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Vegan = Artificial? Perceived naturalness of vegan meat substitutes and animal products based on different processing stages

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Abstract

Veganism and vegan substitute products are on the rise and are becoming increasingly popular. Still, they are commonly tied to being ultra-processed. This study examined the perceived naturalness of vegan substitute products versus meat and dairy products using different processing levels to gather more information on the current beliefs of people regarding these types of foods. The results revealed that vegan substitute products are perceived to be less natural than meat or dairy products, but the study could not yield significant results on whether processing levels increase this perception. Participants who indicated to be vegan or vegetarian rated meat products as less natural than people consuming animal products. These results could contribute to further research on liking and consumption of vegan substitute products and thereby positively impact the movement against climate change.

Keywords: naturalness, vegan, meat substitute products, environment, food processing

German Abstract

Eine vegane Ernährungsweise und zugehörige Ersatzprodukte erleben einen Aufschwung und gewinnen zunehmend an Popularität. Die Akzeptanz von veganen Ersatzprodukten ist entscheidend für die Reduktion des Fleischkonsums und die Förderung einer nachhaltigeren Ernährungsweise. Dennoch werden sie häufig als stark verarbeitet angesehen. In dieser Studie wird die wahrgenommene Natürlichkeit von veganen Ersatzprodukten im Vergleich zu Fleisch- und Milchprodukten in unterschiedlichen Verarbeitungsstufen als eine potenzielle Erklärung untersucht, um mehr Informationen über die Ansichten der Menschen in Bezug auf diese Lebensmittel zu sammeln. Die Ergebnisse zeigten, dass vegane Ersatzprodukte im Vergleich zu Fleisch- oder Milchprodukten als weniger natürlich wahrgenommen werden. Die Studie konnte jedoch nur teils signifikante Ergebnisse darüber liefern, ob aufsteigende Verarbeitungsstufen diese Wahrnehmung verstärken. Teilnehmer:innen, die angaben, vegan oder vegetarisch zu sein, bewerteten Fleischprodukte weniger natürlich als Personen, die tierische Produkte konsumieren. Diese Ergebnisse könnten zur weiteren Forschung über die Akzeptanz und den Konsum von veganen Ersatzprodukten beitragen und damit positiv die Bekämpfung des Klimawandels beeinflussen.

Schlüsselwörter: Natürlichkeit, vegan, Fleischersatzprodukte, Umwelt, Lebensmittelverarbeitung

Introduction

If there is one topic that should currently be highly relevant to every single person on this planet, it is the pressing issue of climate change. Humanity is rapidly exhausting nature's resources and is fast approaching a very dangerous point of no return. Political measures all over the world are starting to be taken but mostly do not go far enough as to relieve the population's fear of this situation. Many individuals are therefore left with their self-directed motivation to live a more environmentally friendly life by renouncing to habits that contribute to heightened co₂-emissions (Stollberg & Jonas, 2021).

The present study is tied to this self-directed motivation, wanting to contribute to heighten it by exploring consumer's perception of environmentally friendly products vs. conventional products. One habit that plays a big role is meat and animal product consumption, which is why this study will focus on the perception of vegan substitute products in comparison to meat.

A meat-based diet requires more energy, land and water resources and is therefore less sustainable than a plant-based diet (Pimentel & Pimentel, 2003). More precisely, livestock farming for meat and animal product consumption purposes make up 18% of anthropogenic greenhouse emissions worldwide (Burdick & Waskow, 2009), which is why lowering one's meat consumption should be a priority in order to contribute to sustainability. People's level of concern regarding sustainability in food production is high (Grunert et al., 2014), and given this background, it is no surprise that veganism and vegetarianism are a rapidly growing trend in many western countries. A vegetarian diet excludes all types of animal meat and by-products of animal slaughter. A vegan diet follows a stricter philosophy by excluding all animal products from their lifestyle and particularly their diet, thereby refraining from consuming meat, eggs, dairy products and other animal derived substances. The estimated number of people in Germany who classify themselves as vegetarians was 6,50 million in 2020, which makes up

7,8% of the German population. Within three years that number grew to 8,12 million (Institut für Demoskopie Allensbach, 2023), which makes up roughly 10% of the entire German population. In 2016, the amount of people who followed a vegetarian diet were merely 4,6% (Mensink et al., 2016). Even the more restricting vegan diet is becoming increasingly popular, counting 1,13 million people who classified themselves as vegan in Germany in the year 2020, and 1,52 million in 2023 (Institut für Demoskopie Allensbach, 2023). The reasons for endorsing these two types of diets are amongst others their health benefits, animal rights but also their benefit to the environment (de Boer et al., 2017; Leitzmann, 2014). Due to the increasing number of vegans and vegetarians, meat and animal product substitute options are becoming more diverse and numerous. Vegan or vegetarian meat and dairy alternatives are products that resemble animal products regarding their taste and texture and oftentimes also have a similar protein content. The products are mostly made from cereal, legumes or mushrooms. Supermarkets nowadays offer a great variety of substitute products, and the selection continues to grow. Sales of vegan and vegetarian foods nearly doubled from 2017 to 2019. (*Umsatz mit vegetarischen und veganen Lebensmitteln in Deutschland bis 2019*, n.d.). The trend towards plant-based is a great step forward for a more environmentally friendly lifestyle, but there are still some reservations around this topic. This study seeks to explore how plant-based meat alternatives are perceived by comparing them to equivalent meat products and having participants rate the perceived naturalness of said products. The aim of the study is to find out whether vegan substitute products are perceived as less natural than animal products, as a potential reason for a lower acceptance of these products.

Acceptance of vegan substitute products

The variety and abundance of substitute products is important because according to Apostolidis & McLeay (2016) an effective way to lowering society's meat consumption is the replacement of animal products with meat substitutes. Replacing a known and liked dietary

staple like meat with a similar tasting and looking food reduces the effort of altering one's diet and therefore increases the possibility of reducing one's meat consumption which then again could contribute to lowering anthropogenic greenhouse emissions.

Unfortunately, in spite of the ever-increasing number of vegetarians and vegans, the overall acceptance of meat substitutes is rather low (Apostolidis & McLeay, 2016; Elzerman et al., 2011) and the amount of people who regard environmental friendliness as one of their primary factors in choice of food is low as well (Grunert et al., 2014).

A possible explanation could be the marginalization and stigmatization of vegans in the mass media and social settings in addition to the devaluation of this specific lifestyle by non-vegans (Cole & Morgan, 2011; Markowski & Roxburgh, 2019). Avoiding meat and animal products forms part of a more ethical way of eating and thus also contributes to being more sustainable. Such an exemplary lifestyle however could be very demanding and would mean significant changes in people's diet and behavior, possibly leading to people who embrace a meat-based diet to potentially hold contradicting values (Rothgerber, 2014). Sustainability or animal welfare can be important for a person even though they like to eat meat at the same time. Upholding two contradicting values might feel uncomfortable. The devaluation of veganism presents a coping strategy that helps non-vegans avoid the confrontation with the ethics regarding omnivorous eating habits (Cole & Morgan, 2011). According to this reasoning, it is no wonder that vegan and vegetarian eating habits are the most negatively rated group out of all eating habits in the U.S. (MacInnis & Hodson, 2017). This viewpoint helps the normalization of omnivorous eating habits and therefore marginalization of plant-based diets. Vegans also tend to be associated with specific moral and ethical viewpoints such as endorsing animal rights (Wrenn, 2017). People following a meat-based diet might therefore feel threatened and as part of their identity is being judged by people following a plant-based diet which in turn could cause resentment and derogation.

