. In case that you are not assigned to a group within 15 minutes you will be forwarded to collecting a **payment of £ 2.00**. Once the interactive game starts, you will be able to earn a variable **bonus payment of up to £ 5.00** in addition to a **fixed amount of £ 2.50**. Throughout the survey, there will be further possibilities to earn **additional payments of up to £ 1.50** in form of mini tasks. Remember if you exit the survey, we will not be able to pay you!

Treatment Instructions

Any decision you make from now on will be relevant for the bonus payment. In the game, you will be playing in a group of **[3/6] participants** (this is you and [2/5] more participants) over **10 climate rounds**. The threshold needed to prevent climate change with certainty is **[42/60/84/120]** Points. The group members' investments in the climate account can help to prevent climate change. [However, investments of the group members can get lost on the way and will be added to the climate account only with a **probability of 70%.** That is, only in 7 out of 10 cases, the Points you invest will be added to the climate account. In 3 out of 10 cases the Points you invest will be lost. After each climate round, you will only be

informed about the successful investments into the climate account.] [If the threshold is not reached, dangerous climate change will occur with **90% probability** (in 9 out of 10 cases). However, **climate change will not directly affect your group, but another randomly selected group**. If your group does not reach the threshold, the other group faces a 90% probability (in 9 out of 10 cases) to lose all Points left in the personal accounts. Not reaching the threshold has no effect on your own group, your private account and your bonus payment. Note: Your group is NOT affected by the outcome of another group. / If the threshold is not reached, dangerous climate change will occur with **90% probability** (in 9 out of 10 cases). If climate change occurs all Points left in the personal accounts will be lost. In addition, **whether climate change occurs also depends on another randomly selected group** that is playing at the same time as you. If this group does not reach the threshold, your group also faces a **90% probability** (in 9 out of 10 cases) to lose all Points left in the personal accounts irrespective of the outcome in your own group. Thus, whether climate change occurs depends on your group as well as the other group. / If the threshold is not reached, dangerous climate change will occur with 90% probability (in 9 out of 10 cases). If climate change occurs all Points left in the personal accounts of the members of your group will be lost.]

Decision Screen

How many Points do you want to invest into climate protection? [0 to 4 points in 1-point increments]

This is climate round [1-10] of 10.

Your Personal Account: X Points.

Please keep this window open at all times.

Outcome Screen

[You have invested **X Points** to the climate account. / You chose to invest **X Points** into climate protection. A random number generator determined that your investment [will/will not] be added to the climate account.] In total, members of your group have successfully invested X Points into the climate account in this climate round.

So far, X **Points** have been invested into the climate account in total. Your group needs **[X/no] more Point(s**) to reach the threshold amount of **[42/60/84/120] Points** [with certainty. / However, remember that in order to prevent dangerous climate change with certainty, also another randomly selected group needs to reach the threshold.]

This was climate round [1-10] of 10.

You have X **Points** left in your personal account.

Please keep this window open at all times.

Interactive Game completed

Before you receive your payment, we kindly ask you to fill out a brief questionnaire. Remember that you will only be able to collect the fixed payment of £2.50 after careful completion of the questionnaire.

Questionnaire A: Risk and Time Preferences, Trust in Society

Please answer the following questions.

- Generally speaking, would you say that most people can be trusted (1), or that you can't be too careful in dealing with people (10)? [Likert scale, 1 = trusted, 10 = can't be too careful]
- How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future? [5-Point Likert scale, 1 = very unwilling, 5 = very willing]
- How willing or unwilling are you to take risks in general? [5-Point Likert scale, 1 = very unwilling, 5 = very willing]
- How willing are you to punish someone who treats you unfairly, even if there may be costs for you? [5-Point Likert scale, 1 = very unwilling, 5 = very willing]
- How willing are you to return a favor to someone who has done a favor for you? [5-Point Likert scale, 1 = very unwilling, 5 = very willing]

Questionnaire B: Cognitive Reflection Test [Not Displayed]

Questionnaire C1: Environmental Attitudes

How much do you agree or disagree with the following statements: [all answered on a 5-Point Likert scale, 1 = strongly disagree, 5 = strongly agree]

- Climate change affects me personally nowadays.
- Climate change will affect me personally in the future.

Questionnaire C2: Environmental Values

How much do you agree or disagree with the following statements: [all answered on a 5-Point Likert scale, 1 = strongly disagree, 5 = strongly agree]

- We worry too much about the future of the environment and not enough about prices and jobs today.
- People worry too much about human progress harming the environment.

Questionnaire D: Environmental Knowledge

Generally speaking, how much do you feel you know about climate change?

- know nothing at all
- know a little
- know something
- know a lot
- know a great deal

How true do you think the following statements are? For each statement below, just tick the box that comes closest to your opinion of how true it is. [4-Point Likert scale, 1 = definitively not true, 4 = definitively true]

- Climate change is caused by a hole in the earth's atmosphere.
- Every time we use coal or oil or gas, we contribute to climate change.
- Since 1880, the global average temperature has increased by about 1° C.
- Climate change is mainly caused by natural processes, and not human activities.

Questionnaire E: Survey Measures of Behavioral Barriers

How much do you agree or disagree with the following statements: [all answered on a 5-Point Likert scale, 1 = strongly disagree, 5 = strongly agree]

- I find it hard to know whether the way I live is helpful or harmful to the environment
- Environmental problems have a direct effect on my everyday life.
- My personal actions can contribute to prevent climate change.

Questionnaire F1: Environmental Behavior Reported Private Domain

[Never/Rarely/Sometimes/Often/Always]

- How often do you make a special effort to sort glass or tins or plastic or newspapers and so on for recycling?
- How often do you make a special effort to buy fruit and vegetables grown without pesticides or chemicals?
- How often do you cut back on driving a car for environmental reasons?
- How often do you reduce the energy or fuel you use at home for environmental reasons?
- How often do you choose to save or re-use water for environmental reasons?
- How often do you avoid buying certain products for environmental reasons?
- How often do you re-use or recycle used products, such as clothes or furniture?
- How often do you avoid consuming meat products?

Questionnaire F2: Environmental Behavior Reported Public Domain

[yes/no]

- Are you a member of an environmental organization whose main aim is to protect or preserve the environment?
- In the last five years, have you signed a petition about an environmental issue?
- In the last five years, have you given money to an environmental group?
- In the last five years, have you taken part in a protest or demonstration about an environmental issue?

Results of the Interactive Game

The total amount of Points in your personal account is: X **Points.**

In total, your group has invested **X Points** into the climate account.

The threshold to prevent dangerous climate change is at **[42/60/84/120] Points.**

[Your group failed to reach the threshold. Therefore, climate change occurs with a probability of 90% (that is in 9 out of 10 cases). As announced in the instructions this does not influence your earnings. However, if climate change occurs another group that depends on you will lose the Points in their personal accounts. / Your group passed the threshold and climate change will not occur. As announced in the instructions this does not influence your earnings. However, the group that depends on you will keep their earnings, given they also reached the threshold themselves.][Your group failed to reach the threshold. As announced in the instructions your success will also depend on another group / Your group passed the threshold. As announced in the instructions your success will also depend on another group.] [Your group failed to reach the threshold. Therefore, climate change occurs with a probability of 90% (that is in 9 out of 10 cases). If climate change occurs all members of your group will lose the Points in their personal accounts. A random draw determined that climate change [occurs/will not occur] and [you will lose the Points in your personal account/ all players of your group will keep their Points in their personal account.] [Your group as well as the other group influencing your outcomes failed to reach the threshold. / The other group influencing your outcomes passed the threshold. However, your group failed to reach the threshold. / Your group reached the threshold. However, the other group influencing your outcomes failed to reach the threshold. Therefore, climate change occurs with a probability of 90% (that is in 9 out of 10 cases). A random number generator determined that climate change [occurs/will not occur] and you will [lose/keep] the Points in your personal account. [Your group as well as the other group influencing your outcomes reached the threshold and climate change will not occur. Therefore, all players of your group will keep their points in the personal account.]

Therefore, your final earnings from the game are **X Points.**

These points are worth **£ X.**

These Points will be added up to the **fixed amount of £ 2.50.**

Final Results

Your final Points from the game are **X Point(s).** Your final Points from the estimation questions are **X Point(s).** Your final Points from the problem-solving task are **X Point(s).**

In sum, these Points are worth**:** £ X. Your guaranteed participation fee is £ 2.50. In total, your payment amounts to £ X.

This amount will be transferred to you Prolific Account, £ 2.50 Pounds immediately and the remaining difference to your earnings as a bonus payment shortly thereafter.

Please continue to the next page to be linked back to Prolific.

Appendix C: Experimental procedures and protocols in the vignette experiment

In the vignette experiment, respondents decided about donations to an environmental charity. At the beginning of the experiment, they were informed that all donations went to "One Tree Planted", a non-profit organization founded in 2014 that relies exclusively on donations to finance afforestation and reforestation projects around the globe. As the basis for this vignette study, reforestation projects offer several advantages. They provided an immediate link to climate change mitigation as forests serve as an important carbon sink taking up carbon through photosynthesis. Even small size donations for reforestation can have a tangible impact.

Furthermore, the organization is active in all world regions and allows donors to dedicate their funding to projects in specific countries. This allowed us to test for differences in donation behavior conditional on the immediacy of the benefits of the projects by varying whether the reforestation projects were carried out in the respondent's country or another country. As our participants were recruited among Prolific members from the UK and the US, we varied between these two countries in our experimental descriptions.

In the experiment, the participants were shown descriptions of environmental projects in a randomized order, and they had to make a donation decision for each project. Here, they were asked what amount from £0 to £1 they would like to invest in the project. The invested amount translated to a probability that £1 would be donated to the project(Becker et al., 1964). Phrased differently, for every additional 10 Pence, the probability of a donation increased by 10%. At the end of the study, a computerized mechanism randomly drew one of the vignettes and participants received the sum they kept in this decision scenario, plus a fixed participation fee of £2. After the study, participants received a donation receipt to their Prolific account as proof that their donations had been received by the organization.

Appendix D: Experimental instructions of the vignette experiment

This section includes the study description on Prolific and the experimental instructions of the vignette experiment. We removed the instructions for a second decision task, the results of which are not reported in the paper.

Study description on Prolific

In this survey, we want to find out why people support environmental projects. You will make decisions about real donations to different environmental projects.

Overall, completing the survey will take about **20 minutes**. You will receive a **fixed amount of £2** if you complete the study. In addition, you can receive a **variable bonus payment of up to £1** depending on the choices you make in the survey.

All information provided will be treated confidentially and your anonymity towards the researchers and other participants is guaranteed. The task will only be available on **PC and tablet**, not on smartphones and does not support the browser Internet Explorer.

Thank you very much for your participation! Please do not hesitate to contact us, should you have any questions.

Welcome I

Welcome! Before the start of the survey, **please enter your Prolific-ID** (24 alphanumeric characters). Please remember that we will only be able to pay you if you finish the entire survey.

Please indicate your country of residence

- United Kingdom
- United States of America
- Other

If you selected "other", please specify [open text input]

Information about data protection

- Your participation is voluntary.
- Your responses are anonymous and cannot be linked to your person.
- The data will be treated confidentially.
- The European General Data Protection Regulation (GDPR) applies.

If you have any questions about the survey, please use the „Contact Researcher" Button in

Prolific. Thank you for your participation!

Welcome II

Welcome!

In this survey, we want to find out why people support environmental projects. On the next screens, you will find detailed instructions on the different parts of the study.

Overall, completing this survey will take about **20 minutes**. You will receive a **fixed amount of £ 2** if you complete the study. In addition, you can receive a **variable bonus payment of up to £ 1** depending on your decisions in different tasks.

Please take your time when reading the instructions and making your decisions. Your anonymity towards the researchers and the other participants is guaranteed.

Welcome III

In the following, we will show you descriptions of **12 environmental projects**. All projects are implemented by a conservation organization. All projects are currently looking for financial funding. In this study, you will decide how much financial funding each project should receive by **providing donations to the projects**.

For each environmental project, you can decide how much you want to donate **in two decisions tasks**. At the end of the survey, we will randomly draw one environmental project and one decision task to determine the amount donated and the project receiving your donation.

For each task, you have an **endowment of £ 1**, which you can use for your donations. All donations are made to real environmental projects implemented by "One Tree Planted", a non-profit organization focused on global reforestation. Founded in 2014, "One Tree Planted" has planted more than 10 million trees around the world. As a non-profit charity, the projects of the organization depend on donations. Within four weeks after you completed this survey, we will send you a donation confirmation to your prolific profile as a proof that your donations were received by the organization.

Task

In the **decision task**, you can decide how much of your £ 1 you want to invest into the environmental project (Project A). You can invest between £ 0 and £ 1. Your investment determines the probability that £ 1 will be donated to the project. While the donation will always be £ 1, your investment determines the likelihood that a donation is made or not. All money not invested is added to your variable bonus payment.

With each additional £ 0.1, the probability increases by 10%. For example, if you invest £ 0.5, a donation of £ 1 will be made in half of all cases (50% probability); if you invest £ 1 into the Project, a donation of £ 1 will be made with certainty (100% probability); and if you invest nothing (£ 0), no donation will be made (0% probability).

Below you find an example for the decision task.

Project

Project description: …

The project plants trees ...

Decision Task: You can invest between £ 0 and £ 1 into the Project and keep the rest for yourself. Your investment determines the probability (0% - 100%) of a donation to the Project. Irrespective of how much you invest, the donation will be £ 1, but your investment determines how likely it is that the donation will be made.

How much do you want to invest into the Project? [£ 0 to £ 1 in £ 0.1 increments]

You invest £ X into the Project. A donation of £ 1 is made with a probability of % (in out of 10 cases). £ X will be added to your bonus payment.

Projects

The Environmental Projects

Before starting with the decisions tasks, we provide you some background information on the environmental projects. All projects collect donations to plant trees and to support reforestation. Forests are critical in the fight against climate change as they remove excess carbon from the atmosphere. Forests effectively mitigate some of the harmful impacts of rising carbon emissions and air pollution.

At the same time, the world's natural forests are at risk. In many places all over the world, forests are cleared to make room for livestock, replaced by mono-crop plantations like soy and palm oil, and exploited for timber. Forests are not only of critical importance to the world's climate, but also for food supply, air quality, species habitat, and the livelihoods of people.

Forestation projects, which are active worldwide, plant trees on currently unforested land and grow existing forests. Scientific studies have shown the potential of these projects in creating forest cover and in supporting environmental sustainability. All of the environmental projects described here depend on your donations. Any donation can benefit a forestation project somewhere in the world.

Hypothetical Scenario

Hypothetical Project I

Before you start with the actual projects, we are interested in your **personal opinion on a hypothetical Project I**. There are no true or false answers to the following questions. **None of your answers on this page will affect your final donation or your bonus payment**.

Project I

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Imagine you are asked to invest into Project I. You would be able to invest between £ 0 and £ 1 into the Project and keep the rest for yourself. Your investment would determine the probability (0% - 100%) of a donation to the Project. Irrespective of how much you invest, the donation would be £ 1, but your investment determines how likely it is that the donation would be made.

How much of £ 1 would you invest into the hypothetical Project I? [£ 0 to £ 1 in £ 0.1 increments]

How much of £ 1 do you think someone ought to invest into the hypothetical Project I? [£ 0 to £ 1 in £ 0.1 increments]

Decisions Start

You complete both decision task for 12 different environmental projects. Each project has a unique alphabetic identifier and they are presented in random order.

At the end of the study, we will **randomly choose one project** to determine your donation to the conservation organization and your variable bonus payment. Each project has the same probability to be randomly chosen.

Please read all the project descriptions carefully to make an informed decision about your donation.

Project Choice [repeated 12 times]

Decision Task. You can invest between £ 0 and £ 1 into Project X and keep the rest for yourself. Your investment determines the probability (0% - 100%) of a donation to the Project. Irrespective of how much you invest, the donation will be £ 1, but your investment determines how likely it is that the donation will be made.

[Insert project vignette here]

How much do you want to invest into Project X? [£ 0 to £ 1 in £ 0.1 increments]

You invest £ X into Project X. £ X will be added to your bonus payment.

The button to continue will automatically appear after 20 seconds.

Decision Tasks Completed

On this page, a random number generator will select one environmental project to determine your donation to the conservation organization and your bonus payment.

Results

The random number generator selected environmental **Project X.**

You invested £ X into environmental Project X. We will generate a random number between 0.00 and 1.00. If the random number is lower than your investment, a donation will be made. If the random number is higher than your investment, no donation will be made.

The random number is X and a donation of 1 Pound **[is made/is not made]** to Project X.

£ will be added to your bonus payment.

For your information, this project is again shown below.

Final Page

Thank you for taking part in this study!

You receive a fixed payment of £ 2 and a bonus payment of £ X.

In total, your payment amounts to £ X.

Appendix E: Experimental vignettes

The vignettes were varied in a 2 x 2 x 3 design. In the treatments, the project descriptions varied a) one's own benefit or affectedness by the donation to the environmental project (immediacy barrier), b) the likelihood of survival of the trees in the respective location (uncertainty barrier), and c) the relative importance of the individual donation for the environmental project (marginality barrier).

Immediacy

Immediacy high:
The project plants trees **in [own country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

Immediacy low:
The project plants trees **in [other country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in this country directly** by improving air quality and restoring bio-diversity.

Dependency:

The project plants trees **in [own country]**. Expenditures for tree care and forest preservation **are not covered** by the donations and, thus, the success of the project **depends on the efforts of the local community**. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

Uncertainty

Uncertainty no:

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

Uncertainty high:

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **70% of all planted trees survive**.

Marginality

Marginality low:

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Marginality high:

The donations of all study participants are pooled and used to plant a grove of trees. You will receive a confirmation of **the combined donation** to this project at the end of this study.

Appendix F: List of all experimental vignettes shown to participants

Baseline: Immediacy high, uncertainty no, marginality low

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Immediacy low, uncertainty no, marginality low

The project plants trees **in [other country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in this country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Dependency, uncertainty no, marginality low

The project plants trees **in [own country]**. Expenditures for tree care and forest preservation **are not covered** by the donations and, thus, the success of the project **depends on the efforts of the local community**. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Immediacy high, uncertainty high, marginality low

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **70% of all planted trees survive**.

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Immediacy low, uncertainty high, marginality low

The project plants trees **in [other country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in this country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **70% of all planted trees survive**.

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Dependency, uncertainty high, marginality low

The project plants trees **in [own country]**. Expenditures for tree care and forest preservation **are not covered** by the donations and, thus, the success of the project **depends on the efforts of the local community**. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **70% of all planted trees survive**.

Your donation allows the project to plant one additional tree. You will receive a confirmation of **your individual donation** to this project at the end of this study.

Immediacy high, uncertainty no, marginality high

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

The donations of all study participants are pooled and used to plant a grove of trees. You will receive a confirmation of **the combined donation** to this project at the end of this study.

Immediacy low, uncertainty no, marginality high

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

The donations of all study participants are pooled and used to plant a grove of trees. You will receive a confirmation of **the combined donation** to this project at the end of this study.

Dependency, uncertainty no, marginality high

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

The donations of all study participants are pooled and used to plant a grove of trees. You will receive a confirmation of **the combined donation** to this project at the end of this study.

Immediacy high, uncertainty high, marginality high

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

The donations of all study participants are pooled and used to plant a grove of trees. You will receive a confirmation of **the combined donation** to this project at the end of this study.

Immediacy low, uncertainty high, marginality high

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

The donations of all study participants are pooled and used to plant a grove of trees. You will receive a confirmation of **the combined donation** to this project at the end of this study.

Dependency, uncertainty high, marginality low

The project plants trees **in [country]**. Expenditures for tree care and forest preservation **are fully covered** by the donations. The forestation will **benefit people in your country directly** by improving air quality and restoring bio-diversity.

The success of the project depends on the geographical location and local conditions of the project site. On this project's site, **nearly all of the planted trees survive**.

The donations of all study participants are pooled and used to plant a grove of trees. You will receive a confirmation of **the combined donation** to this project at the end of this study.

Appendix G: Descriptive statistics and sample description

802 people completed the laboratory experiment and 800 filled in the final questionnaire. Table G.1 shows the distribution of the socio-demographic characteristics of participants. In contrast to standard laboratory experiments, which recruit participants from a student population, Prolific provided us with access to a more diverse sample.

Table G.1. Descriptive statistics.

	Percent/ Average	**N**
Gender		
Female	58.25%	466
Male	41.75%	334
Age	29.4	800
Education		
Low (High School and Less than High School)	24.75%	198
Middle (College or Vocational)	32.75%	262
High (Graduate Degree)	40.50%	324
Missing	2.00%	16
Income		
Low (Less than £1.000)	55.40%	443
Middle (1.001-2.000 £)	26.25%	210
High (More than 3.000£)	13.75%	110
Missing	4.63%	37
Grown up in		
Urban area	62.88%	503
Rural area	36.88%	295
Missing	0.24%	2
Country of Residence		
UK	81.4%	651
USA	18.4%	147
Missing	0.2%	2

The final questionnaire further collected data on climate change skepticism and environmental knowledge. We find that the proportion of people who only partially or not at all agree with the statement "climate change is happening" is 3.6% in our study. Comparative values from a representative study using ISSP data are slightly higher at 10% for the United Kingdom and 12% for the United States, but date back to 2010 (Tranter & Booth, 2015). In the European Social Survey (2016), 93.6% of people from the United Kingdom agreed with a statement that climate change is "probably" or "certainly" happening (Poortinga et al., 2018). Thus, our sample shows climate change skepticism close to, but slightly lower than, the extent of skepticism identified by representative studies. This could be explained either by the fact that the study was conducted five to ten years after the data collection for the ISSP and the ESS or because the experiment was explicitly

advertised as a study on environmental decision-making and therefore might have attracted more individuals who are concerned with environmental issues. However, the main objective of the present study was not to estimate the distribution of environmental concern in the population but to identify the influence of the three behavioral barriers related to environmental decision-making.

Table G.2. Climate change skepticism and self-reported environmental knowledge.

	Percent	***N***
Agreement "Climate Change is happening"		
Disagree	1.2%	10
Partly agree	2.4%	19
Agree	96.4%	771
Self-reported environmental knowledge		
Know nothing to a little	14.00%	112
Know something	52.50%	420
Know a lot	33.5%	268

Table G.3 compares the distribution of the main socio-demographic characteristics between the 800 participants completing the questionnaire in the lab study and the 658 participants in the vignette study. The table demonstrates that the share of population groups did not substantively change due to attrition after the lab experiment.

Table G.3. Distribution of sociodemographic characteristics in the lab and vignette study.

	Lab	**Vignette**
Women (Share)	58.3%	61.0%
Age	29.4	29.3
Education		
Low (High School and Less than High School)	24.75%	25.30%
Middle (College or Vocational)	32.75%	31.40%
High (Graduate Degree)	40.50%	41.31%
Missing	2.00%	1.98%
Income		
Low (Less than £,1.000)	55.40%	58.69%
Middle (1.001-2.000 £,)	26.25%	25.30%
High (More than 3.000£,)	13.75%	11.28%
Missing	4.63%	4.73%
Grown up in		
Urban area	62.88%	61.80%
Rural area	36.88%	37.90%
Missing	0.24%	0.30%
Country of Residence		
UK	81.4%	88.1%
USA	18.4%	11.9%
Missing	0.2%	0%

Appendix H: Behavioral barriers and the value-action gap

Table H.1 shows the effects of the behavioral barriers on the standardized value-action gap in the lab (model (1) and (2)) and the vignette experiment (model (3) and (4)) as plotted in Figure 4. Models (1) and (3) test for the effect of the number of barriers, whereas models (2) and (4) distinguish between the different types of barriers. Models (1) and (2) include an additional control variable indicating if a player finished the collective-risk social dilemma game, and a dummy indicating if a player of the group dropped out during the collective-risk social dilemma game.

Table H.1. The effects of the behavioral barriers on the value-action gap.

	Value-Action Gap (Lab)	**Value-Action Gap (Lab)**	**Value-Action Gap (Vignette)**	**Value-Action Gap (Vignette)**
	(1)	**(2)**	**(3)**	**(4)**
Number of Barriers (ref.: 0)				
1 Barrier	0.0550		0.216***	
	(0.0535)		(0.0184)	
2 Barriers	0.126**		0.384***	
	(0.0498)		(0.0212)	
3 Barriers	0.173***		0.519***	
	(0.0501)		(0.0268)	
Marginality (ref.: Low Marginality)				
High Marginality		0.0772**		0.00530
		(0.0337)		(0.00870)
Uncertainty (ref.: Low Uncertainty)				
High Uncertainty		0.0571**		0.203***
		(0.0248)		(0.0133)
Immediacy (ref.: High Immediacy)				
Low Immediacy		0.0899**		0.344***
		(0.0411)		(0.0221)
Dependency		0.00345		0.274***
		(0.0326)		(0.0201)
Observations	8,354	8,354	7,896	7,896
R^2	0.175	0.176	0.227	0.239

Notes: Regression coefficients in cells with session-clustered standard errors in parentheses. Model 1 and model 2 include additional controls indicating if all players of a group completed the climate game (Finished Dummy) and if a player dropped out during the climate game (Drop-Out Dummy). Not Reported: Periods, Values, Constant. P-values: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix I: Sensitivity tests

To determine the robustness of the models, we performed additional analyses in Tables I.1 and I.2. The models in Table I.1 include the number of barriers as independent variable and the value-action gap in the lab as dependent variable (testing the robustness of model (1) in Table H.1). In Table I.2, we use the same model specifications as in Table I.1, however with the dummies for the three barriers as the central predictors (testing the robustness of model (2) in Table H.1).

Model (1a) includes participants who finished the game exclusively. Model (1b) includes an additional variable, indicating whether in a period the climate target had already been reached in the previous round. To reach the climate target individuals had to contribute to a climate account, but beyond that point, contributions did not yield additional social or individual benefits. Therefore, we assume that actions deviate more strongly from values once the threshold has been passed. Model (1c) repeats the analysis at the individual level and takes the difference between average contributions across the ten periods and values as the dependent variable. Models (1a) to (1c) include the variable Values, whereas specification (1d) assesses the robustness of our findings to dropping this variable. Table I.1 shows that the main results for the number of barriers are robust to these model specifications.

Table I.1. Sensitivity tests I

	Value-Action Gap (Lab) (1a)	**Value-Action Gap (Lab) (1b)**	**Value-Action Gap (Lab) (1c)**	**Value-Action Gap (Lab) (1d)**
Number of Barriers (ref.: 0)				
1 Barrier	0.0832	0.0463	0.127	0.0996
	(0.0644)	(0.0592)	(0.0986)	(0.0964)
2 Barriers	0.157**	0.130**	0.240**	0.196**
	(0.0595)	(0.0566)	(0.0911)	(0.0796)
3 Barriers	0.212***	0.170***	0.323***	0.217**
	(0.0599)	(0.0554)	(0.0917)	(0.0888)
Drop Out Dummy		0.0799		0.0987
		(0.0946)		(0.121)
Finished Dummy	0.182***	0.144***	0.278***	0.172***
	(0.0340)	(0.0369)	(0.0521)	(0.0444)
Threshold Passed Dummy		0.892***		
		(0.0554)		
Values	0.507***	0.482***	0.775***	
	(0.0300)	(0.0312)	(0.0459)	
Observations	8,020	8,354	802	8,354
R^2	0.176	0.207	0.303	0.056

Notes: Regression coefficients in cells with session-clustered standard errors in parentheses. Difference to main Model 1: 1a contains only observations from players finishing the game. 1b additionally controls for whether the threshold was already passed in a given period. 1c uses the value-action gap calculated at the individual level. 1d drops the Values-variable. Not Reported: Periods, Constant. P-values: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Likewise, Table I.2 shows that the effects of marginality and immediacy are robust to the four alternative model specifications. Only the effect of the uncertainty barrier turns insignificant in the final model (2d). Taken together, this suggests that the effects of the barriers in the lab are very robust to different specifications.

