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"The Exposure to a Lifetime of Stress and its Impact on Trust and the Building of Trust"

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Introduction

Humans are inherently social, and being socially connected is exceptionally significant. Specifically, social connections can work as a buffer against harmful effects of aversive events (Gable & Bedrov, 2022) and can reduce the risk of mortality (Holt-Lunstad et al., 2010). A key part of building social connections is the ability to trust, and especially learning whom to trust, and whom not to trust (Adedeji et al., 2023). One factor that has been linked to impacting our ability to trust others, and consequently building social connectedness, is the experience of stress (Reiter et al., 2022, Potts et al., 2019). However, previous research has typically focused on investigating the effect of acutely stressful situations on trust and social connection to others (Nitschke et al., 2022, Von Dawans et al., 2012, 2019); the impact of chronic stress, or the cumulative experience of stress, is still unclear. With many intense stressors over the last years (e.g. the COVID-19 pandemic, armed conflicts, and political divisiveness), reported stress levels among the population are rising (American Psychological Association, 2022). Hence, this topic warrants further research to investigate the yet unknown consequences of stress. This study aims to fill the existing research gap around the relationship between lifetime stress, trust, and the building and maintaining of social connections.

The role of social connections and trust

In our interconnected society the value of social connections is profoundly important. Relationships and social interactions play a crucial role, impacting our well-being and health outcomes (Umberson & Montez, 2011). In a meta-analytic review across 148 studies, participants with strong social relationships had a 50% higher probability of survival, and therefore the highest prediction of reduced risk of mortality, compared to individuals with poor or insufficient social relationships (Holt-Lunstad et al., 2010). In fact, missing such social connections can have harmful consequences. Loneliness has been associated with a 26% risk of premature death, 29% higher risk of social isolation, and 32% higher probability of living alone (Holt-Lunstad et al., 2015). It also leads to higher rates of morbidity in adults (Cacioppo & Cacioppo, 2014).

Hence, being socially connected does not only help with our psychological well-being, it also has a significant and positive influence on physical well-being (Holt-Lunstad, 2021). Marriage for instance has been associated with favourable outcomes in terms of

cardiovascular and chronic diseases, as well as alleviation of depressive symptoms (Umberson & Montez, 2010). Furthermore, a greater number of social contacts is also linked to lower levels of stress, general worry, and fatigue (Nitschke et al., 2020). In a broader context, augmenting social connectedness can effectively lower feelings of distress (Holt-Lunstad, 2018). It is quite evident that keeping strong social connections significantly contributes to fostering both our emotional and physical well-being (Bristol et al., 2021).

To build such important social connections we have to place trust in others. Trust, defined as "To believe that someone is good and honest and will not harm you" (Cambridge Dictionary, n.d.), becomes the foundation for connections. It is manifested when an individual makes an initial sacrifice that, potentially at their own expense, hinges on the response of another (Alós-Ferrer & Farolfi, 2019). We implicitly or explicitly learn to trust our friends and family, our colleagues and employers, but also fellow citizens in general (Alós-Ferrer & Farolfi, 2019). When we trust someone, we want to know the trustee's predictability and, at the same time, have certain expectations for them (Hancock et al., 2023). Individually, trusting another person implies possible rewards as well as risks if the other person abuses the given trust to our disadvantage (Hancock et al., 2023). As humans do not like uncertainty and risk, learning whom to trust helps alleviate uncertainty and manage risks (Frederiksen, 2014). Apart from social connections, trust plays an especially important role in economic interactions (Cochard et al., 2004), as socio-economic interactions with strangers again inherently involve risk (Hula et al., 2021). Even though our society is based on cooperation and mutual trust, not everyone is trustworthy. Thus, learning to recognise the trustworthiness of interaction partners is critical for successful social interactions (Sladky et al., 2021).

In conclusion, social connections play a crucial role in human life, helping us with survival, our health and overall well-being. A relevant aspect of building and maintaining social connections is trust, especially learning whom to trust. Hence, it is important to understand what factors can affect our ability to form and maintain trust and our social connectedness. One of the many influencing factors is stress (Von Dawans et al., 2012, 2019).

The stress response

We all experience stress in our life. It starts early in childhood when confronted with the intricate dynamics involved in establishing social connections, goes on to college with academic deadlines and accompanies us through our work and personal life. While stress is a

natural response to the demands of daily life, it can transition into an unhealthy state when it disrupts the ability to function effectively on a day-to-day basis (Epel et al., 2018).

But what is stress exactly? Stress is the body's response to anything that requires immediate attention or action when a stressor (i.e., something challenging and/or frightening) threatens the status-quo (McEwen, 2017). As such, it is an innate reaction that helps us overcome challenges and respond to difficulties in our lives (McEwen, 2017). Broadly speaking, there are two primary ways stress can be categorised: acute stress and chronic stress.

Acute stress is an immediate response to stressors, triggering rapid bodily reactions aimed at maintaining and restoring equilibrium (Russell & Lightman, 2019). This process is vital for adapting to changing external conditions while preserving internal stability—a concept known as homeostasis (Billman, 2020). Homeostasis plays a crucial role in sustaining normal physiological functioning, particularly in the face of heightened demands (Kudielka & Kirschbaum, 2005). When confronted with a stress-inducing situation, the body activates the hypothalamus-pituitary-adrenal (HPA) axis. Consisting of the hypothalamus, pituitary gland, and adrenal glands, its primary function is to regulate the stress response (Guilliams & Edwards, 2010). Initially, the hypothalamus responds to a stressor by initiating the release of corticotropin-releasing hormone (CRH), which then signals the pituitary gland to secrete adrenocorticotropic hormone (ACTH) (Godoy et al., 2018). ACTH enters the bloodstream and travels to the adrenal glands located on top of the kidneys. The outer layer of the adrenal glands, called adrenal cortex, is then prompted by ACTH to release cortisol (Godoy et al., 2018). Cortisol subsequently orchestrates various changes that help the body effectively cope with stress. For instance, it mobilises energy resources like glucose, ensuring enough energy to address the threatening situation (Tasker & Herman, 2011). Furthermore, cortisol influences several other physiological systems, including the immune and the cardiovascular system, as well as affective and cognitive processes (Kudielka & Kirschbaum, 2005). When the levels of cortisol in the bloodstream rise, receptors in certain parts of the brain, such as the hypothalamus and hippocampus, detect it (Tasker & Herman, 2011). This detection consequently triggers a negative feedback mechanism, resulting in the inhibition of the stress response (Tasker & Herman, 2011).

The acute stress response can yield both constructive and deconstructive effects. On a short notice, the activation of the HPA axis helps to maintain homeostasis, ultimately providing a better chance of survival when the body is under threat (Russell & Lightman, 2019). This biological reaction therefore effectively aids in addressing the stressor. However,

recurrent or prolonged activation heightens the likelihood of diseases and premature mortality (Slavich & Shields, 2018). A persistent and recurrent exposure to stressors can lead to being chronically stressed, along with its associated consequences. Chronic stress can thus be understood as the cumulative result of a lifetime's worth of stress exposure (Lampert et al., 2016).