A study conducted in the U.S. found that vegan food entities were twice as popular when they were labeled as “healthy” or “sustainable” instead of “vegan” (Sleboda et al., 2024). Therefore, when wanting to lower society’s meat consumption it could be more effective to focus on meat free products on their own and not categorizing them as part of a vegan or vegetarian identity (de Boer et al., 2017). The difficulty here however lies in the fact that substitute products are still niche products and overall, society still prefers meat over a substitute (Apostolidis & McLeay, 2016; Sleboda et al., 2024). To increase the consumption of meat substitutes and thus reduce the environmental impact, it is important to find out what prevents consumers from buying meat substitutes or motivates them to choose meat alternatives, as there is no comprehensive answer yet. The present study aims to further close this gap in research by proposing a new approach as to why vegan substitute products are less likely to be consumed. As mentioned before, there are plenty of potential reasons for this phenomenon, but one idea has not been extensively researched yet. A possible explanation could be the perceived lower naturalness of vegan meat substitutes in comparison to „the real thing“. Meat substitutes are a rather new product and there is little research concerning their acceptance and how those substitutes could be incorporated into people’s diets (Elzerman et al., 2015). Since this approach seems very promising and holds plausible explanations which could contribute to a better understanding of people’s food choice, this study will focus on the perceived naturalness of vegan substitute products compared to meat and other animal derived products to gather more knowledge and information on that topic, as insight on the perception of meat substitutes could help increase their consumption and thus could contribute to achieving more sustainability in people’s everyday life.

Naturalness

Naturalness is one of the most aspired qualities and particularly in the domain of food, there is a „preference for naturalness“ (Rozin, 2005). Additional proof of this is provided by Li & Chapman (2012), who found that consumers chose the “natural” option over the “unnatural” one, as long as the two options were otherwise equal or there was no evidence of the “unnatural” product being superior. While it is generally accepted that naturalness is a highly positive adjective to describe foods with (Rozin, 2006), there is uncertainty about the exact definition of the term (Petty, 2015). According to the Cambridge Dictionary (2022) the term “natural” is described as “found in nature and not involving anything made or done by people”. One could assume that human intervention is consequently the factor that makes foods seem less natural to consumers. Items that are untouched and in its primal state equal natural, while processed foods indicate the contrary, which is the meaning previous studies ascribed the term “natural” (Evans et al., 2010; Rozin, 2005, 2006), and where this study will mainly lay their focus on. Nevertheless, it should not be ignored that other definitions of this term also do exist, and that naturalness is used in other contexts too.

As stated before, a food product being described as natural has a high value. Food naturalness is linked to healthiness and nutritional suitability (Bäckström et al., 2004; Siipi, 2013). Food that is natural contributes to maintaining a person’s health and energy levels, while non-natural foods could potentially harm its eater by insufficient or superabundant need satisfaction (Siipi, 2013). Consumers seem to place a great emphasis on this, as interest in foods labeled as natural is on the rise. This can be seen in the steady increase of product sales labeled as “natural” and “organic” referring to the product’s nutrition values. Products labeled as "natural" and "organic" accounted for as much as 70% of the increase in sales in large food companies from 2007 to 2011 (Cao & Yan, 2016).

According to Paul Rozin (2005), people trust foods described as natural to be desirable, as this description improves the image of said foods. The desirability of foods in their primal, untouched state is even reflected in the English language. As (Rozin et al., 2009) noticed in their research, additives frequently indicate something negative or derogatory, so to highlight additives possessing positive qualities, designated words exist like “supplements” or “fortified”.

This statement, together with the above-mentioned reasoning can be taken to mean that naturalness is probably one of the most important criteria people rely on when choosing their food, provided one can afford to choose. Consumers even believe that natural food is inherently better than other options (Rozin, 2005). What is natural is therefore more likely to be accepted. On the other hand, this means that foods that are believed to be unnatural are less likely to be accepted.

Paul Rozin (2006) did plenty of research on naturalness judgements in the domain of food that further break the reasoning behind this statement down in detail and that is explained below. His findings conclude a so-called “process sufficient hypothesis”, which postulates that if two food entities are identical in substance but one entity endured more processing steps than the other to reach the same state, the more processed entity will be rated as less natural (Rozin, 2006). Simply put, the more processing steps a food entity endures, the less natural the product is perceived. He also confirmed his postulated “process dominant hypothesis“, which confirms that a food entity which was processed twice but in that process was transformed into matching the original content is rated as less natural than a food entity that was processed only once but is different in content (Rozin, 2006). The process dominant hypothesis therefore proves that a food entity is perceived as less natural when it has endured more processing steps even when the content matches the original product. These findings support the assumption that processed content is viewed as less natural, even if it matches the original content.

The ambivalence of meat “substitutes”

Circling back to vegan meat substitute products, this finding could have some negative implications regarding their purchasing intention. As vegan protein products are marketed as meat substitutes instead of innovative products of their own, they could be viewed as less natural. The term “substitute” excludes the nativeness of the product, implying that it is not a natural entity but simply a replacement for an originally natural product such as meat. Therefore, it could be assumed that vegan and vegetarian meat substitutes are perceived as less natural than they are and thus viewed more negatively than their equivalent meat products. With the acceptance being lower for less natural products (Rozin, 2005), this perception could hinder the purchase intention of such meat substitute products.

For meat substitute products to match the content of their equivalent meat products, however, is a very important factor. If the plant-based protein product does not properly substitute a meat product, it might be bought additionally instead of in place of meat, which would defeat the purpose of reducing meat consumption in order to fight climate change (Elzerman et al., 2015). As meat is still considered to be an elementary staple in western culture’s diets and it is believed to be the conventional protein source in well-balanced meals (McBey et al., 2019), major rethinking needs to be done on which attributes lead foods to appear natural, conventional and good for consumer’s health and diet.

Elzerman et al. (2011) contributed to increase the acceptance of meat substitute products by incorporating them into a meal context. They found out that if meat substitutes fit into meals that are common and well-liked, the consumer acceptance is higher, even for omnivores. The conclusion that can be drawn from this is that conventionality and naturalness are key factors in consumer’s acceptance of new foods. People are creatures of habit, so meat substitutes need to fit into already established practices and need to be considered a suitable

replacement. For vegan protein products to properly substitute the meat component in a meal is crucial, however, it might clash with the perceived naturalness of these foods.

Naturalness and meat substitute products

As sufficiently elaborated above, consumers use naturalness as a key factor for accepting and buying new foods (Rothgerber, 2013). Meat substitute products are a rather recent phenomenon and new variations are constantly premiering in supermarkets. In a study conducted by McBey et al. (2019) the researchers found that the lack of knowledge regarding what those novel substitute products are made of deterred the consumers from buying it. Participants in this same study stated that meat substitute products were unappealing due to the fact that they were processed and therefore not natural (McBey et al., 2019). The fact that consumers draw this conclusion about meat substitute products may stem from the marketing behind those food entities. As vegan protein products are marketed as meat substitutes, and the term substitute excludes the nativeness of the product, it could be assumed that vegan meat substitutes are perceived as less natural than they are and therefore viewed more negatively than original meat products. Be that as it may, the notion that meat substitutes are more processed and therefore less natural exists (McBey et al., 2019), and it discourages customers from buying them, which in turn means that more meat products are bought and less is done for sustainability. The process sufficient hypothesis (Rozin, 2006), as mentioned above, underlines that by proving that a food entity that is more processed than another is viewed as less natural. Following that line of argument would mean that consumers will view the meat substitute product as more processed than the equivalent meat product and therefore perceive the substitute product as less natural. Even if the substitute product equals the equivalent meat product, consumers will place more importance on the processing of the food entities. They will therefore declare foods that are equivalent to a meat or animal product as less natural due to their believed processing. In line with the process dominant hypothesis (Rozin, 2006),

products that do not resemble the meat product but have fewer processing steps are viewed as more natural than meat substitutes that equal the meat product. Paul Rozins findings hereby support the assumption that processed content is viewed as less natural, even if it matches the original content. His research gives reason to believe that vegan meat substitutes could be viewed as less natural.

It is important to note, that food products like meat sausages that are processed but have been around for a very long time could be viewed as food staple, thereby letting consumers “forget” that those products are not naturally occurring in their final “ready-to-eat” form. It is therefore essential, assuming this line of argument presents to be highly relevant in terms of why substitute products are less popular, to educate on that topic. The processing levels of food entities do not depend on whether it is an animal or substitute product. Vegan products that resemble meat do not necessarily endure more processing steps. This study aims to contribute to spreading awareness to consumers that health and naturalness of a food entity are not dependent on the food being a meat substitute or not.