Table I.2. Sensitivity tests II

	Value-Action Gap (Lab)	**Value-Action Gap (Lab)**	**Value-Action Gap (Lab)**	**Value-Action Gap (Lab)**
	(2a)	**(2b)**	**(2c)**	**(2d)**
Marginality (ref.: Low Marginality)	0.0826**	0.0843**	0.126**	0.108**
High Marginality	(0.0347)	(0.0381)	(0.0532)	(0.0451)
Uncertainty (ref.: Low Uncertainty)	0.0638**	0.0527*	0.0975**	0.0425
High Uncertainty	(0.0238)	(0.0265)	(0.0365)	(0.0318)
Immediacy (ref.: High Immediacy)				
Low Immediacy	0.100**	0.0901**	0.153**	0.122**
	(0.0411)	(0.0434)	(0.0630)	(0.0566)
Dependency	0.0203	0.0120	0.0310	0.00638
	(0.0312)	(0.0349)	(0.0478)	(0.0456)
Drop Out Dummy		0.0817		0.100
		(0.0939)		(0.122)
Finished Dummy	0.177***	0.139***	0.270***	0.168***
	(0.0368)	(0.0398)	(0.0564)	(0.0440)
Threshold Passed Dummy		0.889***		
		(0.0562)		
Values	0.506***	0.480***	0.773***	
	(0.0298)	(0.0312)	(0.0456)	
Observations	8,020	8,354	802	8,354
R^2	0.177	0.208	0.305	0.059

Notes: Regression coefficients in cells with session-clustered standard errors in parentheses. Difference to Main Model 2: 2a contains only observations from players finishing the game. 2b additionally controls for whether the threshold was already passed in a given period. 2c uses the value-action gap calculated at the individual level. 2d drops the Values-variable. Not Reported: Periods, Constant. P-values: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix J: Behavioral barriers and peer effects

We further investigate the effects of group dynamics in the collective-risk social dilemma game and include time and reciprocity preferences of the participants. Model (1) shows that the extent of the value-action gap strongly depends on the contributions of others in the previous round of the climate game. However, in model (2), we observe that an increasing number of barriers reduced the effect of others. Models (1) to (3) additionally reveal that the value-action gap increases throughout 10 periods in the climate game. Importantly, all models control for whether groups already passed the threshold at that point. In model (4), we include time and reciprocity preferences as collected in the post-experimental survey. The model demonstrates that higher willingness to give up something today to benefit in the future and willingness to reciprocate a favor are both related to a smaller value-action gap.

Table J.1. The social and temporal dimensions of the value-action gap.

	Value-Action Gap (Lab)			
	(1)	**(2)**	**(3)**	**(4)**
Others' Contribution [t-1]	-0.0628***	-0.104***		
	(0.0132)	(0.0358)		
Number of Barriers (ref.: 0)				
1 Barrier		-0.0377		0.120
		(0.189)		(0.0975)
2 Barriers		-0.0284		0.233**
		(0.214)		(0.0859)
3 Barriers		-0.152		0.324***
		(0.167)		(0.0888)
Interaction Effect				
1 Barrier x Others' Contribution [t-1]		0.0247		
		(0.0396)		
2 Barriers x Others' Contribution [t-1]		0.0385		
		(0.0441)		
3 Barriers x Others' Contribution [t-1]		0.0780**		
		(0.0367)		
Period (Ref.: 1)				
2			-0.0362	
			(0.0284)	
3	-0.00974	-0.00459	-0.0460	
	(0.0340)	(0.0361)	(0.0287)	
4	0.0730*	0.0764*	0.0349	
	(0.0394)	(0.0388)	(0.0343)	
5	0.0390	0.0403	0.0184	

	(0.0334)	(0.0340)	(0.0255)	
6	0.0505	0.0551	0.0245	
	(0.0465)	(0.0467)	(0.0462)	
7	0.0952**	0.0974***	0.0696	
	(0.0350)	(0.0345)	(0.0408)	
8	0.171***	0.173***	0.164***	
	(0.0514)	(0.0511)	(0.0510)	
9	0.225***	0.225***	0.237***	
	(0.0461)	(0.0461)	(0.0468)	
10	0.334***	0.328***	0.366***	
	(0.0527)	(0.0516)	(0.0398)	
Time Preferences				-0.271***
				(0.0556)
Reciprocity Preferences				-0.1692**
				(0.0805)
Drop out dummy	X	X	X	
Finished dummy	X	X	X	X
Observations	7,477	7,477	8,354	802
R^2	0.217	0.221	0.204	0.322

Note: Regression coefficients in cells with clustered standard errors in parentheses. Clustering at session level. Dependent variable: standardized Value-Action Gap. Not reported: Values, Threshold Passed Dummy, Drop Out Dummy, Finished Dummy, Threshold Passed Dummy. P-values: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix K: Non-linear age effects

Table K.1 tests for the existence of non-linear age effects in the value-action gap. The analysis is based on the models shown in Table 2, but uses a continuous age variable and adds a squared age term as an additional variable in the regression model. The results confirm for the laboratory setting a negative age effect on the value-action gap but with decreasing marginal changes for older age groups. Similar patterns are also observable for the vignette study, but the coefficients are overall weaker and insignificant.

Table K.1. Testing for non-linear age effects

	Value-action gap (lab)	**Value-action gap (vignette)**
	(1)	**(2)**
Gender (Ref.: female)		
Male	0.200***	0.262***
	(0.0612)	(0.0721)
Age	-0.0655***	-0.0186
	(0.0227)	(0.0205)
Age x Age	0.000719**	8.82e-05
	(0.000320)	(0.000273)
Education (Ref.: low)		
Medium	0.0422	-0.0538
	(0.0923)	(0.0934)
High	0.121	-0.0683
	(0.0765)	(0.0956)
Income (Ref.: low)		
Medium	0.0533	0.100
	(0.0612)	(0.0802)
High	0.0646	0.00587
	(0.0836)	(0.106)
Country (Ref.: UK)		
USA	-0.0352	0.221**
	(0.0762)	(0.106)
Observations	798	655
R^2	0.330	0.321

Notes: Models (1) and (2) shows regression coefficients with robust standard errors in parentheses. The dependent variables are standardized. Not Reported: Values, Constant, "Other"/No Response for Education and Income, Treatment (Model (1)), Finished Dummy (Model (1)). P-values: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

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Appendix Chapter 2

Disclaimer

We hereby declare that this paper reports all experimental sessions and treatments conducted within the course of this study. Instructions in German language are available from the authors upon request.

Appendix A. The EU regulation 2021/2616

The regulation is part of the European Commission's initiative regarding sustainable development, aiming to include sustainability considerations into the financial system to support the transformation towards a green, resilient and circular system, in line with the European Green Deal. The regulation also contributes to the aims to direct financial and capital flows to green investment and avoid stranded assets. It modifies previous regulations in two ways:

First, ESG preferences of clients are added to the suitability assessment when providing investment advice or portfolio management. Thus, in addition to investment experience, ability to bear losses, risk tolerance, etc., ESG preferences need to be elicited. This is particularly important, since clients often do not raise such preferences themselves, and in this case, these preferences could not be considered in financial advice. The regulation ensures that products that are sustainability-related are recommended to clients who report a preference for ESG investments in the elicitation. Based on the ESG preferences, advisors know whether and to what extent the following financial instruments should be integrated in the investment recommendation: i) financial instruments that determine a minimum amount invested in (environmentally) sustainable investments and ii) financial instruments that consider principal adverse impacts on sustainability factors.

Second, the regulation integrates sustainability risks into the organizational requirements, that is, ESG considerations are put at the heart of the financial system. Additionally, investment firms that provide investment advice and portfolio management services must explain the difference between fully or in part sustainable ESG investments, investments that consider principal adverse impacts and other instruments that are not sustainable.

Appendix B. Sample characteristics and descriptive statistics

Table B.1. Balance table by information treatment.

	Basic	Financial	ESG	Combinatio	Total sample	*p*-val.
	M(*SD*), f (%)	*M*(*SD*), f (%)	*M*(*SD*), f (%)	*M*(*SD*), f (%)	*M*(*SD*), f (%)	
Biospheric values	5.91 (1.14)	5.97 (1.09)	6.07 (0.94)	6.05 (1.10)	6.00 (1.07)	0.045
Altruistic values	5.83 (1.09)	5.84 (1.04)	5.94 (0.94)	5.92 (1.10)	5.88 (1.04)	0.191
Household income	2.04 (0.89)	2.04 (0.96)	2.05 (0.92)	2.10 (0.88)	2.06 (0.91)	0.679
Financial literacy	0.80 (0.28)	0.82 (0.27)	0.78 (0.29)	0.79 (0.29)	0.80 (0.28)	0.233
Age (in years)	48.78 (15.56)	48.58 (15.75)	47.58 (15.27)	47.88 (15.54)	48.20 (15.53)	0.518
Gender						0.385
Female	233 (41.4%)	219 (39.7%)	261 (45.6%)	259 (45.7%)	972 (43.1%)	
Male	329 (58.4%)	332 (60.1%)	310 (54.2%)	307 (54.1%)	1278 (56.7%)	
Non-binary	1 (0.2%)	1 (0.2%)	1 (0.2%)	1 (0.2%)	4 (0.2%)	
Highest education						0.734
Primary/ second. degree	14 (2.5%)	10 (1.8%)	14 (2.4%)	13 (2.3%)	51 (2.3%)	
Vocational training	97 (17.2%)	102 (18.5%)	96 (16.8%)	95 (16.8%)	390 (17.3%)	
Sec. degree (no A-levels)	59 (10.5%)	62 (11.2%)	62 (10.8%)	62 (10.9%)	245 (10.9%)	
High school (A-levels)	176 (31.3%)	175 (31.7%)	189 (33.0%)	203 (35.8%)	743 (33.0%)	
College / foreperson	16 (2.8%)	20 (3.6%)	30 (5.2%)	19 (3.4%)	85 (3.8%)	
University degree	195 (34.6%)	174 (31.5%)	175 (30.6%)	164 (28.9%)	708 (31.4%)	
Other degree	6 (1.1%)	9 (1.6%)	6 (1.0%)	11 (1.9%)	32 (1.4%)	
Household children	0.41 (0.77)	0.47 (0.83)	0.43 (0.80)	0.39 (0.77)	0.42 (0.79)	0.391
Experience	3.17 (2.92)	3.46 (2.92)	3.40 (3.00)	3.16 (2.93)	3.30 (2.95)	0.207
Risk preference	5.41 (2.45)	5.53 (2.47)	5.57 (2.28)	5.44 (2.48)	5.49 (2.42)	0.675
Trust in ESG	5.20 (1.30)	5.38 (1.28)	5.40 (1.19)	5.23 (1.34)	5.31 (1.28)	0.023
Relevance of the incentive	5.19 (1.78)	5.22 (1.87)	5.27 (1.74)	5.30 (1.72)	5.24 (1.77)	0.694
Email provided	0.86 (0.34)	0.87 (0.34)	0.89 (0.32)	0.91 (0.29)	0.88 (0.32)	0.133
Attention check passed	352 (62.52%)	386 (69.93%)	379 (66.26%)	395 (69.66%)	1512 (67.08%)	0.964
Survey wave	1.61 (0.49)	1.62 (0.49)	1.61 (0.49)	1.61 (0.49)	1.61 (0.49)	0.971

Note. f = frequency, % = percent of the basic information treatment (N = 563), financial return information (N = 552), ESG impact information (N = 572), both (N = 567) and the full sample (N = 2,254), M = mean, SD = standard deviation. For categorical variables (gender, education), frequencies, and percentage of the sample (in parentheses) are displayed. For the other variables, the mean and standard deviation is presented. [a] Statistics on number of children in the household and household income are calculated over the 10 imputed datasets, as described in Section 3.2. Measured variables.

Table B.2. Balance table by mode of sustainability preference elicitation treatment.

	General elicitation	Specific elicitation	Total sample	p-value
	$M(SD)$, f (%)	$M(SD)$, f (%)	$M(SD)$, f (%)	
Biospheric values	6.01 (1.05)	5.99 (1.08)	6.00 (1.07)	0.598
Altruistic values	5.90 (1.03)	5.86 (1.05)	5.88 (1.04)	0.321
Household income	2.09 (0.93)	2.03 (0.89)	2.06 (0.91)	0.132
Financial literacy	0.79 (0.29)	0.80 (0.28)	0.78 (0.28)	0.326
Age (in years)	48.08 (15.46)	48.32 (15.60)	48.20 (15.53)	0.712
Gender				0.126
Female	481 (42.8%)	491 (43.5%)	972 (43.1%)	
Male	643 (57.2%)	635 (56.2%)	1278 (56.7%)	
Non-binary	0 (0.0%)	4 (0.4%)	4 (0.2%)	
Highest education				0.091
Primary / secondary deg.	28 (2.5%)	23 (2.0%)	51 (2.3%)	
Vocational training	179 (15.9%)	211 (18.7%)	390(17.3%)	
Sec. degr. (no A-levels)	113 (10.1%)	132 (11.7%)	245 (10.9%)	
High school (A-levels)	367 (32.7%)	376 (33.3%)	743 (33.0%)	
College / foreperson	44 (3.9%)	41 (3.6%)	85 (3.8%)	
University degree	381 (33.9%)	327 (28.9%)	708 (31.4%)	
Other degree	12 (1.1%)	20 (1.8%)	32 (1.4%)	
Household children	0.43 (0.80)	0.42 (0.79)	0.42 (0.79)	0.733
Experience	3.30 (2.92)	3.29 (2.97)	3.230 (2.95)	0.950
Risk preference	5.48 (2.43)	5.50 (2.41)	5.49 (2.42)	0.848
Trust in ESG	5.29 (1.27)	5.33 (1.30)	5.31 (1.28)	0.509
Relevance of the incentive	5.21 (1.76)	5.27 (1.79)	5.24 (1.77)	0.416
Email provided	0.88 (0.33)	0.88 (0.32)	0.88 (0.32)	0.662
Attention check passed	748 (66.55%)	764 (67.97%)	1512 (67.08%)	0.892
Survey wave	1.61 (0.49)	1.62 (0.49)	1.61 (0.49)	0.687

Note. f = frequency, % = percent of general elicitation (N = 1,124), specific elicitation (N = 1,130), and the full sample (N = 2,254), M = mean, SD = standard deviation. For categorical variables (gender, education), frequencies, and percentage of the sample (in parentheses) are displayed. For the other variables, the mean and standard deviation is presented. [a] Statistics on number of children in the household and household income are calculated over the 10 imputed datasets, as described in Section 3.2. Measured variables.

We provide characteristics of both survey waves and the full sample in Table B.3. The population sample is balanced in terms of gender while the investor sample mirrors the general overrepresentation of male investors (Holmen et al., 2021). We detect no significant differences with regards to age. We find that education, household income, experience in investing and financial literacy are higher in the retail investor sample than in the population sample. Compared to other studies (Gutsche et al., 2023) the financial literacy of the retail investor is slightly higher, while that in the population sample is lower. This finding and the observed higher risk preferences of the retail investor sample are in line with previous research comparing finance professionals with the general population (Holmen et al., 2021). We furthermore observe that biospheric and altruistic value orientation is higher in the retail investor sample.

Table B.3. Descriptive statistics of sample characteristics by survey wave.

	Retail investor	Population	Full sample
	M(*SD*), f (%)	*M*(*SD*), f (%)	*M*(*SD*), f (%)
Gender			
Female	261 (30.0%)	711 (51.4%)	972 (43.1%)
Male	606 (69.6%)	672 (48.6%)	1278 (56.7%)
Non-binary	4 (0.5%)	0 (0.0%)	4 (0.2%)
Age (in years)	47.69 (13.83)	48.52 (16.50)	48.20 (15.52)
Income[a]			
Less than 1,000 euros	11 (1.26%)	62 (4.49%)	73 (3.24%)
1,001 to 2,000 euros	67 (7.68%)	309 (22.36%)	376 (16.68%)
2,001 to 3,000 euros	167 (19.15%)	321 (23.22%)	488 (21.65%)
3,001 to 4,000 euros	189 (21.67%)	298 (21.56%)	487 (21.61%)
4,001 to 5,000 euros	181 (20.76%)	214 (15.48%)	395 (17.52%)
5,001 to 6,000 euros	117 (13.42%)	93 (6.73%)	209 (9.27%)
6,001 to 7,000 euros	57 (6.54%)	37 (2.68%)	94 (4.17%)
7,001 to 8,000 euros	22 (2.52%)	20 (1.45%)	42 (1.86%)
8,001 euros or more	61 (7.00%)	28 (2.03%)	90 (3.99%)
Household children[a]	0.47 (0.81)	0.40 (0.78)	0.42 (0.79)
Household income[a]	2.29 (0.99)	1.91 (0.83)	2.06 (0.91)
Highest educational level			
Primary/secondary deg.	12 (1.38%)	39 (2.82%)	51 (2.26%)
Vocational training	101 (11.60%)	289 (20.90%)	390 (17.30%)
Sec. degr. (no A-levels)	72 (8.27%)	173 (12.51%)	245 (10.87%)
High school (A-levels)	287 (32.95%)	456 (32.97%)	743 (32.96%)
College/foreperson	42 (4.82%)	43 (3.11%)	85 (3.77%)
University degree	337 (38.69%)	371 (26.83%)	708 (31.41%)
Other degree	20 (2.29%)	12 (0.87%)	32 (1.42%)
Experience			
Not invested	53 (6.08%)	722 (52.21%)	775 (34.3%)

Less than 1 year	34 (3.90%)	59 (4.27%)	93 (4.1%)
1 – 2 years	75 (8.61%)	98 (7.09%)	173 (7.7%)
3 – 4 years	87 (9.99%)	93 (6.72%)	180 (8.0%)
5 – 6 years	67 (7.69%)	91 (6.58%)	158 (7.0%)
7 – 8 years	56 (6.43%)	47 (3.40%)	103 (4.6%)
9 – 10 years	51 (5.86%)	50 (3.62%)	101 (4.5%)
More than 11 years	448 (51.44%)	223 (16.12%)	671 (29.8%)
Financial literacy	0.90 (0.20)	0.74 (0.31)	0.80 (0.28)
Biospheric values	6.21 (0.81)	5.87 (1.18)	6.00 (1.07)
Altruistic values	6.04 (0.80)	5.78 (1.16)	5.88 (1.04)
Risk preference	6.51(2.20)	4.85 (2.33)	5.49 (2.42)

Note. f = frequency, % = percent of the retail investor sample (N = 871), the population sample (N = 1,383), and the full sample (N = 2,254), M = mean, SD = standard deviation. For categorical variables (gender, income, education, experience), frequencies, and percentage of the sample (in parentheses) are displayed. For the other variables, the mean and standard deviation is presented. [a] Statistics on income, number of children in the household and the resulting household income are calculated over the 10 imputed datasets, as described in Section 3.2. Measured variables.

Table B.4. Summary statistics by survey wave.

Variable	Retail investor	Population	Full sample
	M(*SD*), f (%)	*M*(*SD*), f (%)	*M*(*SD*), f (%)
ESG investments (%)	0.69 (0.26)	0.64 (0.29)	0.66 (0.28)
ESG investments (euros)	411.91 (154.50)	383.35 (174.61)	394.39 (167.67)
Conventional Fund A (euros)	68.58 (88.10)	93.29 (100.17)	83.74 (96.42)
Conventional Fund B (euros)	119.52 (106.13)	123.36 (109.05)	121.87 (107.92)
Sustainable Fund C (euros)[a]	181.98 (127.35)	173.84 (133.44)	176.99 (131.16)
Sustainable Fund D (euros)[a]	229.93 (138.30)	209.51 (151.27)	217.40 (146.70)
Satisfaction with info	5.83 (0.96)	5.45 (1.21)	5.60 (1.13)
Satisfaction with elicitation	5.86 (1.02)	5.50 (1.22)	5.64 (1.16)
General sustainability preference elicitation			
0% - no sustainable products	27 (3.10%)	60 (4.34%)	87 (3.86%)
Up to 25%	108 (12.40%)	264 (19.09%)	372 (16.50%)
Up to 50%	244 (28.01%)	405 (29.28%)	649 (28.79%)
Up to 75%	264 (30.31%)	289 (20.90%)	553 (24.53%)
100% - only sustainable	228 (26.18%)	365 (26.39%)	593 (26.31%)
Specific sustainability preference elicitation[b]			
Avoid negative impact	124 (30.02%)	227 (34.19%)	351 (32.59%)
Sustainable according to law	195 (47.22%)	332 (50.00%)	527 (48.93%)
Both	94 (22.76%)	105 (15.81%)	199 (18.48%)
Acceptance of recommendation	239 (26.41%)	547 (39.55%)	776 (34.42%)
Deviation from recommendation	15.81 (95.99)	14.48 (117.11)	15.00 (109.41)
Stability of investment[c]	0.33 (0.47)	0.34 (0.47)	0.34 (0.47)

Note. f = frequency, % = percent of the retail investor sample (N = 871), the population sample (N = 1,383), and the full sample (N = 2,254), M = mean, SD = standard deviation. For categorical variables (general elicitation, specific elicitation), frequencies, and percentage of the sample (in parentheses) are displayed. For the other variables, the mean and standard deviation is presented. [a] Fund C and D match the product categories in the specific mode of elicitation: Fund C avoids negative impacts on ESG-factors while fund D invests in activities that are considered sustainable by law. [b] Only participants in the respective treatment and who chose "*up to 25%*" or more in the general elicitation were shown the specific elicitation. Thus, the reported sample size of the specific elicitation is reduced to N = 1,077. [c] Stability of investment decisions equals is binary: the investment is revised on one or both hypothetical scenarios (stability = 0); the investment is not revised (stability = 1).

Appendix C. Multiple hypothesis testing

We control for multiple hypothesis testing by including the p-values of all hypothesis tests in the Benjamini-Hochberg procedure (Benjamini-Hochberg, 1995), applying the "p.adjust" function in in the "stats" package version 3.6.2 in R (Table C.1). The *p*-values of the regression coefficients are derived from the respective model that includes our experimental manipulations (information and mode of sustainability preference elicitation) and the explanatory variables (biospheric and altruistic values, household income, and financial literacy).

Table C.1 Results of the multiple hypothesis testing correction.

	p-value	p-Value Bonferroni	p-value Benjamini-Hochberg	Hypoth. holds Bonferroni	Hypoth. holds Benjamini-Hochberg
H3. Biospheric values are related to higher ESG investments	< 0.0001	< 0.0001	< 0.0001	1	1
H1.1. Impact info increases ESG investments	< 0.0001	< 0.001	< 0.0001	1	1
H3. Financial literacy is related to more ESG investments	< 0.0001	< 0.001	< 0.0001	1	1
H1.1. Financial info increases ESG investments	0.002	0.058	0.014	0	1
H3. Household income is related to higher ESG investments	0.007	0.198	0.040	0	1
H1.2. Combined info increases ESG investments	0.009	0.264	0.042	0	1
H4. Heterogeneity altruistic values and combined info	0.010	0.297	0.042	0	1
H4. Heterogeneity altruistic values and financial info	0.030	0.888	0.111	0	0
H4. Heterogeneity financial literacy and financial info	0.050	1	0.166	0	0
H1.3. Impact info increases satisfaction	0.088	1	0.265	0	0
H4. Heterogeneity income and financial return information	0.130	1	0.333	0	0
H4. Heterogeneity financial literacy and impact info	0.148	1	0.333	0	0
H1.1. Impact info increases ESG investments more than financial info	0.153	1	0.333	0	0
H4. Heterogeneity financial literacy and combined info	0.156	1	0.333	0	0
H4. Heterogeneity altruistic values and impact info	0.214	1	0.413	0	0
H1.4. Combined info vs. financial info: satisfaction	0.222	1	0.413	0	0

H4. Heterogeneity income and combined information	0.234	1	0.413	0	0
H1.2. Combined info vs. financial info: ESG investments	0.275	1	0.458	0	0
H1.3. Financial info increases satisfaction	0.335	1	0.506	0	0
H4. Heterogeneity biospheric values and financial info	0.337	1	0.506	0	0
H2.2. Mode of elicitation affects satisfaction	0.355	1	0.507	0	0
H1.4. Combined info increases satisfaction	0.430	1	0.568	0	0
H1.3. Impact info increases satisfaction more than financial info	0.435	1	0.568	0	0
H4. Heterogeneity income and impact info	0.518	1	0.647	0	0
H4. Heterogeneity biospheric values and impact info	0.565	1	0.677	0	0
H3. Altruistic values are related to higher ESG investments	0.750	1	0.824	0	0
H2.1. Mode of elicitation affects ESG investment	0.768	1	0.824	0	0
H4. Heterogeneity biospheric values and combined info	0.778	1	0.824	0	0
H1.2 Combined info vs. impact info: ESG investments	0.818	1	0.824	0	0
H1.4 Combined info vs. impact info: satisfaction	0.824	1	0.824	0	0

Note. The first column contains the hypothesis with the resulting p-values in the second column in ascending order. Columns 3 and 4 show the expected *p*-values according to the Bonferroni-correction and the Benjamini-Hochberg procedure. Columns 5 and 6 indicate, whether the hypothesis holds multiple hypothesis testing (0 = no, 1 = yes).

Appendix D. Full models for information and ESG investments

Table D.1. OLS models: Impact of information on ESG investments.

	(1)	(2)	(3)	(4)
Financial return	0.055***	0.055**	0.049**	0.041**
	(0.017)	(0.017)	(0.016)	(0.015)
ESG impact	0.082***	0.082***	0.071***	0.063***
	(0.016)	(0.016)	(0.016)	(0.015)
Financial * impact	-0.064**	-0.064**	-0.058**	-0.045*
	(0.023)	(0.023)	(0.022)	(0.022)
Specific elicitation mode		0.001	0.003	0.005
		(0.012)	(0.011)	(0.011)
Biospheric values			0.071***	0.063***
			(0.009)	(0.009)
Altruistic values			0.003	-0.014
			(0.009)	(0.009)
Household income			0.018**	0.024**
			(0.006)	(0.007)
Financial literacy			0.090***	0.074***
			(0.021)	(0.022)
Age				-0.001
				(0.000)
Male				-0.038**
				(0.012)
Non-binary				-0.323*
				(0.129)
Education				0.017***
				(0.004)
Children				0.012+
				(0.007)
Experience				0.003
				(0.002)
Risk preference				-0.011***
				(0.003)
Trust in ESG				0.043***
				(0.005)
Relevance incentive				0.003
				(0.003)
Email address				-0.001
				(0.017)
Attention check				-0.032**

Table D.1. OLS models: Impact of information on ESG investments.

	(1)	(2)	(3)	(4)
				(0.012)
Survey wave				-0.001
				(0.013)
Constant	0.605***	0.604***	0.062^{+}	0.001
	(0.012)	(0.013)	(0.037)	(0.058)
N	2254	2254	2254	2254
Adjusted R^2	0.012	0.011	0.116	0.172
F	9.797	7.349	37.795	24.338
p	0.000	0.000	0.000	0.000

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample).

We use OLS models to test for interaction effects of our two treatment variables (financial return and/or ESG impact information and the mode of the sustainability preference elicitation). In Model (1) in Table D.2, we regress ESG investments on the treatment dummies indicating whether financial return and/or ESG impact information was presented and on the interaction with the elicitation mode dummy. In Model (2) we use satisfaction with the information as the dependent variable, and in Model (3) we use satisfaction with the sustainability preference elicitation. We do not find a significant interaction effect for the information with the mode of eliciting ESG sustainability preferences (all *p*-values > 0.35).

Table D.2. OLS models: Interaction of information and mode of elicitation.

	(1)	(2)	(3)
Financial return	0.049*	0.028	0.172+
	(0.024)	(0.096)	(0.098)
ESG impact	0.078***	0.104	0.145
	(0.023)	(0.095)	(0.097)
Financial * impact	-0.070*	-0.029	-0.127
	(0.033)	(0.135)	(0.139)
Specific elicitation mode	-0.011	-0.057	-0.029
	(0.023)	(0.096)	(0.098)
Financial * elicitation	0.011	0.120	-0.049
	(0.033)	(0.136)	(0.139)
Impact * elicitation	0.008	0.073	-0.039
	(0.033)	(0.135)	(0.138)
Financial * impact * elicitation	0.012	-0.121	0.110
	(0.047)	(0.191)	(0.196)
Constant	0.610***	5.535***	5.537***
	(0.016)	(0.067)	(0.069)
N	2254	2254	2254
Adjusted R^2	0.010	0.000	0.001
F	4.332	0.936	1.469
p	0.000	0.477	0.174

Note. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). The mode of eliciting ESG sustainability preferences is included as dummy (0 = general elicitation, 1 = specific elicitation).

Appendix E. Customer satisfaction with the information

Table E.1 OLS models: Impact of information on satisfaction with the information.

	(1)	(2)	(3)	(4)
Financial return	0.088	0.088	0.056	0.008
	(0.068)	(0.068)	(0.058)	(0.055)
ESG impact	0.140*	0.140*	0.099+	0.047
	(0.067)	(0.067)	(0.058)	(0.055)
Financial * impact	-0.089	-0.089	-0.065	0.009
	(0.095)	(0.095)	(0.082)	(0.078)
Specific elicitation mode		0.010	0.018	0.005
		(0.048)	(0.041)	(0.039)
Biospheric values			0.223***	0.156***
			(0.032)	(0.031)
Altruistic values			0.208***	0.129***
			(0.033)	(0.031)
Household income			0.075**	0.058*
			(0.023)	(0.024)
Financial literacy			0.947***	0.697***
			(0.077)	(0.079)
Age				0.002
				(0.001)
Male				-0.102*
				(0.043)
Non-binary				-0.192
				(0.465)
Education				0.045***
				(0.014)
Children				-0.057*
				(0.027)
Experience				0.004
				(0.009)
Risk preference				0.040***
				(0.009)
Trust in ESG				0.229***
				(0.017)
Relevance incentive				0.036**
				(0.012)
Email address				0.243***
				(0.062)
Attention check				-0.209***

Table E.1 OLS models: Impact of information on satisfaction with the information.