Lifetime Stress Exposure

An exposure to lifetime stress, or chronic stress, can therefore be understood as the effect of accumulating stressors on our body (Slavich & Shields, 2018). Throughout various stages of life, we live through many stressful experiences that pose risks to or demands on our current lives (Scheid & Brown, 2010). By now, studies show that early-life stress causes higher responsiveness to stress and cognitive deficiencies in adulthood, indicating that the impacts of stress at various stages of life interact (Lupien et al., 2009). The accumulating impact of the stressors can result in maladaptive alterations in both physiology and behaviour, ultimately compromising overall health (Gianaros et al., 2007). The prolonged states of stress can disrupt the body's natural balance, known as homeostasis (Juster et al., 2010). These changes in the homeostasis are referred to as “allostasis” (Lee et al., 2015). Allostasis describes the process by which an organism adjusts its internal environment to appropriately align with external environmental demands (Juster et al., 2010). Typically, allostasis can be either adaptive or maladaptive, depending on its intensity or contextual significance (Lee et al., 2015). When stress stimuli are excessive and recurrent, the restoration of the body's original homeostatic levels may be incomplete (Lee et al., 2015). As a result, chronic stress can lead the body to anticipate stressors and react as if a stressful environment would persist (Lee et al., 2015). This state leads to insufficient buffering mechanisms and frequent activation of stress response systems (Guidi et al., 2020). In response, the body establishes a new set point for future adaptation. The difference between the new and previous set points can be interpreted as the "cumulative burden of adaptation to stress", the so-called allostatic load (Lee et al., 2015). McEwen and Stellar introduced this concept as the "wear and tear" of organ systems (McEwen & Stellar, 1998, as cited in Bobba-Alves et al., 2022).

Over time, the allostatic load causes alterations in the body that can ultimately contribute to the development of various diseases (McEwen & Seeman, 1999). These can include conditions like elevated blood pressure or impaired immune function (McEwen, 2007). It also causes cognitive and emotional changes, for example psychological distress

(Guidi et al., 2020), depressive disorders (Mariotti, 2015), and anxiety (McEwen, 2008). The influence of stress on our body and behaviour is well researched. However, there is still no clear definitive answer as to the influence of lifetime stress exposure on our social behaviour, and, more specifically, our ability to trust and socially connect with others (Toussaint et al., 2014, Wu et al., 2020).

Impact of stress on social behaviour

The impact of stress on prosocial behaviour has been the subject of numerous studies, whereby most research has been conducted using acute models of stress that induce stress in an experimental, laboratory setting. Here, the research findings are mixed. A recent meta-analysis investigated the effect of experimentally induced acute stress on prosocial behaviours in economic games (Nitschke et al., 2022). The authors included 23 studies with a total of 2197 participants, and no significant differences between stress and control groups were found. The results suggest that acute stress does not consistently increase or decrease prosocial behaviour (Nitschke et al., 2022). Similarly, Faber and Häusser (2021) point out how current empirical research shows that stress does not alter prosocial behaviour clearly in one direction.

However, Von Dawans et al. (2012) investigated whether men behave more aggressively or prosocially when experiencing an acute psychosocial stressor. The Trier Social Stress Test for Groups (TSST-G) was used to induce stress experimentally, afterwards the participants engaged in interactive games involving real monetary incentives. The results showed that induced acute psychosocial stress increased trust, trustworthiness, and sharing behaviour (Von Dawans et al., 2012). When applying a similar study design on a sample of women, stress exposure again increased trustworthiness and sharing (Von Dawans et al., 2019). Moreover, acute stress has also been linked to increased emotional empathy (Wolf et al., 2015). Contrasting these findings, Potts et al. (2019) found a stress-related decrease in trust. Participants who were under acute stress did, on average, have less trust than the control group in the trust game (Potts et al., 2019). Stressed participants also seem to gamble more, but entrust less money to interaction partners (Feldman-Hall et al., 2015). It should be noted however, that methodological differences in stressor type and latency make it difficult to compare results across studies.

While the impact of acute stress on prosocial behaviour remains uncertain, even less is understood about the effects of chronic stress or the exposure to lifetime stress on social abilities. It is generally apparent that current life stress does influence one's capacity to form

connections with others (Hensel et al., 2022). However, the question remains: What about the impact of long-term exposure to stress?

The Covid-19 pandemic over the past three years serves as an example of how ongoing stress can affect our capacity to form social ties. It has led to a decrease in positive affect and poorer mental health and well-being (Macdonald & Hülür, 2021). Notably, pandemic-related stress has been associated with reduced well-being among healthcare professionals, leading to burnout (Yıldırım et al., 2021). Although social connectedness is a crucial factor in reducing burnout (Yıldırım et al., 2021), recent studies have indicated that these accumulating levels of ongoing stress have negatively impacted social connections. Can & Avçin (2021) conducted a study focusing on perceived stress among healthcare workers during the first months of the Covid-19 pandemic in 2020. 529 healthcare professionals participated by using self-applied online questionnaires, revealing a connection between increasing stress and decreasing trust in relationships (Can & Avçin, 2021). Correspondingly, Wekenborg et al. (2022) concluded that burnout symptoms are negatively associated with sharing, trust, and trustworthiness. Elevated levels of pandemic-related stress led to less social connectedness, which then contributed to an increase of burnout symptoms (Yıldırım et al., 2021). Simultaneously, stress levels rose along with the feeling of loneliness (Menon et al., 2021), demonstrating the complicated relationship between life stress and social connections. Heightened stress levels can result in diminished social connections, while the lack of social connections can lead to higher stress levels. On the other hand, greater social connectedness was associated with lower levels of perceived stress during the lockdowns (Nitschke et al., 2021.) Overall, stronger perceptions of social connection during the pandemic were associated not only with lower scores of stress, but also with levels of depression and anxiety (Soares et al., 2022). Following on from the previous stated study by Menon et al. (2021), students with more social contacts experienced “only” low to moderate stress. The pandemic thus serves as an illustration of the intricate relationship between stress and social connection, showcasing how these factors mutually influence each other. Furthermore, the importance of social connections as a protective buffer against perceived stress was highlighted.

To now get a better understanding of the connection between lifetime stress exposure and prosocial behaviour, Wu et al. (2020) conducted a meta-analysis investigating the relationship between early-life stress and prosociality. Their definition of early-life stress referred to persistent or intense adverse environmental encounters throughout one's childhood or adolescence. They included 123 articles and their results implied that early-life stress is

linked to lower levels of self-reported prosocial behaviours and traits, such as agreeableness, empathy, and cooperativeness. Hence, early-life stress exhibited a negative correlation with prosociality, although the results can only be generalised with caution, as the effect size was relatively small (r = -.085) (Wu et al., 2020).

