Bringing in Augmented Reality (AR) to foster a Sustainable Choice of Proteins

The Era of Spatial Computing is Here: Augmented Reality as a Stimulus for Evoking Pleasant Arousal Feelings to Encourage Sustainable Protein Choices in the Supermarket

MSc Thesis | Julie van Welie

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The Era of Spatial Computing is Here: Augmented Reality as a Stimulus for Evoking Pleasant Arousal Feelings to Encourage Sustainable Protein Choices in the Supermarket

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Abstract

The protein transition is a huge societal challenge to mitigate climate change. To support consumers in their decision on a sustainable protein choice, interventions such as nudging and labeling are researched before. The optimal way to communicate sustainability information remains unknown. A solution could be to provide consumers with information through augmented reality (AR) to lower the complex cognitive processes associated with sustainable choices. The current research aims to explore whether the power of AR could be of support in the decision process in the supermarket through value activation, and investigates the effect of meat attachment on intentions to choose sustainably. With animal welfare and environment as most important concepts to communicate in this transition, an experimental questionnaire with a futuristic AR scenario was provided to research whether the pleasant arousal feelings that drive intention could be beneficial to foster the protein transition. The findings indicate that respondents who got the AR stimulus experience, perceived increased stimulation and hedonism which led to higher intention to choose a sustainable source of protein. Moreover, meat attachment was found to not influence the perceived stimulation by consumers. The research implicates that AR can support value activation of important concepts, overcome information complexity and mitigate the influence of meat attachment in the choice of protein. A more personal value-based activation though AR based on their own motivations may help consumers to understand environmental consequences and individual contribution better.

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Abbreviations

AR	Augmented reality
AW	Animal welfare
MA	Meat attachment
PH	Perceived hedonism
PS	Perceived stimulation
WG	Warm glow

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1. Introduction

A compelling body of evidence clearly indicates that the excessive consumption of meat has a significant contribution to both environmental consequences and the prevalence of lifestyle diseases (Onwezen et al., 2021). The meat industry is a large global emitter, responsible for almost 15 per cent of the total emissions (Kwasny et al., 2022). Acknowledging the future challenges that flow from environmental consequences and lifestyle diseases, consumer patterns must shift towards decreased amounts of meat consumption and increased amounts of plant-based sources of proteins (Onwezen et al., 2021). The largest GHG emissions is at dinner where on average 47 per cent of total emissions is consumed due to animal-based foods such as meat, behavior change of consumers at dinner could make beneficial impact (Vellinga et al., 2019). To make it easier for consumers to choose sustainable, the retailer Lidl made a bold move by placing meat and meat alternatives on the same shelves to encourage plant protein consumption (van der Giesen, 2023).

However, understanding the sustainability impact of products is often challenging for consumers, especially due to the absence of direct observable impact and the sheer numbers of labels indicating different types of sustainability issues (De Bauw et al., 2021; Ingenbleek & Krampe, 2022). Labels indicating impacts could be a solution, however consumer perspectives indicate that there are problems in terms of trust, meanings and consistency (Ingenbleek & Krampe, 2022). Some European countries proposed and (partly) implemented unified scores: called ‘Eco-score’ indicating impacts (De Bauw et al., 2021; Ministerie van Algemene Zaken, 2023). Indicating that current information provision via labelling is not effective and research requests more innovative information provision tools, new approaches to sustainability communications can be explored (De Bauw et al., 2021; Honee et al., 2022a; Ingenbleek & Krampe, 2022). Augmented Reality (AR) could be a promising avenue, as it has the potential to bridge the gap between abstract sustainability concepts and consumers' concerns.

AR can be described as an interactive visualization system that allows the merging of digital content with the real environment, providing consumers with the ability to enhance reality with context-specific virtual information (Riva et al., 2016; van Esch et al., 2019). AR is a suitable tool as almost every consumer has an AR-capable device (e.g. mobile phone). AR can serve as a valuable tool by offering real-time visual assistance in the retail environment, comprehending the environmental impact of the meat industry. This can help consumers make the sustainability impact of their choices more concrete and tangible. Moreover, AR has an effect on the user experience in retail setting as it facilitates providing hedonic information to consumers which expect to evoke positive emotions, which are associated with warm glow feelings, higher user satisfaction and willingness to buy, leading to sustainable behaviors (Poushneh & Vasquez-Parraga, 2017; White et al., 2019). All in all, AR has the potential to foster sustainability transitions such as avoiding food waste, leading to the idea to use AR to support the protein transition (Honee et al., 2022).

It has been discovered that influencing the emotional side might positively impact intentions for meat substitutes and meat reduction (Taufik, 2018). The effect of AR on the consumer emotional response towards a sustainability issue such as food waste is not yet explored (Honee et al., 2022). Against this background, recognizing the power AR could have and the expected growth due to introduction of AR devices on the market (Apple, 2023; Meta 2023), plus the request of future research to marketing strategies with involvement of AR to enhance the consumer experience (Poushneh & Vasquez-Parraga, 2017), the aim of this research is to examine whether visualization of impacts through AR can foster sustainable sources of proteins. Accordingly, the main research question is:

Can the use of Augmented Reality (AR) evoke pleasant arousal feelings which encourage choices towards sustainable sources of protein in the supermarket?

Although earlier research suggested the benefits of AR in retail environment, a possible downside in the protein transition is the positive affective feelings consumers get from meat consumption, also known as meat attachment (MA) (Kwasny et al., 2022). Moderating effects that strengthen or weaken the effect of AR in the protein transition are nearly unexplored. As potential (negative) consequence of MA, it is important to explore the moderating role of MA between use of AR and openness to change towards an altered more sustainable source of protein (Graça et al., 2015). Consequently, the first sub research question is as follows:

How does meat attachment moderate in the intention to choose a sustainable source of protein?

As AR's impact on consumer behavior gathers increasing attention, it becomes essential to dive deeper into the underlying mechanisms driving its effectiveness. One aspect of this technology is its ability to stimulate change (Riva et al., 2016). Openness to change, in this context, represents an individual's readiness and willingness to embrace sustainable sources of protein, thereby transitioning from traditional meat consumption (Ajzen, 2002; Kwasny et al., 2022; Schwartz, 2012). Drawing on the theory of Basic Human Values developed by Swartz (1992), it is important to explore whether openness to change might be of positive outcome for consumers' intention to choose altered source of sustainable protein. Hence, our second sub-question is:

Can openness to change be identified as underlying mechanism of the positive impact of AR on the intention to choose a sustainable source of protein?

To address the mentioned research questions, the research is structured as follows. First, the theoretical background on decision making and the protein transition is provided, followed by, the hypotheses and conceptual model. Hereafter, the materials and methods are described. The quantitative exploratory approach strives to explore insights into the value that AR can generate in the protein transition. The results and discussion are provided with preliminary understanding of relationships between variables. This section returns to the initial research questions posed for the thesis, followed by recommendations for future research. In the conclusion, the insights that emerged from the thesis are stated.

2. Theoretical Background and Hypothesis Development

2.1. AR in decision-making

2.1.1. Innovative decision-making

Consumers are making decisions in a digital environment where new impressions and product information are constantly interrupting (Court et al., 2009). Unlike traditional decision-making, where choices were narrowed down to a final option, digital channels now introduce both the expansion and shrinkage of options in the choice set, creating a dynamic evaluation of choices (Reich et al., 2021). Within the context of the protein transition, shopping behavior is routinized, requiring action on a daily basis (Kwasny et al., 2022). New impressions and product information are in this case often not taken along. For instance, actions like installing an energy-efficient fridge are one-time efforts demanding more cognitive resources, while grocery shopping involves repeated actions. To foster sustainable choices in the supermarket, it becomes crucial to disrupt unsustainable habits. The effectiveness of interventions promoting meat reduction depends significantly on how well the provided information aligns with the specific needs of the target audience (Kwasny et al., 2022). The Construal-Level Theory explains that sustainability is often perceived as a high-level construal as it represent distant events and abstract information (Trope & Liberman, 2010). The nature of sustainability information is not in line with the information demand of consumers in the protein transition as they want to be informed on more detailed consequences of impacts (Kwasny et al., 2022). By communicating sustainability consequences in a more concrete, contextualized and feasible event through AR, the level of construal is lowered and consumers tend to focus more on the present and themselves (Trope & Liberman, 2010).

Given that consumers are often low on cognitive resources during grocery shopping, influencing emotions emerges as a promising strategy to change behavior (Antonetti & Maklan, 2014; White et al., 2019). Consumers tend to perceive sustainable behavior as complex, time-consuming, and effortful, leading them to neglect information and revert to routinized behavior (White et al., 2019). The Elaboration Likelihood Model explains this as the peripheral route as the consumer has little ability to process information and takes mental shortcuts (Maclnnis & Jaworski, 1989). Despite their awareness of the responsibility for the sustainable impact on the planet, consumers often find it psychologically distant to align their actions with their visions (Faludi et al., n.d.). Effective persuasive messaging plays therefore a crucial role in shaping behaviors and attitudes (Yule & Cummings, 2023). Augmented Reality (AR) serves as a valuable decision support tool, offering a comprehensive view of potential actions and enabling faster, well-informed decisions (Martins et al., 2022). This, in turn, leads to greater satisfaction within the decision-making process. The stimuli can uplift the experienced cognitive and peripheral arousals which are positively related to consumers' behavioral intentions (Pleyers & Poncin, 2020). Linking to the Likelihood Elaboration Model again, the motivation and ability of consumers can potentially be increased through AR leading to consumers in the central route where they are able to process information and cognitive response is stimulated (Maclnnis & Jaworski, 1989).

AR could display, like traditional packaging, utilitarian information such as ingredients, materials country of origin etc. (Scholz & Duffy, 2018; van Esch et al., 2019). But what AR can what traditional packaging cannot, is providing hedonic information which evokes positive emotions such as joy and pride. The virtual nature of AR significantly impacts hedonic satisfaction and informativeness (Qin et al., 2021). The absence of information regarding the consequences of sustainable and unsustainable behavior may contribute to the limited incentive for sustainable consumption. AR has the potential to address this gap by attracting attention and facilitating unplanned purchases of sustainable protein sources, leveraging the positive feelings associated with the "warm glow" phenomenon (van Esch et al., 2019; Poushneh & Vasquez-Parraga, 2017). Moreover, given that consumers are often uncertain of their impact and about the consequences of their sustainable actions, through AR they can better foresee the

consequences of a purchase and gain certainty about a product's attributes (Heller et al., 2019). Onwezen et al. (2021) found that interventions with the goal of providing of information found to be promising. It can be expected that with AR stimuli, an enriched consumer experience could support consumers towards more sustainable products.