	(1)	(2)	(3)	(4)
				(0.043)
Survey wave				0.021
				(0.048)
Constant	5.507***	5.502***	2.063***	1.187***
	(0.048)	(0.053)	(0.138)	(0.209)
N	2254	2254	2254	2254
Adjusted R^2	0.001	0.001	0.258	0.348
F	1.904	1.437	99.153	60.996
p	0.127	0.219	0.000	0.000

Note. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample).

Appendix F. Full models for each survey wave

We show the full models as preregistered in each survey wave. In Table F.1, Models (1) and (2) are the models for the full sample (N = 2,254) and ESG investments, applying the exclusion criteria of survey wave 2. Models (3) and (4) use the retail investor sample with application of the exclusion criteria of survey wave 1. Models (5) and (6) show the effects for the retail investor sample while applying the exclusion criteria of survey wave 2. Models (7) and (8) use the population sample, applying the exclusion criteria of survey wave 2.

In Table F.2, Models (1) and (2) are the models for the full sample (N = 2,254) and satisfaction with the information, applying the exclusion criteria of survey wave 2. Models (3) and (4) use the retail investor sample with application of the exclusion criteria of survey wave 1. Models (5) and (6) show the effects for the retail investor sample while applying the exclusion criteria of survey wave 2. Models (7) and (8) use the population sample, applying the exclusion criteria of survey wave 2.

Table F.1. OLS models: Impact of information on ESG investments by survey wave.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial return	0.055***	0.041**	0.034	0.028	0.037	0.025	0.067**	0.053**
	(0.017)	(0.015)	(0.029)	(0.027)	(0.025)	(0.023)	(0.022)	(0.020)
ESG impact	0.082***	0.063***	0.057*	0.047+	0.052*	0.037	0.101***	0.080***
	(0.016)	(0.015)	(0.029)	(0.028)	(0.024)	(0.023)	(0.022)	(0.020)
Financial* impact	-0.064**	-0.045*	-0.048	-0.050	-0.037	-0.024	-0.082**	-0.063*
	(0.023)	(0.022)	(0.041)	(0.038)	(0.035)	(0.033)	(0.031)	(0.028)
Specific elicitation mode		0.005		-0.014		-0.011		0.015
		(0.011)		(0.019)		(0.017)		(0.014)
Biosph-eric values		0.063***		0.086***		0.070***		0.061***
		(0.009)		(0.017)		(0.014)		(0.011)
Altruistic values		-0.014		-0.027		-0.014		-0.015
		(0.009)		(0.017)		(0.015)		(0.011)
Househo-ld income		0.024**		-0.005		0.004		0.040***
		(0.007)		(0.012)		(0.009)		(0.010)
Financial literacy		0.074***		0.038		0.046		0.083**
		(0.022)		(0.054)		(0.044)		(0.026)
Age		-0.001		0.001		0.000		-0.001
		(0.000)		(0.001)		(0.001)		(0.000)

Table F.1. OLS models: Impact of information on ESG investments by survey wave.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Male		-0.038**		-0.050*		-0.062**		-0.029+
		(0.012)		(0.023)		(0.019)		(0.015)
Non-binary		-0.323*		-0.345**		-0.349**		
		(0.129)		(0.127)		(0.126)		
Education		0.017***		0.011		0.012*		0.019***
		(0.004)		(0.007)		(0.006)		(0.005)
Children		0.012+		0.011		0.009		0.012
		(0.007)		(0.013)		(0.011)		(0.010)
Exp-erience		0.003		0.007		0.005		0.001
		(0.002)		(0.006)		(0.004)		(0.003)
Risk pref-erence		-0.011***		-0.013*		-0.012**		-0.010**
		(0.003)		(0.005)		(0.004)		(0.003)
Trust in ESG		0.043***		0.035***		0.036***		0.047***
		(0.005)		(0.008)		(0.007)		(0.006)
Relevance of the incentive		0.003		0.006		0.005		0.001
		(0.003)		(0.006)		(0.005)		(0.005)
Email address		-0.001		0.014		-0.002		-0.006
		(0.017)		(0.036)		(0.031)		(0.021)
Attention check		-0.032**				-0.039+		-0.031*
		(0.012)				(0.020)		(0.015)
Survey wave		-0.001						
		(0.013)						
Constant	0.605***	0.001	0.662***	0.046	0.651***	0.095	0.575***	-0.040
	(0.012)	(0.058)	(0.021)	(0.134)	(0.017)	(0.097)	(0.016)	(0.063)
N	2254	2254	620	620	871	871	1383	1383
Adj. R^2	0.012	0.139	0.002	0.092	0.004	0.100	0.015	0.154
F	9.797	20.202	1.403	4.695	2.048	6.357	8.173	15.768
p	0.000	0.000	0.241	0.000	0.106	0.000	0.000	0.000

Table F.1. OLS models: Impact of information on ESG investments by survey wave.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

Note. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Robust standard errors in parentheses. In Models (1) and (2) we used the full sample (N = 2,254), in Models (3) and (4) the retail investor sample, applying the preregistered exclusion criteria for survey wave 1 (N = 620), in Models (5) and (6) the retail investor sample (N = 871) and in Models (7) and (8) the population sample (N = 1,383). Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample).

Table F.2. OLS models: Impact of information on satisfaction with information by survey wave.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial return	0.088	0.008	0.104	0.046	0.185*	0.074	0.034	-0.040
	(0.068)	(0.055)	(0.105)	(0.098)	(0.092)	(0.085)	(0.092)	(0.072)
ESG impact	0.140*	0.047	0.204^{+}	0.173^{+}	0.292**	0.210*	0.045	-0.062
	(0.067)	(0.055)	(0.105)	(0.099)	(0.091)	(0.084)	(0.092)	(0.072)
Financial* impact	-0.089	0.009	-0.108	-0.083	-0.192	-0.069	-0.030	0.062
	(0.095)	(0.078)	(0.147)	(0.138)	(0.130)	(0.119)	(0.130)	(0.101)
Specific elicitation mode		0.005		0.015		0.026		-0.012
		(0.039)		(0.070)		(0.060)		(0.050)
Biospheric values		0.156***		0.070		0.093^{+}		0.179***
		(0.031)		(0.062)		(0.051)		(0.039)
Altruistic values		0.129***		0.149*		0.128*		0.120**
		(0.031)		(0.061)		(0.053)		(0.039)
Household income		0.058*		0.047		0.038		0.073*
		(0.024)		(0.041)		(0.034)		(0.034)
Financial literacy		0.697***		0.344^{+}		0.415*		0.735***
		(0.079)		(0.195)		(0.161)		(0.092)
Age		0.002		0.002		0.004		0.001
		(0.001)		(0.003)		(0.003)		(0.002)
Male		-0.102*		-0.057		-0.062		-0.135*
		(0.043)		(0.084)		(0.070)		(0.054)
Non-binary		-0.192		-0.467		-0.472		
		(0.465)		(0.457)		(0.457)		
Education		0.045***		0.055*		0.040^{+}		0.046**

Table F.2. OLS models: Impact of information on satisfaction with information by survey wave.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		(0.014)		(0.025)		(0.021)		(0.017)
Children		-0.057*		-0.063		-0.041		-0.061+
		(0.027)		(0.048)		(0.040)		(0.036)
Experience		0.004		-0.014		-0.018		0.010
		(0.009)		(0.022)		(0.015)		(0.011)
Risk preference		0.040***		0.041*		0.042**		0.040***
		(0.009)		(0.018)		(0.015)		(0.012)
Trust in ESG		0.229***		0.199***		0.205***		0.240***
		(0.017)		(0.030)		(0.026)		(0.021)
Relevance of the incentive		0.036**		0.068***		0.063***		0.010
		(0.012)		(0.020)		(0.017)		(0.017)
Email address		0.243***		-0.055		0.040		0.305***
		(0.062)		(0.129)		(0.113)		(0.075)
Attention check		-0.209***				-0.115		-0.257***
		(0.043)				(0.072)		(0.054)
Survey wave		0.021						
		(0.048)						
Constant	5.507***	1.187***	5.738***	2.163***	5.638***	1.949***	5.423***	1.277***
	(0.048)	(0.209)	(0.075)	(0.479)	(0.064)	(0.353)	(0.065)	(0.224)
N	2254	2254	620	620	871	871	1383	1383
Adj. R^2	0.012	0.139	0.002	0.092	0.004	0.100	0.015	0.154
F	9.797	20.202	1.403	4.695	2.048	6.357	8.173	15.768
p	0.000	0.000	0.241	0.000	0.106	0.000	0.000	0.000

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. In Models (1) and (2) we used the full sample (N = 2,254), in Models (3) and (4) the retail investor sample, applying the preregistered exclusion criteria for survey wave 1 (N = 620), in Models (5) and (6) the retail investor sample (N = 871) and in Models (7) and (8) the population sample (N = 1,383). Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample).

Appendix G. Modes of sustainability preference elicitation

We regress ESG investments on the specific sustainability preference with the general elicitation method as the reference point (Table G.1). In Model (1), we regress ESG investments on the elicitation mode dummy. In Model (2) we add the financial return and ESG impact information dummies, the explanatory, and the control variables. In Models (3) and (4) we use the same models with satisfaction with the elicitation as the dependent variable. F-tests of Models (1) and (2) are not significant ($p > 0.36$), while F-tests of Models (3) and (4) are highly significant ($p < 0.001$). The results of all models indicate no significant relationship between the mode of elicitation and ESG investments or satisfaction with the sustainability preference elicitation.

Table G.1. OLS models: Impact of mode of elicitation on ESG investments (Model (1) & (2)) and satisfaction with information (Model (3) & (4)).

	ESG investments		Satisfaction with elicitation	
	(1)	(2)	(3)	(4)
Specific elicitation mode	0.002	0.005	-0.044	-0.053
	(0.012)	(0.011)	(0.049)	(0.040)
Financial return		0.041**		0.058
		(0.015)		(0.057)
ESG impact		0.063***		0.028
		(0.015)		(0.056)
Financial * impact		-0.045*		0.044
		(0.022)		(0.080)
Biospheric values		0.063***		0.149***
		(0.009)		(0.031)
Altruistic values		-0.014		0.127***
		(0.009)		(0.032)
Household income		0.024**		0.058*
		(0.007)		(0.025)
Financial literacy		0.074***		0.743***
		(0.022)		(0.081)
Age		-0.001		0.001
		(0.000)		(0.001)
Male		-0.038**		-0.050
		(0.012)		(0.044)
Non-binary		-0.323*		-0.188
		(0.129)		(0.477)
Education		0.017***		0.033*
		(0.004)		(0.014)
Children		0.012+		-0.040
		(0.007)		(0.027)

Table G.1. OLS models: Impact of mode of elicitation on ESG investments (Model (1) & (2)) and satisfaction with information (Model (3) & (4)).

	ESG investments		Satisfaction with elicitation	
	(1)	(2)	(3)	(4)
Experience		0.003		0.017+
		(0.002)		(0.009)
Risk preference		-0.011***		0.038***
		(0.003)		(0.010)
Trust in ESG		0.043***		0.259***
		(0.005)		(0.017)
Relevance incentive		0.003		0.025*
		(0.003)		(0.013)
Email address		-0.001		0.260***
		(0.017)		(0.064)
Attention check		-0.032**		-0.178***
		(0.012)		(0.044)
Sample		-0.001		0.096+
		(0.013)		(0.049)
Constant	0.656***	0.001	5.663***	1.027***
	(0.008)	(0.058)	(0.035)	(0.215)
N	2254	2254	2254	2254
Adjusted R^2	0.000	0.172	0.000	0.347
F	0.032	24.338	0.823	60.907
p	0.858	0.000	0.364	0.000

Note. $^+ p < 0.1$, $^* p < 0.05$, $^{**} p < 0.01$, $^{***} p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample).

Appendix H. Treatment heterogeneity

We examine treatment heterogeneity among participants concerning the effect of the financial return as well as the ESG impact information. Døskeland & Pedersen (2021) find that financial return information is more effective in high wealth investors than in low wealth investors. Given the relevance of biospheric as well as altruistic value orientation and financial literacy, we extend the previous literature and test for heterogenous treatment effects related to these individual characteristics (biospheric and altruistic value orientation, household income and financial literacy). Thus, we test the following hypothesis:

H4: There is heterogeneity in the treatment effects from information provision across biospheric values, altruistic values, household income and financial literacy.

To test whether there is heterogeneity in the effects of the financial return and ESG impact information across individual differences (values, household income and financial literacy), we conduct further OLS

regressions (Table H.1). We split each of the variables (household income, biospheric and altruistic value orientation and financial literacy) into two groups at the median. In contrast to our expectations, only one interaction effect (financial * ESG impact * altruistic values) holds up under multiple hypothesis testing correction.

Table H.1. OLS models: Interaction of information and individual characteristics on ESG investments.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial return	0.068*	0.061*	0.110*	0.078*	0.032	0.008	0.096*	0.079*
	(0.023	(0.022	(0.026	(0.024	(0.025	(0.024	(0.026	(0.024
ESG impact	0.067*	0.059*	0.115*	0.083*	0.072*	0.052*	0.113*	0.085*
	(0.023	(0.022	(0.026	(0.025	(0.025	(0.023	(0.025	(0.023
Financial * impact	-0.073*	-0.058+	-0.150***	-0.109**	-0.037	-0.022	-0.116**	-0.081*
	(0.033	(0.032	(0.037	(0.035	(0.037	(0.034	(0.036	(0.033
Specific elicitation		0.004		0.004		0.003		0.004
		(0.011		(0.011		(0.011		(0.011
Biospheric values	0.173*	0.121*		0.112*		0.112*		0.112*
	(0.022	(0.022		(0.012		(0.012		(0.012
* Financial return	-0.036	-0.038						
	(0.032	(0.030						
* ESG impact	0.012	0.011						
	(0.032	(0.030						
* financial * impact	0.018	0.013						
	(0.045	(0.043						
Altruistic values		0.037*	0.173*	0.060*		0.038*		0.037*
		(0.013	(0.023	(0.023		(0.013		(0.013
* Financial return			-0.087*	-0.063*				
			(0.033	(0.031				
* ESG impact			-0.057+	-0.028				
			(0.033	(0.031				
* Financial * ESG impact[a]			0.131**	0.092*				
			(0.047	(0.044				
Household income		0.033*		0.034*	0.024	0.007		0.033*
		(0.013		(0.013	(0.024	(0.023		(0.013
* Financial return					0.040	0.057+		
					(0.034	(0.032)		
* ESG impact					0.016	0.024		
					(0.034	(0.031)		

Table H.1. OLS models: Interaction of information and individual characteristics on ESG investments.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
* Financial * ESG impact					-0.050	-0.053		
					(0.049	(0.044)		
Financial literacy		0.042**		0.041**		0.043**	0.119**	0.078**
		(0.012)		(0.012)		(0.012)	(0.024)	(0.022)
* Financial return							-0.073*	-0.063*
							(0.034	(0.031
* ESG impact							-0.050	-0.034
							(0.033	(0.031
* Financial * ESG impact							0.087+	0.048
							(0.047	(0.044
Constant	0.519*	0.271*	0.499*	0.264*	0.591*	0.292*	0.535*	0.256*
	(0.016	(0.052	(0.018	(0.052	(0.018	(0.052	(0.018	(0.052
Control variables	NO	YES	NO	YES	NO	YES	NO	YES
N	2254	2254	2254	2254	2254	2254	2254	2254
Adj. R^2	0.098	0.180	0.067	0.181	0.016	0.180	0.032	0.181
F	35.854	22.491	24.215	22.633	6.128	22.531	11.492	22.581
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample). Control variables: Age, gender, education, experience, risk preference, trust in ESG, relevance of the incentive, email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed control question, 1 = failed), sample dummy (1 = retail investor sample, 2 = population sample). [a] Only this effect holds after multiple hypothesis testing correction.

Appendix I. Robustness checks

To determine the robustness of the models and to account for our study design, we performed additional analyses. The models in Table I.1 use the same model specifications as in Table 5, yet with robust standard errors clustered by age and gender. The results show that the results are relatively robust to these model specifications, except for Model (2), where the effect of the combined information becomes insignificant in the full sample (however, with $p < 0.1$) and in Model (3), where the effect of the ESG impact information in the retail investor sample becomes insignificant (again, $p < 0.1$).

Table I.1. Robustness check: OLS models showing the impact of information on ESG investments, with standard errors clustered by age and gender.

	(1)	(2)	(3)	(4)	(5)	(6)
Financial return	0.055***	0.041***	0.037	0.025	0.067***	0.053*
	(0.017)	(0.015)	(0.027)	(0.026)	(0.024)	(0.021)
ESG impact	0.082***	0.063***	0.052+	0.036	0.101***	0.080***
	(0.019)	(0.017)	(0.027)	(0.024)	(0.025)	(0.022)
Financial * impact	-0.064*	-0.045+	-0.037	-0.024	-0.082*	-0.063*
	(0.028)	(0.025)	(0.040)	(0.038)	(0.034)	(0.031)
Specific elicitation mode		0.004		-0.013		0.015
		(0.010)		(0.015)		(0.012)
Biospheric values		0.063***		0.070***		0.061***
		(0.008)		(0.017)		(0.010)
Altruistic values		-0.013		-0.013		-0.015
		(0.009)		(0.018)		(0.009)
Household income		0.024*		0.004		0.040***
		(0.009)		(0.010)		(0.013)
Financial literacy		0.076***		0.055		0.083***
		(0.024)		(0.043)		(0.028)
Constant	0.605***	0.042	0.651***	0.163	0.575***	-0.011
	(0.012)	(0.058)	(0.018)	(0.111)	(0.016)	(0.068)
Control variables	NO	YES	NO	YES	NO	YES
N	2254	2254	871	871	1383	1383
Adjusted R^2	0.012	0.171	0.004	0.122	0.015	0.190
F	8.155	46.390	1.902	7.534	6.774	29.873
p	0.000	0.000	0.138	0.000	0.000	0.000

Note. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. In Models (1) and (2) we used the full sample (N = 2,254), in Models (3) and (4) the retail investor sample (N = 871) and in Models (5) and (6) the population sample (N = 1,383). Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and the same for ESG impact information). Control variables: age, gender, education, children, experience, risk preference, trust in ESG products, relevance of the incentive (*To me, 600 euros is* …, answered on a 7-point Likert scale, 1 = *no significant amount of money* to 7 = *a significant amount of money*), email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), sample dummy in Model (2) (1 = retail investor sample, 2 = population sample). Coefficients in Models (2), (4) and (6) slightly deviate from those reported in Table 5, as gender here is included as a continuous variable for technical reasons.

In the models shown in Table I.2 we use the same specifications as in Table 6, except for clustering the robust standard errors by gender and age. The results indicate that the main results are robust to these specifications. Exceptions are that the effect of ESG impact information on satisfaction is now insignificant ($p < 0.1$) in the full sample (Model (1)) and that the effect of financial information turns insignificant ($p < 0.1$) in the retail investor sample (Model (3)). Taken together and as reported in the main paper, the results do not indicate a significant effect of information on satisfaction.

Table I.2. Robustness check: OLS models showing the impact of information on satisfaction with the information with standard errors clustered by age and gender.

	(1)	(2)	(3)	(4)	(5)	(6)
Financial return	0.088	0.008	0.185^{+}	0.074	0.034	-0.040
	(0.077)	(0.056)	(0.105)	(0.093)	(0.107)	(0.076)
ESG impact	0.140^{+}	0.047	0.292***	0.209*	0.045	-0.062
	(0.074)	(0.059)	(0.101)	(0.093)	(0.100)	(0.077)
Financial * impact	-0.089	0.009	-0.192	-0.068	-0.030	0.062
	(0.104)	(0.080)	(0.145)	(0.122)	(0.147)	(0.115)
Specific elicitation		0.005		0.023		-0.012
		(0.040)		(0.067)		(0.046)
Biospheric values		0.156***		0.094^{+}		0.179***
		(0.034)		(0.051)		(0.040)
Altruistic values		0.129***		0.129*		0.120***
		(0.035)		(0.054)		(0.043)
Household income		0.058*		0.038		0.073*
		(0.023)		(0.034)		(0.032)
Financial literacy		0.696***		0.429***		0.735***
		(0.087)		(0.154)		(0.102)
Constant	5.507***	1.288***	5.638***	2.020***	5.423***	1.411***
	(0.056)	(0.198)	(0.078)	(0.496)	(0.076)	(0.242)
Control variables	NO	YES	NO	YES	NO	YES
N	2254	2254	871	871	1383	1383
Adjusted R^2	0.001	0.348	0.012	0.178	0.000	0.400
F	1.446	142.991	3.880	9.556	0.087	152.783
p	0.237	0.000	0.013	0.000	0.967	0.000

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. In Models (1) and (2) we used the full sample (N = 2,254), in Models (3) and (4) the retail investor sample (N = 871) and in Models (5) and (6) the population sample (N = 1,383). Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and the same for ESG impact information). Control variables: age, gender, education, children, experience, risk preference, trust in ESG products, relevance of the incentive (*To me, 600 euros is* …, answered on a 7-point Likert scale, 1 = *no significant amount of money* to 7 = *a significant amount of money*), email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), sample dummy in Model (2) (1 = retail investor sample, 2 = population sample). Coefficients in Models (2), (4) and (6) slightly deviate from those reported in Table 6, as gender here is included as a continuous variable for technical reasons.

Table I.3. recreates the models shown in Table 7 with the same specifications except for again clustering the robust standard errors by gender and age. The main results remain robust and all effects of the elicitation mode on ESG investments (Models (1) and (2)) as well as on satisfaction (Models (3) and (4)) remain insignificant.

Table I.3. Robustness check: OLS models showing the impact of the elicitation mode on ESG investments (Model (1) & (2)) and on satisfaction with information (Model (3) & (4)).

	ESG investments		Satisfaction with elicitation	
	(1)	(2)	(3)	(4)
Specific elicitation mode	0.002	0.004	-0.044	-0.053
	(0.012)	(0.010)	(0.048)	(0.038)
Financial return		0.041***		0.058
		(0.015)		(0.059)
ESG impact		0.063***		0.028
		(0.017)		(0.056)
Financial * impact		-0.045^{+}		0.044
		(0.025)		(0.086)
Biospheric values		0.063***		0.149***
		(0.008)		(0.035)
Altruistic values		-0.013		0.127***
		(0.009)		(0.037)
Household income		0.024*		0.058*
		(0.009)		(0.023)
Financial literacy		0.076***		0.744***
		(0.024)		(0.085)
Constant	0.656***	0.042	5.663***	1.078***
	(0.008)	(0.058)	(0.038)	(0.204)
Control variables	No	Yes	No	Yes
N	2254	2254	2254	2254
Adjusted R^2	0.000	0.171	0.000	0.347
F	0.032	46.390	0.844	132.809
p	0.859	0.000	0.361	0.000

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Control variables: age, gender, education, children, experience, risk preference, trust in ESG products, relevance of the incentive (*To me, 600 euros is* …, answered on a 7-point Likert scale, 1 = *no significant amount of money* to 7 = *a significant amount of money*), email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), sample dummy in Model (2) (1 = retail investor sample, 2 = population sample)). Coefficients in Models (2), (4) and (6) slightly deviate from those reported in Table 7, as gender here is included as a continuous variable for technical reasons.

To determine the robustness of the models and to account for the timing of the data collection, we performed additional analyses. Models (1) and (2) in Table I.4 use the same model specifications as Models (1) and (2) in Table 5, yet with month-year fixed effects. Models (3) and (4) in Table I.4 use the same model specifications as Models (1) and (2) in Table 6, again with month-year fixed effects. The results show that our findings are robust to these model specifications, indicating no effect of the data collection times on the effect of information on ESG investments (Models (1) and (2)) as well as on the effect of information on satisfaction (Models (3) and (4)).

Table I.4. Robustness check: OLS models showing the impact of information on ESG investments and satisfaction with month-year fixed effects.

	(1)	(2)	(3)	(4)
Financial return	0.055***	0.041***	0.092	0.009
	(0.017)	(0.015)	(0.067)	(0.054)
ESG impact	0.082***	0.063***	0.141*	0.046
	(0.017)	(0.016)	(0.066)	(0.055)
Financial * impact	-0.064***	-0.045*	-0.093	0.008
	(0.023)	(0.022)	(0.094)	(0.077)
Specific elicitation mode		0.004		0.005
		(0.011)		(0.038)
Biospheric values		0.063***		0.156***
		(0.009)		(0.035)
Altruistic values		-0.014		0.129***
		(0.009)		(0.034)
Household income		0.024***		0.058*
		(0.008)		(0.024)
Financial literacy		0.074***		0.696***
		(0.023)		(0.080)
Control variables	NO	YES	NO	YES
N	2254	2254	2254	2254
Adjusted R^2	0.018	0.171	0.027	0.347

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and the same for ESG impact information). Control variables: age, gender, education, children, experience, risk preference, trust in ESG products, relevance of the incentive (*To me, 600 euros is* …, answered on a 7-point Likert scale, 1 = *no significant amount of money* to 7 = *a significant amount of money*), email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), sample dummy in Model (2) (1 = retail investor sample, 2 = population sample).

Appendix J. Exploratory results

We explore the effect of the information treatments and the mode of elicitation on the stability of the investment decisions in two hypothetical scenarios about future developments of their conventional and ESG investments and how the share of ESG investments deviates from the recommendations that participants receive based on their stated ESG sustainability preferences.

Appendix J.1. Stability of investment decisions

Stability in one's investment decisions can be a success factor when considering long-term investments. Investors with unstable investment decisions often suffer losses due to being affected by temporary changes in prices of their investments. For example, they may be subject to the disposition effect (Shefrin and Statman, 1985) or to buying at high prices and selling at low prices (Bucher-Koenen and Ziegelmeyer, 2014). In an investigation of investor cash flows from 1980 to 2002, Bollen (2007) shows that those investors who invest in sustainable funds respond more positively to positive returns and less negatively to negative returns (compared to conventional investors) and are more loyal to sustainable funds. Recent results from a survey study additionally reveal that loyalty to sustainable funds is positively related to ethical motives, while loyalty is negatively related to financial motives (Peifer, 2014). Also, individuals who already hold sustainable investments tend to be more interested in new sustainable products (Rossi et al., 2019). We test whether stability of investments is affected by our treatments in Table J.1, using logit regressions with the binary variable stability of investments as outcome variable.

Table J.1. Logit model: The impact of information on stability of investment.

	(1)	(2)	(3)	(4)
Financial return	-0.025	-0.025	-0.027	-0.046
	(0.126)	(0.126)	(0.126)	(0.129)
ESG impact	-0.126	-0.126	-0.127	-0.104
	(0.126)	(0.126)	(0.126)	(0.129)
Financial * impact	-0.002	-0.003	-0.004	-0.004
	(0.179)	(0.179)	(0.179)	(0.183)
Specific elicitation mode		-0.031	-0.028	-0.042
		(0.089)	(0.090)	(0.092)
Biospheric values			0.031	0.021
			(0.070)	(0.073)
Altruistic values			-0.030	0.002
			(0.071)	(0.074)
Household income			0.066	0.048
			(0.049)	(0.058)
Financial literacy			0.062	0.027
			(0.168)	(0.189)
Age				0.015***
				(0.003)

Table J.1. Logit model: The impact of information on stability of investment.

	(1)	(2)	(3)	(4)
Male				0.115
				(0.101)
Non-binary				0.607
				(1.050)
Education				-0.098***
				(0.032)
Children				0.069
				(0.064)
Experience				0.042*
				(0.020)
Risk preference				-0.070***
				(0.022)
Trust in ESG				-0.087*
				(0.039)
Relevance incentive				-0.054^{+}
				(0.029)
Email address				-0.258^{+}
				(0.143)
Attention check				-0.322***
				(0.104)
Survey wave				0.054
				(0.114)
Constant	-0.612***	-0.596***	-0.789***	-0.038
	(0.088)	(0.099)	(0.301)	(0.493)
N	2254	2254	2254	2254

Note. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample).

Appendix J.2. Deviation from the investment recommendation

The deviation from the recommendation considers the difference between the financial advisors' recommendations based on the sustainability preference elicitation and the actual investment. Investors and especially those who start to invest are often unfamiliar or feel uninformed (Brunen & Laubach, 2022; Wins & Zwergel, 2016) and seek assistance from a financial advisor who gives recommendations based on the investor's stated preferences. Financial return and ESG impact information might decrease the deviation from the recommendation by providing reasons for ESG investments.

We resort to OLS regressions to explore whether financial and ESG impact information affect the deviation from the non-binding recommendation. We use the same models as for the ESG investments (Table 5 in

the main text), but with the absolute deviation from the recommendation for ESG investments as the dependent variable. The results (Table J.2) offer no convincing evidence of financial return and ESG impact information affecting the deviation from the recommended ESG investment amount.

The reason for this finding might be that this recommendation for ESG investments was based on the stated ESG sustainability preferences. High stated sustainability preferences resulted in a recommendation to invest more of the endowment in sustainable funds and vice versa for low stated sustainability preferences. If participants indicate their preferences close to the actual preference (and thus the intention), the resulting recommendation closely reflects their preferences. Moreover, the elicited ESG sustainability preferences were already affected by the information (see Table 5 in the main text), before taking the investment decision. This effect then translated to recommendations for more ESG investments.