Present study

Based on the theoretical background detailed above, there are two central hypotheses that can be developed. Firstly, foods that are processed are perceived as less natural than non-processed foods and secondly, this phenomenon will appear stronger for vegan food entities than it will be for omnivore food entities. To test this notion, participants were presented with food products that were either non-processed or processed to different extents. Additionally, the products were either vegan or non-vegan. Participants had to rate the perceived naturalness of each product and were required to rate the products on their believed level of processing as manipulation check.

In the next few paragraphs, the reasoning and relevance of this research is taken up again before breaking down the posed hypotheses into further detail.

Identifying the research gap

Research regarding factors that could contribute to climate protection are crucial nowadays to adjust to and teach more sustainable ways of living. Vegan and vegetarian substitute products could be guideposts for an increased renouncement of meat and therefore could also positively impact environmental protection. Researching perceived lower naturalness of said substitute products as a potential explanation for a lower consumption rate compared to omnivore options is a factor that has not yet been thoroughly investigated. Hence, contributing to enriching the research regarding acceptance criteria of meat substitute products could help explain the different perceptions of vegan and non-vegan products and consequently help to eliminate false prejudices against vegan substitute products.

Moreover, as there are no clear guidelines or definitions on what people perceive as natural, additional research on naturalness of novel foods could further the understanding thereof and contribute to enriching already existing findings.

Relevance of the research

A plant-based diet contributes to a more climate friendly lifestyle, which is vital in this day and age, as the climate crisis is probably one of the most relevant topics that concern every human being worldwide. Acquiring more knowledge about the perceptions people have concerning a vegan diet, especially in western countries where the capacity to act against it is greater than in some other areas, are therefore very important to make efficient and climate friendly decisions, not only for the direct consumer, but also for the food industry, gastronomy, and the government. Gaining insights into how people perceive these products might help encourage people to switch to or at least try vegan alternatives.

This research casting a light specifically on the perception of vegan substitute products would also be useful for further education. If vegan meat substitutes are perceived as less natural, education on this matter would be beneficial to implement in schools or other

institutions to reduce the reasons why people might not be willing to restrict their meat consumption.

Research question and hypotheses

The aim of the study is to address the issue of the negative connotation of vegan substitute products by trying to contribute to finding a possible explanation, namely lower perceived naturalness of these products, for the different perceptions of vegan and non-vegan food products. In order to cast light on this issue, following research question has been developed: Will vegan substitute products be perceived as less natural than equivalent meat or animal derived products and to what extent will the participant's perceptions differ from one another?

Paul Rozin (2006) states in his findings that if two food entities are identical in substance but one entity endured more processing steps than the other to reach the same state, the more processed entity will be rated as less natural. Furthermore, he proved that a food entity is perceived as less natural when it has endured more processing steps even when the content matches the original product (Rozin, 2006). This study aims to replicate these findings, which is why the first and second hypotheses read as follows:

H1: Overall, in accordance with Paul Rozins process sufficient hypothesis, food products that are processed will be rated as less natural than the original food entities.

H2: In line with Paul Rozins process dominant hypothesis, the more processing steps a food entity undergoes, the less natural this entity will be rated.

Following the above line of argument gives reason to believe that vegan protein products are portrayed to be substituting already existing meat products, which on one hand is useful to encourage consumers to buy the substitutes instead of meat or animal products thus contributing to a more sustainable future. On the other hand, however, substitute products are at risk of being perceived as less natural due to this portrayal.

H3: Vegan processed food entities will be rated as less natural than their according processed non-vegan food entities.

Not only is it highly possible that vegan substitute products will be rated as less natural than their equivalent meat and animal derived products, but it is also probable that this perception will increase the more processed the products are.

H4: The difference between the perceived naturalness of vegan and non-vegan foods increases with each processing step.

The following section will focus on describing a methodological approach to test these hypotheses.

Method

A 2x4 within subject design was employed. The factor two indicates whether the product is vegan or not, and the factor four indicates the three different processing steps of each food product in addition to the non-processed food products, resulting in four steps total.

Participants

The sample was composed of about 200 participants who were recruited via social media and e-mail. Each person received the same questionnaire that was completed in 2022. Due to exclusion criteria that will be mentioned in more detail in the following paragraphs, the final sample consisted of 118 participants of whom 79 were female and 39 were male ($M_{\text{age}} = 37.7$ years, $SD_{\text{age}} = 16.8$). The sample had an age range of 60 with the youngest participant being 21 and the oldest 81. 87 of them were university graduates, all but 5 of the remaining participants were university (undergraduate) students. 70% of the sample indicated to be carnivores with the rest of them being vegetarian, only a very small percentage followed a vegan diet.

Questionnaire

The rating scale used was adapted by Paul Rozin (2005) and aimed to assess the perceived naturalness of certain products from 0 (completely unnatural) to 100 (completely natural). To test the scale, three items were presented (mountain summit, boiled egg, plastic gun) to underline specific naturalness levels as can be seen in figure 1.

Wie natürlich schätzen Sie folgende Items ein?

Tragen Sie in das nebenstehende Textfeld eine Zahl von 1 bis 100 ein. Bitte beachten Sie, dass 1 vollkommen unnatürlich, und 100 vollkommen natürlich darstellt.

Eine Bergspitze in den Anden, die nie bestiegen wurde	
Eine Spielzeugpistole aus Plastik	
Ein hartgekochtes Ei	

Figure 1. Test scale.

The three test items were followed by 11 main items, from here on referred to as (food) products. Those were categorized into 3 different food groups being soy, and beef and milk both as a derivate of the cow. All three categories are once assessed as the unprocessed main product and as differently processed derivatives of those foods. Each food group contains three processing steps additionally to the unprocessed food products. As beef and milk both have the same origin, this brings the total number of products to 11. The vegan food products were a regionally organically grown soybean (unprocessed); soy slices or cutlets made from regionally grown organic soy; tofu mince made from regionally grown organic soy; mince made from soy protein isolate, produced from regional organic soybeans. The meat and dairy products were a regional grazing cow from organic farming; minced beef from regional organic beef; regional organic pasture milk with 3.8% fat; a German sausage spread called “Mettwurst” from regional organic beef; cream cheese made from regional organic whole pasture milk; smoked “Mettwurst” from regional organic beef; low-fat cream cheese made from regional organic whole pasture milk.

Soy cutlets are ground soybeans from which fat is removed and then formed into cutlets. The equivalent carnivore product would be the minced beef, which is produced by removing the tendons and some of the fat, then putting it through a mincer. The two procedures correspond to similar processing steps and therefore make for two very interesting comparisons.

The second processing step includes tofu in the plant-based group. Tofu is made from soy milk and has a very similar processing method to cheese, which is why the dairy group was included. The equivalent carnivore product is the “Mettwurst” which is made by adding fat and spices and then shaping it as well as tofu and cheese are made into the preferred shape.

The third processing step includes mince made from soy protein isolate which is gained from the by-products of soy oil and must be processed under high heat. In the carnivore group, the equivalent product would be smoked “Mettwurst”, which is cold smoked for approximately 12 hours and then left to mature for one to two days.

The last two processing steps both contain chemical changes such as temperature alterations or addition of spices which, according to Paul Rozin (2005), should result in a significant reduction in naturalness. In the last processing category, the chemical change contains temperature for the carnivore as well as the plant-based group which again shows the similarities in processing and makes them comparable.

By pure logic, the different groups should be considered about equally as natural depending on their processing step but based on the previous reasoning it can be expected that the plant-based group will be rated as less natural.