2.1.2.Emotions in decision making

While emotions in decision making are relatively understudied, choosing products in the supermarket is human behavior which is highly driven by emotions (Betzler et al., 2022; Lerner et al., 2015). When actions derive a positive or hedonic feeling (warm glow), consumers are more inclined to act sustainable (White et al., 2019). On the shorter run, the emotions pride and joy influence consumers intentions and on the longer run, optimism can maintain sustainable behaviors. To predict sustainable consumption, emotions explained a substantial part of variance for increased sustainable behavior (Betzler et al., 2022). Onwezen et al. (2022) found that positive emotions are the main driver of consumers' intention. The research found that the emotions joy, pride, and content are predictors in the protein transition and positive affective variables highly contributed to the acceptance of alternative proteins (Onwezen et al., 2022). Especially in this research about an AR intervention, the relevance of affective components in the information display is recommended and not yet explored.

2.2. Consumer transition

2.2.1.Sustainable protein consumption

The production of proteins has a significant environmental impact, with the production of proteins derived from animals having a bigger impact than that of proteins derived from plants (Aiking & de Boer, 2020; Grasso et al., 2019). Sustainable proteins have more environmental benefits compared to meat, these sources are mostly plant-based and often comparable amount of protein content. From a consumer perspective, the absence of standardization in sustainability information on products in the supermarket is a problem as it causes ambiguity (De Bauw et al., 2021). The Eco-score is such a standardized information source but not yet widely implemented. The Eco-score calculation considers various factors, including the utilization of raw materials, product origin, the presence of sustainability certifications, and packaging type, scores displayed in Table 1 (Lidl, n.d.). Products with a minimal environmental footprint receive an 'A' rating in green, whereas products with a substantial environmental impact are assigned an 'E' rating in red. For consumers, the Eco-score tool is simple to understand but visual distraction (e.g. many claims, nutritional information etc.) on food packaging plays a major role in choices (De Bauw et al., 2021). The consideration of all product information still requires a lot of cognitive effort. De Bauw et al. (2021) recommended to further explore experiments beyond the scoring system. Thus, promising could be to attract consumers towards environmental information and lower cognitive processes through AR (Gómez-Rios et al., 2023).

Table 1: Overview of protein sources, levels of impact: low (indicating positive change for future generation), medium, high (indicating negative change for future generations)

Protein source	**Environmental impact**	**Eco-score**
Beef	High	**E**
Pork*	Medium	**C**
Chicken	Medium	**C**
Pulses*	Low	**A**
Meat alternatives	Low	**A**

Notes: * are not taken along in the questionnaires as they have similar impact as other protein sources

2.2.2.Protein transition: consumers' role

Globally the meat consumption is still increasing (Ingenbleek & Zhao, 2018). People still avoid information (strategic ignorance) or convince themselves that they can eat meat and be a good person (motivated reasoning) (Bouwman et al., 2022). Providing information that activate emotions regarding their behaviors could lower meat attachment (Kwasny et al., 2022; White et al., 2019). However, consumers often do not process the provided information correctly due to information overload, lack of information and confusion, this explains the low uptake of sustainability information (White et al., 2019). The openness to change behavior is an important concept, as consumers that have high meat attachment are often not open for information that is needed to change behavior (Giménez & Tamajón, 2019; Kwasny et al., 2022). Some consumers are already triggered by the health concerns in relation to meat consumption which increased the consumer demand and thereby market potential for meat alternatives. Contrary to other transitions, consumers play a key role in the protein transition (Tziva et al., 2020). The consumer acceptance of alternative protein sources is still relatively low but there are some that have potential (Onwezen et al., 2021). The market for meat alternatives is not homogenous and there are consumer segments with different motivations for reducing meat intake (Ingenbleek & Zhao, 2018). The motivations can be about health, environmental concerns but also animal welfare related. An aggregated cognitive mental map of Dutch consumers shows that the most important concepts for the protein transition are animal welfare (AW = "concerns about the well-being of animals"), health ("concerns about personal health"), environmental concerns (= "concerns about impact of meat production on the environment"), and availability of alternatives (= "the range of alternatives to meat") (Bouwman et al., 2022; van den Boom et al., 2023, p. 4).

There are various product categories for replacing meat (Ingenbleek & Zhao, 2018). Pulses and plant-based meat alternatives were most accepted by consumers. The relative low (vs. meat) acceptance of these alternative protein sources is also present in other novel food categories flowing from food neophobia. More general literature about sustainable consumption explains the low uptake of sustainable products by feelings of uncertainty about outcomes by consumers (White et al., 2019). A way to take away feelings of uncertainty is to make plant-based meat-like products, called meat analogues (Ingenbleek & Zhao, 2018). There are a couple of large companies on the market such as The Vegetarian Butcher and Beyond Meat, they are producing mostly plant-based products that have the similar taste and structure as meat (Ingenbleek & Zhao, 2018). But also, retailers (private label) are globally selling meat analogues to increase the development of sustainable proteins.

A series of interventions to support the protein transition such as nudging and increasing consumers knowledge have been researched before, changed behavior on the longer run remains unclear (Yule & Cummings, 2023). The role of emotions in the Eco-scoring system is ignored, probably because traditional packaging does not have the ability to influence emotions, contrary to AR stimuli which can positively influence emotions (De Bauw et al., 2021; Gómez-Rios et al., 2023). Therefore, providing the consumer with AR stimuli has potential to support in the protein transition.

2.3. Motivational domains

2.3.1.Relevant theory: Basic Human Values

For consumers with low intentions towards alternative proteins, to increase motivations, interventions could activate moral values (Onwezen et al., 2022). Values are the basis of decision making and the only direct predictor of a person's behavior (Betzler et al., 2022). As values can predict behavior, Swartz's theory of Basic Human Values is used to deeper understand the nature of consumers choices on protein sources in the supermarket (Giménez & Tamajón, 2019; Yule & Cummings, 2023). The theory on values is highly valuable as the concept is central in social sciences and crucial in explaining change

for both Durkheim and Weber (Schwartz, 2012). Values have seven features according to Swartz's theory:

1. *Values are beliefs*: Swartz's argues that when values are activated, they become infused with feelings. In turn, decisions in the supermarket are highly dependent on feelings as choices are made with low cognitive resources (Antonetti & Maklan, 2014).
2. *Values refer to desirable goals*: people for whom pro-environmental and animal welfare are important to their values, are motivated to pursue these in their goals.
3. *Values transcend specific actions and situations*: values are relevant in multiple situations such as in work, school, personal life and family, but thus also in food consumption, this is different from norms and attitudes which are about specific situations or actions.
4. *Values serve as standards or criteria*: values guide selection and evaluation (good/bad) of actions, people, policies and events. When the value pro-environment is highly important to a person they base the evaluation of everyday decision on this (e.g. judge meat eating as bad).
5. *Values are ordered by importance*: people are characterized through ordered systems of values that are formed through prioritizing relative important values. People can attribute more importance to for example novelty and change than to universalism. Novelty and change values would be important in the protein transition.
6. *The relative importance of multiple values guide action*: the tradeoff among relevant and competing values guides behaviors. For example, in the choice on protein, tradition and conformity can play an important role at the expense of stimulation and hedonism.

The theory explains motivational domains that influence behavior (Giménez & Tamajón, 2019). Values can be explained through what is important for individuals in their life and everyday decisions, such as protein source at dinner, that are based on these values (Schwartz, 2012; Kwasny et al., 2022). The four original order values (1987) are self-transcendence, conservation, self-enhancement and openness to change, the circular display of the values represent the motivational continuum, see Figure 1.

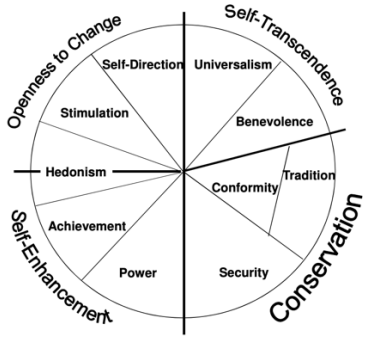

Figure 1: Theoretical model of relations among ten motivational types of values (Schwartz, 2012)

Openness to change is of importance as the aim of this research is to encourage people to a change of behavior in the supermarket. The most effective way to persuade people is to trigger an emotional response (Maclnnis & Jaworski, 1989). Expected is that when this value is activated trough the concepts displayed through AR, the consumer is more inclined to process information (central route) about the consequences of eating meat and the positive outcomes of altering eating habits (Kwasny et al., 2022; Maclnnis & Jaworski, 1989). Openness to change (OPEN) is defined as: "controlling one's own impulses and behavior, according to social norms and expectations" (Giménez & Tamajón, 2019, p. 3). It is further explained by three second-order values: hedonism, stimulation, and self-direction. The first motivational domain: hedonism, is the pursuit of personal gratification and sensory pleasure of an individual consumer. Secondly, stimulation is explained through the journey of searching novelty and

variety, necessary to maintain an optimal level of functioning. Lastly, self-direction is the autonomy of thinking, action and viewpoint (Giménez & Tamajón, 2019). Stimulation and hedonism are associated with pleasant arousal and positive emotions which can be influenced through AR, the two values could potentially lead higher effort and motivation to lower meat consumption and support the protein transition, therefore these are taken along in this research (Maclnnis & Jaworski, 1989; Schwartz, 2012; Taufik, 2018).

2.4. Hypothesis Development

AR has demonstrated its capacity to improve processing fluency and boost decision-making comfort, and this effect is anticipated to be especially beneficial when consumers have restricted cognitive resources during grocery shopping (Heller et al., 2019). As AR stimulates positive processing fluency of consumers, hedonic value and emotional pleasure, it can expected that the responsiveness to sustainability appeals is higher as the cognitive load is lower (Davidavičienė et al., 2019; van Esch et al., 2019; White et al., 2019). The definition of 'perceived stimulation' is: "Feeling of optimal and positive activation" (Giménez & Tamajón, 2019; Schwartz, 2012). When the product attribute 'sustainability' is stimulated through AR, the openness to change is expected to turn positive. Consequently, the following hypothesis is proposed:

H1. Consumers who use AR perceive higher stimulation in openness to change compared to consumers not using AR.

It has been suggested that fostering emotional engagement, particularly through hedonic pleasure, can motivate individuals to embrace sustainable consumption (Faludi et al., n.d.; White et al., 2019). AR's ability to visualize the consequences of consumption patterns has the potential to make emotional costs and benefits more tangible. The definition of "perceived hedonism" is feeling of joy, pride and/or optimism (Giménez & Tamajón, 2019; Schwartz, 2012). It is anticipated that AR, by providing vivid and hedonic information, can evoke feelings of pride and joy, particularly when linked to sustainable protein consumption (White et al., 2019)

H2. Consumers who use AR perceive higher hedonism in openness to change compared to consumers not using AR.