As mentioned previously, encountered stressors interact at various stages of life (Lupien et al., 2009). It starts at very early stages of life with the psychological state of the mother already playing a significant role. Maternal stress, depression, and anxiety have been tied to heightened basal HPA axis activity in children (Lupien et al., 2009). Research now focuses on investigating the connection between early stress exposure and prosocial behaviour. For instance, Howe (1994) studied the relationship between preschool children from African American single mothers, and their behaviour in the classroom. There was a notable negative correlation ($r= -.49$, $p<.01$) between maternal stress and the prosocial behaviour of their children (Howe, 1994). Depending on the kind of early life-stress, prosocial behaviours in adulthood are less likely - particularly when the individual was subjected to violence (Jirsaraie et al., 2019). Gangadharan et al., (2022) analysed how exposure to violence during childhood and adolescence impacts the adult individuals' antisocial, prosocial and risk-taking behaviour. Participants who directly experienced violence during the Cambodian genocide (1975–1979), exhibited more antisocial and reckless behaviours decades afterwards. However, there weren't any systematic effects on prosocial behaviour (Gangadharan et al., 2022). Similarly, in a French study involving 612 participants, experiencing childhood environmental adversity did not significantly correlate with cooperation as an adult in the trust game (Lettinga et al., 2021). Consistent with the previous studies, there was no difference in trust between girls who had previously suffered physical or sexual abuse and girls who had not, using the trust game as the paradigm (Sellnow et al., 2019). On a more positive note, Steinbeis et al. (2015) found that participants with a higher cortisol baseline, that was interpreted as a long-term stress load, showed an increase in trust. Additionally, a study examining the relationship between acute stress and prosociality, included the influence of current life stress on helping behaviour (Hensel et al., 2022). Acute stress was positively associated with prosocial behaviour, and current life stress, measured by cortisol levels, moderated the relationship. Particularly, at low levels of current life stress, a positive association between acute stress and prosocial behaviour was observed (Hensel et al., 2022).

Overall, studies on the connection between lifetime stress and social connections are rather scarce with contradicting results. As highlighted in the beginning, relationships and

social interactions are crucial for one's mental health (Umberson & Montez, 2010), especially for coping and adapting to crises such as the Covid-19 pandemic. Some studies already show how high stress influences negatively building and keeping social connections. It is essential for future events, but also possible interventions, to investigate further the impact of exposure to lifetime stress.

This study therefore sets out to investigate the effects of lifetime stress, measured by aversive life events, on trust and trust building, measured by the amount of money given to another player in a trust game. As the predictability of a trustee is important when building trust (Hancock et al., 2023), we test specifically if the amount of money sent to another individual changes depending on who you are playing with, based on your lifetime stress.

The hypotheses thus are:

H1: Lifetime stress exposure influences trust, measured by the amount of money given to another player, in the trust game.

The study predicts that individuals experiencing higher levels of life stress will display different monetary behaviour compared to those with lower life stress levels.

H2: Lifetime stress exposure influences monetary behaviour differently depending on the interaction partner (prosocial or selfish) in the trust game.

The study hypothesises that the effect of lifetime stress on monetary behaviour in the trust game will be different depending on whether the interaction partner is perceived as prosocial or selfish. Specifically, individuals with higher life stress may exhibit greater sensitivity to the interaction partner's behaviour and adjust their money, and trust, accordingly.

Methods

Participants

We invited 173 healthy participants to the experiment. The mean age of the sample *w*as 26.70 years old (standard deviation [SD] = 08.09, range = 18–68 years old). Individuals were excluded from participation if they had any acute illnesses or a lifetime history of psychiatric or neurological conditions, drug or alcohol abuse, and if they were underaged. Five participants had to be excluded based on performance in the trust game. Here, participants that did not alter their responses over the experiment and did not differentiate between the prosocial and selfish player were excluded. Our final sample therefore consisted of 168 participants.

Procedure

Participants were recruited via the online platform Vienna CogSciHub, where they could register themselves for the experiment. Participants first completed an online pre-screener that included a short demographic questionnaire and the Stress and Adversity Inventory (STRAIN) Screener. The exclusion criteria were also assessed. If eligible, the participants were then able to register for an in-person session. The study occurred from January 31, 2023, to May 11, 2023, and the registration to the experiment was open the whole period. The study was conducted in a computer room of the Social, Cognitive and Affective Neuroscience Unit (SCAN Unit) at the University of Vienna. It took two hours and consisted of seven tasks, including the trust game, a demographic questionnaire, the Stress and Adversity Inventory (STRAIN) questionnaire and four other tasks related to another study. All tasks were in German.

Up to eight participants could take part in one session. After arriving at the computer room and being greeted, the participants were asked to put their mobile phones away to avoid any distractions. Then they were randomly seated at a computer and asked to provide informed consent. Subsequently, they were guided through an introductory presentation that offered an overview of the session. Each session started with a trust game, followed by the Demographic Questionnaire and the STRAIN, and four other tasks. Each task was started manually by the study conductor. At the end, the study conductor provided a debriefing. The participants filled out the deception-check questionnaire and signed the payment form. In the deception-check questionnaire they were asked if they noticed anything abnormal in the trust game, and if yes, to describe it. They received 22 Euros for the participation, the money got transferred by the University of Vienna.

Trust game

To investigate the effects of lifetime stress on trust and social behaviour, we used a design from behavioural economics, the so-called “Trust Game”. The game, introduced by Berg et al. in 1995, revealed that participants show a high willingness to trust and reciprocate trust in situations where interactions are anonymous and carefully controlled. This made the Trust Game a valuable method for measuring trust. Subsequent research further validated the Trust Game's ability to specifically measure trust, distinct from factors like risk (Houser et al., 2010) and purely altruistic motives (Brülhart & Usunier, 2012). Validating the use of monetary exchange in trust games, Vilares et al. (2012) additionally suggest that trust is a personality trait and subjects who are trustful in monetary settings behave similarly during

other exchanges. Due to its reliability and versatility, the Trust Game has become a widely accepted tool for assessing trust levels across various contexts.

In the standard, one-shot version Subject A ("the Investor") starts with 10 € and then decides how much of that money will be given to subject B ("the Trustee"), knowing that this share will be tripled before it is actually given to subject B. Subject B receives the tripled amount and determines how much to return to subject A (Tzieropoulos, 2013). We decided to have several rounds of the interaction with two trustees. The participants played 16 rounds in the role of the “investor” with two alternating trustees. In our study, the trustees were not real people but simulated by the game. One trustee was the “trustworthy / prosocial” player, the other trustee was the “not trustworthy / selfish” player. At the beginning of every round, the investor received an endowment of 10 monetary units (MU). They then had to invest at least one MU in the other player. The investment was tripled and transferred to the trustee, who then made a back-transfer. In the first two rounds, the trustees' back-transfers were 100% of the subject's investment so that there were no immediate ceiling or floor effects on the investment and the following adaptation could be easily measured. For the remaining rounds, for the prosocial trustee back-transferred were either 100%, 150%, or 200% of the investment. The selfish trustee on the other hand transferred either 100%, 75%, or 50% of the investment. Each option had an equal chance of happening. See Figure 1 for a visual depiction of the game.