In the results, we do not observe a value-action gap (Haider et al., 2019; Kollmuss and Agyeman, 2002) between preferences and actions ("investments"). Indeed, several scholars suggested the existence of a value-action gap in investment decisions (Bauer et al., 2021; Brunen and Laubach, 2022; Diouf et al., 2016; Nilsson, 2008; Paetzold and Busch, 2014; Vyvyan et al., 2007; Wins and Zwergel, 2016). Yet, the actual gap might occur one step earlier in the decision-making process, namely between the environmental/social values and the reported preference. Thus, for future studies, it might be worthwhile to differentiate between i) an intention-behavior gap (e.g., Carrington et al., 2014) occurring between stated preferences and investment decisions, and ii) a value-action gap, occurring between pro-environmental/pro-social values and actions in general.

Table J.2. OLS models: Impact of information on deviation from recommendation.

	(1)	(2)	(3)	(4)
Financial return	5.860	5.780	6.003	5.258
	(6.554)	(6.553)	(6.539)	(6.562)
ESG impact	-3.285	-3.376	-1.970	-2.928
	(6.496)	(6.495)	(6.493)	(6.513)
Financial * impact	-4.916	-4.830	-5.568	-3.662
	(9.220)	(9.218)	(9.198)	(9.232)
Specific elicitation mode		6.878	6.679	7.101
		(4.609)	(4.602)	(4.610)
Biospheric values			-4.823	-4.739
			(3.600)	(3.651)
Altruistic values			-3.857	-4.035
			(3.657)	(3.722)
Household income			3.757	4.210
			(2.579)	(2.908)
Financial literacy			10.658	7.954
			(8.603)	(9.427)

Table J.2. OLS models: Impact of information on deviation from recommendation.

	(1)	(2)	(3)	(4)
Age				-0.311+
				(0.171)
Male				5.078
				(5.083)
Non-binary				-43.804
				(55.363)
Education				0.806
				(1.608)
Children				1.515
				(3.152)
Experience				2.245*
				(1.026)
Risk preference				-1.756
				(1.120)
Trust in ESG				3.415+
				(1.965)
Relevance incentive				-0.098
				(1.454)
Email address				4.193
				(7.399)
Attention check				7.537
				(5.145)
Survey wave				4.351
				(5.727)
Constant	14.982**	11.598*	46.469**	28.012
	(4.612)	(5.138)	(15.390)	(24.917)
N	2254	2254	2254	2254
Adjusted R^2	0.000	0.000	0.006	0.007
F	0.786	1.147	2.591	1.828
p	0.502	0.333	0.008	0.014

Note. $^{+}p < 0.1$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. Robust standard errors in parentheses. Information is included as dummy variables (0 = no financial return information, 1 = financial return information; and same for ESG impact information). Description of the dummy variables: email address dummy (0 = no, 1 = yes), attention check question dummy (0 = passed attention check, 1 = failed), survey wave dummy (1 = retail investor sample, 2 = population sample).

Appendix K: Experimental material (translated to English)

PAGE	TEXT (Participants' View)	Scale
Welcome	Dear Sir or Madam, in this study we are interested in investment decisions. This study is conducted by the [author's institute] and funded by [name of funding] as a contribution to basic research. As part of the study, you have the opportunity to invest 600 euros in various investment products. Among all participants, [10/5] will be randomly selected and their investment decision will be financed and realized out by us. These [10/5] persons will be paid the value of the investment after one year. The winners will be informed in about two weeks by email. There are no right or wrong answers in this survey. Please answer spontaneously and truthfully. By conscientiously and completely filling out the questionnaire, you are making a significant contribution to our scientific research! Many thanks for your support. [Names of authors and contact data]	
	GDPR	
Data protection	**By confirming the stated conditions at the bottom of this page, you can proceed to the questionnaire.** [data protection statement] **I hereby confirm that I agree and consent to the above conditions.**	
	Explanation ESG	
Info ESG	Please imagine the following situation. You are at an investment consultation at your bank because you want to invest 600 euros and are informed about various relevant aspects and investment options: In addition to classic factors such as liquidity, time horizon, return on investment and risk, ESG factors can also be taken into account when investing your assets. ESG is an abbreviation for Environmental, Social and Governance. Specifically, you can decide whether you want to invest in investment products that pursue sustainability goals in these	

	three areas while adhering to certain criteria. The diagram below illustrates this concept. Please click "Next" when you have read the criteria of these factors.	
	Information [random allocation to one of the 4 possibilities]	
Basic information	[no text]	For treatment 1 and 2
Financial return information	You receive even more information about ESG investing during the consultation: **Earning returns with ESG investments** By investing in companies that take ESG factors into account and report on them transparently, you can achieve returns and minimize specific risks. Companies that consider ESG factors often operate in industries of the future and are focused on achieving long-term success. An ESG investment can also pay off financially by minimizing specific risks related to environmental disasters, failure to respect labor rights, or rising carbon prices.	For treatment 3 and 4
ESG information	You receive even more information about ESG investing during the consultation: **Promoting sustainability with ESG investments** By investing in companies that take ESG factors into account and report on them transparently, you can have an impact and promote sustainability. Investing in companies that consider ESG factors means strengthening their development opportunities and position in the market. With an ESG investment, you can make a difference and ensure that your money does not support companies that exploit nature and people or are among the worst CO2 emitters.	For treatment 5 and 6
Fin. & ESG Information	You receive even more information about ESG investing during the consultation: [show both, financial and ESG impact information]	For treatment 7 and 8

<table>
<tr><td></td><td>Elicitation of ESG sustainability preferences</td><td></td></tr>
<tr><td>Text for all</td><td>Based on the information received: Please indicate how much of the 600 euros you would like to invest sustainably according to ESG criteria. According to your selection below, the next page will suggest how you could divide your investment amount of 600 euros among different funds. You can adjust this suggestion however you wish.</td><td>For treatment 1 - 8</td></tr>
<tr><td>General elicitation</td><td>What is the minimum amount of your investment that should go into investment products that meet ESG sustainability criteria? [general sustainability preference elicitation]
○ 0 % - no sustainable products [1]
○ up to 25 % [2]
○ up to 50 % [3]
○ up to 75 % [4]
○ up to 100 % - only sustainable products [5]</td><td>For treatment 1-8</td></tr>
<tr><td>Specific elicitation
[If in the general elicitation 25% or more is selected]</td><td>If you choose an ESG investment, you can choose one or both of the following two product categories. [specific sustainability preference elicitation]
○ Investment products that avoid important negative impacts on ESG factors. [1]
○ Investment products that invest in activities that are considered sustainable according to legal requirements (Disclosure Regulation, Taxonomy Regulation). [2]</td><td>For treatment 2, 4, 6, and 8</td></tr>
<tr><td></td><td>Investment decision</td><td></td></tr>
<tr><td>Investment decision</td><td>Your bank advisor will now present you with four funds and, based on your input, tell you how you can allocate your 600 euros.
<table><tr><td>Fund</td><td>Fund A</td><td>Fund B</td><td>Fund C</td><td>Fund D</td></tr><tr><td>Orientation</td><td colspan="2">Conventional</td><td colspan="2">Sustainable</td></tr><tr><td>Type</td><td>Fund with focus on energy and finance</td><td>Fund with focus on information technology and healthcare</td><td>Fund that avoids negative impacts on ESG factors</td><td>Fund that invests in activities that are considered sustainable by law</td></tr><tr><td>Risk and return profile</td><td>6</td><td>6</td><td>6</td><td>6</td></tr><tr><td>Performance in the last year</td><td>Greater than 30 %</td><td>Greater than 30 %</td><td>Greater than 30 %</td><td>Greater than 30 %</td></tr><tr><td>Largest shares by sector</td><td>Finance, Oil, Gas</td><td>Microelectronics, Semiconductors, Agricultural products</td><td>Insulation technology, Metal recycling, Electricity</td><td>Plant engineering, Wind energy, Semiconductors</td></tr></table>You can now accept or change the following proposal. To do so, enter the amount in the respective box.
<table><tr><td></td><td>Suggestion Fund A: € 150
Your investment in fund A:</td><td>Suggestion Fund B: € 150
Your investment in fund B:</td><td>Suggestion Fund C: € 150
Your investment in fund C:</td><td>Suggestion Fund D: € 150
Your investment in fund D:</td><td>Sum</td></tr><tr><td>Please indicate an amount</td><td>150</td><td>150</td><td>150</td><td>150</td><td>600</td></tr></table>The amount of investment must total 600 euros. Remember that [ten/five] participants will be randomly selected, where this decision will be implemented and paid out after one year according to the development of the funds.</td><td></td></tr>
</table>

	Revision Investment [randomized question order]	
Text for all	Imagine it is August 2022 and your advisor is now reporting to you how the investments previously described to you have performed in the market, giving you the opportunity to adjust your investments.	
Revision conventional	Assume that the **conventional investments have 5% more increase in value** than the sustainable ESG investments. **Would you adjust your sustainable investments**? *[revision_conv]* o significantly reduce [1] o reduce a little [2] o neither reduce nor increase [3] o increase a little [4] o significantly increase [5]	
Revision sustainable	Assume that **sustainable ESG investments have 5% more increase in value** than the conventional investments. **Would you adjust your sustainable investments?** *[revision_sust]* o significantly reduce [1] o reduce a little [2] o neither reduce nor increase [3] o increase a little [4] o significantly increase [5]	
	Questions about satisfaction with info texts	
	Finally, we are interested in your opinion.	
Satisfaction Info	**The information I received at the beginning about ESG investing was ...** (As a reminder, the information is shown again below).	1 = totally disagree; 7 = totally agree
	… understandable *[sat_info_under]*	
	… simple *[sat_info_easy]*	
	… informative *[sat_info_info]*	
	… helpful *[sat_info_help]*	
	… trustworthy *[trust_info]*	
	[Screenshot of information, according to treatment]	
	Questions about satisfaction with the elicitation	
Satisfaction with elicitation	**The way I was asked how much I would like to invest in ESG investment products was...** (As a reminder, this choice is shown again below as a screenshot).	1 = totally disagree; 7 = totally agree
	… understandable *[sat_elicit_under]*	
	… simple *[sat_elicit_easy]*	
	… informative *[sat_elicit_info]*	
	… helpful *[sat_elicit_help]*	
	… trustworthy *[trust_elicit]*	
	[Screenshot of information, according to treatment]	
Randomized Order of Questionnaire Blocks Start		
	Questions on values [randomized question order]	

Values	**Please indicate how important the following values are to you as guiding principles in your life.**	1 = totally against my; 7 = of utmost importance DeGroot (2007, 2008)
Biospheric values	Preventing pollution: protection of natural resources *[values_pollution]*	
	Repecting the earth: respectful treatment of the environment *[values_respect]*	
	Unity with nature: living in harmony with nature *[values_unity]*	
	Protecting the environment: preserving nature *[values_protect]*	
Altruistic values	Equality: equal opportunities for all *[values_equality]*	
	A world at peace: free of war and conflict *[values_peace]*	
	Social justice: correcting injustice *[values_justice]*	
	Helpfulness: working for the welfare of others *[values_help]*	
	Questions for motives and trust [randomized question order]	
Trust	**Please indicate how strongly you agree with the following statements:** **I trust that providers follow ESG guidelines.** *[trust_ESG]*	1 = totally disagree; 7 = totally agree; adapted from Nilsson (2008) and Wins & Zwergel (2016)
	Questionnaire Financial Literacy [randomized question order]	
Financial Literacy	**Suppose you have 100 euros credit balance in your savings account. This balance earns interest at 2% per year and you leave it in this account for 5 years. What do you think: How much will your balance be after 5 years?** *[literacy_interest_rates]* o higher than 102 euros [1] o exactly 102 euros [2] o lower than 102 euros [3] o do not know [4]	Lusardi (2008)
	Suppose the interest rate on your savings account is 1% per year and the inflation rate is 2% per year. What do you think: After one year, will you be able to buy as much, more or less than today with the balance of the savings account? *[literacy_inflation]* o more than today [1] o as much as today [2] o less than today [3] o do not know [4]	
	Do you agree with the following statement, "Investing in stocks of a single company is less risky than investing in a fund with stocks of similar companies"? *[literacy_risk]* o agree [1] o disagree [2] o do not know [3]	
	Attention check	
Attention check for retail investor sample	**In which of the following countries did you already invest at the stock market? Please do not tick anything here and leave the answer blank, this is a control question.** *[attention_check]*	

	○ Germany [1] ○ Austria [2] ○ USA [3] ○ China [4] ○ Other countries [5]	
Attention check for population sample	**In which of the following countries do you have your bank accounts (savings account, checking account, etc.)? Please do not tick anything here and leave the answer blank, this is a control question.** *[attention_check]* ○ Germany [1] ○ France [2] ○ USA [3] ○ China [4] ○ Other countries [5]	
	Questionnaire investments	
Risk preference	**How would you rate your risk preference in terms of financial investments?** *[risk_preference]*	0 = totally not risk taking to 10 = totally risk taking; Dohmen et al., (2011)
Investments	**Do you have money invested in stocks, funds or bonds?** *[invested_yes_no]* ○ yes [1] ○ no, I also have no interest [2] ○ no, but I'm very interested [3]	
Experience in investing [if previous question is answered with yes]	**For approximately how many years have you had experience as an investor with stocks, funds, bonds, etc.?** *[experience]* 1. less than 1 year [1] 2. 1 to 2 years [2] 3. 3 to 4 years [3] 4. 5 to 6 years [4] 5. 7 to 8 years [5] 6. 9 to 10 years [6] 7. more than 11 years [7]	
Randomized Order of Questionnaire Blocks End		
	Lastly, we would like you to answer a few questions about yourself:	
Gender	**Which gender do you feel you belong to?** *[gender]* ○ female [1] ○ male [2] ○ non-binary [3]	
Age	**Please indicate your age in years:** [open; from 18 to 120] *[age]*	
Education	**Please indicate your highest level of education completed:** *[education]* ○ primary/secondary degree [1] ○ vocational training [2] ○ second degree without A-levels [3] ○ high school with A-Levels [4]	

	○ college / foreperson course / master (craftsmen) [5] ○ university (university/university of applied sciences [6] ○ other [7]	
Household income	**Please provide the monthly net household income of all persons currently living permanently in your household:** (Household income is the sum of the income of all persons living together in a household and can be made up of various sources of income. Please refer to the current net monthly amount, e.g., after deduction of taxes and social security contributions, and add regular payments such as pensions, unemployment benefits, housing allowances, child support, alimony, etc. If you are not sure, please estimate the monthly amount). *[income]* ○ below 1.000 euros [1] ○ 1,001 to 2,000 euros [2] ○ 2,001 to 3,000 euros [3] ○ 3,001 to 4,000 euros [4] ○ 4,001 to 5,000 euros [5] ○ 5,001 to 6,000 euros [6] ○ 6,001 to 7,000 euros [7] ○ 7,001 to 8,000 euros [8] ○ 8,001 euros or more [9] ○ no answer [99]	Gutsche et al. (2023)
Household size	**How many people including you live permanently in your household?** *[household_size]* ○ 1 person [1] ○ 2 persons [2] ○ 3 persons [3] ○ 4 persons [4] ○ 5 or more persons [5]	
Household_children	**How many of the people in your household are under 18?** *[household_children]* ○ none [0] ○ 1 person [1] ○ 2 persons [2] ○ 3 persons [3] ○ 4 persons [4] ○ 5 or more persons [5]	
Relevance Incentive (only in population sample)	**To me 600 euros is …** *[relevance_incentive]*	1 = no significant amount of money; 7= a significant amount of money
Best of Knowledge	**I have answered in this study to the best of my knowledge and belief and my data may be processed** *[best_of_knowledge]*	1 = totally disagree; 7 = totally agree

Email-Address	Among all participants, [10/5] will be randomly selected whose investment decision will actually be implemented and paid out. **If you would like to participate in this prize draw, please enter your email address now**: [open with check for correct input] *[email_adress]*	
Send results	**Would you like to receive the results of the study?** *[mail_results]* ○ yes [1] ○ no [2]	
End of Survey		
Thanks	Thank you very much for your participation! Your contribution helps us a lot. The questionnaire is now closed, you can now close this window. [Contact data]	

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Appendix Chapter 3

Appendix A. Study 1: Developing the SFL inventory

Appendix A.1. Sustainable finance literacy (SFL) questions (German and English)

Table A.1. Overview of expert feedback rounds for inventory development.

			Round		
Institution	Focus of Department/Expert	N experts	1	2	3
Austrian Financial Market Authority (FMA)	Conduct supervision of banks, investment strategies and sustainable finance	3	X		X
Environment Agency Austria (Umweltbundesamt)	Green finance	1	X		
Consumer Advocacy Austria (VKI)	Labels (UZ49), greenwashing	1		X	
Austrian National Bank (OeNB)	Green finance	1		X	
Austrian Bankers' Association (Bankenverband)	Banking law, sustainable finance	2		X	
Austrian Society for Environment and Technology (ÖGUT)	Green Investments	1		X	
Rating & consulting agency	Sustainable investment	1		X	
Consulting agency	Sustainable finance	1		X	
Financial advisor	Investment advice for retail investors	1		X	

Note. This table presents the experts involved in the feedback rounds for the inventory development. Experts within the same institution (displayed in table rows) provided joint feedback.

Table A.2. German original and English translation of all SFL questions of the inventory.

	German	English	true /false
Q1	Die Abkürzung ESG bedeutet Umwelt, Soziales und gute Unternehmensführung (Environmental, Social und Governance).	The abbreviation ESG stands for Environmental, Social and Governance.	true
Q2	Die Berücksichtigung von ESG-Faktoren beim Investieren hat das Ziel, mehr Profit zu erwirtschaften.	Considering ESG factors when investing aims to generate more profit.	false
Q3	Greenwashing bedeutet, dass ein Finanzprodukt beispielsweise als umweltfreundlich beworben wird, obwohl Umweltaspekte bei der Veranlagungsstrategie kaum oder nicht berücksichtigt werden.	Greenwashing means that a financial product is, for example, advertised as environmentally friendly, even though environmental aspects are hardly or not at all considered in the investment strategy.	true
Q4	Qualitätssiegel (Labels) wie das Österreichische Umweltzeichen (UZ49) sollen sicherstellen, dass ein Anlageprodukt festgelegten Nachhaltigkeitskriterien entspricht.	Quality labels such as the Austrian Eco-Label (UZ49) aim to ensure that an investment product complies with defined sustainability criteria.	true
Q5	Die EU-Taxonomie ist ein Klassifikationssystem, das festlegt, welche wirtschaftlichen Tätigkeiten als ökologisch nachhaltig (= grün) angesehen werden.	The EU Taxonomy is a classification system that defines which economic activities are considered environmentally sustainable (= green).	true
Q6	Eine Geldanlage, die zu einem oder mehreren Umweltzielen der EU-Taxonomie	An investment that contributes to one or several environmental objectives of	true

	beiträgt, ohne die jeweils anderen Umweltziele wesentlich zu beeinträchtigen, ist als ökologisch nachhaltig definiert.	the EU Taxonomy without significantly compromising other environmental goals is defined as ecologically sustainable.	
Q7	Finanzinstitute müssen gemäß EU-Verordnung bei der Wertpapier-Anlageberatung die Kund:innen nach ihren ESG-Nachhaltigkeitspräferenzen befragen und diese berücksichtigen.	EU regulations require financial institutions to ask clients about their ESG sustainability preferences and take these into account when providing investment advice.	true
Q8	Nachhaltigkeitsratings von Finanzprodukten und Unternehmen, die durch private Ratingagenturen erstellt werden, haben untereinander vergleichbare Standards.	Sustainability ratings of financial products and companies issued by private rating agencies have comparable standards.	false
Q9	Die Begriffe „ESG“ und „grün“ in Bezug auf nachhaltige Anlageprodukte sind gesetzlich definiert. Wenn der Name eines Anlageprodukts diese Begriffe beinhaltet, weist dieses Produkt ein Qualitätssiegel (Label) auf.	The terms "ESG" and "green" are legally defined in the context of sustainable investment products. If the name of an investment product includes these terms, this product has an eco-label.	false
Q10	Die Berücksichtigung von Qualitätssiegeln, Nachhaltigkeitsratings und Nachhaltigkeitsberichten der Unternehmen reduziert die Gefahr, auf Greenwashing hereinzufallen.	The consideration of eco-labels, sustainability ratings, and sustainability reports from companies reduces the risk of falling for greenwashing.	true
Q11	Neben dem Factsheet, beinhalten auch das Basisinformationsblatt bzw. das KIID („Key Investor Information Document“) und der (Fonds-)Prospekt ausführliche Nachhaltigkeitsangaben zu einen Finanzprodukt.	In addition to the factsheet, the basic information sheet or the KIID ("Key Investor Information Document") and the (fund) prospectus also contain detailed sustainability information on a financial product.	true
Q12	Durch Ausschlusskriterien können Staaten, Branchen bzw. Unternehmen, die bestimmte ESG-Kriterien nicht erfüllen, von der persönlichen Veranlagung ausgeschlossen werden.	Exclusion criteria can be used to exclude countries, sectors or companies that do not fulfill certain ESG criteria from personal investments.	true
Q13	Die Anlagestrategie "Best-in-class" bedeutet, dass von allen zur Auswahl stehenden Unternehmen einer Anlageklasse, diejenigen ausgewählt werden, die gewisse ESG-Kriterien am besten erfüllen.	The "best-in-class" investment strategy means that of all the companies available for selection in an asset class, those that best fulfill certain ESG criteria are selected.	true
Q14	Divestment bedeutet im Kontext von nachhaltigen Investments, dass Kapital aus Unternehmen, die auf Kosten von Umwelt und sozialen Aspekten wirtschaften, abgezogen wird.	In the context of sustainable investing, divestment means withdrawing capital from companies that operate at the expense of the environment and social aspects.	true
Q15	Die eigene Anlagestrategie sollte von jeder/jedem Anleger/in individuell gewählt werden, da sie von eigenen Nachhaltigkeitspräferenzen und insbesondere der Risikobereitschaft sowie dem Zeithorizont abhängig ist.	Each investor should individually choose their own investment strategy, as it depends on their own sustainability preferences and, in particular, their risk tolerance and time horizon.	true

Q16	Nachhaltige Anlageprodukte können neben Einzelaktien auch Anleihen, Investmentfonds oder Indexfonds bzw. ETFs (Exchange Traded Funds) sein.	Sustainable investment products can include individual stocks, bonds, investment funds, or index funds and ETFs (Exchange Traded Funds).	true
Q17	ESG-Anlageprodukte können nur bei spezifischen Händlern gekauft werden, die sich auf nachhaltige Produkte spezialisiert haben.	ESG investment products can only be purchased from specific retailers that specialize in sustainable products.	false
Q18	Die Anzahl und Vielfalt der verfügbaren nachhaltigen Anlageprodukte haben in den letzten Jahren deutlich zugenommen.	The number and variety of available sustainable investment products have increased significantly in recent years.	true
Q19	Die Gebühren für nachhaltige Anlageprodukte sind immer deutlich höher als für konventionelle Anlageprodukte.	The fees for sustainable investment products are always significantly higher than those for conventional investment products.	false
Q20	Der Finanzsektor hat große Wirkung auf die Realwirtschaft, weil er dazu beitragen kann, Kapitalflüsse stärker auf nachhaltige Investitionen auszurichten.	The financial sector has a significant impact on the real economy, as it can help to direct capital flows more towards sustainable investments.	true
Q21	Ein Investment in einen nachhaltigen Fonds, der Unternehmen mit einem niedrigen CO2e-Abdruck beinhaltet, reduziert direkt globale CO2e-Emissionen.	An investment in a sustainable fund that includes companies with a low CO2e footprint directly reduces global CO2e emissions.	false
Q22	Investor:innen und Fondsgesellschaften können Einfluss auf Unternehmen haben, indem sie vom Management Maßnahmen für eine nachhaltigere Geschäftstätigkeit fordern.	Investors and investment firms can influence companies by demanding for more sustainable business practices from management.	true
Q23	Impact-Investments haben insbesondere die Vermeidung schädlicher Geschäftsmodelle zum Ziel.	Impact investments specifically aim to avoid harmful business models.	false
Q24	Ein Nachhaltigkeitsrisiko ist ein Ereignis in den Bereichen Umwelt, Soziales oder Unternehmensführung, das sich negativ auf den Wert bzw. die Rendite einer Investition auswirken kann.	A sustainability risk is an event in the areas of environment, social, or governance that can negatively impact the value or return of an investment.	true
Q25	Nachhaltige ESG-Investments reduzieren das Risiko, dass das eigene Kapital in veraltete Technologien, Unternehmen oder Branchen investiert wird.	Sustainable ESG investments reduce the risk of investing one's capital in outdated technologies, companies, or industries.	true
Q26	Die Gewinne sind bei nachhaltigen ESG-Finanzprodukten deutlich geringer als bei konventionellen Finanzprodukten.	The returns are significantly lower for sustainable ESG financial products than for conventional financial products.	false
Q27	Da nachhaltige Unternehmen die Kosten für die Überwachung und Berichterstattung von ESG-Daten tragen, schneiden sie an der Börse im Durchschnitt schlechter ab als Unternehmen, die ESG-Richtlinien nicht einhalten.	Since sustainable companies bear the costs of monitoring and reporting ESG data, they, on average, perform worse on the stock market than companies that do not comply with ESG guidelines.	false
Q28	Grüne Kredite („sustainablility linked loans“) können z.B. für energiesparende Projekte zu günstigeren Finanzierungskonditionen	Green loans ("sustainability-linked loans") can be offered at more favorable financing conditions, for	true

	angeboten werden, wenn vorab festgelegte Nachhaltigkeitsziele erreicht werden.	example for energy-saving projects, if predefined sustainability objectives are achieved.	
Q29	Bei einem nachhaltigen Girokonto oder Sparbuch, das mit dem Österreichischen Umweltzeichen (UZ49) versehen ist, werden Kundeneinlagen nachhaltig veranlagt oder für grüne Kredite weitervergeben.	For a sustainable checking account or passbook that is certified with the Austrian Eco-Label (UZ49), customer deposits are invested sustainably or re-lent for green loans.	true
Q30	Banken und Versicherungen veranlagen das Geld, das auf Sparkonten bzw. in Versicherungsprodukte einbezahlt wird, automatisch nachhaltig.	Banks and insurance companies automatically invest money paid into savings accounts or insurance products in a sustainable way.	false

Note. This table shows the original SFL questions and the English translations. The questions, initially formulated in German, were translated by three researchers and student assistants individually, then compared, and in case of disagreement a majority vote decided on the final translation.

Appendix A.2. Difficulty and discrimination index (Study 1)

The item difficulty index (also called item easiness) is a measure used to assess the difficulty level of a test item, focusing on how challenging the question is for participants (Ebel & Frisbie, 1972; Gronlund & Linn, 1990). Instead of merely calculating the overall percentage of correct responses, it employs the Truman Kelley method, which involves analyzing the share of correct responses among the top 27% and bottom 27% of overall performers in a sample. This approach provides a more nuanced understanding of item difficulty by comparing performance across different literacy levels within the sample. Items with a difficulty index below 0.2 are considered very difficult and may be candidates for removal from the test, as their inclusion could unfairly impact overall scores. Similarly, items with a difficulty index above 0.85 are considered too easy and might also be considered for deletion because they might not effectively differentiate between participants' literacy.

The item discrimination index is a crucial metric in test analysis, measuring an item's capacity to differentiate between high and low scorers. An item with high discrimination implies that participants with high overall scores on the SFL measure correctly answered the item, whereas those with low overall scores did not. This characteristic is essential for ensuring that test items are capable of distinguishing between varying levels of participant knowledge or ability. An item with a discrimination index less than zero suggests the paradoxical situation where participants who otherwise performed poorly on the test tended to answer the item correctly more often than those who performed well. This could indicate that the item does not align with the test's intended literacy assessment. Items with a discrimination index ranging from 0 to 0.19 are considered to have poor discrimination and ought to be considered for deletion.

The results (Table A.3) show that Q9 and Q23 are below the recommended difficulty index threshold and the discrimination index threshold. Q21 also performs poorly in the discrimination index and lies close to the threshold for the difficulty index. Thus, we removed these questions from the measure to enhance the overall quality and reliability.

Table A.3. Difficulty and discrimination index.