Graça et al. (2015) found that meat attachment is associated to people that are less prone to switch their eating habits towards more plant based protein sources. Therefore, the concept meat attachment is expected to (negatively) moderate the relationship between perceived stimulation and intention to alter the initial protein source.

H3. The positive effect of the use of AR on the perceived stimulation will be weaker for consumers with high (vs. low) meat attachment.

Hedonism and stimulation are adjacent values, motivational emphases are on a desire for affectively pleasant arousal (Schwartz, 2012). Related, the warm glow refers to feelings of positivity that consumers experience when they support products that implement sustainability initiatives (Hult et al., 2018). In protein transition context, "warm glow" refers to the positive emotional satisfaction or contentment that consumers experience when they actively engage in the process of reducing their meat consumption (Taufik, 2018). Moreover, the satisfaction feelings from engaging in a sustainable activity flows from intrinsic motivation and thereby has longer term effects on behavior (Abbott et al., 2013). This emotional

satisfaction is closely associated with their intentions to curtail meat consumption and their willingness to choose meat substitutes. In essence, the "warm glow" effect suggests that the consumer derive emotional well-being from making more sustainable dietary choices, such as reducing meat consumption. This positive emotional association can serve as a motivating factor for individuals to continue and sustain their efforts to consume less meat and opt for alternative protein sources. It highlights the significance of emotional engagement and personal fulfillment in driving intentions and behaviors related to meat reduction and the adoption of meat substitutes (Taufik, 2018). Supplying sustainability information is positively associated with warm glow feelings (Lin et al., 2017).

For meat reduction, consideration of emotional motivations needs to be considered. As described above, the basic human values ‘stimulation’ and ‘hedonism’ contribute to pleasant arousal (Schwartz, 2012). Positive feelings of pleasant arousal are expected to fuel pleasant arousal feelings which after are associated with consumers’ meat reduction intention and could potentially lead to readiness of altering protein source (Taufik, 2018). It is not realistic to assume people who are not familiar with the meat analogues, purchase a new product due to one exposure to AR (Yule & Cummings, 2023). Therefore, intentions are measured as these are direct predictors of actual behavior (Onwezen et al., 2022).

H4. Perceived stimulation (a) and perceived hedonism (b) are positively related to pleasant arousal feelings.

H5. The pleasant arousal is positively related to the intention to alter towards a sustainable protein source.

2.5. Conceptual Model

The model in Figure 2 explores the stimulus-response relationship inherent in the use of AR, seeking to understand how the use of AR can trigger changes in consumer intentions. The visual stimulus through AR has the potential to drive changes, particularly concerning their intention to opt for more sustainable protein choices.

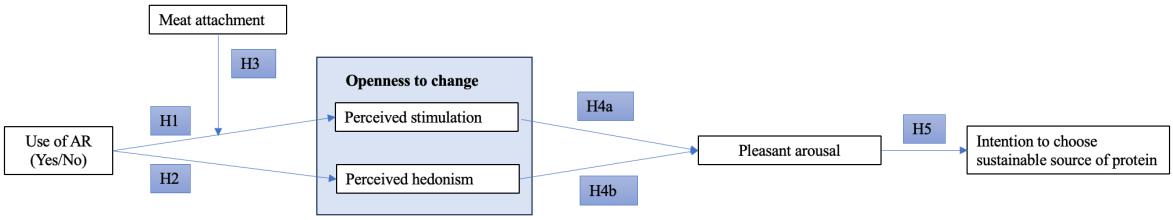

Figure 2: Conceptual Model

3. Methods and Material

3.1. Experimental design

The research is conducted in a consumer-product interaction setting. There are two scenarios, scenario 1 is without the interaction of AR, no stimuli (control condition) and scenario 2 is with interaction of AR as stimuli (experimental condition) encouraging altering protein choice. A set of two scenarios (AR or no AR stimuli) with two levels (beef or chicken) are specifically designed for this study. The research opted for a between-subjects design to compare various conditions rather than employing a within-subject design to account for individual differences. The setup resulted in a 2 (meat type, between subjects) *2 (stimuli, between subjects), with personal meat attachment as moderator. As stated before in the hypothesis, the focus of the research was to compare between the AR as stimuli versus traditional packaging in the supermarket.

Table 2: Overview of scenarios and levels

	Stimuli		
Scenarios		**1: No AR**	**2: AR**
	Beef vs. vegetarian beef	Intention to choose altered source of protein	Intention to choose altered source of protein
	Chicken vs. vegetarian chicken	Intention to choose altered source of protein	Intention to choose altered source of protein

A comparison is made between two protein sources, revealing a discernible difference in their sustainable impact as indicated by the Eco-score (De Bauw et al., 2021). The two levels are presented in this research: beef (Eco-score **E**) vs. vegetarian option for beef (Eco-score **A**) and chicken (Eco-score **C**) vs. vegetarian option for chicken (Eco-score **A**). Participants were randomly assigned to one of the four between subjects' groups: beef_NoAR (beef vs vegetarian beef; no AR), beef_AR (beef vs vegetarian beef; AR), chicken_NoAR (chicken vs. vegetarian chicken; no AR) and lastly chicken_AR (chicken vs. vegetarian chicken; AR), see Table 2.

The research aimed to find out whether AR encourages consumers towards sustainable sources of protein, therefore, price information was excluded as this could distract and potential impact was eliminated. The questionnaires were pre-tested in face-to-face interview to overcome any problems or ambiguities, the feedback was processed to finalize the online questionnaires.

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3.2. Respondents & procedure

This research used an online survey addressed to consumers in the Netherlands based on unrestricted non-probability sampling method called convenience sampling as monetary resources are absent. The method was cheapest and easiest to conduct. As the focus was on exploring the early stages of whether AR may have an impact, a sophisticated sample was not needed (Blumberg et al., 2014). Age was used as a control variable, as younger participants are relatively confronted more often with digital innovations compared to older groups (Ingenbleek & Krampe, 2022). For each group, recruitment of 30 to 40 respondents was sufficient to have a proper sample for statistical tests (Field, 2009). The respondents were recruited via convenience sampling via the researchers own network (Instagram, LinkedIn).

The survey flow can be found in Appendix B. Respondents were introduced with the aim of the study at the start of the questionnaire to treat them with the ethical considerations (Blumberg et al., 2014). Continuing to the next step, the respondent was randomly assigned to one of the four groups and was shown the following description (e.g. chicken_AR group):

“Imagine you walk in the supermarket, and you want to buy some protein source for dinner tonight, you are going to make a dish with chicken as protein source. You look at the shelves to the available options which include: chicken (Eco-score C) and a meat alternative for chicken (Eco-score A). You are in the moment of choosing an option and you look at all the different packages. The Augmented Reality** tool that you using are seamlessly blending sustainability impact information about the protein sources. In the example you see a simplified version of such information."

*Eco-score C = medium environmental impact, Eco-score A = low environmental impact
**Augmented reality (AR) is a technology that overlays digital information, such as images, videos, or 3D objects, onto the real world through a device like a smartphone, enhancing the user's perception of their environment.

Figure 3: Example of AR in retail context in the questionnaire

The rest of the scenario descriptions can be found in Appendix A. After the scenario description, a video was played with (experimental) or without (control) an AR filter. In the following section, the constructs were measured based on the information demand in the consumer decision journey, see section 3.4 and Appendix B. First, the constructs stimulation and hedonism were measured, followed by pleasant arousal and intention to alter towards a sustainable protein source. MA and demographic information was gathered at the end of the questionnaire.

3.3. Stimuli generation

First person point of view videos with simulation of a simplified real life shopping context with or without AR stimuli are shown to the participant. Research in advertising found that first person narratives are appropriate for message content where the aim is communicating emotions and values (Stern, 1991). The goal is to show the participant how AR (vs. no AR) potentially contributes to our daily lives in a few years. To make sure the respondents fully watch the video, they could not proceed the page with the video for a duration of 20 seconds, while the video had a duration of 15 seconds. The provision of information was on AW, environmental concerns, and availability of alternatives. In the video, the attention was first attracted through AR with hedonic information related to AW. The information focused on taking away animals from the chain. When going to the product evaluation phase a few seconds later, information on the consequences of the altered choice of protein were shown to the participant, for an example see Figure 4. Two types of protein sources (meat vs vegetarian option) are compared with each other, where a difference in sustainable impact was present. The AR filters were based on the Vegetarian Butcher (VB) visuals, as presented in their sustainability impact report (De Bauw et al., 2021; The Vegetarian Butcher, 2021). VB has product specific visual information on environmental consequences and is therefore used in the current research. To make respondents aware of plant-based alternatives to meat and make it more easy for consumers to compare the two products, the two products were displayed next to each other.

Figure 4: Example of experimental condition (chicken_AR)

For clarification, the image with the sustainable impact information was on top of the page with questions on the constructs. In Figure 4, an example of the hedonic and consequences information are shown. The participant in the control condition was shown the exact same video but then without an AR stimulation. Figure 5 shows the control condition. Within the control condition, there are is again a beef and a chicken group (see 4.1).

Figure 5: Example of the control condition (chicken_NoAR)

In Appendix A, there can be found how the other scenarios beef_AR and beef_NoAR were displayed in the questionnaires.

3.4. Measures

The constructs were measured on five-point Likert scales (5 = strongly agree, 1 = strongly disagree) or assessed by applying sematic scales (0 – 100), see Appendix B for an overview of the construct and items and on which scales they were measured.

3.4.1. Perceived hedonism and stimulation

The openness to change was measured through perceived hedonism and stimulation. To measure these concepts, items from the Marketing Scales Handbook were used as these are validated and used previously. Pham and Avnet (2004) measured perceived stimulation through measuring the degree to which a person describes an advertisement as stimulating pleasing, in this case AR is seen as ad. Participants were asked to answer their opinion on pleasing stimulation (1. Not fun/fun; 2. Dull/exciting; 3. Unenjoyable/enjoyable) with sliders from 0 to 100 (Bearden et al., 2010). The perceived hedonism is measured through a person's attitude resulting from sensations derived from images, done in a research of Voss, Spangenberg, and Grohmann (2003). The items in the questionnaire aimed to measure attitudes (1. Catchy/not catchy; 2. Appeals me/doesn't appeal me; 3. Excites me/doesn't excite me) with sliders from 0 to 100 (Bearden et al., 2010).