The investor, however, did not receive any prior information about the trustees and had to learn through trial-and-error how to best invest their money (i.e., high investments with the prosocial trustee, low investments with the selfish trustee).

After 10 rounds the subjects were asked to rate the trustworthiness of the trustee they were playing against with a slider on a scale from 0 to 10. The goal of the game was to have as many MU left in the end as possible.

The participants were told at the beginning of the game that they could, in addition to the agreed payment, earn extra money (up to two Euros) in this task. This was not true as everyone received the same amount in the end, no matter how much MU they had. In the beginning of this task they were also told that they would play against “real” people, meaning other participants. With the deception-check questionnaire in the end, we controlled if the participants were able to notice that they were only playing against an algorithm. The deception was cleared up during the debriefing.

Stress and Adversity Adventory (STRAIN)

The Stress and Adversity Adventory (STRAIN) was developed to assess lifetime stress using a self-report questionnaire (Slavich & Shields, 2018). Questions are presented serially and participants respond by clicking on the computer screen. It assesses 55 stressors, including 26 acute life events and 29 chronic difficulties that are known to affect health. It covers 12 stressors in major life domains, including housing, education, work, health, marital/partner, reproduction, financial, legal/crime, life-threatening situations, etc.. It also includes five different socio-psychological characteristics: interpersonal loss, physical danger, humiliation, entrapment, and role change/disruption (Slavich & Shields, 2018).

For each stressor the participants are asked follow-up questions that determine each stressor's timing, frequency and duration. The STRAIN also measures the perceived severity of the stressors. It therefore allows us to evaluate the "objective" stress experience (the stressor count) and also the "subjective" stress experience (the stressor's severity) (Slavich & Shields, 2018).

For example, the participant gets asked if they had ever experienced being fired from a full-time job. If they answer "Yes," additional questions follow, asking them about the number of occurrences, the stressfulness or threat level at its peak, the timing in the participant's life, and the duration of the stressor. The question about the stressfulness, accounting for the perceived severity, uses a Likert-Scale (e.g.: How stressful or threatening was this for you at the worst time? Hardly or not at all / A little / Moderately / Quite Extremely).

To assess each participant's lifetime stress exposure, a cumulative total lifetime stressor count and a cumulative total lifetime stressor severity are calculated. The possible range for lifetime stressor count is 0–166, for the perceived severity 0–265.

The STRAIN exhibits strong concurrent and predictive validity, displaying robust correlations with commonly utilised stress assessment instruments across various time periods (Sturmbauer et al., 2019).

Statistical analysis

In order to understand the association between lifetime stress, trust, and learning to trust, we ran two separate mixed effects models (one assessing lifetime stress frequency and one lifetime stress severity) using an Areas Under the Curve (AUC) as the dependent variable. AUCs are often used to comprise information for repeated measurements (Pruessner et al., 2003). In our study, the AUCs were calculated as a summarised score for task

performance to investigate the given trust towards another person. Specifically, for each participant, the AUC for the prosocial player and the AUC for the selfish player were calculated separately over all 16 trials (or interactions). All 16 trials of each participant and each interaction partner were combined into one AUC. The AUC then measured the accumulated effect of interacting with, and learning to trust, the interaction partner. Higher AUCs for the prosocial partner represent higher investment, while lower AUCs for the selfish partner showcase lower investment. It therefore also predicts how well the participant can distinguish between the prosocial and selfish interaction partner.

We then calculated two linear mixed effect models to examine the influence of lifetime stress on trust learning (the AUC). In each model we included the AUCs as outcome variables and the STRAIN (frequency and severity), age, gender, and interaction partner (prosocial versus selfish) as predictors. Age and gender of the participants were included as covariates. The inclusion of these covariates is based on existing research, suggesting that, when compared to younger adults, older adults give more money to untrustworthy interaction partners and less to trustworthy partners (Seaman et al., 2023). They also show less learning than younger adults (Seaman et al., 2023). Older adults as well have impaired amygdala-mediated trust learning (Sladky et al., 2022). Additionally, effects of stress and age are interactive (Graham et al., 2006). Regarding gender, some studies have shown that women experience more stressful life events than men (Armstrong et al., 2018). A variety of studies also investigated if gender differences in trusting others exist, but the results vary a lot, and there's no clear answer to if and how gender influences trust in an economic interaction (Buchan et al., 2008).

We ran simple intercept models, with participant ID as our random intercept for each model. The analyses were conducted in R and Jasp.

Results

Descriptive Statistics

We had a non-clinical sample with 36 men, 129 women and two participants that chose not to disclose their gender identity. To assess the levels of life stress, we determined the number of stressors (stressor count) and severity of the stressors of each participant with the STRAIN questionnaire. The participants experienced an average of 27.8 stressors over the lifespan (Median = 25, SD = 15.0; range = 1 - 93, possible range: 0–166), with an average total lifetime severity score of 66.6 (Median = 61, SD = 37.0; range = 5 - 198, possible range:

0–265). In comparison, the German validation study conducted by Sturmbauer et al. (2019) reported 15.65 stressors over the life course (SD = 10.61; range = 0–71) and overall lifetime severity of 37.61 (SD = 26.80; range = 0–163). After comparing our study to theirs and examining our distribution, we can conclude that we had a moderately stressed sample with higher levels of stress among some participants.

Trust game and monetary behaviour

After looking at the data of the trust game, we excluded participants if the difference between the amount of money they gave to the social player and the amount of money they gave to the selfish player was zero. In this case, the participants maybe did not understand the task or failed to differentiate between the two players. Of the 173 participants who completed the study five participants were excluded.

Lifetime stress and trust-behaviour

To understand the association between lifetime stress, trust and learning to trust, we ran two mixed effect models. We used AUCs for trust as an outcome variable, and the STRAIN (frequency and severity), age, gender and interaction partner as predictor variables. For the models we ran simple intercept models with the participant ID as our random intercept. The models included fixed effects for each predictor variable. For the models, men were the reference group (Group =1). The models were as follows:

Stress severity

The first model investigated the main effects of age, gender, interaction partner (prosocial or self), and standardised severity rating of life stress on participants' AUC scores. Age (Estimate = -6.037 [SE = 0.006], t(167) = -0.001, p = 0.999), gender (Women: Estimate = -6.725 [SE = 0.108], t(167) = -0.6261, p = 0.532; Other: Estimate = 4.500 [SE = 0.417], t(167) = 1.078, p = 0.283), and the stress severity rating (Estimate = -0.070 [SE = 0.046], t(167) = -1.515, p = 0.132) did not have a significant effect on the investment behaviour. However, the results showed that investment behaviour in the trust game significantly differed based on the interaction partner (iPself) (Estimate = -1.484 [SE = 0.057], t(167) = -26.244, $p < 0.01$), indicating that participants behaved differently depending on the other player. Participants exhibited lower AUC scores when interacting with a selfish partner.

