

**The effect of information provision on attitude, intention,
and food choice behaviour**

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Four experimental studies

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Abstract

The agricultural and food sector in Germany is facing a number of challenges. Consumers are increasingly dissatisfied with contemporary livestock production and, in addition, livestock farming accounts for a substantial share of global greenhouse gas emissions. Moreover, the prevalence of nutrition-related disease rises. Whereas consumers' meat intake on average exceeds recommendations, whole grain intake rarely meets the recommended levels. Thus, effective strategies are needed to influence consumers' acceptance of contemporary livestock farming, and dietary behaviour with respect to meat and whole grain intake. Providing information is one of several different policy instruments that can be used to influence consumers' attitude, intention, and food choice behaviour. Information campaigns are classified as a soft intervention, do not limit consumers' freedom of choice, and yield rather high acceptance rates among consumers. Although a number of theoretical frameworks can account for the effect of information provision, the empirical evidence for an effect of information provision on behaviour yields mixed evidence.

The goal of this cumulative thesis is to further investigate the effectiveness of information provision as an intervention to influence attitudes, intentions, and food choice behaviour. Moreover, this thesis investigates factors that determine the effectiveness of information provision. Related to the contemporary challenges of agricultural and food sector, this thesis investigates the effect of information in the domain of acceptance of animal husbandry, meat consumption, and whole grain consumption with four experimental studies ($n = 1087$). The results indicate that information provision can have beneficial effects on consumer attitude, intention, and food choice behaviour, which supports the use of information provision as a policy tool. Elements that have shown to increase the effectiveness of information provision were the inclusion of health-related information and repeated exposure to the information. Moreover, for certain types of information such as environmental information, target group-oriented information tailoring might be superior in order to change attitudes. Hence, to achieve a transition towards higher societal acceptance of animal husbandry, reduced levels of meat consumption, and increased whole grain consumption, information provision is a promising avenue for the agricultural and food sector.

Kurzfassung

Der Agrar- und Ernährungssektor in Deutschland steht vor einer Reihe von Herausforderungen. Die Verbraucher*innen sind zunehmend unzufrieden mit der heutigen Tierhaltung. Zusätzlich ist die Viehzucht für einen erheblichen Teil der weltweiten Treibhausgasemissionen verantwortlich. Auch steigt die Prävalenz von ernährungsbedingten Krankheiten. Während der Fleischkonsum der Verbraucher*innen im Durchschnitt über den empfohlenen Mengen liegt, liegt der Verzehr von Vollkornprodukten meist darunter. Daher sind wirksame Strategien erforderlich, um die Akzeptanz der Verbraucher*innen für die moderne Tierhaltung und ihr Ernährungsverhalten zu beeinflussen. Die Bereitstellung von Informationen ist eines von mehreren verschiedenen politischen Instrumenten, das eingesetzt werden kann, um die Einstellung, die Intention und das Ernährungsverhalten der Verbraucher*innen zu beeinflussen. Informationskampagnen werden als softe Intervention eingestuft, schränken die Wahlfreiheit nicht ein und werden von der Bevölkerung als Maßnahme zumeist akzeptiert. Obwohl es eine Reihe theoretischer Erklärungen für die Wirksamkeit von Informationsgabe gibt, sind die empirischen Belege, dass Informationen zu einer Verhaltensänderung führen können, nicht eindeutig.

Ziel dieser kumulativen Dissertation ist es, die Wirksamkeit von Informationsgabe als Intervention zur Beeinflussung von Einstellungen, Intentionen und Ernährungsverhalten der Verbraucher*innen weiter zu erforschen. Außerdem wird untersucht welche Faktoren die Wirksamkeit von Informationsgabe beeinflussen. Bezogen auf die aktuellen Herausforderungen des Agrar- und Ernährungssektors untersucht diese Arbeit die Wirkung von Informationen im Bereich der Akzeptanz von Tierhaltung, Fleischkonsum und Vollkornkonsum anhand von vier experimentellen Studien ($n = 1087$). Die Ergebnisse deuten darauf hin, dass Informationen positive Auswirkungen auf die Einstellung, Intention und das Ernährungsverhalten haben, was den Einsatz von Informationen als politisches Instrument unterstützt. Die Einbeziehung gesundheitsbezogener Informationen und der wiederholte Kontakt mit den Informationen sind Faktoren, welche die Wirksamkeit erhöhen. Darüber hinaus scheint bei bestimmten Arten von Informationen, wie z.B. Umweltinformationen, eine zielgruppenorientierte Informationsgabe besser geeignet zu sein, um eine Einstellungsänderung zu bewirken. Insgesamt ist die Bereitstellung von Informationen ein vielversprechender Weg für den Agrar- und Ernährungssektor, um eine höhere gesellschaftliche Akzeptanz der Tierhaltung, einen geringeren Fleischkonsum und einen höheren Vollkornkonsum zu erreichen.