3.4.2. Pleasant arousal

Warm glow feelings are not concretely operationalized in earlier research but are associated with pleasant arousal and satisfaction feelings (Abbott et al., 2013; Taufik, 2018). White et al. (2019) found that optimism is a predictor for sustainable behavior in the longer run, as there was no standardized definition of warm glow. The positivity nature of the concept optimism is taken to operationalize the warm glow and make it measurable. The associated positive feelings are measured through the two items hope and encouragement (with sliders from 0 to 100) as they are also associated with longer term behavior and stimulation and in this research called: pleasant arousal (Bearden et al., 2010).

3.4.3. Intention to alter protein source

Based on research about recycling intention, the concept was defined as: "a person's willingness and stated likelihood of participating in an altered choice of protein" (White, MacDonnell, & Dahl, 2011). In a research on emotions and sustainable buying by Onwezen et al., (2022), intention was described as the effort a person is willing to make to buy sustainable products in the future. The intention was measured though two items displayed in Appendix B. To make more clear which proteins are sustainable the Eco-score was included in this question, see Table 1.

3.4.4. Meat attachment

The concept 'meat attachment' was measured through four items from a Meat Attachment Questionnaire which measures the positive bond towards consuming meat (Graça et al., 2015). The meat attachment is described through four factors: hedonism, affinity, entitlement and dependence. For this research, hedonism and dependence were most important to measure as the aim was to find out whether the positive bond, factor hedonism, will moderate the relationship towards another sustainable protein source, then it is also important to see if participants are dependent on meat. Graça et al. (2015) used 5 point Likert-scale.

3.4.5. Covariates

Descriptions of covariates can be found in Appendix B, age was an important variable to measure as expected is that younger people are more used to digital innovations than older people. The diet that people are following could also have impact on the choice for a protein, for example it can be expected

that people who follow a vegetarian diet, will choose the vegetarian option. Flexitarians are probably also more open towards a vegetarian option for meat. The shopping behavior is tested to see whether people with a curious attitude in the supermarket are more open to another choice than people who describe their shopping behavior as neutral or consistent. Curiosity is described as closing the knowledge gap of information by consumers, where they are expected to be more open for the information shown via AR (Yule & Cummings, 2023).

4. Results

4.1. Data collection and analysis

The data was analyzed in the software IBM SPSS version 26. In total, 263 responses were recorded. After data collection and purification, the data of 141 respondents was used for the data analysis. The research used a variety of (non-)parametric tests (Blumberg et al., 2014). Most of the data is derived from interval/scale measurements which implies that the tests are parametric and more powerful than when nominal or ordinal data is used. The scales for perceived hedonism and perceived stimulation are on a scale from 0 to 100. Pleasant arousal feelings and intention are on a scale of 1 to 5. Considering the different scales, variables were transformed in Z-scores. Four new variables were created to standardize the scales. An overview of the statistical tests is presented in Table 3.

Table 3: Overview of the statistical tests used to test hypothesis

Hypothesis	**Input variables**	**Output variables**	**Statistical test**
H1	Use of AR	Perceived stimulation	Independent samples t-test
H2	Use of AR	Perceived hedonism	Independent samples t-test
H3	Meat attachment	Perceived stimulation	Independent samples t-test + Univariate Analysis
H4	Perceived stimulation Perceived hedonism	Warm glow	Regression analysis
H5	Pleasant arousal	Intention altered choice of protein	Regression analysis

4.2. Respondents

In the research 141 people participated, the sample consisted of men (n = 62), women (n = 78) and other (n =1) ranging in age from 18 to 70. Most participants fell in the age group between 22 and 25 years. The shopping behavior was mostly described as curious (n = 59) and consistent (n = 56), with mean of 1.81 (SD = 0.783). The most reported diet was flexitarian (n = 74), followed by omnivore/meat eater (n = 41) and after vegetarian (n = 23) and vegan (n = 3). Over 50 per cent of the respondents earned less than €2,000 per month (M = 2.47, SD = 1.55). A full overview of means and standard deviations of the sample can be found in Table 4.

Table 4: Means and *SD* of sample (n =141)

	Gender	**Age**	**Shopping**	**Diet**	**Income**	**Meat attachment**
M	1.57	30.88	1.81	3.09	2.47	2.52
SD	0.51	13.93	0.78	0.73	1.55	1.07

Note: See Appendix B Table B1 for meaning and measurement of scales

4.3. Data distribution and validation checks

In the questionnaire, constructs were measured through items that are used in previous research as these are used before and validated (see 3.4). To test reliability of the constructs, a reliability analysis was conducted in SPSS. Nunnally (1978) argues that values above 0.7 are considered to indicate sufficient reliability. The internal consistency was measured through Cronbach's Alpha, results are shown in Appendix B Table B2. All values for Cronbach's Alpha were sufficient except for the construct 'pleasant arousal' for chicken_AR, the value was not sufficiently reliable; however, the construct fulfills the intended purpose and contains valuable information. One measure does not provide a complete

picture of the scale reliability (Sijtsma, 2009). As the same scales was used in all other scenarios, a sufficient scale can be assumed.

The data is tested for extreme outliers using boxplots for all mean variables. Four possible outliers in the pleasant arousal variable were found (Mean_WG) and further tested on being extreme outliers through Hoaglin & Iglewicz (1987) method for testing labeling of outliers. The additional test did not indicate extreme outliers thus reliability can be expected. To test the significant differences between groups demographics' among the observed data, the Chi-square test was used.

Besides the constructs of interest, the model included covariates (age, gender, diet, shopping behavior). The goodness-of-fit statistics provided an acceptable fit. A Chi-square analysis for the covariates is done to test whether the measures were independent. For gender ($\chi^2 = 3.677$, $df = 6$, $p = 0.720$), age ($\chi^2 = 88.283$, $df = 96$, $p = 0.700$), shopping behavior ($\chi^2 = 5.963$, $df = 9$, $p = 0.744$) and diet ($\chi^2 = 3.415$, $df = 9$, $p = 0.746$), no possible relationships between the variables are assumed.

The variables perceived stimulation and perceived hedonism (H1, H2) were further checked for underlying assumptions of comparing means: sampling distribution is normal, interval level of data, variances are roughly equal and scores are independent, see Table 5 (Field, 2009). It is worth noticing that for one group the K-S statistic indicates non-normality for perceived stimulation, see Table 5. This departure is probably a result the scales are an average of four groups using different items. The Shapiro–Wilk test does indicate normality in that group. To deal with the assumptions for the statistical tests, bootstrapping is performed (Field, 2009). Moreover, Table 6, 7 and 8 show the outcomes of the Levene's test for Equal Variances, the test indicated that for the beef group, perceived hedonism does not assume equal variances, the test then utilizes un-pooled variances and a correction to the degrees of freedom. Ideally, in business research the populations have equal variances, but often this assumption is not met as the characteristics of a population vary (Blumberg et al., 2014).

To test H4 and H5, linear regression was used. The underlying assumption of multicollinearity, homoscedasticity, normally distributed errors, and independence of errors must be met to draw conclusions on the population (Field, 2009). The multicollinearity test indicated appropriate VIF values, see Appendix C. The test on independence of observations results show a Durbin-Watson value of 1.894 for H4 indicating a positive relation between adjacent residuals (Field, 2009). For H5, the Durbin-Watson value of 2.194 indicating a negative relation between adjacent residuals. Moreover, normality of errors and homoscedasticity were checked through histograms and scatterplots which can be found in Appendix C. Table 9 shows an overview of all means and standard deviations broken down by groups, constructs and items.

Table 5: Test of Normality – PS and PH

Group categories		**K-S Statistic**	**K-S: *p***	**Shapiro-Wilk statistic**	**SW: *p***
Beef_NoAR	PS	0.115	0.200	0.942	0.091
df = 31	PH	0.142	0.114	0.957	0.241
Chicken_NoAR	PS	0.152	0.026*	0.947	0.071
df = 38	PH	0.099	0.200	0.964	0.259
Beef_AR	PS	0.128	0.160	0.950	0.113
df = 35	PH	0.104	0.200	0.976	0.629
Chicken_AR	PS	0.095	0.200	0.974	0.522
df = 37	PH	0.130	0.115	0.957	0.165

Note: * significant, normality from this test cannot be assumed

Table 6: Levene's Test for Equality of Variances, PS (H1)

Group	**Levene's statistic**	***p***
Beef	0.003	0.958
Chicken	0.086	0.770
Beef + chicken	0.069	0.794

Table 7: Levene's Test for Equality of Variances, PH (H2)

Group	**Levene's statistic**	***p***
Beef	5.764	0.019*
Chicken	0.339	0.562
Beef + chicken	3.9884	0.048*

Note: *significant, no equal variances can be assumed

Table 8: Levene's Test for Equality of Variances, MA (H3)

Group	**Levene's statistic**	***p***
Low vs high	0.040	0.843

Table 9: Overview of means and standard deviations for PS, PH, WG, Intention

	Beef_NoAR (*n* = 31)	**Chicken_NoAR (*n* = 38)**	**Beef_AR (*n* = 35)**	**Chicken_AR (*n* = 37)**
	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)
Gender	1.55 (0.51)	1.55 (0.56)	1.54 (0.51)	1.62 (0.492)
Age	32.19 (14.29)	32.87 (15.76)	28.40 (12.56)	30.08 (12.97)
Shopping	1.55 (0.62)	1.89 (0.80)	1.94 (0.80)	1.81 (0.85)
Diet	2.97 (0.80)	3.13 (0.70)	3.17 (0.67)	3.05 (0.78)
Income	2.58 (1.67)	2.61 (1.53)	2.11 (1.45)	2.57 (1.56)
Meat attachment	2.39 (1.09)	2.53 (1.11)	2.43 (0.94)	2.71 (1.15)
Perceived Hedonism [a]				
Not fun – fun	40.39 (28.21)	38.13 (23.69)	57.15 (21.04)	61.05 (23.54)
Dull – exciting	40.68 (27.45)	37.61 (22.43)	56.08 (26.17)	59.00 (24.91)
Unenjoyable – enjoyable	41.39 (27.20)	42.63 (24.55)	60.44 (20.51)	59.27 (26.67)
Perceived stimulation [a]				
Not catchy – catchy	33.74 (22.17)	34.18 (24.10)	54.50 (25.20)	54.89 (26.53)
Does not appeal me – appeals me	37.74 (28.69)	37.61 (25.59)	54.03 (26.43)	56.43 (26.63)
Does not excite me – excite me	32.77 (20.00)	33.26 (21.63)	51.29 (24.90)	52.03 (26.76)
No activation – positive activation	41.16 (27.95)	36.89 (26.49)	58.32 (25.40)	59.54 (29.71)
Pleasant arousal [b]				
Encouraged	2.87 (1.18)	2.95 (1.06)	3.46 (0.89)	3.73 (0.87)
Hopeful	2.81 (1.20)	2.84 (1.05)	3.43 (0.85)	3.62 (0.86)
Intention to alter choice of protein [b]				
It is likely […] more sustainable one	3.58 (1.34)	3.55 (1.13)	3.63 (1.00)	3.97 (0.96)
I predict that […] sustainable source of protein	3.74 (1.39)	3.68 (1.04)	3.63 (1.00)	4.03 (0.93)