We then included an interaction term between interaction partner and standardised severity rating of life stress. The results showed again that investment behaviour differed

significantly based on the interaction partner (Estimate = -1.484 [SE = 0.056], t(167) = -26.600, p < 0.01). Furthermore, the interaction between the interaction partner and the severity rating had a significant effect on investment behaviour (Estimate = -0.012 [SE = 0.056], t(167) = -2.127, p = 0.035), suggesting that the relationship between iP and AUC was moderated by the level of stress severity. Age (Estimate = -0.000 [SE = 0.006], t(167) = -0.001, p = 0.999), gender (Women: Estimate = -0.067 [SE = 0.108], t(167) = -0.626, p = 0.532; Other: Estimate = 0.450 [SE = 0.417], t(167) = 1.078, p = 0.282), and stress severity alone (Estimate = -0.010 [SE = 0.054], t(274) = -0.200, p = 0.841) did not have a statistically significant effect on investment behaviour in this model. See Table 1 and 2 for an overview of the results.

Stress frequency

For the second model we then investigated the main effects of age, gender, interaction partner (prosocial or self), and standardised count of life stress events on participants' AUC scores, and also the interaction between interaction partner and standardised count/frequency. When looking at the main effects, age (Estimate = -0.001 [SE = 0.005], t(167) = -0.204, p = 0.838),
gender (Women: Estimate = -0.081 [SE = 0.107], t(167) = -0.760, p = 0.448); Other: Estimate = 0.367 [SE = 0.413], t(167) = 0.890, p = 0.377), and stressors count (Estimate = -0.043 [SE = 0.045], t(167) = -0.961, p = 0.338) did not have a significant effect on the investment behaviour. Similar to the previous model, the investment behaviour significantly varied based on the interaction partner (Estimate = -1.484 [SE = 0.057], t(167) = -26.244, p < 0.01).

Finally, we examined the interaction between interaction partner and standardised count/frequency of life stress on AUC scores. The results indicated that investment behaviour significantly varied based on the interaction partner (Estimate = -1.485 [SE = 0.056], t(167) = -26.547, p < 0.01). However, age (Estimate = -0.001 [SE = 0.005], t(167) = -0.205, p = 0.838), gender (Women: Estimate = -0.082 [SE = 0.107], t(167) = -0.760, p = 0.448; Other: Estimate = 0.367 [SE = 0.414], t(167) = 0.886, p = 0.377) and the frequency of stressors alone (Estimate = 0.011 [SE = 0.053], t(277.547) = 0.213, p = 0.832) did not have a significant effect on the investment behaviour. However, the interaction between the stressor's frequency and interaction partner was barely not significant (Estimate = -0.110 [SE = 0.056], t(167) = -1.969, p = 0.051). See Table 3 and 4 for an overview of the results.

Taken together all four models, we saw that with an increasing level of experienced life stress severity, the AUCs decreased. However, the effect was only visible for the AUCs towards the selfish interaction partner.

Discussion

Despite a growing number of studies aimed at identifying how stress influences our prosocial behaviour, surprisingly little is known about the impact of chronic stress, more specifically the exposure to lifetime stress, on trust and the building of trust. This is striking given how important trust, and trusting others, is for everyday decisions (Sladky et al., 2021). The research objective of this study was to examine the impact of lifetime stress, measured by aversive life events, on trust and trust building. Specifically, the study aimed to investigate how individuals' monetary behaviour in a trust game changes depending on their experience of life stress and the behaviour (selfish / prosocial) of their interaction partner. The focus was on understanding the effect of lifetime stress on learning to, and building trust, a fundamental component of socially connectedness in our every-day life. The purpose of this research was to fill the gap in the existing literature by providing insights into the relationship between lifetime stress exposure and trust-related behaviours.

When looking at the trust behaviour in the trust game, the majority of the participants initiated the trust game by contributing five MU, which was in line with expectations, given its status as a relatively secure choice. Following the initial two rounds with each interaction partner, the learning phase started. The participants learned to understand the behavioural patterns and responses of each interaction partner following the money transfer. Subsequently, they adapted their investment, resulting in a steady learning curve (see Figure 2). As hypothesised, the resulting adaptation indicates that the behaviour of the interaction partner impacts investment behaviour in the trust game. Participants learned to differentiate between the selfish and the prosocial player, and adapted their monetary behaviour.

This observed behaviour is consistent with findings from previous research. Individuals show behavioural adaptability most of the time, and change their level of trust in response to behavioural signals from others (Bell et al., 2018). A study by Fett et al. (2012) observed a similar pattern to our results, where healthy subjects adjusted their levels of trust based on direct behavioural feedback (high/low money return) in a trust game. Furthermore, the perception of distrust has been shown to influence attitudes towards others (Macko, 2020). As the act of giving less money may be perceived as an expression of distrust, this

could explain how our participants learned quickly to send less money to the selfish player. Throughout, people invest more money with trustees whose reputation and facial appearance suggest they are trustworthy rather than untrustworthy (Bailey et al., 2015). A trustee's perceived ability and benevolence are the factors most associated with trust in interpersonal relationships (Mayer et al., 1995). Participants also make significantly higher investments when being informed that they interact with a trustworthy counterpart (Fett et al., 2012). This underscores the significance of feedback, which, in our study, took the form of money return. People's decision-making is frequently influenced by social cues or feedback (Colombo et al., 2014). Recent research by Brudner et al. (2023) demonstrated that participants shared more with other participants who provided more positive feedback.

Our study extends this understanding even further, as the results revealed that with an increasing level of lifetime stress, trust in the selfish interaction partner decreased, as indicated by the fact that participants with a higher level of life stress gave less money to the selfish player. However, the interactions with the prosocial players remained unaffected by higher stress levels, when compared to lower levels.

Acute stress is known to increase sensitivity to social feedback (Feldman-Hall et al., 2015). In our study, increasing levels of experienced life stress corresponded to growing distrust towards the selfish player. Leaning on the study by Feldman-Hall et al. (2015), this might indicate that increased stress levels heighten our sensitivity to behaviours that are antisocial or punitive. This explanation would align with the common phenomenon in social relationships called "altruistic punishment", which represents the punishment of unfair behaviour by others, even at a personal cost (Fehr & Gächter, 2002). Vinkers et al. (2013) investigated if acute stress affects how people respond to unfair offers in a game called the "Ultimatum Game" (UG). In the UG, one person proposes a way to split some money with another person. The second person can either accept the offer and both get the money as proposed or reject it, and neither person gets anything. The researchers found that, overall, the likelihood of rejecting an offer in the UG depended on how much of the money was being offered (Vinkers et al., 2013). However, when playing the game immediately after being experimentally induced stressed, the rejection rate was higher (Vinkers et al., 2013). This mechanism could also apply for individuals with high levels of lifetime stress. Another broader implication of the present study could be that higher levels of lifetime stress prompt more extreme behaviour. Higher chronic stress is known to predict greater negativity bias, characterised by expectations of negative outcomes, and also predicts poorer social skills (Braund et al., 2019). This could then lead to reacting more extremely to antisocial or

punishing behaviour, as shown in our results. Moreover, increasing levels of experienced life stress could lead to a generalised increase in distrust. Bell et al. (2018) found that participants who have experienced interpersonal trauma, invested far less in the prosocial interaction partner than did controls. Interestingly enough, contrary to our findings, investments towards the selfish interaction partner in the trust game were equally among the healthy and the stressed group (Bell et al., 2018). Similarly, higher levels of child maltreatment are also linked to higher levels of mistrust later in life (Hepp et al., 2021). Ceccato et al. (2018) revealed that women's preferences for hypothetical incentives are negatively associated with chronic stress levels and lead to lower hypothetical transfers. Nonetheless, in our study, the stress levels alone (severity and stressor count) did not significantly impact investment decisions in the trust game. Our hypothesis that life stress alone influences trust was therefore not supported.