Procedure

At the beginning of the study conducted through the platform “Unipark”, participants were asked to sign an informed consent form stating they could terminate their participation

at any time. They were informed about the anonymity of the study. There were no time restrictions and every participant filled out the same form. They were instructed to familiarize themselves with the used rating scale and had to fill out a test version before rating the actual products. The rating scale was tested to make sure there was a solid understanding of the demanded task. Participants who rated the mountain summit below 70 were excluded, as well as participants who rated the plastic gun over 30. Additionally, participants who did not place the boiled egg between 40 and 90 were also excluded. The upward trend in this range results from the median rating being 65 for the boiled egg and not 50 as expected and originally planned. Additionally, an attention check and language check were conducted, and the age was limited to 18 and up.

Participants also had to answer standard demographic questions before filling out the main part of the questionnaire consisting of the 11 products mentioned above. Naturalness and degree of processing were rated for those products, which were presented in random order. Afterwards participants had to state their usual diet and liking of meat substitute products. Finally, they were given the possibility to comment on the study allowing feedback or open questions.

Data analysis

Different strategies using the statistical programming language R Version 4.3.2 (R Core Team, 2022) were applied in order to analyse the data. For all data manipulation tasks, the *tidyverse* family of packages (Wickham et al., 2019) was used. To compute partial , the *lsr* package of Navarro (2015) was used.

For all statistical analyses conducted, a threshold of $p \leq 0.05$ was utilized to determine the significance of test outcomes. The exploration of hypotheses involved the use of means accompanied by 95% confidence intervals to demonstrate variances between groups, alongside ANOVAs and multivariate regressions for identifying significant relationships

among various factors. Where relevant, -statistics, -values, and partial η^2 were presented to provide comprehensive details on the outcomes of statistical tests.

Results

The present study posed two central hypotheses to potentially explain the preference for meat and omnivore products versus their vegan substitute product equivalents. Processed food entities would be rated as less natural than non-processed food entities and this effect would be even stronger for vegan food products in comparison to omnivore food products. The results are expected to support these hypotheses. The outcome should ideally replicate Paul Rozins results, strengthening the process-sufficient and the process-dominant hypothesis. There is also expected to be an effect relating naturalness to different types of food. Vegan food products should be perceived as less natural than their equivalent non-vegan products. Additionally, an interaction effect is expected, namely the strength of the effect increasing with each of the three processing steps the food products are categorized in. Simply put, vegan products should be rated as less natural than meat and dairy products. In addition, the more processed the vegan food product is, the less natural it will be rated in comparison to their equivalent non-vegan products.

Replication of the process sufficient and process dominant hypothesis

To investigate the H1 of whether processed food exhibits lower naturalness scores than non-processed food and thereby replicate Paul Rozins results, the corresponding means were calculated across all participants. The ANOVA of the factor that indicates whether the products are processed or non-processed exhibits a statistically significant effect on naturalness score ($F(1, 234) = 121, p = 0.00, \eta^2 = 0.34$). Figure 1 illustrates this statistically significant difference by showing the average naturalness scores and 95% confidence

intervals for both food categories. Non-processed food exhibits an average naturalness score of 81.3 ($SD = 14.7$), while processed food has an average of 59.3 ($SD = 15.9$).

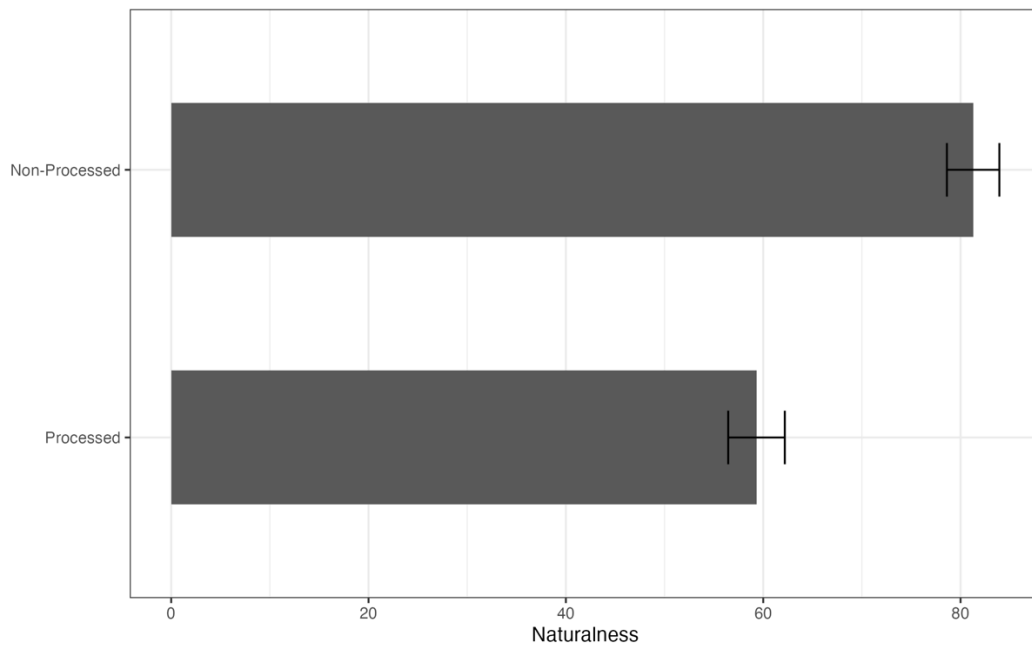


Figure 1: Average naturalness scores by food type. The error bars indicate corresponding 95% confidence intervals.

The H2 states that the naturalness of food should decrease with the number of processing steps. The ANOVA of the factor that indicates the processing step exhibits a statistically significant effect on the naturalness score ($F(1, 468) = 63.3, p = 0.00, \eta^2 = 0.28$).

Figure 2 shows the average naturalness across all products for each processing step. The naturalness scores for the processing steps are as follows: 81.3 for non-processed ($SD = 14.7$), 65.1 for step 1 ($SD = 15.9$), 58.9 for step 2 ($SD = 16.7$), and 53.9 for step 3 ($SD = 17.4$). Pairwise t-tests confirm the visual evidence: non-processed foods have a statistically significant higher naturalness than products from step 1 ($p = 0.00$), step 2 ($p = 0.00$), and step 3 ($p = 0.00$); foods in step 1 have a statistically significantly higher naturalness than step 2 ($p = 0.02$) and step 3 ($p = 0.00$); lastly, products in step 2 do not exhibit a statistically significantly different naturalness from products of step 3 ($p = 0.11$). Overall, these results replicate established results on the process sufficient and process dominant hypothesis.

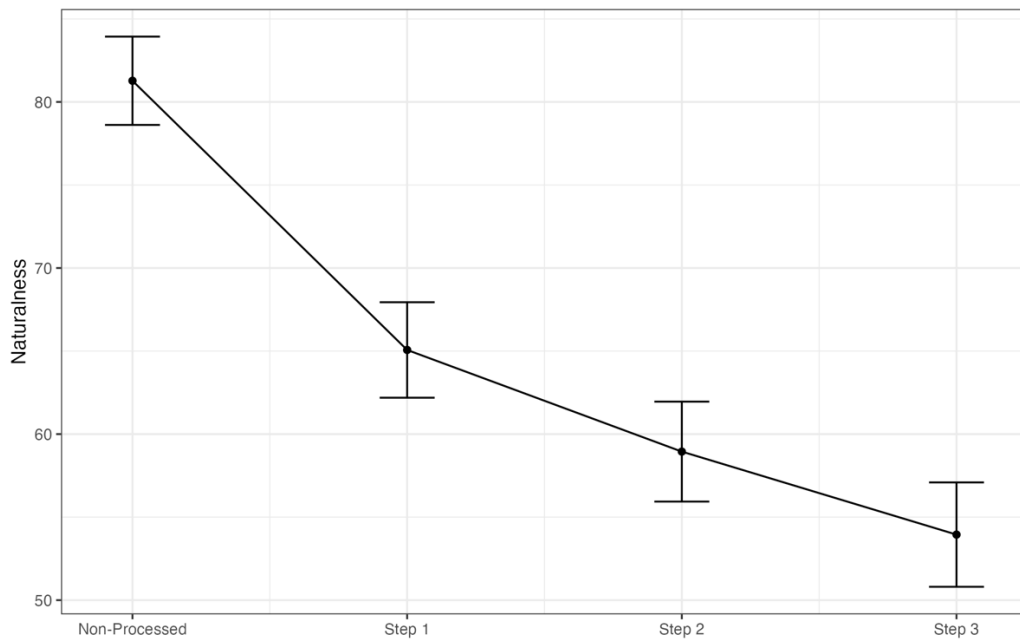


Figure 2: Average naturalness scores by processing step. The error bars indicate corresponding 95% confidence intervals.