Note: [a] measured on a 0 – 100 scale, [b] measured on a 1 -5 scale,

4.4. Hypothesis testing

4.4.1.Perceived stimulation & perceived hedonism

Table 10: Means and standard deviations of perceived stimulation

Group	***n***	***M***	***SD***
Beef_NoAR	31	36.35	22.71
Chicken_NoAR	38	35.48	22.67
Beef_AR	35	55.00	24.05
Chicken_AR	37	55.72	24.83

The proposed hypothesis 1 was tested using independent samples t-test. Results showed that groups that received AR perceived higher stimulation compared to groups not received AR, see Table 10. For all scenarios normality can be assumed expect for one scenario. Bootstrapping is performed to deal with the assumption of normality (LaFlair et al., 2015; Wright & Field, 2009). For the meat type beef, results indicate significant difference in means of perceived stimulation, indicating AR does positively affect perceived stimulation (β = -3.227, p = 0.002). For the meat type chicken, results indicate significant difference in means of perceived stimulation, indicating AR does positively affect perceived stimulation (β = -3.687, p = 0.000). Moreover, interesting to test is whether the meat type (beef vs. chicken) in the manipulated condition is significantly different. The results show that the meat type does not influence the perceived stimulation (β = -0.124, p = 0.902). Lastly, the meat type in the control condition did not show significant difference in means indicating the perceived stimulation does not differ between chicken and beef (β = -0.158, p = 0.902). It can be expected that the means of perceived stimulation is changed due to AR stimulation, supporting H1.

Table 11: Means and standard deviations of perceived hedonism

Group	***n***	***M***	***SD***
Beef_NoAR	31	40.82	26.55
Chicken_NoAR	38	39.45	22.11
Beef_AR	35	58.14	19.05
Chicken_AR	37	59.77	22.23

The proposed hypothesis 2 was tested using independent samples t-test. Results showed that groups that received AR, perceived higher hedonism compared to groups not received AR, see Table 11. For the meat type beef, results indicate significant difference in means of perceived stimulation, indicating AR does positively affect perceived stimulation (β = -3.011, p = 0.004). For the meat type chicken, results indicate significant difference in means of perceived hedonism, indicating AR does positively affect perceived hedonism (β = -3.968, p = 0.000). Moreover, interesting to test is whether the meat type (beef vs. chicken) in the manipulated condition is significantly different. The results show that the meat type does not influence the perceived hedonism (β = -0.334, p = 0.740). Lastly, the meat type in the control condition did not show significant difference in means indicating the perceived hedonism does not differ between chicken and beef (β = 0.232, p = 0.817). It can be expected that the means of perceived hedonism is changed due to AR stimulation, supporting H2. Table 12 shows an overview of means and standard deviations of AR vs no AR and Figure 7 shows the estimated marginal means of perceived stimulation (a) and perveived hedonism (b) among the AR and no AR group.

Table 12: Overview of means and standard deviations of AR and no AR

Group	Construct	*n*	*M*	*SD*
No AR	PS	69	35.88	22.53
	PH	69	40.07	24.03
AR	PS	72	55.38	24.29
	PH	72	58.98	20.62

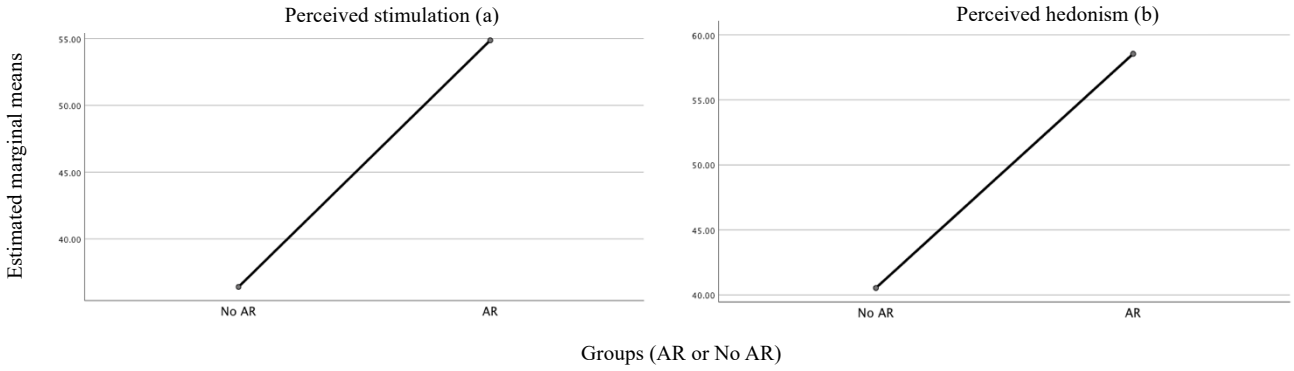

Figure 6: Estimated marginal means of perceived stimulation (a) and perveived hedonism (b)

4.4.1.1. Moderation of meat attachment

The proposed hypothesis 3 was tested using independent samples t-test. The dummy variable, median split divides the respondents into high and low meat attachment. A median split (median = 2.500) was used to divide the groups in either high (value of > 2.5) or low (value =< 2.5) meat attachment. Taking into account the cumulative percentage, the participants that had a value of 2.5 were categorized in the low meat attachment group. The results show that meat attachment is not a significant moderator of perceived stimulation meaning no significantly higher stimulation was found when people were classified as low meat attached (β = 2.611, p = 0.108), rejecting H3. Additional statistical analysis is done to explore the impact of meat attachment on perceived stimulation. A Univariate Analysis of Variance shows that 77 respondents got the label low meat attachment and 64 respondents got the label high meat attachment. Figure 7 shows the estimated marginal means of perceived stimulation in the low vs. high meat attachment groups.

Table 13: Means and standard deviations of perceived stimulation

Group	*n*	Mean (PS)	*SD*
Low meat attachment	77	48.96	25.96
High meat attachment	64	42.07	24.85

Figure 7: Estimated Marginal Means of perceived stimulation

4.4.1.2. Pleasant arousal

The proposed hypothesis 4 was tested using regression analysis, the perceived stimulation and perceived hedonism are positively related to pleasant arousal feelings. The results show that 46% (R^2 = 0.460) of variance in pleasant arousal feelings is explained by perceived stimulation and perceived hedonism (β = 58.872, p = 0.000), supporting H4. Moreover, with the data there can also be tested on whether people who were using AR experienced increased pleasant arousal feelings. The results show that No AR stimuli (n = 69, M = 2.870, SD = 1.045) compared to AR stimuli (n =72, M = 3.562, SD = 0.746) is significantly different in the score on pleasant arousal feelings (β = 20.665, p = 0.000).

4.4.1.3. Intention towards sustainable protein source

The proposed hypothesis 5 was tested using regression analysis, diet is something that needs to be controlled for as vegetarians and vegans would expectedly choose for the vegetarian and thus sustainable option, these people are excluded from the sample. A regression analysis with the selection variable diet is equal or greater than 3 (3 = flexitarian, omnivore = 4) is done (n = 115). The results show that pleasant arousal feelings are positively related to intention to alter towards a more sustainable protein source (β = 34.101, p = 0.000), supporting H5. The R^2 value of 0.232 indicates that 23.2% of the variance in the intention is explained by the pleasant arousal feelings. Moreover, it is interesting to explore whether and how much impact AR has.

A regression analysis with the selection variable use of AR is done. For the group without AR (n = 56), a significant effect of pleasant arousal feelings on intention is still found (β = 10.669, p = 0.002, R^2 = 0.165). The group with AR stimuli (n = 59) results again in a significant effect of pleasant arousal feelings on the intention to choose a sustainable source of protein (β = 31.448, p = 0.000, R^2 = 0.356). The F-value of the AR group is higher, the higher F-value indicates a stronger case for rejecting the null hypothesis.

Figure 8 provides an overview with the supported and rejected hypothesis based on earlier research and empirical data in the current research.

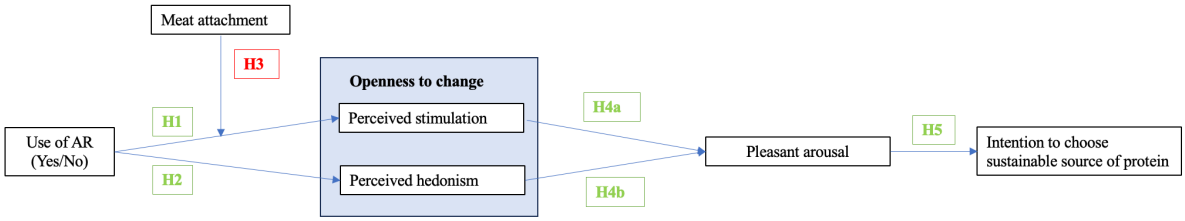

Figure 8: The CM with supported hypothesis (green) and rejected hypothesis (red)

5. Discussion and Implications

The output of this research contributes to the growing literature on consumer behavior towards sustainable protein sources. Across the study, it is demonstrated whether AR can be of value in the consumers' intention to choose for a more sustainable source of protein. The study was designed to explore whether AR evokes pleasant arousal feelings and to generate insight into underlying mechanisms that influence the intention to choose a sustainable source of protein. These insights can contribute to science and practice in the field innovative tools to support the protein transition.

From existing literature, it became clear that in the transition to sustainable proteins, it is crucial that the information supplied matches the information needs of the consumer during the decision-making process (Kwasny et al., 2022). In this research, the aim of AR was to attract consumers' attention and stimulate towards sustainable protein choice in the active evaluation phase. This was done by placing the AR filter over the sustainable protein source. After attention attraction, positive consequences are important to communicate, these were based on concepts found to be important in the protein transition (van den Boom et al., 2023). The problem of meat attachment in previous research was here not found to be influencing the perceived stimulation for the consumers who answered the questionnaire. No weaker perceived stimulation was found when a person was highly attached to meat. The behavioral intention is supported by evoking pleasant arousal feelings. When these feelings are reached there was a greater chance of ending up in a state of readiness towards a sustainable source of protein (Taufik, 2018).