Instead, the relationship between lifetime stress and trust is influenced by the perceived severity of life stress, but not the stressor count. When examining the impact of lifetime stress, our results revealed that solely the lifetime stress severity, but not the frequency of experienced life stressors, had a significant impact on the relationship between the interaction partner and the participant's behaviour. Few existing studies already suggest that employing subjective ratings of stressor severity can enhance the relationship between stress and psychological effects (Espejo et al., 2010). Consistently, subjective assessments of stress severity have shown to be stronger indicators of poor health than exposure to stressors (Shields et al., 2022, Toussaint et al., 2014). Two explanations have been proposed in the past. First, whereas stressor exposure measurements treat all stressors equally, stress severity measurements, which "weight" stressors according to their intensity as reported by the subject, may be able to more accurately predict bad health by avoiding treating all stressors equally (Shields et al., 2022). Second, individual differences in stress vulnerability may be crucial indicators of subjective stress evaluations (Shields et al., 2022). These two assumptions could be applicable on trust behaviour as well.

Nonetheless, the frequency of experienced stressors obtained a p-value of 0.051, just outside the conventional threshold for statistical significance ($p < 0.05$). While this result does not meet the traditional criteria for significance, it still warrants careful consideration and interpretation. The marginal level of significance of the stressor frequency suggests that there might be some potential trends or effects present in the data. It is important to acknowledge that the lack of statistical significance at the conventional threshold may be due to various factors, such as the sample size, the variability of the data, or other uncontrolled

variables. Still, future investigations are necessary to validate the kinds of conclusions that can be drawn from this study.

Taken together, our findings still embed in previous research revealing no connection between self-reported social trust and hardship in childhood (Lettinga et al., 2021). In their assessment of childhood adversity, Lettinga et al. (2021) used Childhood Environmental Adversity and Life-history Strategy Items, which solely measure the frequency of stressors and not their perceived severity. Similarly, Ceccato et al. (2018) concluded that the perceived chronic stress has overall no effect on social choices in monetarily rewarded dictator decisions for either gender. In their study, the authors used the Tries Inventory for Chronic stress that measures the frequency of stressful events in the last three months, but not the severity of them (Ceccato et al., 2018). These results thus imply, in line with our study, that the frequency of stressors has no significant influence, as it is also in our results.

While investigating the influence of lifetime stress on trust and learning to trust, we also examined the potential role of covariates, specifically age and gender. The inclusion of these covariates in the analysis derives from their potential association with trust-related behaviours (Seaman et al., 2023, Armstrong et al., 2018). The results revealed that neither age nor gender exhibited statistically significant associations with trust. It suggests that, in the specific context of our study, these variables may not be drivers of trust-related behaviours or in the trust learning process. This outcome deviates from some earlier studies that reported significant effects of these variables on trust dynamics. Nevertheless, the results still align with existing studies. When considering age, the outcomes are consistent with the outcome by Sutter & Kocher (2007). In their study, the authors concluded that trust grows almost linearly from childhood to early adulthood, but remains relatively constant across adult age groups (Sutter & Kocher, 2007). Notably, all our participants were 18 years or older, and therefore an exclusively adult group. Turning to gender, a meta-analysis by Van Den Akker et al. (2020) investigating the relationship between trust and gender found no significant gender difference in the gift-exchange game ($g = 0.15$). In terms of the trust game, men exhibited higher levels of trust ($g = 0.22$), but when it came to trustworthiness, no significant gender difference emerged ($g = 0.04$) (Van Den Akker et al., 2020). Future research should explore specific contexts and conditions, but also investigate potential interaction effects.

Summarising previous findings and our own results, the topic has yielded mixed findings. Previous research supports the idea that people adapt their behaviour based on

interaction partner cues, we concluded that this is true even with higher levels of lifetime stress exposure. We propose that lifetime stress may heighten sensitivity to antisocial behaviour, leading to an increase in distrust towards selfish individuals. Additionally, experienced life stress can lead to a greater negativity bias and poorer social skills, potentially contributing to the observed results. Our study adds to the limited knowledge about exposure to lifetime stress and trust behaviour, and provides valuable insights that may help clarify some aspects. While the frequency of experienced stressors did not yield statistically significant results, the marginal p-value and the observed trends suggest avenues for further exploration. Further research is needed to better understand the complexities of the relationship between lifetime stress, trust, and the building of social connections.

Limitations and directions for further research

The study has a few limitations that should be considered when interpreting the results. First, we used the trust game as a measure of trust. Even though studies have shown that the trust game's measure of trust significantly predicts generalised self-reported trust (Banerjee et al., 2021), its efficacy as a "good" measure of trust is still questioned. A practical concern is if "giving money" is a valid measure for trust, as there could be other confounding factors such as prosocial motivations (Alós-Ferrer & Farolfi, 2019). For future studies researchers should therefore consider combining the trust game with other measures and study designs to gain a more comprehensive understanding of trust in various contexts. Second, since we used a self-report questionnaire, the STRAIN, to assess stress, self-reporting biases may still have had an unmeasured impact on the outcomes. The participants' accounts of the stressors they have experienced throughout their lives also may have been influenced by recent stressors as well (Slavich & Shields, 2018). Third, gender was not equally distributed in our sample, with way more women than others (129 women to 36 men and 2 participants that did not disclose further information). We had a wide age of range, but the study sample also exhibited homogeneity with respect to ethnic groups. Future research should thus strive to include samples that demonstrate greater representativeness of the target population. Finally, the present study focused exclusively on self-report measures to assess experienced lifetime stress, and did not involve the collection of biological samples. Given the potential significance of biological markers, particularly cortisol, future investigations should consider assessing biomarkers as well. Incorporating these measures would provide valuable insights into the physiological underpinnings of lifetime stress and deepen the understanding of its relationship to trust and prosocial behaviour.

In conclusion, this study contributes to the existing literature by providing valuable insights into the impact of experienced lifetime stress on trust and trust behaviour. The results show that participants were able to adapt their behaviour, consequently their levels of trust, to the nature of the interaction partner. The results demonstrate that stress severity plays a critical role in shaping individuals' trust-related behaviours. The count of the experienced stressors, however, does not. When we look at the research that came before ours and compare it with our findings, we see that not enough attention has been given to the severity of experienced life stress. This reveals a new field to explore in our future studies. Our findings highlight the importance of considering assessments of stress severity in understanding the influence of lifetime stress on behavioural outcomes.