Vegan food entities and naturalness

After successfully replicating the theories used as foundation to explore the theories posed in this study, the hypotheses that relate naturalness to food type are investigated. The H3 of whether vegan products exhibit lower naturalness than non-vegan products is investigated. The ANOVA of the factor that indicates whether the products are vegan or non-vegan exhibits a statistically significant effect on naturalness score ($F(1, 234) = 7.77, p = 0.01, \eta^2 = 0.03$). *Figure 3* shows the corresponding lower mean of vegan products compared to non-vegan ones. Vegan products exhibit an average naturalness score of 61.7 ($SD = 18.9$), while non-vegan products show an average score of 67.9 ($SD = 15.4$).

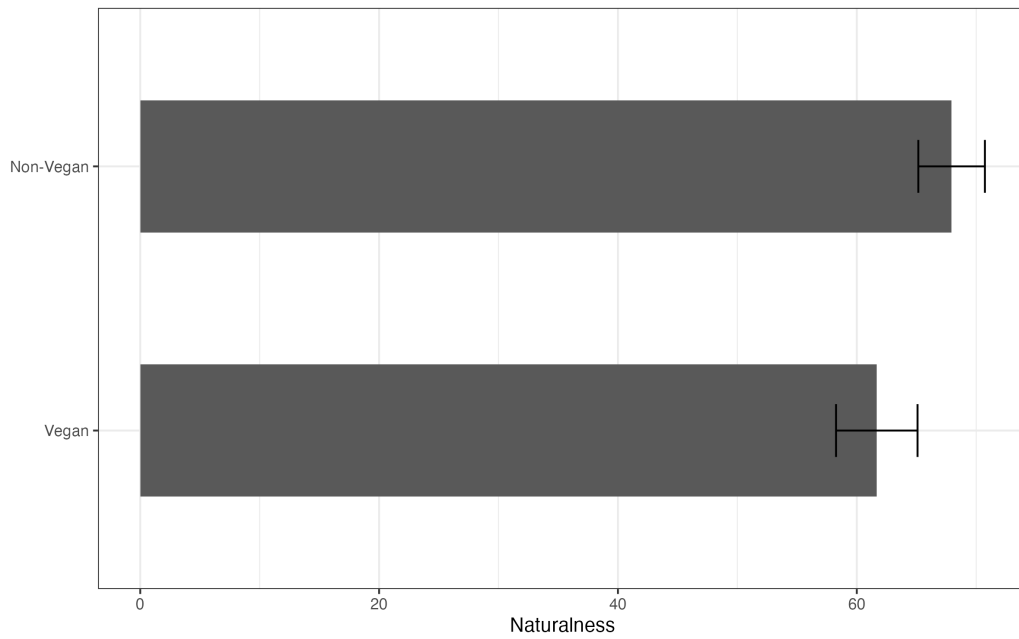


Figure 3: Average naturalness scores by food type. The error bars indicate corresponding 95% confidence intervals.

To evaluate the H4 of whether the difference between the perceived naturalness of vegan and non-vegan foods increases with each processing step, a repeated measures ANOVA and a multivariate regression approach are employed. The repeated measurements ANOVA yields a statistically significant effect of food type ($F(1, 117) = 11.985, p = 0.00, \eta^2 = 0.024$), processing step ($F(1.82, 212.81) = 202.486, p = 0.00, \eta^2 = 0.211$), and for the interaction of food type and processing step ($F(2.4, 281.32) = 14.819, p = 0.00, \eta^2 = 0.012$). To further analyse the details of the relationship between processing steps and differences in perceived naturalness between vegan and non-vegan foods, a multivariate regression approach is employed. Table 1 shows the results of a regression of naturalness scores on an intercept, the food type indicator, a categorical variable that indicates the processing steps, and interaction terms of the food group indicator with the processing steps. The statistically significant coefficients on the processing steps 1 to 3 replicate the previous finding of decreasing naturalness with higher number of processing steps. The positive interaction term of the food group indicator with processing step 1 indicates that non-vegan foods are

perceived to be more natural than vegan foods for processing step 1 only. This difference is not statistically significant for the other processing steps, hence only partial support for H4 could be found. *Figure 4* provides a graphical representation of these findings.

Table 1: Multivariate regression to assess the relationship between naturalness score, food type and processing steps.

Effect	Estimate	SE	95% CI		p
			LL	UL	
Intercept	80.30	1.84	76.69	83.91	.000
Non-Vegan	1.96	2.60	-3.15	7.06	.452
Step 1	-22.08	2.60	-27.18	-16.97	.000
Step 2	-23.82	2.60	-28.93	-18.72	.000
Step 3	-28.59	2.60	-33.69	-23.48	.000
Non-Vegan x Step 1	11.73	3.68	4.52	18.95	.002
Non-Vegan x Step 2	2.98	3.68	-4.23	10.20	.417
Non-Vegan x Step 3	2.51	3.68	-4.70	9.73	.495

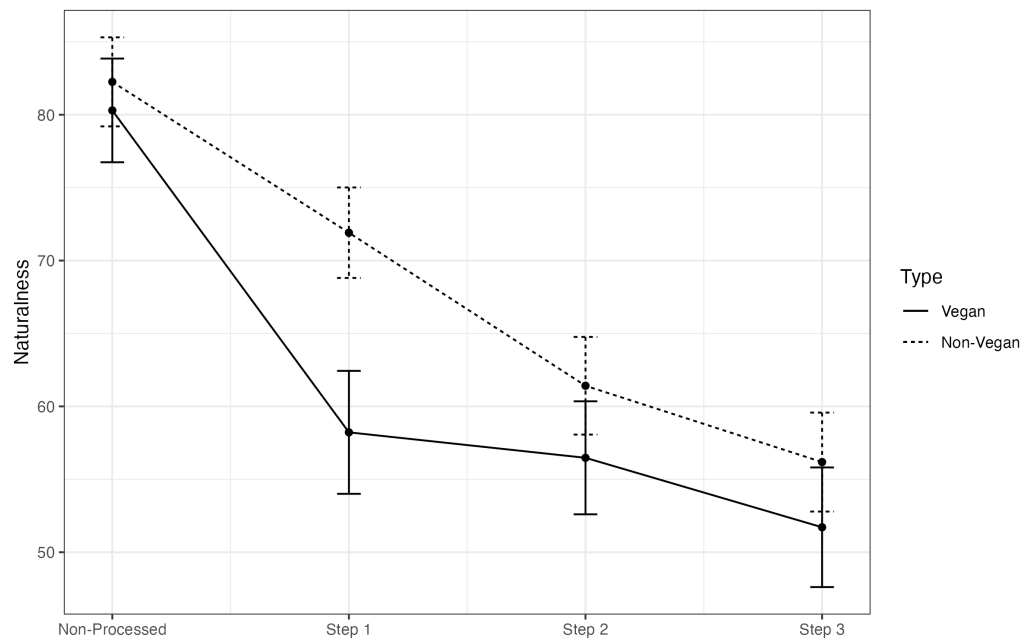


Figure 4: Average naturalness scores by product type and processing step. The error bars indicate corresponding 95% confidence intervals.

Additional analyses

In addition to the main analyses, it was also examined whether the participant's diet and liking of vegan substitute products had an impact on the results.