With regard to the predictors perceived stimulation and hedonism, the results indicate that groups that used AR as stimuli, had a significantly higher mean score on both constructs. The rationale behind the hypotheses in the current study based on prior research, were that when the concepts (environmental impact, AW and availability of alternatives) that people find important to transition towards sustainable protein sources, are activated through AR, the Schwartz's (2012) value: 'openness to change' would be triggered. When consumers are doing groceries, they are often low on cognitive resources but sustainable information about products requires high cognitive resource processes as the construal level is high (Trope & Liberman, 2010; White et al., 2019). AR benefits the shopping experience through lowering cognitive processes, entertainment and information compared to normal shopping experiences (Dacko, 2017). In agreement with previous studies on sustainable consumption, the value-based factor openness to change significantly predicted sustainable intentions (Betzler et al., 2022). In the fashion industry, hedonic motivations and positive affective response due to AR led to increased purchase intention, which is in this research also the case in retail context (Watson et al., 2020). Moreover, research highlighted the effectiveness of value activation strategy in retail where vegetarian meals were stimulated (Bouwman et al., 2022). This research added to prior work that stimulation and hedonism are underlying values for openness to change which are important to be activated in transitions towards sustainable proteins (Schwartz, 2012).

As Swartz theory argues, value activation causes infusion of values with feelings. The three most important concepts and underlying values to be activated in the current study are further explained through examples from earlier research. The first, AW activation almost doubled the amount of vegetarian meals ordered due to the inability to decouple meat consumption from their moral self-identity when the pro-environmental value was activated (Bouwman et al., 2022). Next, in the current research, the availability of alternatives for meat was highlighted by placing the meat alternative next to the meat and displaying the AR information on the meat alternative as an overview of mental models showed benefits in the protein transition (van den Boom et al., 2023). However, other research found that a separate category for meat alternatives could also be beneficial for more radical plant-based protein sources which are less like meat in terms of taste and structure, which could in turn decrease innovation in the industry (Hoogstraaten et al., 2023). This again depends on the motivations of people

to consume reduced amount of animal proteins (Yule & Cummings, 2023). Lastly, the meat related cognitive dissonance could also be lowered through providing knowledge on the positive sustainable impact, the environmental concept. Knowledge is influential as it is the basis for consumption behavior, new knowledge influences the decision process (Blackwell et al., 2006). The information through AR in this research could be treated as new knowledge on the concepts AW, environmental impact and availability of alternatives. Drawing on what has been written, being open to information on change and impacts of meat was found to be beneficial for choosing a more sustainable source of protein (Graça et al., 2015). The type of meat (beef or chicken) did not make a difference on the perceived stimulation or hedonism.

The current research thus advances the field with the advantage of AR on increased stimulation and hedonism as these activate the concepts environmental impact, animal welfare and availability of alternatives which in the protein transition context are important.

The influence of meat attachment

The omnivore diet is correlated with high meat attachment and thereby causes disinterest in plant-based options (Graça et al., 2015; Yule & Cummings, 2023). This is inconsistent with the finding that meat attachment does not influence the perceived stimulation of respondents. Respondents with low meat attachment perceived higher stimulation compared to high meat attachment but not statistically proven. Respondents with high meat attachment perceived lower stimulation, which is in line with earlier research that found high meat attached consumers are less open to attraction and information displays (Kwasny et al., 2022). However, one could say based on the findings that AR tackled the strategic ignorance of information by highly meat attached people. This could be due to advantages of AR such as increased interest and motivation, reduce of cognitive load and positive emotional experience (Gómez-Rios et al., 2023).

Earlier research already highlighted the importance of message congruence and the misalignment of communicated values (Yule & Cummings, 2023). For more conservative people, taste, health and environment are the most important values to communicate to reach a wider proportion of the omnivore market. The correlations (Appendix B) among the demographics in the current research do not indicate that meat attachment is correlated to age nor to shopping behavior. Expectedly, meat attachment is positively correlated to people's diet. Interesting to highlight is that gender was significantly correlated with MA and was stronger for men. Related, Yule and Cummings (2023) found more women tried plant-based protein sources compared to men and conservative men were less likely to switch towards a plant-based diet. De Boer et al. (2014) also found women more likely to accept sustainable protein sources. An outcome could be to communicate concepts and activate values that are more in line with the person's mindset. AR is highly innovative and could be combined with AI to personalize consumers' experiences and thereby possibly align and activate the relevant values (Devagiri et al., 2022).

Positive driver: pleasant arousal

Perceived stimulation and hedonism positively affect the pleasant arousal feelings which confirms the expectations from prior research devoted to the positive effects of AR on enjoyment and motivation in education (Gómez-Rios et al., 2023). Positive emotions are part of the decision making process and main driver of sustainable purchase intentions (Onwezen et al., 2022). The reasoning behind these hypotheses in the retail context was that when consumers perceive increased openness to change, they would have increased pleasant arousal feelings as they are more open to be influenced through information displays via AR. The current research measured pleasant arousal through items focused on the longer term, expected can be that when these feelings are reached sustainable intentions on the longer term are met (White et al., 2019).

The empirical analysis further supports the assumption that pleasant arousal feelings positively support the intention to choose a sustainable protein source (Watson et al., 2020). By identifying pleasant arousal as underlying mechanism which leads to sustainable protein intentions, regardless of the use of AR, the research of Onwezen et al. (2022) is supported and evidence was provided to the theoretical proposition that positive emotions are an important driver in the protein transition (Onwezen et al., 2022). Another study researched a combination of positive and negative emotions with a theory of Swartz (Norm Activation Model) on pro-environmental behavior, the findings emphasize equally strong effects of positive and negative arousals (Onwezen et al., 2013). Nonetheless, the study stresses the importance of positive emotions as they are understudied compared to negative emotions.

How values relate to attitude and beliefs in the protein transition

The activation of AW, environmental impact, availability of alternatives through AR, in this research is a crucial way to influence attitudes and beliefs as those are based on values which in turn guides the principals in a person's life (Schwartz, 2012). Attitudes evaluate objects, in the current study, the object could be for example the vegetarian chicken (as sustainable protein source). When a person due to the new information, scales the vegetarian chicken as more positive, the likability of a positive attitude on sustainable proteins increases which in turn guide behavior. Moreover, values are also highly related to beliefs (Schwartz, 2012). Beliefs are about how true ideas are, a belief could be: "the environmental impact of vegetarian chicken is way lower", when a person after AR get a stronger belief on this statement, it could guide sustainable behavior. Moreover, research found that people could both engage in strategic ignorance of information on sustainable choices but also in changing their behavior (Bouwman et al., 2022). In the current study, again such a paradoxical result is found, people were half of the time highly attached to meat but also willing to choose a more sustainable protein source due to pleasant arousal. Following the theory of Swartz, the tradeoff between competing values 'openness to change' and 'conservation' leads then to a relative more important value of 'openness to change' (Schwartz, 2012). Bouwman et al. (2022) explains the paradox as when values are activated people are no longer able to decouple meat consumption from their moral self. The strategic ignorance and motivated reasoning are no longer the dominating intentions.

Role of demographics

Income was also not found as a significant predictor of intention to choose sustainable source of protein. In this research, price was out of scope as it could distract the consumer. Sustainability is not highly price sensitive however, when both options would be equally sustainable, research must reveal whether the low sensitivity to price still holds (Hult et al., 2018). Especially for low income consumers, price is an important predictor of food choice in the supermarket (Steenhuis et al., 2011). Compared to an earlier study, that found curiosity drives purchase intention, this study did not find shopping behavior as predictor for intention to choose a sustainable protein source (Hill et al., 2016).

5.1. Practical and theoretical implications

The current research advances the field with the advantage of AR stimulus, suggesting the relevance of value activation in supporting sustainable proteins. For this research the most clearly linked values of Dutch consumers in the protein transition were taken (van den Boom et al., 2023). However, it seems highly relevant to focus on personal values which are categorized by Swartz's theory. The motivations of people to reduce or cut out meat of their diet are different. Therefore, even stronger advantages are expected when the activated values are in line with a person's motivations. This is in accordance with a study on meat curtailment of omnivores (Yule & Cummings, 2023), examples of such values that could be highlighted (among environment) are taste and health. Logically, the value activation strategy had

more impact on people who already had a pro-environmental self-identity when choosing a vegetarian burger (Bouwman et al., 2022).

One aim of the AR tool was to communicate reduced environmental consequences of the sustainable proteins as these are complex for consumers to understand (van den Boom et al., 2023). Expected can be that the consumer gets a comprehensive idea of what role he or she can play and the impact their choice is generating by choosing more sustainable. Moreover, van den Boom et al. (2023) argues consumer engagement could be a promising avenue in the protein transition to help understand the short and long term effects of the protein transition. AR can transform the consumer experience by creating emotional engagement as the tool can make consumers believe the power of their choice and the effect of the change (Riva et al., 2016).

In the supermarket, sustainable protein sources are easy, convenient and widely available. Therefore the value activation strategy is a viable strategy (Bouwman et al., 2022). However, a value activation strategy through AR could contribute to polarization as the AR tool is futuristic and when coming available, high in cost. This would implicate that only people with high income could make use of the tool, and for people where the tool is not available, the chances of transition to more sustainable protein sources is lower or they even give up when they are highly attached to meat. Policy makers must keep in mind the inclusivity in supermarket environments for all consumers.

5.2. Limitations and future research suggestions

The present study has some limitations. It should be mentioned that convenience sampling—mostly with students – is used. The purpose of the study was to determine whether AR could have an impact. While the sample is suitable for this purpose, the composition of the sample does limit the external validity of the research. Younger people are more likely to be confronted with innovative tools such as AR, the current research cannot draw further conclusions on age as it was not found to be a significant predictor of intention towards sustainable proteins. The average age in this research was relatively low thus more research on age and innovative tools must be done.

Moreover, research found that motivations of people to lower meat consumption are highly different. A large part of the sample was flexitarian where potentially a selection bias could be identified as flexitarians, vegetarians and vegan have potentially a preference to the sustainable option. In the intention towards sustainable proteins test, vegetarians and vegans are taken out of the sample to ensure that respondents would consider both options (meat vs. vegetarian option).

Another limitation is that for the measuring the constructs, shortened versions of the scales are used due to reasons of time. The use of the shortened versions might impacted the reliability of the scales, however the Cronbach's Alpha was overall sufficient except for the 'pleasant arousal' of chicken_AR which should therefore be interpreted with caution. Another statistical limitation was the significant Levene's test wherefore additional tests were done. The assumptions for the statistical tests could not all be perfectly met, Field (2009) mentions unfortunately this kind of data is often the norm. Therefore, the results cannot strongly be generalized beyond the sample.