The study additionally gives implications where future research should go, for instance exploring alternative measures of trust and incorporating biomarkers to gain a more comprehensive understanding of the physiological underlyings of lifetime stress and its effects on trust and prosocial behaviour. Future investigations can build upon this research and further deepen our knowledge about the relationship between lifetime stress experience, trust, and the building of social connections, and thereby contributing to a better understanding of human behaviour in stressful contexts. Deepening our understanding of how stress influences our ability to socially connect with and trust others could have valuable implications for improving interpersonal relationships and decision-making in daily life. Given the challenges posed by the pandemic, which has led to a period of heightened stress and impacted our trust in one another —as acknowledged in the study—the insights gleaned from this research can additionally serve as a foundation for contemplating potential interventions in the future.

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Figures:

Figure 1

Visualisation of the trust game

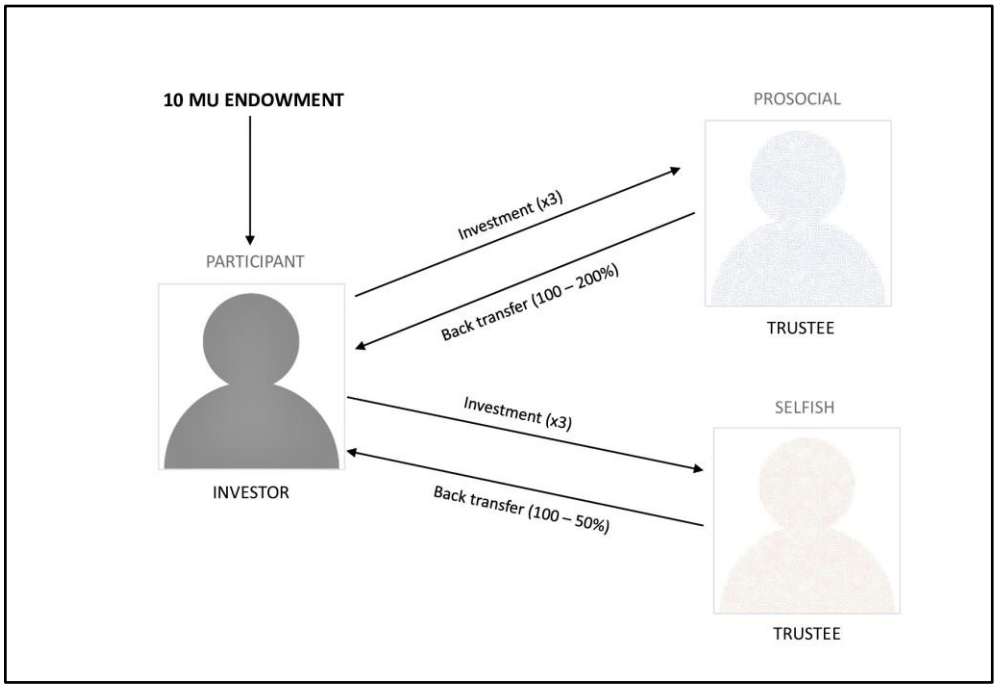

Figure 1. Repeated Trust Game Design: The investor receives an endowment of ten monetary units (MUs) at the beginning of each round. Each round, they then make an investment (between one and ten MUs), which gets tripled and sent to the trustee (prosocial or selfish). The interaction partner then makes a back-transfer. The prosocial trustee sends at least 100% up to 200% of the investment back, while the selfish trustee sends lower amounts, starting by 100% up to 50% of the investment.

Figure 2

Mean investment of the participants

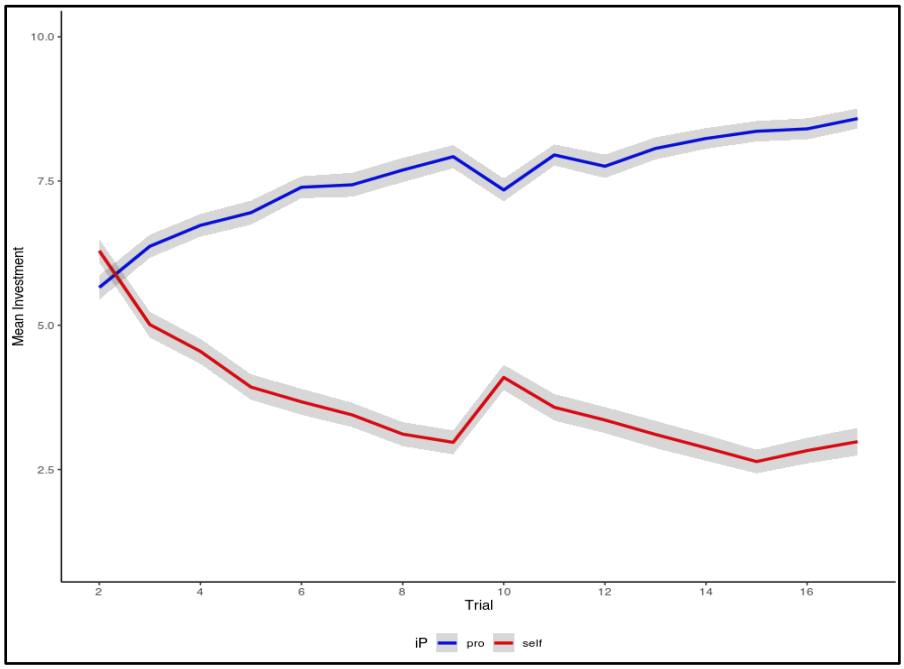

Figure.2: The participants initiated the trust game by contributing five MU, which represents a relatively secure choice. In the first two rounds, the trustees' back-transfers were 100% of the subject's investment so that there were no immediate ceiling or floor effects on the investment. Following the initial two rounds with each interaction partner, a learning phase started. During this phase, participants adjusted their investments, leading to the observed investment pattern where more was invested in prosocial players and less in selfish players. Before round 10, the participants were asked to rate the trustworthiness of their interaction partners. This resulted in a short disruption of their monetary behaviour, showcased in the outliers of the learning curve at trial 10. However, it is noteworthy that this deviation was transient, as the participants fell back into their learned behaviour shortly after. The plot displays the mean investment of all participants.