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Abbreviations

APEM	Associative Propositional Evaluation Model
BS	Between-subjects
ELM	Elaboration Likelihood Model
IPCC	Intergovernmental Panel on Climate Change
KDM	Knowledge Deficit Model
n.a.	Not applicable
NFA	Need for Affect
NFC	Need for Cognition
POS	Point of Sale
SDG	Sustainable Development Goals
TCD	Theory of Cognitive Dissonance
TPB	Theory of Planned Behaviour
UN	United Nations
WHO	World Health Organization
WS	Within-subjects

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Four experimental studies

1. Introduction

1.1. Research motivation

The agricultural and food sector in Germany is facing a number of challenges. Consumers are increasingly dissatisfied with contemporary livestock production (Christoph-Schulz & Rovers, 2020; Birkle et al., 2022; Weible et al., 2016). Common animal husbandry practices, such as the application of slatted floors in pig-fattening stalls (Statistisches Bundesamt, 2020), are evaluated as highly negative by consumers (Busch et al., 2019) although consumers are typically not very knowledgeable about animal husbandry (Wildraut et al., 2015). Moreover, the agricultural sector is responsible for a quarter of global greenhouse gas emissions (Tubiello et al., 2015), which is considered a main driver of climate change (IPCC, 2013). In Germany, livestock farming accounts for a substantial share of the entire greenhouse gas emissions of agriculture (Umweltbundesamt, 2018). One way to reduce the negative impact of livestock farming on environmental sustainability is by changing consumers' dietary behaviour towards a vegetarian or plant-based diet (Tilman & Clark et al., 2014; Macdiarmid et al., 2012). A change in dietary patterns would not only have beneficial effects on environmental sustainability, but also on consumers' health (Dinu et al., 2017). High rates of (red) meat consumption are associated with increased risk of developing cardiovascular diseases (Bronzato & Durante, 2017) or colorectal cancer (Aykan, 2015). Yet, reduced meat consumption is not the only dietary pattern that would be beneficial for consumers' health. Similarly, consumption of whole grain products is associated with lower risks of developing coronary heart diseases (Tang et al., 2015; Meier et al., 2019), type 2 diabetes (Tierl et al., 2020), and overweight (Sanders et al., 2021). Whereas consumers' meat intake on average exceeds recommendations (Godfray et al., 2018), whole grain intake rarely meets the recommended levels (O'Donovan et al., 2019; Sandvik et al., 2014). Therefore, it is necessary to develop effective strategies to navigate consumers towards a healthier and more sustainable diet.

Providing information is one of several different policy instruments that can be used to influence consumers' food choice behaviour. As stated by Weiss and Tschirhart (1994): *'Public information campaigns [...] are one way that government officials deliberately attempt to shape public attitudes, values, or behavior in the hope of reaching some desirable social*

outcome' (p. 82). An example of a widely known information campaign is the '5 A Day' campaign, which targets the consumption of fruits and vegetables and has been adopted by numerous countries (Hawkes, 2013). Such information campaigns can be transmitted through various channels such as billboards, television, newspaper, pamphlets, radio, or via social media platforms (Spiller et al., 2017). They can consist of several communication mediums, for example, textual information, images, or videos. As mentioned by Weiss and Tschirhart (1994), information campaigns aim not only at influencing behaviour, but also at influencing consumers' attitude, knowledge, and values. Providing information is considered a soft intervention that is often placed at the lowest level of the intervention ladder (Griffiths & West, 2015; Nuffield Bioethics Council, 2007). By reducing information asymmetry, providing information enables consumers to make informed choices and allows for autonomous behaviour (Thaler & Sunstein, 2008; Griffiths & West, 2015). Moreover, consumers actively request more information, for instance, in the domain of animal husbandry (Eurobarometer, 2006, 2016) and perceive information provision as a helpful tool to steer their eating behaviour (Foster et al., 2020). Consequently, consumer acceptance of soft policy tools, is rather high (Hagmann et al., 2018; Banerjee et al., 2021). Other policy tools involve financial incentivisation, such as taxes or subsidies (Latka et al., 2021; Thow et al., 2014) or regulatory mechanisms, for example, mandatory meat-free days in canteens (Blondin et al., 2022). However, these instruments require a rather high depth of intervention in market processes and can reduce or even eliminate consumers' freedom of choice (Griffiths & West, 2015). Furthermore, financial strategies influence the economic incentives that are associated with a behaviour; positively in the case of subsidies and negatively through taxes. In contrast, information provision operates without a limitation of freedom of choice and does not impact economic incentives (Griffiths & West, 2015; Nuffield Bioethics Council, 2007; Thaler & Sunstein, 2008). Hence, in order to enable an autonomous behaviour change that is associated with changes in consumers' attitude and knowledge, information provision is the most suitable policy instrument.