Question	Lower group correct	Upper group correct	*N* correct	Difficulty index	Group difference	Discrimination index	Expert rating
Q1	81	252	333	0.588	171	0.604	1,29
Q2	34	149	183	0.323	115	0.406	2,86
Q3	102	265	367	0.648	163	0.576	1,43
Q4	79	261	340	0.601	182	0.643	1,14
Q5	30	234	264	0.466	204	0.721	1,42
Q6	39	224	263	0.465	185	0.654	2,29
Q7	47	210	257	0.454	163	0.576	2,43
Q8	30	96	126	0.223	66	0.233	2,57
Q9	32	73	105	0.186	41	0.145	2,00
Q10	60	234	294	0.519	174	0.615	2,00
Q11	20	211	231	0.408	191	0.675	2,86
Q12	37	232	269	0.475	195	0.689	1,14
Q13	45	215	260	0.459	170	0.601	1,43
Q14	20	171	191	0.337	151	0.534	3,00
Q15	129	268	397	0.701	139	0.491	2,14
Q16	68	266	334	0.590	198	0.700	2,00
Q17	30	158	188	0.332	128	0.452	3,57
Q18	141	280	421	0.744	139	0.491	2,43
Q19	35	154	189	0.334	119	0.420	2,29
Q20	103	268	371	0.655	165	0.583	1,86
Q21	34	85	119	0.210	51	0.180	1,83
Q22	87	247	334	0.590	160	0.565	2,86
Q23	19	21	40	0.071	2	0.007	3,00
Q24	46	188	234	0.413	142	0.502	1,43
Q25	46	228	274	0.484	182	0.643	2,71
Q26	25	157	182	0.322	132	0.466	1,57
Q27	22	140	162	0.286	118	0.417	2,71
Q28	66	238	304	0.537	172	0.608	2,00
Q29	44	217	261	0.461	173	0.611	1,14
Q30	125	226	351	0.620	101	0.357	2,71

Note. This table presents the difficulty and discrimination indices of the 30 SFL questions as well as the questions' expert ratings. Expert rating were based on school notes: 1 = *good and important*, 5 = *not good*, *important*. Note that we used the number of correctly answered questions relative to the overall sample rather than only those who tried to answer the question.

Appendix A.3. Exploratory factor analysis (Study 1)

As preregistered, we used an exploratory factor analysis (principal component analysis; PCA) with Promax rotation, an oblique rotation method that allows for correlation among factors, to examine whether SFL is composed of different categories of knowledge (Table A.4). In our first analysis, PCA1, we study all questions simultaneously. PCA1's structure matrix suggests a four-factor solution in which Factor 1 represents questions on which the correct answer is "true", and Factors 2 through 4 represent "false" questions, with Factors 1 and 2 sharing many questions that load above 0.50 on both factors. Thus, the results indicate that the PCA is sensitive to the "true" and "false" statements (i.e., the answer format), despite the latter questions having been recoded for the analysis and regardless of the content. Therefore, in PCA2, we retained only the "true" questions. Its structure matrix yields a two-factor solution in which all questions load with at least 0.39 on both factors. In PCA3, we also retain only "true" questions and force the analysis to generate only one factor. We obtain loadings of at least 0.46 and an explained variance of 39.90%, indicating that sustainable finance knowledge is likely not composed of different knowledge categories but is instead a homogeneous construct.

Table A.4. Principal component analyses.

	PCA1 Factors 1 to 4				PCA2 Factors 1 to 2		PCA3 Factor 1
	1	2	3	4	1	2	1
Q1_ESG meaning	**0,696**	0,372	-0,086	0,06	**0,563**	**0,69**	**0,662**
Q2_ESG strategy *(R)*	-0,108	-0,322	**0,59**	-0,09			
Q3_greenwashing meaning	**0,684**	0,268	-0,014	0,004	**0,501**	**0,657**	**0,61**
Q4_labels	**0,71**	**0,527**	-0,122	0,266	**0,675**	**0,68**	**0,719**
Q5_taxonomy meaning	**0,64**	**0,538**	-0,082	0,048	**0,679**	**0,562**	**0,656**
Q6_criteria sustainable	**0,635**	**0,522**	-0,155	-0,036	**0,631**	**0,569**	**0,636**
Q7_preference elicitation	**0,559**	**0,573**	-0,129	0,181	**0,635**	0,471	**0,582**
Q8_ratings *(R)*	-0,346	-0,652	0,376	-0,201			
Q10_greenwashing	**0,53**	**0,523**	-0,184	**0,51**	**0,576**	**0,527**	**0,585**
Q11_documents	**0,587**	0,463	-0,123	0,062	**0,566**	**0,566**	**0,6**
Q12_exclusion criteria	**0,54**	**0,564**	-0,179	-0,017	**0,64**	0,457	**0,576**
Q13_best in class	**0,564**	0,442	-0,252	0,352	**0,589**	**0,549**	**0,603**
Q14_divestment	**0,557**	**0,589**	-0,174	-0,145	**0,615**	0,49	**0,583**
Q15_individual strategy	**0,668**	0,313	-0,065	0,177	**0,526**	**0,708**	**0,648**
Q16_products	**0,734**	0,384	-0,07	0,108	**0,58**	**0,751**	**0,699**
Q17_product purchase *(R)*	-0,061	-0,278	**0,581**	-0,359			
Q18_product increase	**0,803**	0,38	-0,035	0,16	**0,617**	**0,798**	**0,743**
Q19_fees *(R)*	-0,087	-0,189	**0,655**	-0,148			
Q20_impact economy	**0,695**	0,437	-0,076	0,295	**0,628**	**0,686**	**0,696**
Q22_engagement	**0,598**	0,463	-0,102	0,163	**0,598**	**0,597**	**0,634**
Q24_sustainability risk	0,434	0,412	-0,412	0,18	0,477	0,392	0,46

Q25_stranded assets	**0,529**	**0,575**	-0,142	0,323	**0,624**	0,495	**0,591**
Q26_performance *(R)*	-0,088	-0,24	**0,682**	-0,09			
Q27_costs & performance *(R)*	-0,107	-0,285	**0,611**	-0,041			
Q28_green loans	**0,658**	**0,568**	-0,183	0,175	**0,661**	**0,632**	**0,686**
Q29_saving sustainable	**0,576**	**0,509**	-0,009	0,142	**0,585**	**0,559**	**0,607**
Q30_banks *(R)*	0,001	-0,479	**0,578**	-0,209			
Q9_name *(R)*	-0,403	-0,56	0,373	-0,238			
Q21_impact_environ. *(R)*	-0,363	-0,662	0,257	-0,167			
Q23_impact_investments *(R)*	-0,565	-0,518	0,289	-0,141			

Note. This table presents the principal component analyses of the 27 SFL questions. *(R)* indicates that the question is reverse-coded, i.e., "false", and recoded for data analysis.

Appendix A.4. Descriptive statistics and additional results (Study 1)

The average correctness rate across the 30 questions was 46.9% (*SD* = 20.41%). The most frequently correctly answered question was Q18 – whether the number of available sustainable investment products increased in recent years, with more than 80% of participants answering correctly. The least correctly answered question was Q23 – only 6.8% of respondents answered this correctly.

Table A.5. Overview on correct responses to 30 SFL questions.

Question	*N*	*M*	*SD*	*N* correct	% correct	Don't know	% Don't know
Q18_product increase	1,047	4.288	0.821	840	80.23	72	6.88
Q15_individual strategy	1,047	4.249	0.892	792	75.64	89	8.50
Q1_ESG meaning	1,047	4.184	0.965	666	63.61	208	19.87
Q3_greenwashing meaning	1,047	4.176	1.024	722	68.96	131	12.51
Q16_ products	1,047	4.087	0.840	686	65.52	193	18.43
Q20_impact economy	1,047	4.067	0.899	736	70.30	115	10.98
Q4_labels	1,047	3.999	0.917	680	64.95	172	16.43
Q22_engagement	1,047	3.862	0.960	664	63.42	136	12.99
Q28_green loans	1,047	3.853	0.906	622	59.41	192	18.34
Q5_taxonomy meaning	1,047	3.840	0.972	524	50.05	291	27.79
Q30_banks (R)	1,047	3.791	1.151	643	61.41	78	7.45
Q13_best in class	1,047	3.756	0.972	518	49.47	281	26.84
Q11_documents	1,047	3.718	0.938	445	42.50	346	33.05
Q12_exclusion criteria	1,047	3.710	1.020	530	50.62	255	24.36
Q6_criteria sustainable	1,047	3.702	0.947	502	47.95	284	27.13
Q7_preference elicitation	1,047	3.670	1.102	505	48.23	241	23.02
Q10_greenwashing	1,047	3.663	1.027	588	56.16	139	13.28
Q25_stranded assets	1,047	3.643	1.030	557	53.20	190	18.15
Q29_saving sustainable	1,047	3.633	1.027	496	47.37	263	25.12
Q24_sustainability risk	1,047	3.517	1.025	476	45.46	230	21.97
Q14_divestment	1,047	3.513	1.022	341	32.57	402	38.40
Q17_product purchase (R)	1,047	3.094	1.184	319	30.47	270	25.79
Q2_ESG strategy (R)	1,047	3.067	1.150	318	30.37	226	21.59
Q27_costs & performance (R)	1,047	3.006	1.006	250	23.88	277	26.46
Q19_fees (R)	1,047	2.980	1.174	302	28.84	183	17.48
Q26_performance (R)	1,047	2.962	1.043	270	25.79	197	18.82
Q8_ratings (R)	1,047	2.855	1.062	241	23.02	221	21.11
Q21_impact environment (R)	1,047	2.730	1.204	247	23.59	164	15.66
Q9_name (R)	1,047	2.524	1.145	170	16.24	227	21.68
Q23_impact investments (R)	1,047	2.442	0.959	71	6.78	404	38.59

Note. This table presents the mean values and frequency of correct answers to the 30 SFL questions in Study 1 (*N* = 1,047). *M* = Mean, *SD* = Standard deviation.

Appendix A.5. SFL and self-reported (sustainable) stock market investments (Study 1)

Table A.6. Logistic regression of self-reported investments on literacy measures.

	Financial market investments		Sustainable investments	
	(1)	(2)	(3)	(4)
SFL	1.349***	0.911**	1.455***	0.823*
	(0.281)	(0.303)	(0.315)	(0.335)
Basic financial literacy objective	1.305***	1.036***	0.577+	0.359
	(0.277)	(0.292)	(0.311)	(0.324)
Advanced financial literacy objective	1.389***	1.280***	0.746*	0.653*
	(0.272)	(0.280)	(0.310)	(0.320)
Sustainability literacy objective	0.145	-0.061	0.475	0.186
	(0.284)	(0.323)	(0.305)	(0.343)
Gender: female		-0.632***		-0.498**
		(0.149)		(0.164)
Age		-0.0004		-0.006
		(0.004)		(0.005)
University degree (Ref.: no)		0.437**		0.134
		(0.159)		(0.169)
Household income above median		0.555***		0.413*
		(0.167)		(0.175)
Household income not reported		0.225		-0.157
		(0.195)		(0.227)
Education in economics		0.147*		0.097
		(0.073)		(0.077)
Professional experience		-0.163		-0.083
		(0.208)		(0.218)
Hassle factor investments		-0.256***		-0.034
		(0.069)		(0.071)
Hassle factor sustainable investments		-0.063		-0.303***
		(0.073)		(0.076)
Sustainable lifestyle		0.021		0.109
		(0.065)		(0.071)
Climate change awareness		0.025		0.060
		(0.056)		(0.062)
Constant	-2.994***	-1.574*	-3.086***	-1.689**
	(0.255)	(0.486)	(0.283)	(0.538)
N	1047	1047	1047	1047
Nagelkerke pseudo R2	0.208	0.196	0.104	0.311

Note. This table presents the results of the hierarchical models regressing reported (sustainable) financial market on SFL, successively adding control variables, based on the sample of Study 1. Standard errors are shown in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B. Study 2: SFL and investment decisions

Appendix B.1. Fund screening and selection for the incentivized investment decision.

In 2022, the Baden-Württemberg consumer center raised greenwashing allegations against Fund C. Using this historical example, we included the DWS Invest ESG Climate Tech LC fund as potentially greenwashed fund (Fund C), using parts of the fund description that were subject to the allegations. To find the alternative funds for the investment decision, we used Refinitiv's EIKON's funds screener and restricted our search to all equity mutual funds notified for trade in Austria (date of retrieval: 04.09.2023). We specifically searched for funds with a theme of (alternative) energy. We aimed for four funds in total, one fund labeled as Article 9 (according to the EU Disclosure regulation; "dark green"), one fund labeled Article 8 (but with the abovementioned formulations for which the fund faced greenwashing allegations; "light green"), and two Article 6 according to the EU's Sustainable Finance Disclosure Regulation (SFDR). Table B.1 gives an overview on the four funds. The sustainable fund is moreover the second most sustainable equity mutual fund aligned with Article 9 according to a test of sustainable funds in Austria, conducted by Cleanvest and the Austrian Chamber of Labor (Fund C was not rated).[35]

Table B.1. Overview on the equity mutual funds used in the investment decision.

Fund	A (conventional)	B (conventional)	C (greenwashing allegations)	D (sustainable)
Name	Schroder ISF Global Energy A Acc USD	Raiffeisen-Energie-Aktien R T	DWS Invest ESG Climate Tech LC	Raiffeisen-SmartEnergy-ESG-Aktien (R) T
ISIN	LU0256331488	AT0000688676	LU1863264153	AT0000A2DFF8
SFDR	Art. 6	Art. 6	Art. 8	Art. 9
Refinitiv ESG score	58.3	61.6	66.2	67.5
MSCI carbon intensity[36]	327.3	199.9	241.1	163.3
Cleanvest rating[37]	5.6	5.2	7.0	8.2
Label	none	none	none	UZ49, FNG-label
Risk	6	5	4	5
Performance 3y	175.6	54.2	15.7	12.7
TER	1.9	2.2	1.6	1.6
Volume	454	136	904	326

Note. This table presents further information on the funds used in the incentivized investment experiment. SFDR shows sustainability classification after the EU's SFDR regulation; Refinitiv ESG score shows Refinitiv's combined ESG score; MSCI carbon intensity shows the MSCI carbon intensity (CO2e per m$ sales); Cleanvest rating shows the Cleanvest rating (out of 10 points maximum); Risk shows the risk classification (max. 7, high risk); Performance 3y. shows the 3-year performance up to 03.09.2023; TER is the total expense ratio; Volume shows the fund volume in million US-dollars.

[35] https://ooe.arbeiterkammer.at/beratung/konsumentenschutz/geld/geldanlage/KS_2023_Studie_Wie_gruen_sind_Oesterreichs_nachhaltige_Fonds.pdf

[36] https://www.msci.com/our-solutions/esg-investing/esg-fund-ratings-climate-search-tool

[37] https://www.cleanvest.org/de/

Appendix B.2. Additional descriptive statistics and results (Study 2)

In Study 1 the response options were on a five-point Likert-scale (anchored at 1 = *definitely false* and 5 = *definitely true*) while in Study 2 the answer options were *true* and *false*. The average of correct answers per question is comparable among Studies 1 and 2 (Table B.2). The different answering formats in the two studies thus did not lead to any marked differences in the share of correct answers. That said, the shares of *I don't know* answers is higher in Study 2, which might to some degree be rooted in the different answer options. In Study 1, the answer option 3 = *undecided* comes close to an *I don't know* indication, and when considering the actual *I don't know* responses and the *undecided* responses in Study 1 (Q3: 11.08%, Q4: 13.09%, Q5: 16.43%, Q12: 14.52%, Q16: 12.61%, Q19: 22.54%, Q26: 28.18%), the overall share becomes more similar between Study 1 and Study 2. We consider learning effects unlikely, since only four participants participated in both Study 1 and in Study 2 (identified via comparison of the personalized IDs supplied by the market research agency).

Table B.2. Descriptive statistics on SFL.

Question	Study 1 (*N* = 1,047)		Study 2 (*N* = 1,510)	
	Correct (*f*, %)	Don't know (*f*, %)	Correct (*f*, %)	Don't know (*f*, %)
Question 3. Greenwashing means that a financial product is, for example, advertised as environmentally friendly even though environmental aspects are hardly or not considered in the investment strategy. *(true)*	722 (68.96%)	131 (12.51%)	1020 (67.55%)	390 (25.82%)
Question 4. Quality labels such as the Austrian Eco-Label (UZ49) aim to ensure that an investment product meets defined sustainability criteria. *(true)* [Austria specific question]	680 (64.95%)	172 (16.43%)	975 (64.57%)	472 (31.26%)
Question 5. The EU Taxonomy is a classification system that defines which economic activities are considered environmentally sustainable (= green). *(true)* [EU specific questions]	524 (50.05%)	291 (27.79%)	678 (44.90%)	744 (49.27%)
Question 12. Exclusion criteria can be used to exclude countries, sectors or companies that do not meet certain ESG criteria from personal investments. *(true)*	530 (50.62%)	255 (24.36%)	594 (39.34%)	766 (50.72%)
Question 16. Sustainable investment products can include individual stocks, bonds, investment funds, or index funds and ETFs (Exchange Traded Funds). *(true)*	686 (65.52%)	193 (18.43%)	882 (58.41%)	541 (35.83%)
Question 19. The fees for sustainable investment products are always significantly higher than those for conventional investment products. *(false)*	302 (28.84%)	183 (17.48%)	594 (39.34%)	558 (36.95%)
Question 26. Returns are significantly lower for sustainable ESG financial products than for conventional financial products. *(false)*	270 (25.79%)	197 (18.82%)	446 (29.54%)	689 (45.63%)

Note. This table presents the share of correct answers and *I don't know* answers to our seven SFL questions. *f* = frequency, % = percentage of sample. Questions in Study 1 were answered on a 5-point Likert-scale with labels (1 = *definitely false*, 2 = *likely false*, 3 = *undecided*, 4 = *likely true*, 5= *definitely true*) with the option to answer, "*I do not know*". Answers are rated as correct, if the response to the (recoded) question is either "*likely true*" or "*definitely true*". Questions in Study 2 were answered with "*true*", "*false*" or "*I don't know*".

Table B.3. Correlation table of SFL items with investment behavior.

	M (SD)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. SFL (7 questions)	0.49 (0.28)															
2. Q3 correct	0.68 (0.47)	0.53														
3. Q4 correct	0.65 (0.48)	0.57	0.21													
4. Q5 correct	0.45 (0.50)	0.60	0.27	0.28												
5. Q12 correct	0.39 (0.49)	0.54	0.15	0.23	0.26											
6. Q16 correct	0.58 (0.49)	0.63	0.25	0.27	0.26	0.22										
7. Q19 correct	0.39 (0.49)	0.59	0.22	0.18	0.16	0.15	0.31									
8. Q26 correct	0.30 (0.46)	0.56	0.14	0.21	0.18	0.17	0.24	0.36								
9. Stock market investments	0.71 (0.35)	0.26	0.16	0.16	0.13	0.08	0.22	0.19	0.13							
10. ESG investments	0.48 (0.38)	0.24	0.13	0.19	0.09	0.08	0.14	0.16	0.21	0.31						
11. Greenw. investments	0.44 (0.30)	-0.16	-0.11	-0.14	-0.11	-0.03	-0.06	-0.10	-0.08	-0.09	-0.15					
12. Greenw. correctly identified	0.28 (0.45)	0.19	0.17	0.13	0.09	0.06	0.07	0.11	0.13	0.09	0.10	-0.10				
13.No greenw. in follow up	0.25 (0.43)	-0.30	-0.27	-0.21	-0.20	-0.15	-0.17	-0.14	-0.10	-0.22	-0.15	0.04	-0.35			
14. Self-reported financial market assets	0.84 (1.21)	0.27	0.14	0.08	0.17	0.12	0.25	0.24	0.11	0.25	0.09	-0.03	0.07	-0.16		
15. Self-reported sustainable assets	0.52 (0.97)	0.25	0.10	0.11	0.14	0.12	0.20	0.22	0.15	0.17	0.17	-0.03	0.09	-0.18	0.75	

Note. This table presents the correlations between SFL, answering each SFL item correctly, and investment behaviors. M = mean, SD = standard deviation. Greenw. = greenwashing. All correlations computed using Spearman's Rho. Correlations with $r_s > 0.10$ are significant at $p < 0.001$, and correlations below $r_s = 0.05$ are not significant ($p > 0.05$) while correlations in between these thresholds are significant at least at $p < 0.05$.

Table B.4. Descriptive statistics of explanatory variables

Explanatory variable	*N*	*M*	*SD*	*Min*	*Max*
SFL	1,510	0.49	0.28	0	1
Advanced financial literacy	1,510	0.66	0.33	0	1
Female	1,510	51.2%	50.0%	-	-
Age in years	1,510	49.03	16.92	18	85
University degree	1,510	15.3%	36.0%	-	-
High household income	1,510	24.7%	43.1%	-	-
Household income not reported	1,510	16.5%	37.1%	-	-
Investment experience in years	1,510	2.17	2.67	0	7
Stockholder image (Cronbach's $\alpha = 0.78$)	1,510	3.94	1.28	1	7
Stock market image: Immorality	1,510	3.61	1.51	1	7
Stock market image: Wealth creating	1,510	3.93	1.36	1	7
Stock market image: ESG	1,510	4.62	1.44	1	7
Hassle factor	1,510	4.18	1.52	1	7
Greenwashing beliefs	1,510	4.43	1.24	1	7
Biospheric Values (Cronbach's $\alpha = 0.84$)	1,510	5.46	1.24	1	7
Altruistic Values (Cronbach's $\alpha = 0.84$)	1,510	5.52	1.26	1	7
Risk taking	1,510	3.17	1.52	1	7
Patience	1,510	4.54	1.31	1	7
General trust	1,510	2.88	1.46	1	7
Left wing views	1,510	3.95	1.25	1	7

Note. This table reports the descriptive statistics of the explanatory variables included in the econometric analyses. *N* = number of observations, *M* = mean, *SD* = standard deviation.

Appendix B.3. Full regression tables (Study 2)

Table B.5. OLS-regression of stock market investments on SFL.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SFL		0.366***	0.294***	0.263***	0.238***	0.234***	0.187***
		(0.031)	(0.035)	(0.035)	(0.035)	(0.036)	(0.035)
Advanced financial literacy	0.243***		0.128***	0.121***	0.111***	0.108***	0.084**
	(0.026)		(0.029)	(0.030)	(0.030)	(0.030)	(0.030)
Female (Ref.: male)				-0.064***	-0.070***	-0.067***	-0.037*
				(0.018)	(0.018)	(0.018)	(0.018)
Age in years				-0.002***	-0.002***	-0.002***	0.000
				(0.001)	(0.001)	(0.001)	(0.001)
University degree (Ref.: no)				0.014	0.009	0.008	-0.013
				(0.024)	(0.024)	(0.024)	(0.024)
High household income				0.007	0.004	0.005	0.006
				(0.021)	(0.021)	(0.021)	(0.020)
Household income not reported				-0.012	-0.017	-0.017	-0.016
				(0.024)	(0.024)	(0.024)	(0.023)
Investment experience in years				0.007*	0.003	0.003	-0.006
				(0.004)	(0.004)	(0.004)	(0.004)
Stockholder image					-0.018*	-0.018*	-0.014+
					(0.008)	(0.008)	(0.008)
Stock market image: Immorality					-0.019**	-0.019**	-0.014*
					(0.007)	(0.007)	(0.007)
Stock market image: Wealth creating					-0.016*	-0.016*	-0.007
					(0.006)	(0.006)	(0.006)
Stock market image: ESG					-0.002	-0.003	0.000
					(0.006)	(0.007)	(0.007)
Hassle factor						-0.008	-0.006

Table B.5. OLS-regression of stock market investments on SFL.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
						(0.006)	(0.006)
Greenwashing beliefs						0.008	0.007
						(0.008)	(0.008)
Biospheric Values							0.010
							(0.009)
Altruistic Values							-0.020*
							(0.009)
Risk taking							0.052***
							(0.007)
Patience							0.020**
							(0.007)
General trust							-0.001
							(0.006)
Left wing views							0.018**
							(0.007)
Constant	0.548***	0.530***	0.480***	0.616***	0.855***	0.856***	0.462***
	(0.019)	(0.017)	(0.021)	(0.034)	(0.055)	(0.060)	(0.081)
N	1510	1510	1510	1510	1510	1510	1510
R2	0.054	0.085	0.097	0.118	0.138	0.139	0.186
R2 Adj.	0.053	0.085	0.096	0.113	0.131	0.131	0.175

Note. This table presents the results of the hierarchical models regressing stock market investments on SFL, successively adding control variables. Note that Model (7) in this table corresponds to Model (4) in the main paper. We use a Wald-test to test for coefficient equality and find that the coefficient estimates for SFL are significantly higher in Model (3) ($F(1507, 1) = 9.27, p = 0.002$), Model (4) ($F(1507, 1) = 6.74, p = 0.01$), Model (5) ($F(1507, 1) = 5.52, p = 0.019$) and Model (6) ($F(1507, 1) = 5.32, p = 0.021$), while in Model (7) the ($F(1507, 1) = 3.70, p = 0.054$), the difference is only weakly significant. Standard errors are shown in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B.6. OLS-regression of sustainable investments on SFL.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SFL		0.328***	0.309***	0.323***	0.322***	0.318***	0.251***
		(0.034)	(0.038)	(0.039)	(0.039)	(0.039)	(0.039)
Advanced financial literacy	0.155***		0.034	0.058+	0.053	0.062+	0.045
	(0.029)		(0.032)	(0.033)	(0.033)	(0.033)	(0.032)
Female (Ref.: male)				0.053**	0.041*	0.042*	0.021
				(0.020)	(0.020)	(0.020)	(0.020)
Age in years				-0.002**	-0.002**	-0.002**	-0.001*
				(0.001)	(0.001)	(0.001)	(0.001)
University degree (Ref.: no)				0.011	0.016	0.014	-0.021
				(0.027)	(0.027)	(0.027)	(0.026)
High household income				-0.007	-0.010	-0.010	-0.007
				(0.023)	(0.023)	(0.023)	(0.022)
Household income not reported				0.043	0.041	0.040	0.033
				(0.026)	(0.026)	(0.026)	(0.025)
Investment experience in years				-0.001	-0.002	-0.003	-0.004
				(0.004)	(0.004)	(0.004)	(0.004)
Stockholder image					-0.030***	-0.024**	-0.016*
					(0.008)	(0.009)	(0.008)
Stock market image: Immorality					0.006	0.011	0.011
					(0.007)	(0.007)	(0.007)
Stock market image: Wealth creating					0.018**	0.017*	0.015*
					(0.007)	(0.007)	(0.007)
Stock market image: ESG					0.000	0.006	0.001
					(0.007)	(0.007)	(0.007)
Hassle factor						-0.004	-0.007
						(0.007)	(0.007)

Table B.6. OLS-regression of sustainable investments on SFL.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Greenwashing beliefs						-0.031***	-0.022**
						(0.009)	(0.008)
Biospheric Values							0.044***
							(0.010)
Altruistic Values							-0.018+
							(0.010)
Risk taking							-0.004
							(0.007)
Patience							0.031***
							(0.008)
General trust							0.027***
							(0.007)
Left wing views							0.049***
							(0.008)
Constant	0.378***	0.320***	0.307***	0.330***	0.364***	0.450***	-0.067
	(0.021)	(0.019)	(0.023)	(0.037)	(0.061)	(0.066)	(0.088)
N	1510	1510	1510	1510	1510	1510	1510
R2	0.019	0.059	0.060	0.073	0.085	0.094	0.162
R2 Adj.	0.018	0.058	0.059	0.068	0.078	0.085	0.150

Note. This table presents the results of the hierarchical models regressing sustainable investments on SFL, successively adding control variables. Note that Model (7) in this table corresponds to Model (4) in the main paper. We use a Wald-test to test for coefficient equality and find that the coefficient estimates for SFL are significantly higher in Models (3) to (7) with $p < 0.001$ for all tests. Standard errors are shown in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B.7. OLS-regression of potentially greenwashed investments on SFL.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
SFL		-0.177***	-0.148***	-0.128**	-0.135***	-0.135***	-0.134**
		(0.034)	(0.038)	(0.039)	(0.040)	(0.040)	(0.041)
Advanced financial literacy	-0.107***		-0.054+	-0.028	-0.020	-0.019	-0.018
	(0.028)		(0.031)	(0.032)	(0.033)	(0.033)	(0.033)
Female (Ref.: male)				-0.008	-0.009	-0.009	0.002
				(0.019)	(0.019)	(0.019)	(0.020)
Age in years				-0.001*	-0.001+	-0.001+	-0.001
				(0.001)	(0.001)	(0.001)	(0.001)
University degree (Ref.: no)				-0.024	-0.026	-0.026	-0.025
				(0.026)	(0.026)	(0.026)	(0.026)
High household income				-0.025	-0.022	-0.022	-0.023
				(0.023)	(0.023)	(0.023)	(0.023)
Household income not reported				-0.004	-0.003	-0.002	0.000
				(0.026)	(0.026)	(0.026)	(0.026)
Investment experience in years				-0.006	-0.006	-0.006	-0.008+
				(0.004)	(0.004)	(0.004)	(0.004)
Stockholder image					0.012	0.013	0.014
					(0.008)	(0.009)	(0.009)
Stock market image: Immorality					-0.002	-0.001	-0.001
					(0.007)	(0.008)	(0.008)
Stock market image: Wealth creating					-0.008	-0.008	-0.006
					(0.007)	(0.007)	(0.008)
Stock market image: ESG					-0.017*	-0.017*	-0.015*
					(0.007)	(0.007)	(0.007)
Hassle factor						0.000	0.000
						(0.007)	(0.007)

Table B.7. OLS-regression of potentially greenwashed investments on SFL.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Greenwashing beliefs						-0.003	-0.004
						(0.009)	(0.009)
Biospheric Values							-0.008
							(0.011)
Altruistic Values							-0.009
							(0.011)
Risk taking							0.009
							(0.008)
Patience							0.008
							(0.009)
General trust							-0.008
							(0.007)
Left wing views							-0.002
							(0.008)
Constant	0.508***	0.529***	0.550***	0.604***	0.667***	0.674***	0.698***
	(0.021)	(0.020)	(0.024)	(0.035)	(0.062)	(0.067)	(0.091)
N	1081	1081	1081	1081	1081	1081	1081
R2	0.013	0.024	0.027	0.036	0.043	0.043	0.050
R2 Adj.	0.012	0.023	0.025	0.029	0.032	0.031	0.032

Note. This table presents the results of the hierarchical models regressing potentially greenwashed investments on SFL, successively adding control variables. Note that Model (7) in this table corresponds to Model (4) in the main paper. We use a Wald-test to test for coefficient equality and find that the coefficient estimates for SFL marginally higher in Model (5) ($F(1) = 3.72, p = 0.054$), Model (6) ($F(1) = 3.74, p = 0.054$) and Model (7) ($F(1) = 3.69, p = 0.055$), while being close to $p = 0.10$ in Model (3) ($F(1) = 2.50, p = 0.114$) and Model (4) ($F(1) = 2.84, p = 0.092$). Standard errors are shown in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B.4. Exploring the mechanisms linking SFL and investment behavior (Study 2)

We use mediation analyses to study whether SFL also has an indirect effect on our outcome variables, i.e., whether part of the main effect is mediated by other underlying variables (as in Cronqvist et al., 2015). This method yields a comprehensive overview of the pathways along which SFL relates to the outcome variables. Table B.8. presents the results of the simultaneous examination of the direct and indirect effects of SFL on stock market investments (Table B.8., Panel A), sustainable investments (Table B.8., Panel B), and potentially greenwashed investments (Table B.8., Panel C), both in the incentivized decision and using self-reported investments. We first report the coefficient estimates and second the effect size relative to the total effect (direct and indirect). For easier interpretation, we also report the overall combined indirect effect.