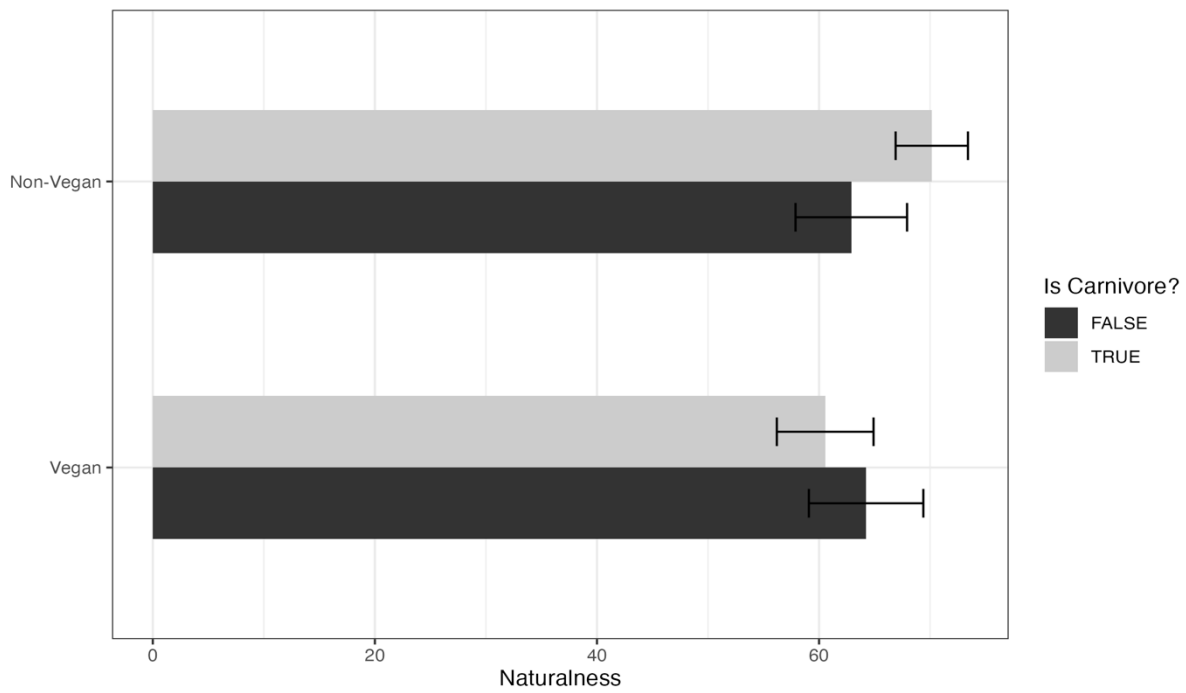


Figure 5: Average perceived naturalness by type of diet. The error bars indicate corresponding 95% confidence intervals.

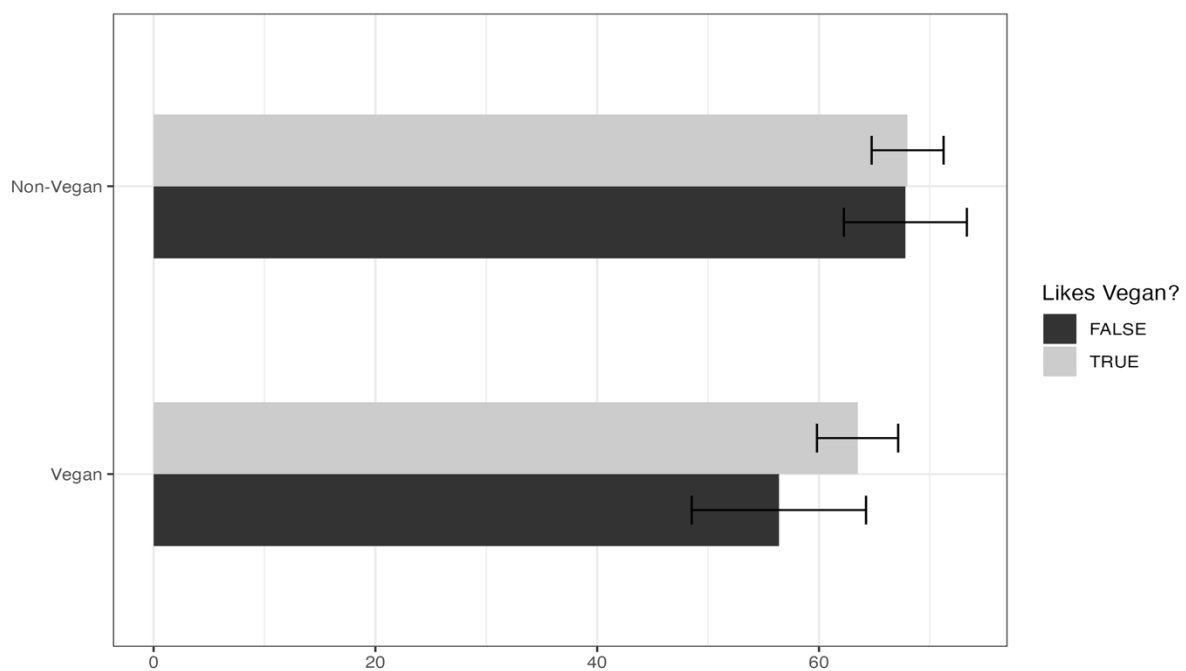


Figure 6: Average perceived naturalness by liking of vegan substitute products. The error bars indicate corresponding 95% confidence intervals.

Figure 5 illustrates that participants who are vegan and vegetarian rate the naturalness of non-vegan products much lower ($M = 62.9$, $SD = 15.4$) than participants who are omnivore ($M = 70.2$, $SD = 15.0$). On the other hand, there is no meaningful difference between participants who are vegan and vegetarian ($M = 64.2$, $SD = 15.8$) compared to omnivores ($M = 60.2$, $SD = 20.1$) regarding the perceived naturalness of vegan food products. The impact of the liking of vegan substitute products did not deliver conclusive results. Figure 6 shows that participants who like vegan food products perceive the naturalness of non-vegan products ($M = 68$, $SD = 15.5$) quite the same as participants who don't like vegan products ($M = 67.8$, $SD = 15.5$). However, participants who like vegan food products exhibit an average perceived naturalness score of 63.5 ($SD = 17.5$) for vegan products, whereas participants who don't like vegan food products report a perceived naturalness score of 56.4 ($SD = 22.0$). This difference is not statistically significant, though. Figure 6 also points out a small interesting - although not significant - detail, namely that vegan products on average have lower naturalness scores.

Discussion

This study aimed to explore the perceived naturalness of vegan substitute products in comparison to their carnivore equivalents and contribute to the existing research revolving around consumer behaviour and environmental protection regarding a vegan diet. Vegan substitute products are still not commonly perceived as an equal alternative to meat products. Previous research has shown that one possible explanation could be the stigmatization and marginalization of the vegan diet (Cole & Morgan, 2011; Markowski & Roxburgh, 2019). Another possible explanation could be the ties a vegan or vegetarian diet has to specific morals and values regarding animal welfare and climate protection (Wrenn, 2017) and the attributes and sometimes prejudices that come with it. How vegan substitute products are perceived is crucial information for further education and development on that matter and

with this study a new perspective and explanation for the discrepancy in perception was explored. First off, this study replicated Paul Rozins (2006) process sufficient and process dominant hypotheses and thereby showed that food entities that are altered – processed – are perceived as less natural than the unprocessed food it derived from. Additionally, the results show a significantly lower perceived naturalness of vegan food entities compared to non-vegan food entities. Finally, although the claim that the difference between the perceived naturalness of vegan and non-vegan foods increases with each processing step can only be partially supported, the different decrease in perceived naturalness from the non-processed product to the first processing step between the vegan and non-vegan food entities is highly significant (compare figure 4). These results show that vegan substitute products are indeed perceived as less natural than their equivalent meat or dairy products resembling their processing steps.