Figure 3

Distribution of the lifetime stressor data

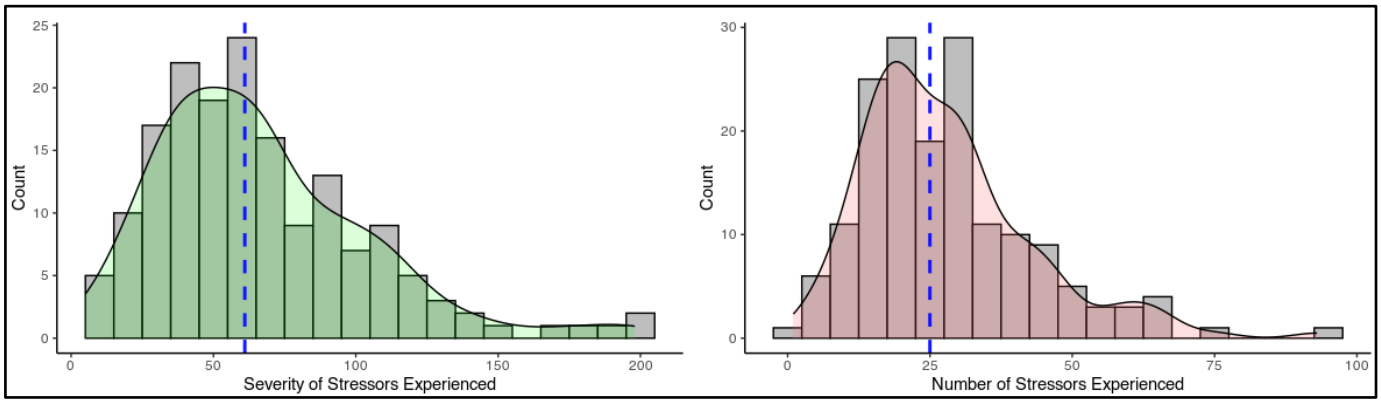

Figure 3: The participants experienced on average a total lifetime severity score of 66.6 (-SD = 37.0)(left panel), and 27.8 stressors (SD = 15.0)(right panel) over the lifespan. The blue dotted line represents the median.

Tables:

Table 1

Model 1

	Estimate	SD	t	df	p
(Intercept)	0.784	0.193	4.058	174.310	< -0.000
Age	< -0.000	0.006	-0.001	167.000	0.999
Gender 2	-0.067	0.108	-0.626	167.000	0.532
Gender 3	0.450	0.417	1.078	167.000	0.283
Interaction partner (selfish)	-1.485	0.057	-26.244	167.000	< 0.000

STRAIN: severity	-0.070	0.0463	-1.515	167.000	0.131

Note: Gender refers to 1 = Men, 2 = Woman; 3 = Other.

Table 2

Model 2

	Estimate	SD	t	df	p
(Intercept)	0.826	0.191	4.322	174.476	< 0.000
Age	-0.001	0.005	-0.205	167.000	0.838
Gender 2	-0.082	0.107	-0.760	167.000	0.448
Gender 3	0.367	0.414	0.886	167.000	0.377
Interaction partner (selfish vs prosocial)	-1.485	0.057	-26.244	167.000	< 0.000
STRAIN: frequency	-0.044	0.045	-0.961	167.000	0.338

Note: Gender refers to 1 = men, 2 = Woman; 3 = Other.

Table 3

Model 3

	Estimate	SD	t	df	p
(Intercept)	0.784	0.193	4.059	174.118	< 0.000
Age	< - 0.000	0.006	-0.001	167.000	0.999
Gender 2	-0.067	0.108	-0.626	167.000	0.532
Gender 3	0.450	0.417	1.078	167.000	0.283
Interaction Partner (selfish vs prosocial)	-1.485	0.056	-26.597	167.000	< 0.000
STRAIN: severity	-0.010	0.054	-0.200	274.083	0.841
Interaction iP * STRAIN	-0.119	0.056	-2.127	167.000	0.035

Note: Gender refers to 1 = men, 2= Woman; 3= Other.

Table 4

Model 4

	Estimate	SD	t	df	p
(Intercept)	0.826	0.191	4.323	174.307	< 0.000
Age	-0.001	0.005	-0.205	167.000	0.838
Gender 2	-0.082	0.107	-0.760	167.000	0.448
Gender 3	0.367	0.414	0.886	167.000	0.377
Interaction partner (selfish vs prosocial)	-1.485	0.056	-26.547	167.000	< 0.000
STRAIN: frequency	0.011	0.053	0.213	277.547	0.832
Interaction iP * STRAIN	-0.110	0.056	-1.969	167.000	0.051

Note: Gender refers to 1 = men, 2 = Woman; 3 = Other.

Abstract English

Social connections are exceptionally significant for our physical and mental health, and research now focuses on investigating what influences our ability to socially connect with others. Stress is one influencing factor; however, research is scarce and the findings often conflict with one another. This research thesis examined the impact of the exposure to lifetime stress on trust and trust building. Using the trust game, 173 participants interacted with a prosocial and a selfish interaction partner run by a computer program. The magnitude of the participants' monetary investment in the interaction partner represented trust. Life stress of the participants was assessed using the Stress and Adversity Inventory (STRAIN) questionnaire. Two separate mixed effects models using an areas under the curve (AUC) as the dependent variable were run. Results showed that life stress alone did not influence the monetary behaviour and therefore trust, but the nature (prosocial/selfish) of the interaction partner did. The relationship was further influenced by the perceived severity of life stress as participants with a higher perceived severity of life stress gave less money to the selfish player. The results indicate that with increasing levels of lifetime stress, people become more distrustful, especially towards a not-trustworthy person. We suggest that higher levels of lifetime stress can make us more sensitive to antisocial and/or punishing behaviour. It maybe also lead to more extreme behaviour.

Abstract Deutsch

Soziale Bindungen sind von außerordentlicher Bedeutung für unsere physische und psychische Gesundheit. Es wird nun erforscht, was unsere Fähigkeit, soziale Bindungen zu anderen aufzubauen, beeinflusst. Stress ist ein bedeutsamer Einflussfaktor, es gibt jedoch nur wenige Studien dazu, und die Ergebnisse stehen oft im Widerspruch zueinander. In dieser Forschungsarbeit wurde untersucht, wie sich die Belastung durch das Erfahren von lebenslangem Stress auf das Vertrauen und das Bilden von Vertrauen auswirkt. 173 Teilnehmer:innen interagierten im "Trust Game" mit einem "prosozialen" und einem "egoistischen" Interaktionspartner. Das Ausmaß der monetären Investition der Teilnehmer in den Interaktionspartner stellte das Vertrauen dar. Der Lebensstress der Teilnehmer:innen wurde mit dem "Stress and Adversity Inventory" (STRAIN)-Fragebogen erfasst. Es wurden zwei separate mixed effect models durchgeführt, bei denen die Areas Under The Cuve (AUC) als abhängige Variable verwendet wurden. Die Ergebnisse zeigen, dass Lebensstress allein keinen Einfluss auf das monetäre Verhalten und damit auf das Vertrauen hatte, wohl aber das Verhalten (prosozial/egoistisch) des Interaktionspartners. Die Beziehung wurde außerdem durch den wahrgenommenen Schweregrad des Lebensstresses beeinflusst. Teilnehmer:innen mit einem höher wahrgenommenen Schweregrad des Lebensstresses gaben dem egoistischen Spieler weniger Geld. Die Ergebnisse deuten darauf hin, dass Menschen mit zunehmendem Lebensstress misstrauischer werden, insbesondere gegenüber einer nicht vertrauenswürdigen Person. Wir vermuten, dass ein höheres Maß an lebenslangem Stress uns empfänglicher für antisoziales und/oder strafendes Verhalten machen kann. Er kann auch zu extremerem Verhaltensweisen führen.