First, we propose a mediation model where the relationship between SFL and stock market investments (incentivized and self-reported) is mediated by participants holding an immoral image of the stock market and of stockholders. The mechanisms behind the increase in stock market investments could be that SFL relates to the individual's perception of the stock market and of stockholders. The existing literature already links basic financial literacy to a more positive view of the stock market (Dobni & Racine, 2015, 2016), while a negative image of stockholders (greedy, selfish, gambler-like) is associated with reduced stock market investments (Henkel & Zimpelmann, 2023). Knowledge regarding ESG investments could counteract stock market aversion and help to overcome negative attitudes towards the stock market (Briere & Ramelli, 2021). These considerations align with other findings, showing that personal values significantly influence investment decisions. For example, left-wing voters and those viewing the stock market as unethical display greater stock market aversion and are less inclined to invest (Kaustia & Torstila, 2011; Keller & Siegrist, 2006). Also, strong pro-environmental attitudes are associated with financial disengagement, e.g., being less likely to own stocks (Anderson & Robinson, 2022) and the financial nature of the stock market leads to low interest in stock market investments (Kaur & Vohra, 2012). SFL – particularly knowledge about the non-financial dimension of ESG investments – could counteract the negative image of the stock market and stockholders, thus encouraging broader participation.

The results of the mediation analysis show that SFL has a positive effect on stock market investments. We find significant indirect positive effects of stock market image (both in terms of its wealth creating capacity and its morality) and the image of stockholders. The direct effects dominate the indirect effects both in the incentivized decision and in the self-reported stock market investments (Table B.8., Panel A). This implies that the direct effect of SFL is stronger. The combined indirect effect of both mediators is about 13 percent in incentivized decisions, and about 25 percent in reported stock market investments.

Second, we propose a mediation model where the relationship between SFL and sustainable investments (incentivized and self-reported) is mediated by greenwashing beliefs, i.e., that "green" assets are usually greenwashed, and by the hassle factor, i.e., the belief that sustainable investing is too complex. The potential mechanisms behind this increase in sustainable investments could be that SFL relates to an enhanced

understanding of ESG impact and more accurate risk-return related beliefs, as well as to a reduction in subjective uncertainty and perceived information costs. In the broader context of stock market investments in general, information costs reduce the propensity to own stocks, whereas greater stock market literacy reduces these costs and consequently increases expected returns (Balloch et al., 2015; Campbell, 2006). Additionally, survey studies provide causal evidence that ignorance of one's own stock market-related knowledge is a key determinant of low participation in the stock market (Yoong, 2011). Applying these findings to the field of sustainable investments, we argue that greater SFL might bridge information gaps and reduce information costs, thereby facilitating more informed and easier sustainable investment decisions. This could lead to changes in sustainable investment behavior such as in the amount invested in funds marketed as sustainable.

We find a positive direct effect of SFL on ESG investments in the incentivized decision as well as on self-reported holdings of sustainable investments. While lower greenwashing beliefs display indirect effects on sustainable investments in the incentivized decision and in the self-reported share of sustainable investments (however, only significant at the 0.10 level), the hassle factor relates to lower self-reported sustainable investments. Again, the direct effects dominate the indirect effects, both in the incentivized decision and in the self-reported investments (Table B.8., Panel B). The combined indirect effect of both mediators is about 5 percent in incentivized decisions, and about 12 percent in self-reported sustainable investments.

Third, we propose a mediation model where the relationship between SFL and potentially greenwashed investments (incentivized and self-reported) is mediated by the subjective ability to identify greenwashing, and, again, by greenwashing beliefs. The potential mechanisms behind this decrease in greenwashed investments could be that SFL relates to the ability to differentiate between genuinely sustainable products and those merely masquerading as such, or that it relates with perceptions that sustainable investments constitute greenwashing per se. Heeb et al. (2023) suggest that investors' concern about the impact of their investment is limited and that investors do not differentiate between a weakly and a more strongly sustainable product. Other studies highlight the adverse effects of greenwashing on investment intentions (Gatti et al., 2021) and show that investors are indeed willing to sacrifice returns to avoid greenwashing (Kleffel & Muck, 2023). Survey studies show that socially motivated investors in particular are concerned about greenwashing (Degryse et al., 2023). We conjecture that investors with higher SFL may be less susceptible to greenwashing, since they are aware of the risk of investing in a greenwashed product and can effectively analyze information to ensure that a product aligns with their sustainability preferences. We find significant negative direct effects of SFL on potentially greenwashed investments (Table B.8., Panel C). Indirect effects are only significant for greenwashing beliefs on the steps to avoid greenwashing.

Table B.8. Mediation analyses on the direct and indirect effect of SFL on investment behavior.

Panel A: SFL and stock market investments				
	SMI incentivized		SMI self-reported	
	Coefficient	% of total	Coefficient	% of total
Direct effect				
SFL	0.320***	87.43	0.145***	75.13
Indirect effect				
Image: Immorality	0.029***	7.92	0.023***	11.92
Image: ESG	-0.001	0.27	-0.000	0.00
Image: Wealth creating	0.007*	1.91	0.011**	5.70
Stockholder image	0.011*	3.00	0.015***	7.77
Combined indirect effect	0.047	12.84	0.048	24.87
Total (direct + indirect)	0.366		0.193	
N	1,510		1,510	
Panel B: SFL and sustainable investments				
	SI incentivized		SI self-reported	
	Coefficient	% of total	Coefficient	% of total
Direct effect				
SFL	0.314***	95.73	0.127***	88.19
Indirect effect				
Hassle factor	0.005	1.52	0.014**	9.72
Greenwashing beliefs	0.010*	3.05	0.003^{+}	2.08
Combined indirect effect	0.015	4.57	0.017	11.81
Total (direct + indirect)	0.328		0.144	
N	1,510		1,510	
Panel C: SFL and potentially greenwashed investments				
	GW incentivized		GW self-reported	
	Coefficient	% of total	Coefficient	% of total
Direct effect				
SFL	-0.183***	103.39	-0.159***	89.83
Indirect effect				
Subjective ability to identify greenwashing	0.005	-2.82	-0.028*	15.82
Greenwashing beliefs	0.001	-0.56	0.004	-2.26
Combined indirect effect	0.006	-3.39	-0.024	13.56
Total (direct + indirect)	-0.177		-0.183	
N	1,081		1,081	

Note. Table B.8., Panel A, reports the direct and indirect effects of SFL on stock market investments (incentivized and self-reported). Table B.8., Panel B, reports the effects on investments in sustainably marketed funds, and Panel C the effects on identification of a fund that faced greenwashing allegation. Note that self-reported stock market investments and sustainable investments were transformed to be from 0 to 1 (before: 0 to 4 or 5, in categories). $^{+}p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B.5. Robustness checks

As a robustness check, we exclude all participants from the full sample who did not provide an email address and chose not to accept the incentive (N = 290). Moreover, we exclude participants who answered *I don't know* on all SFL questions (N = 129) or the advanced financial literacy questions (N = 85). We also exclude participants who spend less than 30 seconds on the investment decision (N = 54) or the SFL questions (N = 59). Since in some cases more than one of these exclusion criteria applied, we have a sample of N = 1,057 participants for the robustness check of the relationship between SFL and stock market investments as well as sustainable investments in the investment decision.

We replicate the analyses on stock market investments reported in Table 12 with the reduced sample and find that the estimates of SFL are robust to these specifications (Table B.9, Models (1) to (4)). Testing for coefficient equality of SFL and advanced financial literacy, however, results in no significant differences in Models (3) and (4), with $p > 0.365$ in all tests. We furthermore calculate two step-regression analyses. In the first step, we include advanced financial literacy (Model (1)) and in the second step we add SFL (Model (3)). Results show that Model (1) explains $R^2 = 0.023$ of variance and Model (3) explains $R^2 = 0.038$, which is a significant increase in additional explained variance due to the inclusion of SFL (ΔR^2: $F(1054,1) = 17.46$, $p < 0.001$).

We replicate the analyses on sustainable investments reported in Table 13 with the reduced sample and find that the estimates of SFL are robust to these specifications (Table B.9, Models (5) to (8)). Testing for coefficient equality between SFL and advanced financial literacy results in significant differences in Models (7) and (8) with $p < 0.005$ in all tests. We again calculate two step-regression analyses. In the first step, we include advanced financial literacy (Model (5)) and in the second, we add SFL (Model (7)). We find that Model (5) explains $R^2 = 0.005$ of the variance and Model (7) explains $R^2 = 0.030$, which is a significant increase in additional explained variance due to the inclusion of SFL (ΔR^2: $F(1054,1) = 27.40$, $p < 0.001$).

As a robustness check for the relationship between SFL and potentially greenwashed investments, we use the sample of the robustness check while, as done for the main analyses, excluding all participants who did not invest sustainably in the investment decision (N = 262). Thus, for this robustness check we have a sample of N = 795 participants. Using this reduced sample, we replicate the analyses on potentially greenwashed investment reported in Table 14 and find that the estimates of SFL are robust to these specifications (Table B.9, Models (9) to (12)). Testing for coefficient equality of SFL and advanced financial literacy results in insignificant differences in Models (11) and (12), with p-values of $p = 0.121$ and $p = 0.094$. We again calculate two step-regression analyses. In the first step, we include advanced financial literacy (Model (9)) and in the second, we add SFL (Model (11)). We find that Model (9) explains $R^2 = 0.007$ of the variance and Model (11) explains $R^2 = 0.020$, which is a significant increase in additional explained variance due to the inclusion of SFL (ΔR^2: $F(792,1) = 11.49$, $p < 0.001$).

Table B.9. OLS-regression of stock market investments, sustainable investments, and potentially greenwashed investments on SFL (7 questions).

	Stock market investments				Sustainable investments				Potentially greenwashed investments			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
SFL		0.225***	0.176***	0.106*		0.275***	0.265***	0.239***		-0.187***	-0.165***	-0.137**
		(0.039)	(0.042)	(0.043)		(0.047)	(0.051)	(0.050)		(0.045)	(0.049)	(0.052)
Advanced financial literacy	0.173***		0.117**	0.074*	0.107*		0.022	0.028	-0.100**		-0.050	-0.011
	(0.034)		(0.037)	(0.037)	(0.042)		(0.044)	(0.044)	(0.039)		(0.041)	(0.043)
Female (Ref.: male)				-0.036+				0.010				0.019
				(0.020)				(0.024)				(0.023)
Age in years				0.000				-0.001				-0.001
				(0.001)				(0.001)				(0.001)
University degree (Ref.: no)				-0.004				0.000				-0.008
				(0.025)				(0.029)				(0.028)
High household income				0.010				-0.013				-0.026
				(0.022)				(0.026)				(0.026)
Household income not reported				0.014				0.081*				0.018
				(0.027)				(0.031)				(0.031)

Table B.9. OLS-regression of stock market investments, sustainable investments, and potentially greenwashed investments on SFL (7 questions).

	Stock market investments				Sustainable investments				Potentially greenwashed investments			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Investment experience in years				-0.006				-0.007				-0.011*
				(0.004)				(0.005)				(0.005)
Constant	0.631***	0.634***	0.574***	0.477***	0.434***	0.361***	0.349***	-0.153	0.492***	0.525***	0.550***	0.732***
	(0.027)	(0.024)	(0.030)	(0.098)	(0.033)	(0.029)	(0.036)	(0.115)	(0.031)	(0.028)	(0.035)	(0.115)
Additional	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
N	1057	1057	1057	1057	1057	1057	1057	1057	795	795	795	795
R2	0.023	0.030	0.039	0.123	0.006	0.031	0.031	0.158	0.008	0.021	0.023	0.057
R2 Adj.	0.023	0.029	0.038	0.106	0.005	0.030	0.030	0.142	0.007	0.020	0.020	0.032

Note. This table presents the robustness checks of the hierarchical models regressing stock market investments, sustainable investments, and potentially greenwashed investments on SFL, successively adding control variables. Additional control variables in Models (4), (8) and (12): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B.10. OLS-regression of stock market investments, sustainable investments, and potentially greenwashed investments on SFL (5 questions).

	Stock market investments			Sustainable investments				Potentially greenwashed investments			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
SFL (5 questions)		0.324***	0.251***	0.147***		0.294***	0.271***	0.221***		-0.131***	-0.096**	-0.075+
		(0.029)	(0.033)	(0.034)		(0.032)	(0.036)	(0.037)		(0.032)	(0.036)	(0.038)
Advanced financial literacy	0.243***		0.142***	0.095**	0.155***		0.045	0.053+	-0.107***		-0.071*	-0.034
	(0.026)		(0.029)	(0.029)	(0.029)		(0.032)	(0.032)	(0.028)		(0.031)	(0.033)
Female (Ref.: male)				-0.036*				0.025				0.002
				(0.018)				(0.020)				(0.020)
Age in years				0.000				-0.001*				-0.001
				(0.001)				(0.001)				(0.001)
University degree (Ref.: no)				-0.013				-0.022				-0.027
				(0.024)				(0.026)				(0.026)
High household income				0.005				-0.009				-0.021
				(0.020)				(0.022)				(0.023)
Household income not reported				-0.022				0.026				0.006

Table B.10. OLS-regression of stock market investments, sustainable investments, and potentially greenwashed investments on SFL (5 questions).

	Stock market investments			Sustainable investments				Potentially greenwashed investments				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
				(0.023)				(0.025)				(0.026)
Investment experience in years				-0.006				-0.004				-0.008+
				(0.004)				(0.004)				(0.004)
Constant	0.548***	0.557***	0.498***	0.462***	0.378***	0.343***	0.324***	-0.073	0.508***	0.501***	0.532***	0.690***
	(0.019)	(0.016)	(0.020)	(0.081)	(0.021)	(0.018)	(0.022)	(0.089)	(0.021)	(0.019)	(0.023)	(0.092)
Additional	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
N	1510	1510	1510	1510	1510	1510	1510	1510	1081	1081	1081	1081
R2	0.054	0.074	0.089	0.182	0.019	0.053	0.054	0.159	0.013	0.015	0.020	0.043
R2 Adj.	0.053	0.074	0.088	0.171	0.018	0.052	0.053	0.147	0.012	0.014	0.018	0.025

Note. This table presents the robustness checks of the hierarchical models regressing stock market investments, sustainable investments, and potentially greenwashed investments on the 5-question SFL inventory, successively adding control variables. Additional control variables in Models (4), (8) and (12): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B.11. OLS-regression of stock market investments, sustainable investments, and potentially greenwashed investments on SFL (7 questions) by gender.

	Stock market investments			Sustainable investments			Potentially greenwashed investments		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Full sample	Male	Female	Full sample	Male	Female	Full sample	Male	Female
SFL	0.187***	0.140**	0.232***	0.251***	0.274***	0.235***	-0.134**	-0.138*	-0.124*
	(0.035)	(0.050)	(0.050)	(0.039)	(0.057)	(0.052)	(0.041)	(0.059)	(0.057)
Advanced financial literacy	0.084**	0.124**	0.052	0.045	-0.038	0.111*	-0.018	-0.040	0.008
	(0.030)	(0.043)	(0.041)	(0.032)	(0.049)	(0.043)	(0.033)	(0.048)	(0.046)
Female (Ref.: male)	-0.037*			0.021			0.002		
	(0.018)			(0.020)			(0.020)		
Age in years	0.000	-0.001	0.001	-0.001*	-0.002*	0.000	-0.001	0.001	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
University degree (Ref.: no)	-0.013	-0.027	-0.006	-0.021	-0.010	-0.039	-0.025	0.016	-0.080*
	(0.024)	(0.033)	(0.035)	(0.026)	(0.038)	(0.036)	(0.026)	(0.036)	(0.037)
High household income	0.006	-0.011	0.023	-0.007	-0.013	-0.009	-0.023	-0.033	-0.003
	(0.020)	(0.027)	(0.031)	(0.022)	(0.031)	(0.032)	(0.023)	(0.030)	(0.034)
Household income not reported	-0.016	-0.019	-0.012	0.033	-0.025	0.069*	0.000	0.010	-0.002
	(0.023)	(0.034)	(0.032)	(0.025)	(0.039)	(0.033)	(0.026)	(0.040)	(0.035)
Investment experience in years	-0.006	-0.006	-0.005	-0.004	0.001	-0.008	-0.008+	-0.009	-0.008
	(0.004)	(0.005)	(0.006)	(0.004)	(0.006)	(0.006)	(0.004)	(0.006)	(0.006)
Constant	0.462***	0.442***	0.481***	-0.067	0.013	-0.076	0.698***	0.674***	0.663***
	(0.081)	(0.108)	(0.120)	(0.088)	(0.123)	(0.125)	(0.091)	(0.127)	(0.130)
Additional controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
N	1510	737	773	1510	737	773	1081	520	561

Table B.11. OLS-regression of stock market investments, sustainable investments, and potentially greenwashed investments on SFL (7 questions) by gender.

	Stock market investments			Sustainable investments			Potentially greenwashed investments		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Full sample	Male	Female	Full sample	Male	Female	Full sample	Male	Female
R2	0.186	0.163	0.203	0.162	0.147	0.217	0.050	0.059	0.082
R2 Adj.	0.175	0.140	0.183	0.150	0.124	0.197	0.032	0.023	0.050

Note. This table presents the main analyses from Table 12, Table 13 and Table 14, regressing stock market investments, sustainable investments, and potentially greenwashed investments on SFL, separated by gender. Additional control variables in all models: Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B.6. Robustness check: Financial market participants vs. non-participants

We re-estimate the models from Tables 12 through 14, separating the sample into financial market participants (N = 654) and non-financial market participants (N = 856) and therefore excluding investment experience as a control variable in the second subsample.

Within the sample of financial market participants, we find similar relationships between SFL and stock market investments as in the full sample (Table 12). The estimates for SFL are lower but remain significant for all models in Table B.12 except for Model (4), with coefficients of about 0.10 on average, i.e., about 10 percentage points higher financial market investments. As before, the two-step regression analysis shows that with the introduction of SFL as a predictor, the total variance explained in stock market investments significantly increases (ΔR^2: $F(651,1) = 11.377$, $p < 0.001$). The Wald test for coefficient equality shows that the estimates of SFL are higher in Model (3) ($p = 0.030$) but not significantly different in Model (4) ($p > 0.306$).

With the sample of non-financial market participants (N = 856), without experience as a predictor variable, we find similar coefficients as in the main model on stock market investments (Table 12). Two-step regressions show an increase in variance explained with the introduction of SFL (ΔR^2: $F(853,1) = 39.597$, $p < 0.001$). The Wald tests show that the estimates for SFL are slightly higher than those for advanced financial literacy (Model (7): $p = 0.043$, Model (8): $p = 0.105$).

Also, using the subsample of financial market participants, the estimate for SFL and sustainable investments is similar as in the full sample (Table 13), with an increase of about 23 percentage points in sustainable investments across all models given high SFL (Table B.13). The estimates for advanced financial literacy are insignificant. Two-step regressions show an increase in total variance explained with the introduction of SFL (ΔR^2: $F(651,1) = 13.539$, $p < 0.001$). Wald tests show that the coefficients of advanced financial literacy are lower across Models (3) and (4) (all $p < 0.02$).

With the sample of non-financial market participants (N = 856), without experience as a predictor variable, we find similar coefficients as in the main model on sustainable investments. Two-step regressions show an increase in total variance explained with the introduction of SFL (ΔR^2: $F(853,1) = 48.491$, $p < 0.001$). The Wald tests show that the coefficient estimates for SFL are higher than those for advanced financial literacy (Models (7) to (8) $p < 0.01$).

Among financial market participants, again excluding those who have not invested sustainably in the investment decision (Table B.14.; N = 511), we find that the estimates of the effect of SFL on potentially greenwashed investments are only significantly negative in Model (2) and not in Models (3) and (4). Two-step regressions show no increase in variance explained with the introduction of SFL (ΔR^2: $F(508,1) = 0.9148$, $p = 0.333$). We find no difference between the effect sizes of SFL and advanced financial literacy (all $p > 0.55$).

With the sample of non-financial market participants who have invested sustainably in the incentivized decision (N = 570), without experience as a predictor variable, we find similar coefficients as in the main model on potentially greenwashed investments (Table 14). Two-step regressions show an increase in total variance explained with the introduction of SFL (ΔR^2: $F(567,1) = 18.524$, $p < 0.001$). The Wald tests show that the estimates for SFL are higher than those for advanced financial literacy (Models (7) and (8) $p < 0.01$).

Table B.12. OLS-regression of stock market investments on SFL by financial market investments.

	Financial market participants				Non-participants			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SFL		0.161***	0.159***	0.071		0.391***	0.308***	0.236***
		(0.044)	(0.047)	(0.049)		(0.044)	(0.049)	(0.050)
Advanced financial literacy	0.052		0.003	-0.002	0.270***		0.152***	0.112**
	(0.037)		(0.039)	(0.040)	(0.037)		(0.041)	(0.042)
Female (Ref.: male)				-0.037				-0.041
				(0.024)				(0.026)
Age in years				0.0002				-0.0003
				(0.0008)				(0.0008)
University degree (Ref.: no)				-0.032				0.022
				(0.027)				(0.040)
High household income				0.037				-0.028
				(0.024)				(0.033)
Household income not reported				0.011				-0.016
				(0.031)				(0.033)
Investment experience in years				-0.012*				
				(0.005)				
Contant	0.766***	0.713***	0.711***	0.682***	0.479***	0.470***	0.417***	0.372***
	(0.030)	(0.028)	(0.034)	(0.109)	(0.025)	(0.022)	(0.026)	(0.116)
Additional controls	NO	NO	NO	YES	NO	NO	NO	YES
N	654	654	654	654	856	856	856	856
R2	0.003	0.020	0.020	0.122	0.057	0.085	0.099	0.179

Table B.12. OLS-regression of stock market investments on SFL by financial market investments.

	Financial market participants				Non-participants			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R2 adj.	0.002	0.019	0.017	0.094	0.056	0.084	0.097	0.160

Note. This table presents the results of hierarchical models regressing stock market investments on SFL, successively adding control variables and splitting the sample into financial market participants and non-participants. Additional control variables in Models (4) and (8): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B.13. OLS-regression of sustainable investments on SFL by reported financial market investments.

	Financial market participants				Non-participants			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SFL		0.219***	0.226***	0.220***		0.378***	0.349***	0.258***
		(0.057)	(0.061)	(0.064)		(0.045)	(0.050)	(0.050)
Advanced financial literacy	0.055		-0.014	-0.008	0.187***		0.054	0.060
	(0.048)		(0.051)	(0.052)	(0.039)		(0.042)	(0.042)
Female (Ref.: male)				0.018				0.026
				(0.031)				(0.026)
Age in years				-0.0007				-0.002*
				(0.001)				(0.0008)
University degree (Ref.: no)				-0.021				-0.010
				(0.035)				(0.040)
High household income				0.010				-0.030
				(0.031)				(0.033)
Household income not reported				0.044				0.035
				(0.041)				(0.033)
Investment experience in years				-0.002				
				(0.007)				
Contant	0.477***	0.393***	0.400***	0.092	0.342***	0.291***	0.272***	-0.146
	(0.039)	(0.036)	(0.044)	(0.141)	(0.026)	(0.023)	(0.027)	(0.116)
Additional controls	NO	NO	NO	YES	NO	NO	NO	YES
N	654	654	654	654	856	856	856	856
R2	0.002	0.022	0.022	0.121	0.027	0.077	0.079	0.195

Table B.13. OLS-regression of sustainable investments on SFL by reported financial market investments.

	Financial market participants				Non-participants			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R2 adj.	0.0005	0.021	0.019	0.093	0.026	0.076	0.077	0.177

Note. This table presents the results of hierarchical models regressing sustainable investments on SFL, successively adding control variables and splitting the sample into financial market participants and non-participants. Additional control variables in Models (4) and (8): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table B.14. OLS-regression of potentially greenwashed investments on SFL by reported financial market investments.

	Financial market participants				Non-participants			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SFL		-0.109*	-0.056	-0.047		-0.227***	-0.222***	-0.221***
		(0.054)	(0.059)	(0.064)		(0.046)	(0.052)	(0.054)
Advanced financial literacy	-0.125**		-0.108*	-0.068	-0.089*		-0.009	0.022
	(0.043)		(0.046)	(0.050)	(0.039)		(0.043)	(0.045)
Female (Ref.: male)				-0.009				0.026
				(0.030)				(0.027)
Age in years				-0.0006				-0.0004
				(0.001)				(0.0008)
University degree (Ref.: no)				-0.010				-0.056
				(0.034)				(0.041)
High household income				-0.035				-0.017
				(0.030)				(0.036)
Household income not reported				-0.025				0.018
				(0.039)				(0.036)
Investment experience in years				-0.015*				
				(0.007)				
Contant	0.519***	0.489***	0.540***	0.714***	0.500***	0.552***	0.555***	0.670***
	(0.035)	(0.035)	(0.041)	(0.135)	(0.027)	(0.025)	(0.030)	(0.127)
Additional controls	NO	NO	NO	YES	NO	NO	NO	YES
N	511	511	511	511	570	570	570	570
R2	0.017	0.008	0.018	0.059	0.009	0.040	0.040	0.075

Table B.14. OLS-regression of potentially greenwashed investments on SFL by reported financial market investments.

	Financial market participants				Non-participants			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R2 adj.	0.015	0.006	0.015	0.020	0.007	0.039	0.037	0.043

Note. This table presents the results of hierarchical models regressing potentially greenwashed investments on SFL, successively adding control variables and splitting the sample into financial market participants and non-participants. Additional control variables in Models (4) and (8): Stockholder image, stock market image: immorality, stock market image: wealth creating capacity, stock market image: ESG image, hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B.7. External validity: Self-reported investment behavior

The results of ordered probit regressions in Table B.15 show that SFL relates to more self-reported financial market investments in Models (2) and (3), while the estimates are not significant in Model (4). Estimates for advanced financial literacy are significant in Models (1) and (3) and also turn nonsignificant when adding more control variables. Among those, particularly investment experience and perceived wealth creating capacity are strong predictors. The odds for being in a higher category of holding stock market products (1 = *1 to 24%,* 2 = *25 to 50%*, 3 = *51 to 75%*, 4 = *76 to 99%*, 5 = *100%*) are 4.15 times higher with high SFL in Model (3) and 1.03 times higher in Model (4). The odds ratios for advanced financial literacy are 3.20 in Model (3) and 1.24 in Model (4). The Wald tests for coefficient equality indicate no significant differences between SFL and advanced financial literacy (all Wald-tests $p > 0.43$). Stock market investments in the incentivized decision and self-reported financial market investments are correlated ($r_s = 0.25$, $p < 0.001$).