This research explored the first steps into the value of the use of AR in the protein transition but took quite general approach on concepts to communicate to the consumer. Moreover, no real AR tool was used on participants but first person point of view videos with an AR filter. The resources for actual AR development were absent but the findings make a powerful argument for researchers to further explore actual AR development in the supermarket.

Literature has indicated that there could be a significant gap between intention and behavior, however, intentions are the largest predictor of behavior (Onwezen et al., 2022). In a study where value activation is used to support vegetarian meals, the post test showed that feelings of meat-related cognitive dissonance increased (Bouwman et al., 2022). For the current study, findings implicate that

AR evoked pleasant arousal and in turn guided intentions towards sustainable proteins, further research with a post test would give a good indication on the self-reported consumption of proteins to get a better understanding of the AR intervention in the longer term (Onwezen et al., 2022). Primarily important because one intervention is often not enough to change routinized behavior or habits.

Next, AR is highly valuable due to interaction with the persons using the tool, in the current research interaction with the tool and feedback on behavior through AR is out of scope due to lack of resources, however, interactivity helps consumers to search for product information and purchase decisions (Li & Karahanna, 2015). Even stronger effects can be expected when people are provided with an interactive experience as the quality of shopping experience is increased and information needs are better met (Park & Yoo, 2020).

Lastly, the theory of Swartz Basic Human Values state various values that predict behavior, apart from openness to change. For this research, the openness to change was the most appropriate first order value to support people in the transition towards more sustainable protein sources. The most contradictory value, conservativeness, is expected to obstruct the intention towards a sustainable choice of protein however this extends the scope of this research. Deeper research into how AR can influence the first order value ‘conservation’ could possibly support the protein transition.

6. Conclusion

The protein transition is a huge societal challenge to mitigate climate change. People often perceive sustainability information on packaging as complex and are attached to meat. Therefore, people tend strategically ignore sustainability information. To support consumers in their decision on a sustainable protein choice, this research found that through displaying extra information on animal welfare and environmental consequences with an AR tool, increased pleasant arousal feelings are evoked compared to consumers not using AR. AR can thus display product information in a hedonic way and align information with the information demand in the different phases of the consumer decision journey, which was found to be important in the protein transition. The pleasant arousal in turn encouraged choices towards sustainable sources of protein in the supermarket. Perceived stimulation and hedonism have been identified as important drivers to change behavior towards sustainable protein intentions. AR thus increased the value priority openness to change of respondents and tackled the information ignorance of highly meat attached people. The increased intention to sustainable protein sources expectedly results in behavior change in the supermarket. Future work, should also consider personal values and their activation through AR as the motivations for changing behavior to sustainable proteins are very different for people. The research makes a powerful statement to further test the effect of AR, including consumer engagement and interactivity, on people in real life retail setting.

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Appendix A

"Imagine you walk in the supermarket and you want to buy some protein source for dinner tonight, you are going to make a dish with [meat type] as protein source. You look on the shelves where the options: [meat type] (Eco-score …*) and a meat alternative for [meat type] (Eco-score …*). You are in the moment of choosing an option and you look at all the different packages. On the next page you see a simplified version of such information."

*Eco-score E = high environmental impact, Eco-score C = medium environmental impact, Eco-score A = low environmental impact

Figure A1: Example of experimental condition (beef_AR)

Figure A2: Example of control condition (beef_NoAR)

Appendix B

Table B1: Overview of constructs, items and levels

Constructs and items	Levels	Reference
Openness to change [Perceived hedonism] I perceived the presentation of the products (with AR[1]) as… 1. Not fun/fun 2. Dull/exiting 3. Unenjoyable/enjoyable [Perceived stimulation] The presentation sustainable impact information (through AR[1]) is… [c] 1. Catchy/not catchy 2. Appeals me/doesn't appeal me 3. Excites me/doesn't excite me	Seven point sematic scale Likert scales (5 = "strongly agree" to 1 = "strongly disagree")	Pham and Avnet (2004) Voss, Spangenberg, and Grohmann (2003)
Pleasant arousal After the product interaction video I feel… 1. Encouraged 2. Hopeful	Likert scales (5 = "strongly agree" to 1 = "strongly disagree")	(Taufik, 2018)
Intention to alter choice of protein It is likely that I will alter my protein source towards a more sustainable one (from [protein source]: Eco-score [rank], to vegetarian option for [protein source]: Eco-score [rank]) I predict that I have the intention to choose a more sustainable source of protein	Likert scales (5 = "strongly agree" to 1 = "strongly disagree")	
Meat attachment [Hedonism/Dependence] To eat meat is one of the good pleasures in life I don't picture myself without eating meat I would feel fine with a meatless diet* Meat is irreplaceable in my diet	[a] Likert scales (5 = "strongly agree" to 1 = "strongly disagree")	(Graça et al., 2015)
Covariates Gender [d] Age [e] Shopping behavior [g] Diet [h] Income [i]	[d] M,F,X [e] Age (1-100) [g] Consistent, curious, neutral [h] Vegan, vegetarian, flexitarian, omnivor [i] ranges of income	

Note: * = reverse-scored items

Table B2: Constructs and corresponding items, reliability scores

	Beef_NoAR	Chicken_NoAR	Beef_AR	Chicken_AR
Openness to change [Perceived hedonism] I perceived the presentation of the products (with AR[1]) as… 4. Not fun/fun 5. Dull/exiting 6. Unenjoyable/enjoyable [Perceived stimulation] The presentation sustainable impact information (through AR[1]) is… [c] 4. Catchy/not catchy 5. Appeals me/doesn't appeal me 6. Excites me/doesn't excite me	0.921	0.914	0.938	0.934
Pleasant arousal After the product interaction video I feel… 3. Encouraged 4. Hopeful	0.881	0.886	0.743	0.509*
Intention to alter choice of protein It is likely that I will alter my protein source towards a more sustainable one I predict that I have the intention to choose a more sustainable source of protein	0.831	0.807	0.808	0.858
Meat attachment To eat meat is one of the good pleasures in life I don't picture myself without eating meat I would feel fine with a meatless diet* Meat is irreplaceable in my diet	0.849	0.849	0.849	0.849

Note: Cronbach's Alpha for meat attachment is measured for all respondents, therefore the value is for every group the same; * not sufficient reliable

Correlations among the demographics are tested to see whether there are patterns in the data that are of value for research in the context of the protein transition, see Table 5.

Table B3: Pearson correlations demographics

	Gender	Age	Shopping behavior	Diet	Income	Meat attachment
Gender	1	-0.251**	0.041	0.321**	-0.329**	0.416**
Age	-0.251**	1	-0.055	0.017	0.742**	0.064
Shopping behavior	0.041	-0.055	1	-0.096	-0.073	-0.098
Diet	-0.321**	0.017	-0.096	1	0.129	0.688**
Income	-0.329**	0.742**	-0.073	0.129	1	0.181*
Meat attachment	-0.416**	0.064	-0.098	0.688**	0.181*	1

Note: * Correlation is significant at the 0.05, ** Correlation is significant at the 0.01, N = 141 (gender: 1 = male, 2 = female; shopping behavior: 1 = consistent, 2 = curious, 3 = neutral, 4 = I don't know; diet: 1 = vegan, 2 = vegetarian, 3 = flexitarian, 4 = omnivore; meat attachment: 1 = no meat attachment, 5 = high meat attachment)

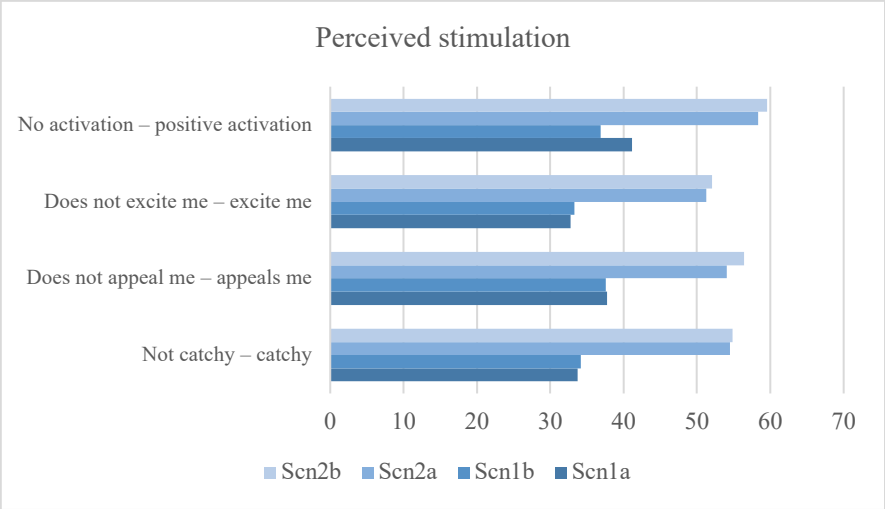

Figure B1: Mean difference PS visualization

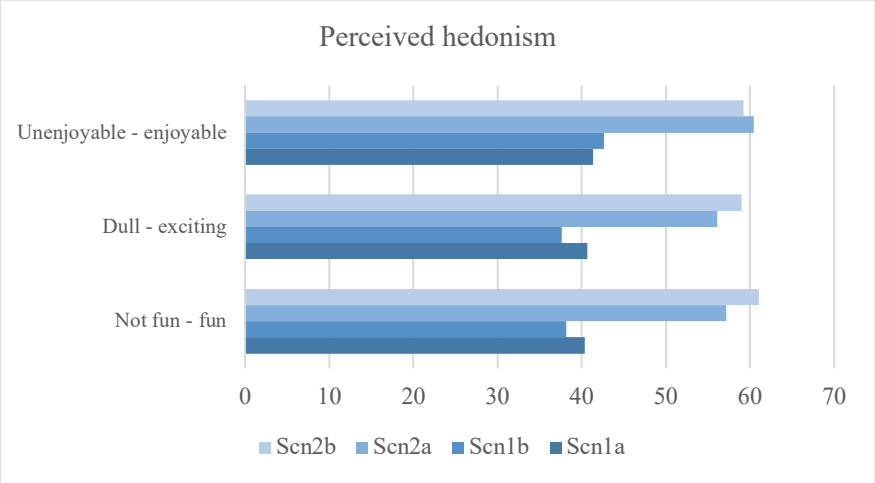

Figure B2: Mean difference PH visualization

Appendix C

Explanation on assumptions:
For chicken_NoAR, the normal Q-Q plot is indicating a little deviation from the reference line. Therefore, bootstrapping is performed to deal with the assumption of normality (LaFlair et al., 2015; Wright & Field, 2009).