Dairy products were included in the experiment to warrant the comparability to tofu, as the process of making cheese and tofu is quite similar. The meat products and the dairy products did not significantly differ from one another; hence they were merged in the analysis and were compared with the vegan food entities. As all non-vegan food entities are staples used in many cuisines since decades, the same conclusions regarding familiarity and cultural use can be drawn.

An interesting result is the finding that vegans and vegetarians seem to perceive meat and dairy products as significantly less natural compared to carnivores. This could be explained by the fact that maybe the inhibition threshold of consuming livestock and their byproducts increases with the time a person refrains from it. Taken together with the opposite trend regarding omnivores and vegan products, although not significant, this could be chalked up to the notion that we normalize what we consume. If a person eats lots of meat and substitute products are rarely seen in their diet, meat and dairy products are what is “natural”

to this person. If they follow a plant-based diet however, the exact opposite might be true for them.

Unfortunately, for a vast majority of the population the first inference still holds up best. Although various studies state that consumption of red meat and processed meat is rather unhealthy in the long run (Domingo & Nadal, 2017; (Demeyer et al., 2008) and consuming the sufficient amount of protein human bodies need can be efficiently done through plant-based products (Pimentel & Pimentel, 2003), there is still an unwillingness to reduce meat consumption (Latvala et al., 2012). This could be linked to our past. In human history, meat has been a symbol of health and wealth for centuries that continues to uphold tradition (Aboelenien & Arsel, 2022). Generations were raised on the belief that meat is a celebratory, almost superior food that was not always available to everyone but was often reserved for the upper class. Now, meat is more affordable and available than ever and those two adjectives exactly fit the description of the products most people buy (Ares et al., 2016). Changing that notion that is deeply rooted in the western culture is going to take a lot of effort and time.

A further hurdle the reputation of a plant-based diet faces is the need of a certain nutritional knowledge to implement it efficiently (Espinosa et al., 2024). Espinosa et al. (2024) found, that even doctors lack sufficient education on nutrition to comprehensively advise to adopting a plant-based diet. After conducting a study where doctors were provided with said information, they could register an increase in acceptance of plant-based diets and their benefits. These results are proof that extensive education is needed in order to leave behind the outdated notion that including meat in one's diet does not necessarily mean this diet is healthy, just because it has been common practice for so many years.

Discovering a lower perceived naturalness as one potential reason for consumer's trend towards choosing omnivore options instead of equivalent vegan substitute options brings the movement towards change a tiny bit closer. These findings support the notion that

meat is still perceived to be more natural and therefore “better” than their vegan substitute product equivalents, which is vital information for the future of sustainability research, although one should be careful to draw this connection too quickly. The crux of the matter is that there is still no distinct definition of the word “natural”. As previously stated, the term “natural” is definitely one that leaves room for interpretation. In this case, we could interpret it as well known, naturally occurring in one’s diet, but there is no certainty that all study participants interpreted it in a similar way.

Implications

As stated above, the results deliver vital information for future sustainability driven research. Vegan substitute products are still niche products and overall, meat products are still preferred. To increase the consumption of substitute products and thus reduce the environmental impact, it is important to find out what prevents consumers from buying them and motivates them to choose the meat alternative after all. Information on the perception of substitute products could help to increase their consumption. With these results showing a perceived lower naturalness for vegan substitute products, future research could link this notion to an assumed lower popularity of these products compared to their meat alternatives and work towards counteracting it. This study showed that the processing steps of meat and vegan products resemble each other and that the false perception of the latter being less natural exists. Future research and education could debunk the prejudice that is commonly held in people’s minds thinking it is different and work towards new ways of incorporating sustainable alternatives into meal contexts, minds and maybe even culture.

To summarize, these study’s results could infer a reason for the negative reputation of vegan substitute products. These findings could have huge implications for the perception of vegan products and vegan lifestyles, and in a broader context also for the discourse on avoiding meat products for environmental reasons.

Limitations and future research

Firstly, it must be noted that this study was conducted in a western cultural context with most participants being highly educated. Ideally, future research could sample the participants differently and include a broader representation of the whole population. Furthermore, it would be advantageous to compare vegans and non-vegans while having a big enough and similar sample size. As this was not possible in the current study, future research could additionally focus on targeting people following a vegan diet, as it might yield more conclusive and informative results.

Additionally, education is oftentimes tied to wealth. A healthy diet, freshly cooked meals and implementing vegan substitute products not only requires a certain knowledge about nutrition, but it can also be quite expensive. The sample used for this study was predominantly highly educated and therefore presumably also rather wealthy. Future research would have to be further spread out in terms of milieu and social class to deliver more accurate results, because it certainly makes a difference whether one addresses people who already ask themselves these very questions out of self-initiative, or those for whom these topics are still very distant.

In terms of content, there are also some issues to consider. As previously noted, the term naturalness leaves room for interpretation. It could be possible that participants interpreted this term differently and therefore did not give coherent answers, even though the naturalness scale was subject to prior testing. Furthermore, albeit painstakingly worked out matches, it is very difficult to compare products with a different origin. The food product's processing steps were not exactly equal, which makes an exact comparison impossible.

Future research could concentrate on comparing full meals instead of only ingredients, as they are easier to match and to conceptualize. Burgers for instance could be presented with vegan patties versus meat patties which essentially is the same comparison than soy minced

meat versus minced meat. The final products, however, are far more similar and comparable to each other. Additionally, future research could also concentrate on other characteristics that might deter people from buying meat substitutes. Lower perceived naturalness is just one aspect of many and on top of that not a very tangible one. Spreading out the research on different aspects not only helps getting a grasp of the big picture, but it could also find details that are not on people's radar yet.

All in all, there is a vast number of possibilities to further investigate consumer behaviour towards meat substitute products and current events revolving climate change should deliver a high motivation to do so. Although historically meat was a privilege and still has a favourable connotation in a broad section of society, it might be time to reconsider. Meat and its association to health and strength might have been historically important, but in today's day and age, the needs might have shifted. We are part of a huge societal change, with a high number of people wanting to partake in it by opening up to new alternatives. The scientific community should take advantage and pour their resources into further education and research to enrich this movement. Sustainable choices are increasingly popular, and the present might be the exact right – and maybe only – time to fundamentally break traditions and work towards a better tomorrow.

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Appendices

Appendix A Questionnaire Screenshots

Instructions

Liebe Teilnehmerin, lieber Teilnehmer,

herzlichen Dank für Ihre Bereitschaft, an meiner kurzen Studie teilzunehmen.

Die Studie wird vom Arbeitsbereich Angewandte Sozialpsychologie und Konsumentenverhaltensforschung der Universität Wien durchgeführt.

Die Studie befasst sich mit wahrgenommener Natürlichkeit verschiedener Lebensmittel und dauert ca. XX Minuten.

Es ist für uns wichtig, dass Sie alle Fragen beantworten. Wenn Sie sich bei einer Frage nicht ganz sicher sind, kreuzen Sie einfach das Feld an, das am ehesten zutrifft. Es geht um Ihre persönliche Einschätzung, es gibt keine richtigen oder falschen Antworten.

Die Studie dient ausschließlich wissenschaftlichen Zwecken. Die Befragung wird vom Institut für Arbeits-, Wirtschafts- und Sozialpsychologie der Universität Wien durchgeführt. Alle Informationen, die wir von Ihnen erhalten, werden vertraulich behandelt und anonymisiert ausgewertet, sodass keine Rückschlüsse auf Ihre Person möglich sind.

- Im Rahmen der Studie werden Ihre Daten kodiert, d.h. im Falle der Abfrage von persönlichen Daten (z.B. Name; IP-Adresse; etc.), werden diese strikt von den Untersuchungsdaten (z.B. Fragebogendaten) getrennt. Durch diese Kodierung wird im Rahmen der wissenschaftlichen Auswertung kein Unbefugter Ihre persönlichen Daten erhalten. Nach Beendigung der Untersuchung werden alle Daten gelöscht, die einen Bezug zu Ihrer Person erlauben. Die Daten werden nicht an Personen weitergegeben, die an der Studie nicht beteiligt sind. In eine mögliche Veröffentlichung der Resultate der Untersuchung gehen die Daten anonymisiert ein. Wir sichern Ihnen zu, dass alle von uns erhobenen Daten entsprechend dem Datenschutzgesetz geschützt werden.