With greater SFL, participants report owning a larger share of sustainable investments across Models (6) to (8) in Table B.15. Estimates for advanced financial literacy are significant in Models (5) and (7). The odds for being in a higher category of holding sustainable investments (1 = *0% - I do not own sustainable assets*, 2 = *1 to 24%*, 3 = *51 – 75%*, 4 = *76 – 99%*, 5 = *100% - I only own sustainable assets*) are 6.90 times higher with high SFL in Model (7) and 2.48 times higher in Model (8). The odds ratios for advanced financial literacy are 1.58 in Model (7) and 0.83 in Model (8). The Wald tests for coefficient equality indicate that the estimates of SFL are higher (all Wald-test $p < 0.001$) than those for advanced financial literacy across all relevant models (Models (5) to (8). Sustainable investments in the incentivized decision and self-reported ownership of sustainable investments are correlated ($r_s = 0.18$, $p < 0.001$).

With greater SFL, participants are less likely to forgo seeking additional information to ensure the sustainability promises of an ESG investment are true and greenwashing is avoided, as shown in Table B.15 ($N = 464$, as only participants who own sustainable investments are included, in line with the Models in Table 14). The estimates of SFL are significant across all models, while those of advanced financial literacy are only significant when it is included as the single predictor in Model (1). The odds for being in a higher category of less information seeking (1 = *always*, 5 = *never* (reversed)) are lower (odds ratio Model (11) = 0.41, odds ratio Model (12) = 0.41) with high SFL. The odds ratios for advanced financial literacy are 0.67 in Model (11) and 0.86 in Model (12). The Wald tests for coefficient equality indicate no significant differences between SFL and advanced financial literacy (all $p > 0.23$).

Table B.15. POLR-regression of self-reported financial market investments, sustainable investments, and greenwashed investment on SFL (7 questions).

	Financial market investments				Sustainable investments				Greenwashed investment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
SFL		2.001***	1.423***	0.028		2.169***	1.931***	0.910***		-1.120**	-0.900*	-0.885*
		(0.191)	(0.211)	(0.249)		(0.218)	(0.241)	(0.275)		(0.341)	(0.378)	(0.420)
Advanced FL	1.695***		1.163***	0.211	1.170***		0.459*	-0.191	-0.718**		-0.406	-0.150
	(0.168)		(0.184)	(0.214)	(0.180)		(0.199)	(0.229)	(0.270)		(0.301)	(0.327)
Female (Ref.: male)				-0.146				0.078				-0.118
				(0.126)				(0.136)				(0.189)
Age in years				-0.014***				-0.017***				-0.009
				(0.004)				(0.004)				(0.006)
University degree (Ref.: no)				0.115				0.019				0.150
				(0.153)				(0.164)				(0.219)
High household income				0.195				0.334*				-0.048
				(0.133)				(0.143)				(0.193)
Household income not reported				-0.029				0.042				-0.163
				(0.164)				(0.178)				(0.262)
Investment experience				0.476***				0.348***				-0.003
				(0.027)				(0.028)				(0.046)

Table B.15. POLR-regression of self-reported financial market investments, sustainable investments, and greenwashed investment on SFL (7 questions).

	Financial market investments				Sustainable investments				Greenwashed investment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Stockholder image				-0.134**				-0.033				-0.046
				(0.051)				(0.056)				(0.079)
Image: Immorality				-0.035				0.102*				-0.143*
				(0.046)				(0.051)				(0.071)
Image: Wealth creating				-0.157***				-0.017				-0.006
				(0.046)				(0.049)				(0.071)
Image: ESG				-0.078+				-0.172***				-0.053
				(0.045)				(0.048)				(0.073)
Additional	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES
N	1510	1510	1510	1510	1510	1510	1510	1510	464	464	464	464
Nagelkerke pseudo R2	0.08	0.08	0.11	0.48	0.04	0.08	0.09	0.31	0.02	0.03	0.03	0.12

Note. This table presents the robustness checks of the hierarchical ordered probit models regressing stock market investments, sustainable investments, and greenwashed investment identification on SFL, successively adding control variables. Additional control variables in Models (4), (8) and (12): Hassle factor, greenwashing beliefs, biospheric values, altruistic values, risk taking, patience, general trust, left wing views. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix B.8. Revised investment decisions (Study 2)

This section explores changes in participants' investment decisions after they have learnt about the greenwashing allegations against one fund. Overall, 734 (67.90%) of the participants that invested in the sustainably marketed funds (N = 1,081) did not change their investment at all, and 776 (71.79%) did not change their investment in the allegedly greenwashed Fund C in the revised investment decision.

Table B.16. Initial investment decision and differences in the revised investment decision.

	N	*M*	*SD*	⊿	*p*-value
All participants with ESG investments					
Stock market investments	1,081	83.1%	19.7%	-1.2pp	< 0.001
Sustainable investments	1,081	67.2%	26.4%	-2.2pp	< 0.001
Potentially greenwashed investment	1,081	43.5%	30.3%	-11.41pp	< 0.001
Investment Fund A	1,081	€70.20	€77.10	€2.47	0.054
Investment Fund B	1,081	€68.22	€78.92	€1.80	0.064
Investment Fund C	1,081	€116.21	€106.28	-€33.98	< 0.001
Investment Fund D	1,081	€161.06	€131.53	€23.83	< 0.001
Investment Savings Account	1,081	€84.30	€98.64	€5.88	< 0.001
Participants with changes in revision					
Stock market investments	347	83.4%	19.0%	-3.7pp	< 0.001
Sustainable investments	347	71.9%	25.3%	-6.9pp	< 0.001
Potentially greenwashed investment	347	52.4%	28.8%	-35.6pp	< 0.001
Investment Fund A	347	€62.01	€73.56	€7.70	0.054
Investment Fund B	347	€57.67	€74.85	€5.61	0.064
Investment Fund C	347	€151.79	€110.29	-€105.86	< 0.001
Investment Fund D	347	€145.34	€113.38	€74.22	< 0.001
Investment Savings Account	347	€83.13	€94.99	€18.32	< 0.001

Note. This table presents the initial investments of all participants who invested in the sustainably marketed funds and those who adapted their investment decision in the revised decision. N = number of observations, M = mean of the initial investment decision, SD = standard deviation of the initial investment decision, ⊿ = difference to initial investment. The p-values are those of paired U-tests. Percentages of the outcome variables on investments do not always perfectly align with the values in euros as the percentages exclude divisions by zero.

The majority of the participants who revised their decision (78.54%) had previously invested in the potentially greenwashed fund. Considering those participants who changed their initial investment in the revised investment decision, we find that both stock market investments (-3.7 percentage points) and sustainable investments (-6.9 percentage points) are significantly lower after learning about greenwashing allegations regarding Fund C (initial investments, differences in the revised investment decision, and test statistics are reported in Table B.16). Namely, participants reduce their investments in the potentially greenwashed Fund C by 105.86 euros, a reduction of 69.74% compared to the initial investment in this fund. In turn, investments in the sustainable Fund D increase by 74.22 euros, an increase of 51.07%

compared to the initial investment in this fund, as do allocations to the savings account (18.32 euros or 22.04%). Investments in the conventional Funds A and B do not change materially.

We analyze the determinants (Table B.17. in the Appendix) of changing the investment in the potentially greenwashed fund. OLS regression Models (1) and (2) use the amount of the reduction (i.e., the difference in Fund C investment between the initial and the revised decisions) as outcome the variable; logit regression Model (3) uses a binary indicator of whether the investment in Fund C was reduced. The results show having invested in the potentially greenwashed fund is the strongest predictor of the decision to revise the investment. Also, sustainable investing for an ESG reason, e.g., impact on ESG factors rather than financial returns, is a strong predictor for reduced potentially greenwashed investments. Financial reasons were stated by 66.49% of participants, and non-financial reasons by 33.51%. Among those who invested sustainably in the incentivized decision, these percentages amount to 61.89% and 38.11%, respectively.

Table B.17. Reasons for reducing potentially greenwashed investment.

	Difference in Fund C		Fund C reduced (binary)
	(1)	(2)	(3)
Stock market investments: initial		-49.527***	-0.656
		(12.020)	(0.431)
Sustainable investments: initial		-86.297***	-1.190***
		(9.514)	(0.334)
Potentially greenwashed investments: initial		-124.822***	-2.937***
		(7.669)	(0.286)
SFL	10.002	0.726	-0.678+
	(11.653)	(10.233)	(0.357)
Advanced financial literacy	-10.630	-7.638	-0.599*
	(9.401)	(8.216)	(0.290)
ESG reason	-22.332***	-13.131**	-0.575***
	(5.667)	(5.081)	(0.171)
Female (Ref.: male)	2.130	1.169	0.058
	(5.692)	(4.982)	(0.172)
Age in years	0.109	0.119	0.006
	(0.176)	(0.154)	(0.005)
University degree (Ref.: no)	2.681	-0.378	-0.115
	(7.444)	(6.494)	(0.216)
High household income	-9.309	-10.150+	-0.311
	(6.498)	(5.672)	(0.195)
Household income not reported	2.105	5.318	-0.152
	(7.459)	(6.517)	(0.222)
Investment experience in years	0.677	-0.406	0.041

Table B.17. Reasons for reducing potentially greenwashed investment

	Difference in Fund C		Fund C reduced (binary)
	(1)	(2)	(3)
	(1.215)	(1.061)	(0.037)
Stockholder image	-0.078	1.166	-0.036
	(2.460)	(2.148)	(0.075)
Stock market image: Immorality	-0.779	-1.020	-0.031
	(2.212)	(1.929)	(0.067)
Stock market image: Wealth creating	-0.956	-1.961	-0.122+
	(2.180)	(1.908)	(0.066)
Stock market image: ESG	1.483	0.785	0.062
	(2.128)	(1.863)	(0.064)
Hassle factor	-2.789	-2.958+	-0.097
	(2.030)	(1.770)	(0.062)
Greenwashing beliefs	0.200	-1.338	0.024
	(2.493)	(2.177)	(0.075)
Biospheric Values	-2.229	-0.334	-0.024
	(3.172)	(2.783)	(0.102)
Altruistic Values	-1.951	-4.762+	-0.263**
	(3.056)	(2.673)	(0.099)
Risk taking	1.712	2.159	0.011
	(2.241)	(1.979)	(0.069)
Patience	-4.565+	-3.062	-0.111
	(2.479)	(2.164)	(0.077)
General trust	-0.604	0.717	0.018
	(1.903)	(1.680)	(0.057)
Left wing views	-4.852*	-2.612	-0.077
	(2.257)	(1.984)	(0.070)
Constant	63.633*	204.051***	8.296***
	(26.328)	(25.618)	(0.962)
N	1081	1081	1081
R2	0.045	0.276	
R2 adj.	0.026	0.259	

Note. This table presents the determinants of the absolute difference in the revision of the investment decision (Models (1) and (2)) as well as a binary outcome variable whether the investment was revised (Model (3)) after learning about greenwashing allegations regarding Fund C. Standard errors are shown in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Appendix C. Questionnaire Study 1 (translated from German)

PAGE	TEXT (Particpants' View)	Scale
Welcome	Dear Sir or Madam, in this questionnaire, we, the [name of the institute] are interested in the topic of financial investments. The participation takes about 12 minutes. By conscientiously and completely filling in the questionnaire, you are making a significant contribution to our scientific research! Thank you very much for your support. [names and contact of authors]	
Data protection	Data protection Your rights and information on data protection - The security of your data is important to us! By confirming the stated conditions at the bottom of this page, you can proceed to the questionnaire. [Data protection agreement] I hereby confirm that I agree and consent to the above conditions.	
	Filter for quota	
	Before you begin, three quick questions about yourself.	
Gender *[gender]*	Which gender do you feel you belong to? 1. Male 2. Female 3. Non-binary, transgender, other	
Age *[age]*	Please indicate your age in years: [open answer format from 14 to 100 years]	*[below 18y will be excluded]*
	Self-rated (Sustainable) Financial Knowledge	
Self-rated basic *[subjective_basic_FL]*	How much do you think you know about the following topics compared to the Austrian population? Money matters	Similiar to Riitsalu 2019; (1 = very low, 7 = very high)
Self-rated advanced FL *[subjective_advanced_FL]*	Investments and the stock market	Similar to Gutsche 2020 and Dobni 2015; (1 = very low, 7 = very high)
Self-rated SFL *[subjective_SFL]*	Sustainable investments	Similiar to Brunen 2022 Gutsche 2020; (1 = very low, 7 = very high)
Self-rated sustainability literacy *[subjective_SL]*	Environmental and sustainability issues	(1 = very low, 7 = very high)
	Sustainable Finance Literacy [randomized question order]	
Sustainable Finance Literacy	Please indicate how likely it is that these statements are incorrect or correct. [30 questions; for all questions see Table A.2. in Appendix A.1. Additionally, one attention check is included (*Please select "definitely correct" here. This is a test question*)]	1 = definitely wrong, 2 = somewhat wrong, 3 = undecided, 4 = somewhat correct,

		5 = definitely correct, 6 = I don't know
	Financial Literacy [randomized question order]	[Big Three]
Basic Fin. Literacy *[FL_basic]*	Now we are interested in your financial knowledge.	
Compound interest *[FL_b_compound_interest]*	Suppose you had 100 € in a savings account, the interest rate was 2 percent per year, and you leave the money in this account for 5 years. How much do you think you would have in the account after 5 years: 1. More than 110 EUR 2. <u>Exactly 110 EUR</u> 3. Less than 110 EUR 4. I don't know	Lusardi 2008 Q1, Also in van Rooij Q2; OECD 2022 QK6
Real interest rate *[FL_b_real_interest]*	Imagine that the interest rate on your savings account was 1 percent per year and inflation was 2 percent per year. How much could you buy with the money in your account after one year? (Assuming you do not have to pay an account maintenance charge) 1. More than today, 2. Exactly the same as today or 3. <u>Less than today</u> 4. I don't know	Lusardi 2008 Q2, Also in van Rooij Q3; Fessler 2020
Risk *[FL_b_risk]*	Do you agree with the following statement: "Buying a single company stock usually provides a safer return than investing in a fund with shares of similar companies"? 1. I agree 2. <u>I disagree</u> 3. I don't know	Lusardi 2008 Q3
	Advanced FL / Stock market literacy [randomized question order]	[three highest loading factors of advanced lit in van Rooij 2011]
Advanced Fin. Literacy *[FL_advanced]*	Next, we are interested in your knowledge of the stock market.	
Stock market *[FL_a_stock_market]*	Which of the following statements describes the main function of the stock market? 1. The stock market helps to predict stock earnings. 2. The stock market results in an increase in the price of stocks. 3. <u>The stock market brings people who want to buy stocks together with those who want to sell stocks.</u> 4. I don't know	Van Rooij adv. Q6; also used in Balloch 2015 Q1;
Mutual funds *[FL_a_mutual_funds]*	Which of the following statements is correct? 1. Once one invests in a mutual fund, one cannot withdraw the money in the first year. 2. <u>Mutual funds can invest in several assets, for example invest in both stocks and bonds.</u> 3. Mutual funds pay a guaranteed rate of return which depends on their past performance. 4. None of the above 5. I don't know	Van Rooij adv. Q8; also used in Balloch 2015 Q9;

Value volatility *[FL_a_volatility]*	Normally, which asset displays the highest fluctuations over time? 1. Savings accounts 2. Bonds 3. Stocks 4. I don't know	Van Rooij adv. Q11; Also used in Balloch 2015 Q4;
	Sustainability literacy [randomized question order]	
Sustainability literacy *[sust_literacy]*	Now we are interested in your knowledge about sustainability.	
Climate change *[SL_clim_change]*	Is the following statement true or false: „Climate change is mainly caused by natural processes and not by human activities." 1. True 2. False 3. I don't know	
Sustainable Development goals *[SL_SDGs]*	Which of the following topics are part of the United Nations Sustainable Development Goals (SDGs)? Multiple answers possible. 1. Good Health and Well-Being 2. Climate Action 3. Partnerships for the Goals 4. I don't know	Filippini 2024
Definition Sustainability *[SL_sustainability]*	In your opinion, which of the following definitions best describes sustainable development? 1. Ensuring universal access to education, health and social services. 2. Constant economic growth while simultaneously minimising the impacts on climate change. 3. Meeting today's needs without compromising future generations. 4. I don't know	Filippini 2024; Zwickle 2013
	Financial Attitudes	
	Please indicate to what extent you agree with the following statements.	
Hassle factor *[hassle_inv]*	Investing in the stock market is complicated and I have to spend a lot of time and effort into it.	1=do not agree at all, 7=agree completely
Hassle factor sustainable *[hassle_sust]*	Investing in sustainable ESG products is complicated and I have to spend a lot of time and effort into it.	1=do not agree at all, 7=agree completely
Attention check 3 *[attention_check_3]*	Please select "strongly disagree" here. This is a test question.	
	Investments	
Current assets *[assets_overall_current]*	Please indicate in which of the following forms of investment you currently have your money invested. *Please select all applicable answers.* 1. Savings book 2. Current account or savings account 3. Building society contract 4. Cash 5. Savings plan 6. Funds (e.g., funds with stocks and/or bonds, including ETFs or index funds) 7. Individual shares	Gutsche 2020; Similar to OECD 2022 QF3 [MC, recode as 1 = yes, 0 = no]

	8. Bonds 9. Cryptocurrencies 10. Retirement provision, such as life insurance or pension insurance 11. Other investments, e.g. gold, property 12. None of the listed forms of investment	
Percent sustainable investments *[assets_sust_perc]*	What is the current percentage of sustainable stock, bonds, and funds (i.e., financial products that take into account Environmental, Social, or Governance factors) in your total amount stocks, bonds and funds? 0. 0% - I do not own sustainable assets. 1. 1 to 24% 2. 25 to 50% 3. 51 to 75% 4. 76 to 99% 5. 100% - I only own sustainable assets. 6. I don't know	Gutsche 2020, similar in Brunen 2022
Sustainable investments *[assets_sustaianble]* *[only if previous questions is answered with more than 0%]*	Please indicate in which of the following sustainable forms of investment you currently have your money invested. *Please select all applicable answers.* 1. Sustainable savings book 2. Sustainable current account or savings account 3. Sustainable savings plan 4. Sustainable funds (e.g., funds with sustainable shares and sustainable bonds, incl. sustainable ETFs or index funds) 5. Sustainable shares 6. Sustainable bonds 7. Sustainable retirement provision, such as life insurance or pension insurance 8. None of the listed forms of investment	
Experience *[experience]*	For how many years have you had experience as an investor with stocks, funds, bonds, etc.? 0. I do not have any experience. 1. Less than one year 2. 1 to 2 years 3. 3 to 4 years 4. 5 to 6 years 5. 7 to 8 years 6. 9 to 10 years 7. More than 11 years	
	Environmental attitudes and behavior	
	Please indicate to what extent you agree with the following statements.	
Sustainable lifestyle *[sust_lifestyle]*	I lead a predominantly sustainable lifestyle in my everyday life	Derived based on Stern 1999; van der Werff 2013.; 1=do not agree at all, 7=agree completely
Climate awareness *[climate_awarenes s]*	Climate change is a serious problem that needs to be solved.	Heeb et al. (2023) 1=do not agree at all, 7=agree completely
	Sociodemographic variables	
	Finally, we would like to ask you to answer a few questions about yourself:	

Education *[education]*	Please indicate your highest level of education completed: 1. Primary/secondary degree 2. Vocational training 3. BMS – College for intermediate vocational eduation 4. BHS – College for higher vocational education (A-levels) 5. AHS – Academic secondary school (A-levels) 6. University (or university of applied sciences) 7. Doctorate, habilitation 8. Other 9. Prefer not to answer	
Economic education *[education_economics]*	How high was the proportion of your education that was dedicated to economics and finance compared to the population in Austria?	Van Rooij 2011; (1 = very low, 5 = very high)
Professional experience *[prof_experience]*	Are you, or have you ever been professionally involved with investments? 1. Yes 2. No	
Household income *[hh_income]*	Please provide the monthly net household income of all persons currently living permanently in your household: (Household income is the sum of the income of all persons living together in a household and can be made up of various sources of income. Please refer to the current net monthly amount, e.g., after deduction of taxes and social security contributions, and add regular payments such as pensions, unemployment benefits, housing allowances, child support, alimony, etc. If you are not sure, please estimate the monthly amount). 1. below 1.000 euros 2. 1,001 euros bis 2,000 euros 3. 2,001 euros bis 3,000 euros 4. 3,001 euros bis 4,000 euros 5. 4,001 euros bis 5,000 euros 6. 5,001 euros bis 6,000 euros 7. 6,001 euros bis 7,000 euros 8. 7,001 euros bis 8,000 euros 9. 8,001 euros or more 10. Prefer not to answer	Gutsche (2020)
	End of Survey	
Comment	Anything else you would like to share with us in closing? [open answer format, text]	
Thanks	Thank you very much for your participation! Your contribution helps us a lot. The questionnaire is now closed, you can now close this window. [contact of authors]	

Appendix D. Questionnaire Study 2 (translated from German)

PAGE	TEXT (Particpants' View)	Scale
Welcome	Dear Sir or Madam, in this questionnaire, we, [name of the institute], are interested in the topic of financial investments. The participation takes about 10 minutes. As part of the study, you have the opportunity to allocate 500 euros to various investment products. Among all participants, 5 will be randomly selected and their investment decision will be financed and realized out by us. These 5 persons will be paid the value of the investment after one year. The winners will be informed in about two weeks by email. By conscientiously and completely filling out the questionnaire, you are making a significant contribution to our scientific research! Thank you very much for your support. [names and contact of authors]	
	Data protection	
Data protection	Your rights and information on data protection - The security of your data is important to us! By confirming the stated conditions at the bottom of this page, you can proceed to the questionnaire. [data protection agreement] I hereby confirm that I agree and consent to the above conditions.	
	Filter for quota	
	Before you begin, three quick questions about yourself.	
Gender *[gender]*	Which gender do you feel you belong to? 1. Male 2. Female 3. Non-binary, transgender, other	
Age *[age]*	Please indicate your age in years: [open answer format from 14 to 100 years]	*[below 18y will be excluded]*
Education *[education]*	Please indicate your highest level of education completed: 1. Primary/secondary degree 2. Vocational training 3. BMS – College for intermediate vocational education 4. BHS – College for higher vocational education (A-levels) 5. AHS – Academic secondary school (A-levels) 6. University (or university of applied sciences) 7. Doctorate, habilitation 8. Other 9. Prefer not to answer	
	Investment Decision	
Investment decision *[investment_decision]*	Please imagine the following situation. You are at an investment consultation at your bank because you want to invest 500 euros for one year. Your bank advisor presents you with four funds and one savings account, to which you can allocate your money. The descriptions shown are based on real investment products. [*funds shown in random order*]	Instructions adapted from Gutsche 2023 and Seifert 2024

Fund	Fund A	Fund B	Fund C	Fund D	Savings account
Short description	This fund invests in equity and equity-related securities of small and mid-cap companies in the energy sector and seeks capital growth.	This fund invests in companies in the oil & gas, service, power, gas, and other sectors of the energy industry.	This fund invests in companies through which investors make targeted investments to achieve climate goals and help counteract climate change through targeted investing.	This fund invests in companies that seek to reduce energy-related greenhouse gases and/or are sustainable according to ESG criteria.	This savings account offers the opportunity to invest money for one year tied at a fixed rate of interest.
Sustainability-related disclosure according to SFDR	Article 6 - Fund without consideration of sustainability criteria	Article 6 - Fund without consideration of sustainability criteria	Article 8 - Fund that promotes environmental or social characteristics	Article 9 - Fund that has a sustainable investment objective	-
Sustainability label	none	none	none	Austrian Eco-Label (UZ 49), FNG-Label	-
Cumulative performance over the last 3 years	more than 12%	more than 12%	more than 12%	more than 12%	2% interest per year
Risk and return profile	Medium risk	Medium risk	Medium risk	Medium risk	-
Fund volume (in euros)	> 136 million	> 136 million	> 136 million	> 136 million	-
Fees	ca. 2% per year	ca. 2% per year	ca. 2% per year	ca. 2% per year	none
Geographical orientation	global	global	global	global	not specified
Compliance with EU-taxonomy	0% taxonomy-compliant	0% taxonomy-compliant	0% taxonomy-compliant	31% taxonomy-compliant, 50% taxonomy-able	not specified
Cleanvest ESG-Rating (1 = low, 10 = high)	5,6 out of 10	5,2 out of 10	7,0 out of 10	8,2 out of 10	not specified
Carbon intensity (per million US-Dollars invested)	327.3 tons	199.8 tons	241.1 tons	163.3 tons	not specified
Top 10 holdings (share of fond volume in %)	Galp Energia (6,5%) USD Cash (4,38%) Ovinitiv Inc (3,87%) Harbour Energy (3,63%) Shell (3,49%) Marathon Oil (3,45%) Drax Group (3,35%) Baker Hughes (3,21%) Equinor Asa (3,21%) John Wood Group (2,99%)	Baker Hughes (5,27%) Equinor Asa (4,97%) Totalenergies (4,71%) Shell (4,66%) Respol (4,37%) Eni Spa (4,19%) Edp Renovaveis (3,82%) Galp Energia (3,71%) OMV (3,71%) Inpex (3,37%)	Darling Ingredients (3,63%) Republic Services (3,41%) Schneider Electric (2,89%) Marsh & McLennan (2,58%) Veolia Environment (2,53%) Owens Corning (2,47%) Nomad Foods (2,39%) Microsoft (2,36%) L'Air Liquide Societe (2,35%) Solaredge Techno (2,34%)	ON Semiconductor (5,42%) EUR Cash (4,65%) Wolfspeed (4,22%) Solaredge Tech (4,19%) Orsted (4,01%) Schneider Electric (3,76%) Infineon Tech (3,76%) Quanta Services (3,67%) First Solar (3,47%) Itron (3,01%)	-

Please distribute 500 euros among these five investment options. You can invest the entire 500 euros in one investment option (4 funds, 1 savings account) or divide the amount evenly or unevenly between all options. To do so, please enter the desired amount in the corresponding fields.
Remember that five participants will be randomly selected, where this decision will be realized and paid out after one year according to the performance.
So, imagine that this is your own money, which you want to have back in a year by selling your funds or withdrawing your money from your savings account.

	Fund A	Fund B	Fund C	Fund D	Savings account
Amount	X €	X €	X €	X €	X €

Questions on Investment Decision

Please answer this question with regards to the investment decision you have just made.