Explanation on significant K-S (D) value:
Research found that smaller sample sizes distributions of *K-S (D)* value is often not uniformly distributed (Bearden et al., 1882). The models are then more often rejected than would occur by chance.

Additional statistical tests:
Hypothesis 1 is further tested as meat type did not indicate significant differences in means, a larger sample can be used combining both AR (n = 72, M = 55.38, SD = 24.29) and no AR (n = 69, M = 35.88, SD = 22.53) groups. Another independent samples t-test shows that perceived AR and no AR means are significantly different (β = -4.936, p = 0.000).
Hypothesis 2 is further tested as meat type did not indicate significant differences in means, a larger sample can be used combining both AR (n = 72, M = 58.98, SD = 20.61) and no AR (n = 69, M = 40.07, SD = 24.03) groups. Another independent samples t-test shows that perceived AR and no AR means are significantly different (β = -5.006, p = 0.000).

Assumption of H3, H4 and H5

Table C1: test results of multicollinearity

Dependent variable	**Construct**	**Tolerance**	**VIF**
Perceived stimulation	MA	1.000	1.000
Pleasant arousal	PS	0.519	1.928
	PH	0.519	1.928
Intention	WG	1.000	1.000

Note: value of 1 indicates no correlation, values between 1 – 5 moderate correlation, value 5 or higher severe correlation

Normality of residuals was checked visually by looking at the histogram, Normal P-P plot and scatterplot, appropriate normality of the distribution can be assumed. No major concerns for skewness and kurtosis can be identified.

H3: histogram, normal PP plot and scatterplot

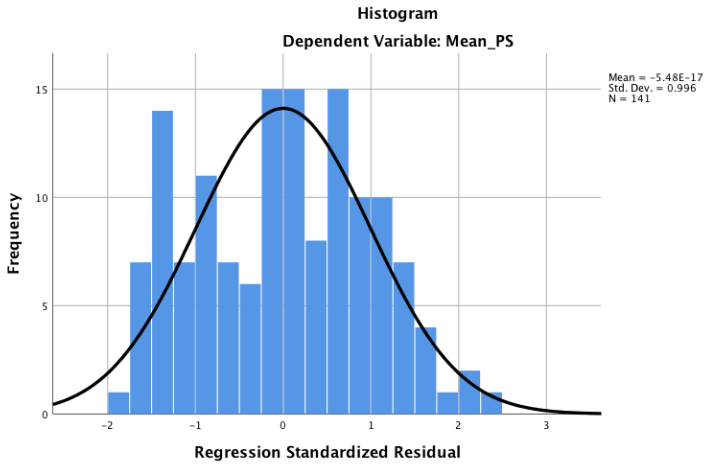

Figure C1: Histogram PS

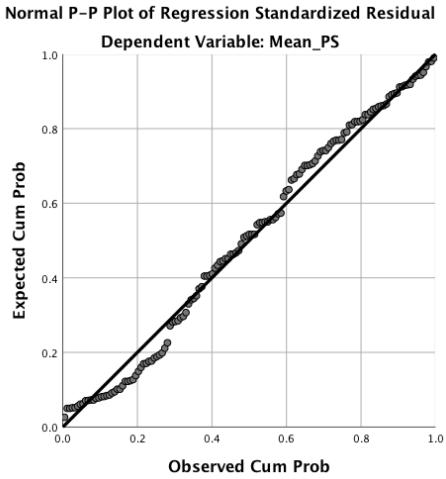

Figure C2: Normal P-P Plot PS

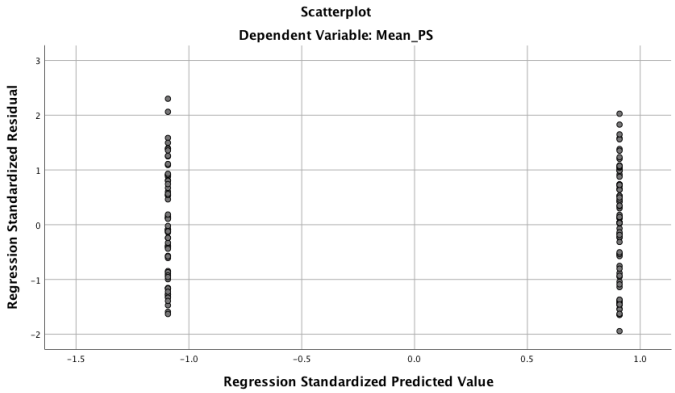

Figure C3: Scatterplot PS

Note: the pattern does not indicate homescedacity. This is because the respondents are either in group 1 (low meat attachment) or in group 2 (high meat attachment)

H4: histogram, normal PP plot and scatterplot

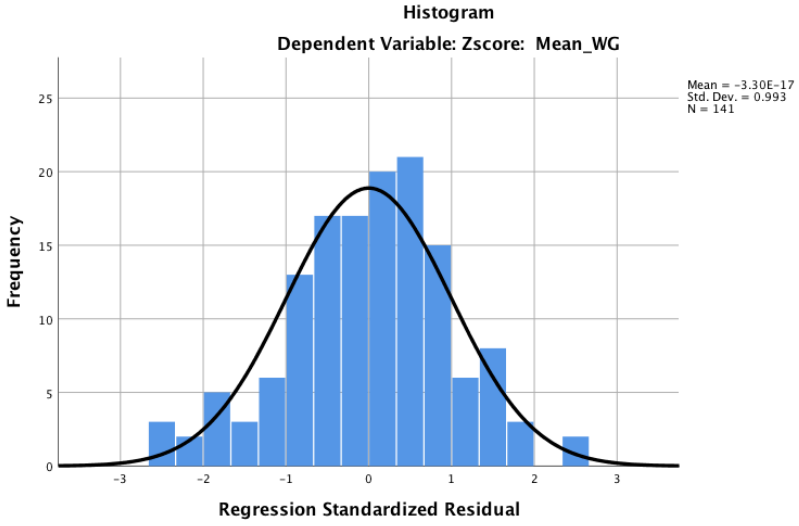

Figure C4: Histogram WG

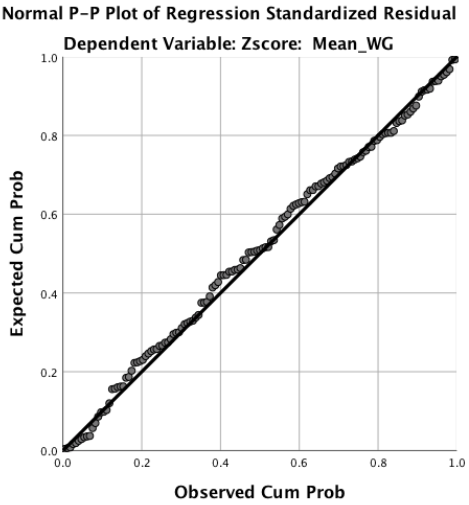

Figure C5: Normal P-P Plot WG

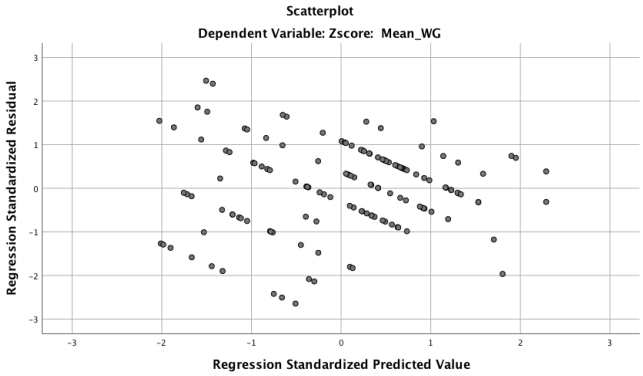

Figure C6: Scatterplot WG

H5: histogram, normal PP plot and scatterplot

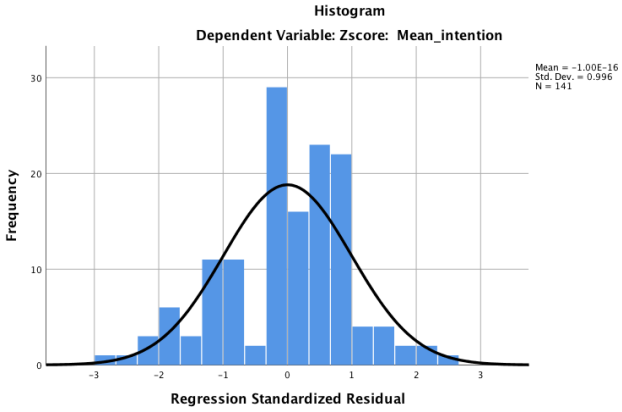

Figure C7: Histogram Intention

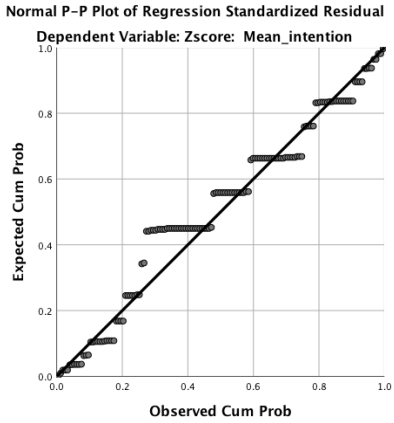

Figure C8: Normal P-P Plot Intention

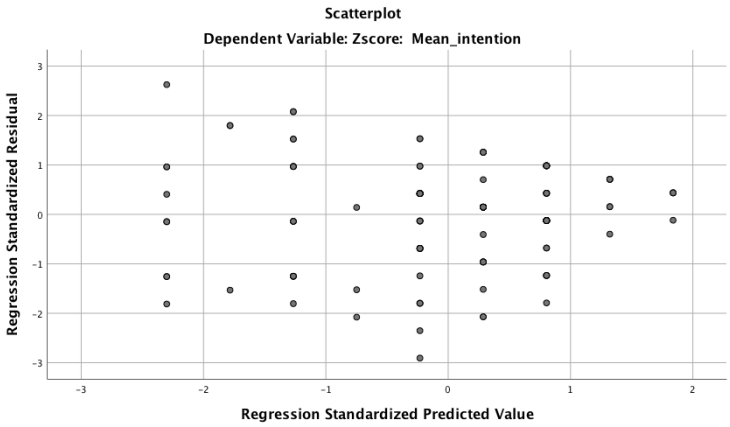

Figure C9: Scatterplot intention