Mit dem Klicken des "Weiter"-Buttons, bestätigen Sie, die Einleitung gelesen zu haben, und willigen ein, an dieser Studie teilzunehmen:

"Ich bin damit einverstanden, dass meine Angaben ausschließlich für wissenschaftliche Zwecke am Institut für Arbeits-, Wirtschafts- und Sozialpsychologie aufbewahrt und ausgewertet werden. Nach Beendigung des Forschungsvorhabens werden alle Daten gelöscht, die einen Bezug zu meiner Person erlauben."

Vielen Dank für Ihre Teilnahme an der Studie!

Demographic Questions

Welches Geschlecht haben Sie?

☐ weiblich

☐ männlich

☐ anderes

Welche Staatsangehörigkeit haben Sie?

☐ Deutsch

☐ Österreich

☐ Schweiz

☐ andere EU

☐ Andere Nicht-EU

Ist Deutsch ihre Muttersprache?

- ☐ Ja
- ☐ Nein

In welchem Jahr sind Sie geboren?

Bitte geben Sie das Jahr in 4 Ziffern an (z.B. 1980).

Geburtsjahr

In welchem Monat sind Sie geboren?

Please select



Wenn Deutsch nicht Ihre Muttersprache ist, wie gut sprechen Sie deutsch?

- ☐ So gut wie meine Muttersprache
- ☐ Sehr gut
- ☐ Gut
- ☐ Mäßig
- ☐ Nicht so gut
- ☐ Sehr schlecht

Welchen höchsten allgemeinbildenden Schulabschluss haben Sie?

- ☐ Ich bin ohne Abschluss von der Schule abgegangen
- ☐ Ich habe einen Abschluss einer Pflichtschule (z.B. Hauptschule oder entsprechende Stufe einer anderen Schulform)
- ☐ Ich habe einen Realschulabschluss oder einen vergleichbaren Abschluss
- ☐ Ich habe einen Abschluss einer Fachschule oder berufsbildenden Schule
- ☐ Ich habe die allgemeine oder fachgebundene Hochschulreife / Abitur / Matura oder die Fachhochschulreife
- ☐ Ich habe einen Universitäts- oder Fachhochschulabschluss (Bachelor, Master, Diplom, Magister, Lizentiat, Staatsexamen, Promotion, Habilitation oder andere)
- ☐ Ich habe einen anderen Schulabschluss und zwar

Practice Phase

Nachstehend ist eine Natürlichkeitsskala von 1 bis 100 abgebildet. 1 steht hier für vollkommen unnatürlich und 100 für vollkommen natürlich. Bitte schätzen Sie die drei nachfolgenden Gegenstände anhand dieser Kriterien auf der Skala ein und tragen Sie die Zahl in das nebenstehende Feld ein.

Wie natürlich schätzen Sie ein hartgekochtes Ei ein?

Bitte beachten Sie, dass 1 vollkommen unnatürlich, und 100 vollkommen natürlich darstellt.



Wie natürlich schätzen Sie eine Plastikpistole ein?

Bitte beachten Sie, dass 1 vollkommen unnatürlich, und 100 vollkommen natürlich darstellt.



Wie natürlich schätzen Sie einen Baum auf einem nie bestiegenen Berg ein?

Bitte beachten Sie, dass 1 vollkommen unnatürlich, und 100 vollkommen natürlich darstellt.



Attention Check

Wenn Sie die Skala richtig verwendet haben, dann sollte das Ei ungefähr bei 50 liegen, die Plastikpistole nah an oder auf der 1 und der unberührte Baum nah an oder auf der 100 liegen.

Bitte halten Sie einen Moment inne und überlegen Sie sich, ob Sie die Skala richtig verwendet haben. Bearbeiten Sie die Skalen für die drei Gegenstände bitte erneut und korrigieren Sie wenn nötig Ihre Eingaben.

Wie natürlich schätzen Sie ein gekochtes Ei ein?

Bitte beachten Sie, dass 1 vollkommen unnatürlich, und 100 vollkommen natürlich darstellt.



Wie natürlich schätzen Sie eine Spielzeugpistole aus Plastik ein?

Bitte beachten Sie, dass 1 vollkommen unnatürlich, und 100 vollkommen natürlich darstellt.



Wie natürlich schätzen Sie eine Bergspitze in den Anden ein, die nie bestiegen wurde?

Bitte beachten Sie, dass 1 vollkommen unnatürlich, und 100 vollkommen natürlich darstellt.



Items (excerpt for illustration purposes)

Nun folgen weitere Gegenstände, die Sie auf der selben Skala laut ihrer Natürlichkeit einschätzen sollen.

Bitte schätzen Sie auf einer Skala von 1 bis 100 folgende Gegenstände ein:

Tofu Hack aus in Österreich angebautem biologischen Soja

Bitte schätzen Sie die Natürlichkeit dieses Gegenstandes von 1, vollkommen unnatürlich, bis 100, vollkommen natürlich, ein.



Ein österreichisches Weiderind aus biologischer Landwirtschaft

Bitte schätzen Sie die Natürlichkeit dieses Gegenstandes von 1, vollkommen unnatürlich, bis 100, vollkommen natürlich, ein.



Soja Geschnetzeltes aus in Österreich angebautem biologischem Soja

Bitte schätzen Sie die Natürlichkeit dieses Gegenstandes von 1, vollkommen unnatürlich, bis 100, vollkommen natürlich, ein.



Post-Experimental Inquiry

Sie sind bei der letzten Seite angekommen. Bitte beantworten Sie noch folgende Fragen:

Bitte geben Sie Ihren Ernährungsstil an: (überwiegende Ernährungsweise)

Bitte kreuzen Sie die Antwortalternative an, die am ehesten auf Sie zutrifft.

☐ uneingeschränkt

☐ vegan

☐ vegetarisch

☐ pescetarisch

☐ kosher

☐ halal

☐ flexitarisch

☐ eingeschränkt aufgrund eines gesundheitlichen Problems (zB Allergien, Unverträglichkeiten, Intoleranzen); und zwar:

☐ sonstiges

Wie viel Aufwand/ Arbeit denken Sie war für die Zubereitung dieses Lebensmittels erforderlich?

	gar kein Aufwand						sehr hoher Aufwand
Geräucherte Mettwurst aus österreichischem Bio-Rind	☐	☐	☐	☐	☐	☐	☐
Tofu Hack aus in Österreich angebautem biologischen Soja	☐	☐	☐	☐	☐	☐	☐
Eine in Österreich biologisch angebaute Sojabohne, nicht gespritzt	☐	☐	☐	☐	☐	☐	☐
Fettarmer Frischkäse aus österreichischer Bio Weidevollmilch	☐	☐	☐	☐	☐	☐	☐
Rinderhackfleisch aus österreichischem Bio-Rind	☐	☐	☐	☐	☐	☐	☐
Mettwurst aus österreichischem Bio-Rind	☐	☐	☐	☐	☐	☐	☐
Frischkäse aus österreichischer Bio Weidevollmilch	☐	☐	☐	☐	☐	☐	☐
Soja Geschnetzeltes aus in Österreich angebautem biologischem Soja	☐	☐	☐	☐	☐	☐	☐
Ein österreichisches Weiderind aus biologischer Landwirtschaft	☐	☐	☐	☐	☐	☐	☐
Österreichische Bio Weidemilch mit 3,8% Fett	☐	☐	☐	☐	☐	☐	☐
Hack aus Sojaproteinisolat, hergestellt aus österreichischen bio Sojabohnen	☐	☐	☐	☐	☐	☐	☐

Möchten Sie uns noch etwas mitteilen?

Hier können Sie Ihre Gedanken und Eindrücke über die Studie notieren und/oder Feedback zum Fragebogen geben.