Reason for Sustainable Assets *[reason_pro_SI_assets]*	What [is/would] be the most important reason for you to invest <u>sustainably</u> (i.e., ecologically, socially, ethically)? 1. mainly a financial reason (For example, the expectation that sustainable investments yield a higher return (profit) than non-sustainable investments). 2. mainly a non-financial reason (For example, the expectation that sustainable investments have a positive impact on the environment or society).	Degryse 2023

Sustainable Finance Literacy [randomized question order]

Sustainable Finance Literacy	Next, we are interested in your knowledge on sustainable finance, e.g., financial products that consider ESG-criteria (Environmental, Social and Governance). Please indicate whether these statements are false or true.	0 = false, 1 = correct, 9 = I don't know;

Greenwashing meaning *[i3_SFL_greenwashing_meaning]*	Greenwashing means that a financial product is, for example, advertised as environmentally friendly even though environmental aspects are hardly or not considered in the investment strategy.	True
Labels *[i4_SFL_labels]*	Quality labels such as the Austrian Eco-Label (UZ49) aim to ensure that an investment product meets defined sustainability criteria.	True
EU Taxonomy *[i5_SFL_taxonomy_meaning]*	The EU Taxonomy is a classification system that defines which economic activities are considered environmentally sustainable (= green).	True
Exclusion criteria *[i12_SFL_exclusion_criteria]*	Exclusion criteria can be used to exclude countries, sectors or companies that do not meet certain ESG criteria from personal investments.	True
Products *[i16_SFL_products]*	Sustainable investment products can include individual stocks, bonds, investment funds, or index funds and ETFs (Exchange Traded Funds).	True
Fees *[i19_SFL_fees_recoded]*	The fees for sustainable investment products are always significantly higher than those for conventional investment products.	False
Performance *[i26_SFL_performance_recoded]*	Returns are significantly lower for sustainable ESG financial products than for conventional financial products.	False
Attention check *[attention_check]*	Please select *„false*" here. This is a test question.	Displayed randomly within the SFL questions; 0 = false, 1 = correct, 9 = I don't know;
Confidence SFL *[confidence_SFL]*	How confident did you feel overall when answering the questions on sustainable finance?	1 = not at all confident, 7 = very confident
Q18-20	Advanced FL / Stock market literacy [randomized question order]	[three highest loading factors of advanced lit in van Rooij et al., 2011]
Advanced Fin. Literacy *[FL_advanced]*	Next, we are interested in your knowledge of the stock market.	
Stock market *[FL_a_stock_market]*	Which of the following statements describes the main function of the stock market? 1. The stock market helps to predict stock earnings 2. The stock market results in an increase in the price of stocks 3. <u>The stock market brings people who want to buy stocks together with those who want to sell stocks</u> 4. I don't know	Van Rooij adv. Q6; also used in Balloch 2015 Q1;
Mutual funds *[FL_a_mutual_funds]*	Which of the following statements is correct? 1. Once one invests in a mutual fund, one cannot withdraw the money in the first year 2. <u>Mutual funds can invest in several assets, for example invest in both stocks and bonds</u>	Van Rooij adv. Q8; also used in Balloch 2015 Q9;

	3. Mutual funds pay a guaranteed rate of return which depends on their past performance 4. None of the above 5. I don't know	
Value volatility *[FL_a_volatility]*	Normally, which asset displays the highest fluctuations over time? 1. Savings accounts 2. Bonds 3. <u>Stocks</u> 4. I don't know	Van Rooij adv. Q11; Also used in Balloch 2015 Q4;
	Stock market / holder image	
Stockholder image *[stock_holder_image]*	Please indicate the extent to which you agree with the following statements. People who participate in the stock market and own financial assets such as stocks or funds, are on average ...	Henkel 2023 1 = completely disagree, 7 = completely agree
[SHI_greedy]	Rather greedy [Info: Greedy: a strong wish to continuously get more of things like wealth, possessions or social values.]	
[SHI_gambler]	Rather gamblers [Info: Gambler: a person that shows the tendency to risk money or other stakes in the hope of being successful.]	
[SHI_selfish]	Rather egoistic [Info: Selfish: being willing to accept negative consequences for other people or the environment to gain a personal advantage as a result.]	
	Please indicate the extent to which you agree with the following statements.	Dobni 2015, 2016, Combination of 3-4 highest loading items; Only relevant dimensions used 1 = completely disagree, 7 = completely agree
Immorality *[SMI_imm]*	The stock market is corrupt, under-regulated and harmful to society as a whole.	
Wealth creating capacity *[SMI_wcc]*	The benefits of investing in the stock market outweigh the costs and risks. [reversed]	
ESG image *[SMI_esg]*	The environment and social aspects are only secondary in the stock market.	Adapted from Jeong 2014 1 = completely disagree, 7 = completely agree
	Investment / greenwashing beliefs	
	Now we are interested in your opinion on sustainable investments, i.e., investments that consider ESG-criteria (Environmental, Social and Governance).	
Subjective ability to identify green product *[subjective_ability_SFL]*	Compared to the Austrian population, how well can you assess which financial investments are eco-friendly (green) and which are just pretending to be?	Similar to Degryse 2023; 1 = not at all good; 4 = mediocre, 7 = exceptionally good
	Please indicate the extent to which you agree with the following statement.	
Greenwashing beliefs *[greenwashing_belief]*	Sustainable investments are often related to greenwashing (a marketing ploy to make financial products appear more eco-friendly than they actually are).	Degryse 2023; 1 = completely disagree, 7 = completely agree

Check greenwashing *[check_gw]*	When purchasing a sustainable investment, I seek additional information (e.g., eco-labels, sustainability ratings, independent reports) to ensure that the environmental promises are true.	Own; 1 = never, 5 = always
Hassle factor sustainable *[hassle_sust]*	Investing in sustainable investments (e.g. sustainable equity funds) is complicated and I have to spend a lot of time and effort on it.	Sivaramakrishnan 2016
	Preferences and traits	
	Next, we would like you to answer a few questions about your preferences:	
Altruistic values *[altruistic_values]*	Please indicate how important the following values are to you as guiding principles in your life.	DeGroot (2007, 2008), we used the two highest correlated items, similar as in Kleffel 2023 and Paetzold 2015 1 = completely against my principles; 7 = of utmost importance
[values_alt_justice]	Social justice: correcting injustice	
[values_alt_equality]	Equality: equal opportunities for all	
Biospheric values *[biospheric_values]*	Please indicate how important the following values are to you as guiding principles in your life.	
[values_bio_unity]	Unity with nature: living in harmony with nature	
[values_bio_protect]	Protecting the environment: preserving nature	
Risk taking *[risk_taking]*	How would you rate your risk tolerance with regard to financial matters?	Similar: Dohmen 2011, also in Gutsche 2023, Henkel 2023, Degryse 2023 1 = not at all willing to take risks, 7 = very willing to take risks
Patience *[patience]*	Generally speaking, how willing are you to give up something that is beneficial for you today in order to benefit more from that in the future?	Gutsche 2023, Falk 2018 1 = not at all willing, 7 = very willing
General trust *[trust_general]*	Generally speaking, would you say that most people can be trusted, or that you can't be too careful in dealing with people?	Guiso 2008, Henkel 2023 1 = you can never be too careful, 7 = you can completely trust most people
Polictical spectrum *[pol_spect]*	In politics, a distinction is often made between "the left" and "the right". Where would you place yourself on the scale below, where 1 means left and 7 means right?	Henkel 2023, obtained from 2020 politics and values LISS panel

Q49-54	Investments	
	Finally, we are interested in your financial investments.	
Stock market investments *[stock_market_ investments]*	Have you invested assets in stocks, bonds or funds (e.g., funds or savings plans with stocks and/or bonds, incl. ETFs or index funds)? 0. No 1. Yes	
Percent investments [*assets_perc*] [only if stock_market_ investments is answered with 1 - yes]	What is the current percentage of stocks, bonds or funds (e.g., funds or savings plans with stocks and/or bonds, incl. ETFs or index funds) in the total amount of your assets? 1. [[[if stock_market_ investments == 0]]] 2. 1 to 24% 3. 25 to 50% 4. 51 to 75% 5. 76 to 99% 6. 100% - I only have investment products such as shares or funds	
Percent sustainable investments *[assets_sust_perc]* [only if stock_market_ investments is answered with 1 - yes]	What is the current percentage of sustainable stock, bonds and funds (i.e., financial products that take into account Environmental, Social, or Governance factors) in your total amount stocks, bonds and funds? 0. 0% - I do not own sustainable assets 1. 1 to 24% 2. 25 to 50% 3. 51 to 75% 4. 76 to 99% 5. 100% - I only own sustainable assets	Gutsche 2023, similar in Brunen 2022
Experience *[experience]*	For how many years have you had experience as an investor with stocks, funds, bonds, etc.? 1. I do not have any experience 2. Less than one year 3. 1 to 2 years 4. 3 to 4 years 5. 5 to 6 years 6. 7 to 8 years 7. 9 to 10 years 8. More than 11 years	
Household income *[hh_income]*	Please provide the monthly net household income of all persons currently living permanently in your household: (Household income is the sum of the income of all persons living together in a household and can be made up of various sources of income. Please refer to the current net monthly amount, e.g., after deduction of taxes and social security contributions, and add regular payments such as pensions, unemployment benefits, housing allowances, child support, alimony, etc. If you are not sure, please estimate the monthly amount). 1. below 1.000 euros 2. 1,001 euros bis 2,000 euros 3. 2,001 euros bis 3,000 euros 4. 3,001 euros bis 4,000 euros 5. 4,001 euros bis 5,000 euros 6. 5,001 euros bis 6,000 euros 7. 6,001 euros bis 7,000 euros 8. 7,001 euros bis 8,000 euros	Gutsche (2023)

	9. 8,001 euros or more 10. Prefer not to answer	
Learning style *[learning_style]*	How would you like to be educated about sustainable finance? 1. Watch videos 2. Read short texts 3. Self-test with questions and feedback on answers 4. Not at all 5. [open answer]	
	Follow-up questions regarding properties of the investment products	
	We now show you once again the investment products that were available when you made your investment decision. *[show funds again]*	
Follow-up question rating *[manip_check_rating]*	With regards to environmental issues, how sustainable do you consider the funds and the savings account to be? Funds A, B, C, D, savings account	1 = not at all sustainable, 7 = completely sustainable
Follow-up question greenwashing *[manip_check_gw]*	Which of the products is most likely greenwashing, i.e., that the promises in the short descriptive text regarding environmental protection do not correspond to the truth or are glossed over 0. None 1. Fund A 2. Fund B 3. Fund C 4. Fund D	
	Debriefing	
Debriefing	None of the funds was officially convicted for greenwashing. However, there were allegations against Fund [A/B/C/D] by the Baden-Württemberg consumer center (LINK). As a result, the fund's advertising was adjusted and non-transparent promises were removed, e.g., that the investors of the fund invest "specifically in the achievement of climate targets" and thus "help to counteract climate change through targeted investment".	
Revised investment decision *[investment_decision_revised]*	You now have the opportunity to adjust your investment decision based on this information. This decision will be used for realization of the investment if you are among the 5 randomly drawn winners. This means that for a possible payout of the value of the investment in one year, the investment decision made now is used and not the one at the beginning of the questionnaire. [[[show investment decision again with selected values of first investment decision]]]	
	End of Survey	
E-Mail-Address *[email_address]*	Among all participants, 5 will be randomly selected whose second investment decision will actually be implemented and paid out. If you would like to participate in this prize draw, please enter your email address now: [open with check for correct input]	
Comment	Anything else you would like to share with us in closing? [open answer format, text]	

Link to info material	If you are further interested in sustainable finance knowledge and would like to learn more about it, we recommend our interactive quiz (Link to website) and the information document linked there.
Thanks	Thank you very much for your participation! Your contribution helps us a lot. The questionnaire is now closed, you can now close this window. [Contact of authors]

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Appendix Chapter 4

Appendix A. Summary of all assessed variables, measurement scale, source of measurement, and indication whether the variable was used for stratification

The study was not limited to testing the effect of nature posters. It was also an aim to investigate other research questions such as on the impact of infrastructures variables (e.g., the volume of containers) and on the prevalence and determinants of "other-managing-behavior" (picking up other peoples' waste). For transparency, all variables that were assessed in the study are presented, whereas we highlight those variables that were used for stratification of the randomization.

Table A.1. Description of assessed variables.

Variable description	Scale	Source	Stratification
Evaluation of cleanness by Wiener Wohnen (WIWO)	0 = clean, 1 = average, 2 = dirty	Employees	
Presence of bulky waste	0 = no, 1 = yes	Employees	
Number of complaints about littered waste	Number	WIWO database	
Costs for removal of bulky waste	Euro	WIWO database	
Cleanness based on objective photo-rating	1 = totally clean, 7 = extremely dirty	Photo-rating	X
Cleanness based on subjective employee- rating	1 = totally clean, 7 = extremely dirty	Employees of WIWO	X
Cleanness based on subjective inhabitant-rating	1 = totally clean, 7 = extremely dirty	Door-to-door-survey	
Smell based on subjective employee-rating	1 = totally clean, 7 = extremely dirty	Employee rating	
Smell based on subjective inhabitant- rating	1 = very good, 7 = very bad	Door survey	
Satisfaction with design of waste disposal areas by inhabitants	1 = very satisfied, 7 = not at all satisfied	Door survey	
Number of small pieces of litter	1 = none, 7 = countless	Photo-rating	X
Number of large pieces of litter	1 = none, 7 = countless	Photo-rating	X
Removal of litter: Equipment necessary	0 = no, 1 = yes	Photo-rating	X
Removal of litter: Dirty	0 = no, 1 = yes	Photo-rating	X
Removal of litter: Effort necessary	0 = no, 1 = yes	Photo-rating	X
Removal of litter: Heavy	0 = no, 1 = yes	Photo-rating	X
Waste in front of room	0 = no, 1 = yes	Employees of WIWO	X
Cigarette butts in room	0 = no, 1 = yes	Employees of WIWO	X
Bulky waste in room	0 = no, 1 = yes	Employees of WIWO	X

Table A.1. Description of assessed variables.

Variable description	Scale	Source	Stratification
Full waste containers	0 = no, 1 = yes	Employees of WIWO	X
Infrastructure of building			
District in Vienna	1-23	WIWO database	X
Building	Code of building	WIWO database	X
Year of construction	Year	WIWO database	
Building and outdoor care (HAB) or just building care (HB)	Text	WIWO database	
If building (WHA) is supervised by building and outdoor care (HAB) or just building care (HB)	0 = HAB, 1 = others	WIWO database	
Inhabitants' association	0 = no; 1 = yes	WIWO database	
Restaurants	Number	WIWO database	
Playground	0 = no; 1 = yes	WIWO database	
Seating area	0 = no; 1 = yes	WIWO database	
Kindergarden (Preschool)	0 = no; 1 = yes	WIWO database	
School	0 = no; 1 = yes	WIWO database	
Seniors-Club	0 = no; 1 = yes	WIWO database	
Housing-Partner premise	0 = no; 1 = yes	WIWO database	
Youth-Club	0 = no; 1 = yes	WIWO database	
Premise for festivities	0 = no; 1 = yes	WIWO database	
Police station	0 = no; 1 = yes	WIWO database	
Infrastructure of disposal areas			
Waste room (indoor) or waste area (outdoor)	Text	WIWO database	
Indoor	0 = no; 1 = yes	WIWO database	X
Number of waste rooms (indoor)	Number	WIWO database	X
Number of waste areas (outdoor)	Number	WIWO database	X
Number of disposal areas	Number	WIWO database	X
Light and movement sensors	0 = no; 1 = yes	WIWO employees	
Number of windows in a waste room	Number	WIWO employees	
Angled room	0 = no; 1 = yes	WIWO employees	
Enclosure	0 = no; 1 = yes	WIWO employees	
Residual waste container	0 = no; 1 = yes	WIWO employees	

Table A.1. Description of assessed variables.

Variable description	Scale	Source	Stratification
Number of residual waste containers	Number	WIWO/waste collector data	
Volume of residual waste containers	Liter	WIWO/waste collector data	X
Volume of residual waste containers per inhabitant	Liter	WIWO/waste collector data	
Wastepaper container	0 = no; 1 =yes	WIWO/waste collector data	
Number of wastepaper container	Number	WIWO/waste collector data	
Volume of wastepaper containers	Liter	WIWO/waste collector data	X
Volume of wastepaper containers per inhabitant	Liter	WIWO/waste collector data	
Volume of wastepaper and residual waste container	Liter	WIWO/waste collector data	
Volume of wastepaper and residual waste container per inhabitant	Liter	WIWO/waste collector data	
Number of plastic/metal containers	Number	WIWO/waste collector data	
Total number of waste collection days according to MA 48	Number	Waste collector data	X
Apartments			
Size in m^2 of all apartments in a staircase	m^2	WIWO database	
Average size in m^2 per apartment in the staircase	m^2	WIWO database	
Average living space in m^2 per resident	m^2	WIWO database	X
Number of apartments per staircase	Number	WIWO database	X
Number of two-room apartments in the staircase	Number	WIWO database	
Number of three-room apartments in the staircase	Number	WIWO database	
Number of four-room apartments in the staircase	Number	WIWO database	
Number of new rentals in the staircase	Number	WIWO database	
Resident turnover rate per staircase (fluctuation)	In percent (*N* rented / *N* apartments)	WIWO database	X

Table A.1. Description of assessed variables.

Variable description	Scale	Source	Stratification
Rate of vacant apartments in the staircase	In percent (*N* vacant / *N* apartments)	WIWO database	
Inhabitants			
Number of inhabitants according to the building description	Number	WIWO database	
Number of inhabitants in the staircase	Number	WIWO database	X
Number of male inhabitants in the staircase	Number	WIWO database	
Number of female inhabitants in the staircase	Number	WIWO database	
Share of male inhabitants	In percent	WIWO database	
Share of female inhabitants	In percent	WIWO database	
Ratio of male to female inhabitants	In percent	WIWO database	X
Average age of inhabitants	Number	WIWO database	
Number of inhabitants under the age of 19 in the staircase	Number	WIWO database	
Number of inhabitants aged between 20 and 59 in the staircase	Number	WIWO database	
Number of inhabitants over 60 in the staircase	Number	WIWO database	
Average number of inhabitants per apartment	Number	WIWO database	X
Variables based on previous Study (Gangl et al., 2022)			
Baseline cleanness based on photo-rating	1 = very clean, 7 = dirty	Gangl et al. (2022)	X
Previously treated area	0 = no, 1 = yes	Gangl et al. (2022)	X
Intervention gone in May 2022	0 = no, 1 = yes	WIWO	X
Intervention deinstalled in May 2022	0 = no, 1 = yes	WIWO	X

Appendix B. Assessment of objective cleanness (photo-rating; translated from German)

Intuitive impression

Description: Just intuitively rate your first impression from 1 to 7. Don't count out the bulky waste - it's about the overall impression. Please focus on the garbage here, so don't include dirty floors/walls, old containers etc. too much!

1 (totally clean) to 7 (extremely dirty)

Definition of bulky waste: Anything that does not fit in the garbage can (slatted frame, wardrobe, armchair, baby carriage, shopping cart, pallet, etc.) or electronic waste (printer, microwave, etc.). If there are parts of a piece of furniture that would fit in the garbage can (drawers, broken chair legs, etc.), classify them as large items of waste!

How many small pieces of waste?

Description: Count the number of pieces of garbage that are roughly the same size or smaller than a hand or that can be crumpled up in it, e.g., a plastic bottle, a small brochure/newspaper, or small pieces of paper.

If you can't tell from the picture whether it's garbage or just leaves/stones or stains on the ground, look at the 2nd picture. If it is still unclear whether it is garbage, do not classify it as garbage. Only classify as garbage what is clearly recognizable as garbage! But write a comment in the table with "ambiguous whether garbage". For example, if a piece of paper is obviously torn and the two pieces are close together, then count it as 1 piece. Evaluate the garbage room/garbage area only on the basis of the garbage, i.e. independently of cigarettes and bulky waste (is collected separately by the OB) - so ignore cigarettes and bulky waste for the evaluation.

1: nothing is on the floor
2: 1 piece
3: 2-3 pieces
4: 4-6 pieces
5: 7-10 pieces
6: 11-20 pieces
7: Countless pieces

How many large pieces of waste?

Description: Count the quantity of all other pieces of garbage here, i.e. those that are larger than a hand (e.g. garbage bag, cardboard, pieces of wood, etc.). If there are pieces inside each other, e.g. boxes with something inside, count them as 1 piece.

1: nothing is on the floor
2: 1 piece

3: 2-3 pieces
4: 4-6 pieces
5: 7-10 pieces
6: 11-20 pieces
7: Countless pieces

Liquid waste (if it looks like something has just leaked, yogurt, paint, etc. - this does not mean water stains, puddles, dried stains on the floor) is scored as waste (i.e. either small or large), and equipment is marked as 4).

What do you have to do to take the garbage room/garbage area down to a "1" rating?

Description: Evaluate the garbage room/garbage area as a whole. Imagine you wanted to clean the entire garbage room/garbage area, i.e. remove all the pieces: Write a "1" in the columns that apply, write a "0" if it does not apply.

Equipment: Do you need a dustpan, broom, cleaning kit or other equipment, e.g. because:

- ... the waste is dangerous, e.g. broken glass.
- ... the waste consists of many small pieces, so that picking it up by hand would be possible but would take too long.
- ... the waste is unhygienic (e.g. handkerchiefs, torn open bin bag with organic waste) or damp (e.g. wet wastepaper), so that picking it up by hand would be possible but disgusting.
- ... the waste cannot be picked up by hand, e.g. mushy leftover food, "liquid" waste such as leaked yogurt.

Dirty: Would you get your hands dirty if you picked up everything - things that you could theoretically pick up (i.e. not liquid stains) (e.g. sticky or wet pieces, organic waste, garbage bag not completely closed)? This does not mean that the room looks dirty or that the garbage looks dirty.

Effort: Should pieces be made smaller before they can be disposed of (so that as much as possible can fit in the garbage can) (e.g. larger cardboard box, approx. everything from the size of a pizza box)?

Heavy: Could a weak person (e.g. children, elderly people) not pick up the garbage (e.g. heavy large garbage bag)?

Appendix C. Guide for door-to-door interviews and subjective cleanness (translated from German)

Greeting

(…)

Informed consent

The information you provide in the survey does not allow any conclusions to be drawn about you personally. The data collected will be used exclusively to improve the waste sector and for scientific purposes (e.g. publications, presentations).

Your participation in the study is voluntary. You can cancel the questionnaire at any time and your data will be deleted.

Selections waste disposal area

Apartment building (drop-down; interviewer selects apartment building without asking)

On which staircase is the garbage area that you use most often? At staircase x, at staircase y ...? (drop-down, incl. option "Other")

Contact with waste area

Do you remember the last time you were in your garbage area? (before 30.08; after 30.08)

Cleanness and satisfaction (1 = totally clean, 7 = extremely dirty)

Please remember: How clean did you find the garbage area when you were last there? Please answer on a scale from 1 to 7: 1 means very clean and 7 means very dirty.

How was the smell in the garbage area when you were last there? 1 means very good and 7 means very bad.

MC1: Subliminal manipulation check (1 = I agree completely, 7 = I don't agree at all)

When you think about the design of the waste area, how much do you agree with the following statements? Please answer on a scale from 1 to 7: 1 means "I agree completely" and 7 means "I don't agree at all".

I am satisfied with the design of the waste area.

The design of the garbage area shows me that Wiener Wohnen cares.

Behavior (1 = always, 7 = never)

I will now describe various situations to you. Please imagine the situations and tell me on a scale of 1 to 7 how you would behave. 1 means "always" and 7 means "never".

The first bin is full. Do you move on to use an empty container further back?

All the bins are full. Do you squeeze the garbage in the container so that your garbage bag still fits in?

You throw garbage into the container. A piece of paper falls on the floor. Do you pick up the piece of paper?

Other-managing-behavior (OMB)

You go to the garbage area. There is a small garbage bag in front of the door. Do you take this garbage bag into the garbage area to dispose of it correctly?

You are in the garbage area and see that there is a small garbage bag in front of the container. Do you pick up the bin liner and dispose of it correctly?

You drop a piece of paper in the garbage area. You pick up the piece and see that there are other pieces of paper on the floor. Do you also pick up the other pieces of paper?

Behaviors bulky waste

You have an old armchair and no longer need it. Are you selling the armchair on the Internet (for example on "willhaben.at")?

You want to throw away a broken box. Do you call the MA 48 bulky waste collection service to have the broken box picked up?

You want to throw away a broken clothes horse. Do you take the clothes horse to the MA 48 waste disposal site?

Statements (1 = I agree completely, 7 = I don't agree at all)

I am now going to read out various statements to you. Please tell me on a scale of 1 to 7 how much you agree with these statements. 1 means "I agree completely" and 7 means "I don't agree at all".

Picking up other people's garbage is a good thing.

Picking up other people's garbage is reasonable.

My family and friends pick up other people's garbage to dispose of it.

Residents in my apartment complex voluntarily take care of the trash that others leave behind.

Picking up other people's garbage is an easy task for me.

It is up to me to pick up other people's garbage and dispose of it correctly.

I can call my neighbors if I need help.

The people in my neighborhood trust each other.

Negative and positive emotions (1= I agree completely, 7 = I don't agree at all; 1 = very much, 7 = not at all)

Please tell me on a scale of 1 to 7 how much you agree with the following statements. 1 again means: "I agree completely" and 7 means "I don't agree at all". I pick up other people's garbage,

... because I feel guilty when there is garbage lying around

... because I feel ashamed when there is a lot of garbage lying around in my apartment building.

Please answer again on a scale from 1 to 7. This time 1 means "very much" and 7 means "not at all".

How much do you like picking up other people's garbage?

How much would you like to pick up other people's garbage in the coming days?

Willingness (drop down, scale 1-7)

How much extra money would you spend per month to keep your apartment complex clean? (drop-down from 0 to 100 euros or more in increments of 10)

How long would you volunteer to work per week to keep your apartment complex clean? (drop-down from 0 minutes to 150 minutes or more in increments of 10)

Imagine that a joint garbage collection campaign is organized in your residential complex. On a scale of 1 to 7, how likely are you to take part?

Infrastructure (yes/no, open number)

Do you always use the same waste area? (yes/no)

Is there cleaning equipment in your waste area? (yes/no)

How often do you go to the garbage area per month? (open number)

Salience check (yes/no)

Have you noticed a change in your garbage area recently? (Yes, there is a poster / Yes, something else / No)

Have you seen a picture of nature in your garbage area? (yes/no) (Only for the intervention group; only ask if the poster was not mentioned and possibly describe the poster)

MC2: Open manipulation check (only for the intervention group) (1 = I agree completely, 7 = I don't agree at all)

When you think about the image of nature, how much do you agree with the following statements? Please answer on a scale from 1 to 7: 1 means "I agree completely" and 7 means "I don't agree at all".

The nature picture makes the waste area more beautiful.

The nature picture reminds me of the beauty of Austria.

The nature picture shows me how important environmental protection is.

The nature picture calms me down.

What would you prefer? 3 euros or the nature picture as a poster for your home?

Connectedness with nature (1 = I agree completely, 7 = I don't agree at all)

On a scale of 1 to 7, please tell me how much you agree with the following statements. 1 means "I agree completely " and 7 means "I don't agree at all".

I feel strongly connected to nature.

Just as a tree is part of a forest, I am also part of nature.

All living beings on this earth are connected and I feel part of it.

Sociodemographics

Now, I have a few more questions about you personally:

Gender (male, female, diverse; recorded by interviewer without asking)

May I ask how old you are? (drop-down: 14-99, n/a)

How many people live in your apartment in total and permanently? (drop-down: 1 to 15 or more)

How many children under the age of 14 live permanently in your household? (drop-down: 1 to 15 or more)

How long have you lived in Vienna? Since which year? (drop-down: 2022 to 1940 or earlier)

What is your mother tongue? (drop-down: German, Turkish, Serbian, Polish, Romanian, Arabic, other)

Comments

Is there anything else you would like to add? Do you have any comments? (open)

Notes/observations of the interviewer (open)

Debriefing & farewell

(…)

Appendix D. Exploration of the difference between posters on the wall versus door

In an exploration, we analyze whether it is sufficient to assemble the nature posters either on the door or on the wall or whether both posters are necessary. All residents who indicated to have been in a waste disposal area since the nature poster was assembled (N = 705) were included in the analysis. Regression results (Table D.1) show that subjective cleanness is most likely only affected by the posters on the door whereas the posters on the wall seem to have little effect on subjective cleanness.

Table D.1: OLS regression models on the effect of the nature posters on the wall versus on the door on subjective cleanness

	(1)		(2)		(3)	
	Estimate (SE)	95% CI	Estimate (SE)	95% CI	Estimate (SE)	95% CI
Nature poster on door	-0.77***	[-1.16, -0.38]			-0.90***	[-1.35, -0.46]
	(0.20)				(0.23)	
Nature poster in room			-0.11	[-0.45, 0.23]	0.25	[-0.13, 0.63]
			(0.17)		(0.19)	
Constant	4.88***	[4.70, 5.06]	4.76***	[4.56, 4.95]	4.82***	[4.63, 5.02]
	(0.09)		(0.10)		(0.10)	
N	706		706		706	
R2	0.020		0.000		0.022	

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Appendix E. Determinants of objective and subjective cleanness

To allow a better interpretation of the results, we conduct exploratory OLS-regressions in which we present the relationship between several assessed variables that have been identified as relevant (e.g., by the housing company) with objective and subjective cleanness at Time 2, where both variables were assessed simultaneously (Table E.1). Exploratory regression results show that bulky waste is the most important determinant of objective cleanness. For subjective cleanness, also bulky waste and in addition, the location of the waste disposal area and the number of inhabitants are important determinants.

Table E.1: Spearman correlations and OLS regression models on the determinants of objective and subjective cleanness.

	Objective cleanness (T2)			Subjective cleanness (T2)		
		OLS-Regression			OLS-Regression	
	Spearman correlation	Estimate (SE)	95% CI	Spearman correlation	Estimate (SE)	95% CI
Nature picture	0.04	0.11	[-0.18, 0.41]	-0.15***	0.11	[-0.34, 0.56]
		(0.15)			(0.23)	
Location (outdoor = 0, indoor = 1)	-0.08	-0.11	[-0.47, 0.25]	0.31***	0.80***	[0.35, 1.25]
		(0.18)			(0.23)	
Number waste disposal areas in building	-0.00	0.01	[-0.01, 0.03]	0.11*	0.01	[-0.01, 0.03]
		(0.01)			(0.01)	
Number of inhabitants in staircase	0.10	0.003+	[0.00, 0.01]	0.36***	0.01***	[0.01, 0.01]
		(0.002)			(0.00)	
Average number of inhabitants per apartment	0.04	0.02	[-0.37, 0.41]	0.15***	-0.05	[-0.53, 0.43]
		(0.207)			(0.24)	
Mean age of inhabitants in staircase	-0.13	-0.02	[-0.06, 0.02]	-0.09*	0.02	[-0.03, 0.07]
		(0.02)			(0.03)	
Fluctuation rate	-0.03	-1.50	[-5.24, 2.23]	0.21***	1.81	[-3.67, 7.29]
		(1.90)			(2.80)	
Waste container volume per inhabitant	0.11	0.00	[0.00, 0.00]	-0.28***	0.00	[0.00, 0.00]
		(0.00)			(0.00)	
Waste disposal area is lockable (0 = no, 1 = yes)	0.04	0.40	[-0.35, 1.16]	-0.04	0.20	[-0.61, 1.02]

		(0.38)			(0.41)	
Bulky waste in area (0 = no, 1 = yes)	0.49***	1.53***	[1.09, 1.97]	0.11*	0.84**	[0.26, 1.42]
		(0.22)			(0.30)	
Constant		2.11+	[-0.28, 4.51]		1.72	[-1.24, 4.67]
		(1.21)			(1.50)	
N		182			494	
R2		0.279			0.201	

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.