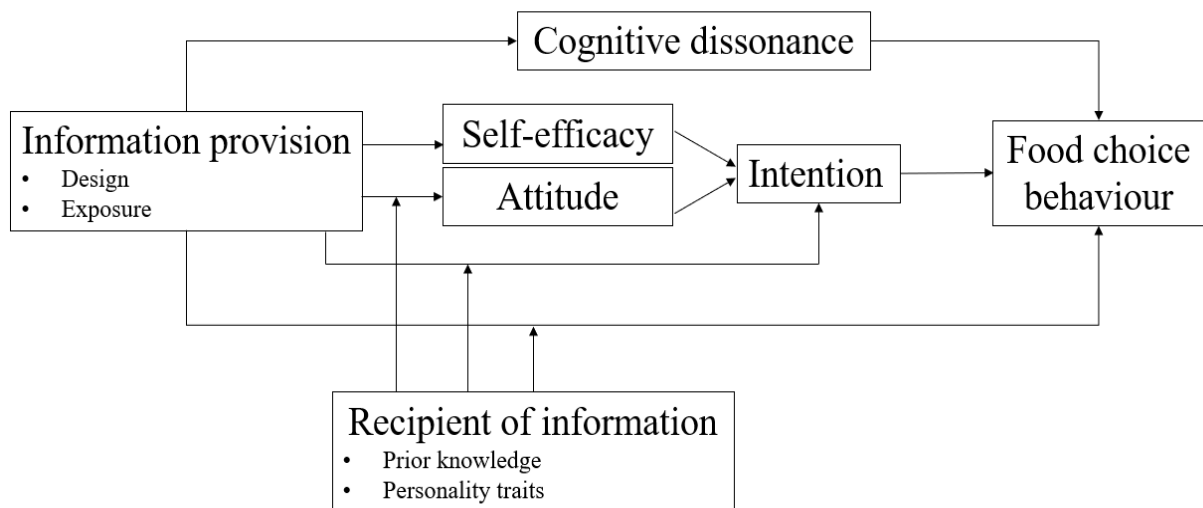
Several theoretical frameworks explain why information campaigns can (in)directly influence consumers' behaviour (Schultz, 2002), attitude (Gawronski & Bodenhausen, 2006), and delineate under which circumstances this effect increases or decreases in magnitude (Petty & Cacioppo, 1986). While there is overall consistent empirical support for the effectiveness of information provision to change consumers' attitudes (Carfora, 2019a; See et al., 2008; Ryffel & Wirth, 2016; Forscher et al., 2019), the effect of information on behavioural intentions and behavioural changes yields mixed evidence (Ottersen et al., 2022; Verain et al., 2017; Vainio

et al., 2018; Jalil et al., 2020, 2022; Carfora et al., 2019a, 2019b; Wolstenholme et al., 2020). The goal of this cumulative thesis is to further investigate the effectiveness of information provision as an intervention to influence attitude, intention, and food choice behaviour. Thereby, the thesis investigates several factors on the information-design side, but also on the information-recipient side, that can determine the effectiveness of information.

1.2. Theoretical background

To better understand the impact of information provision on attitude, intention, and food choice behaviour, this sub-chapter describes different theoretical frameworks. While some frameworks assume a direct information-attitude and information-behaviour relationship, other frameworks assume an indirect relationship. In addition, the mechanisms that determine the effectiveness of information provision are described. Figure 1 provides an overview of the different pathways that are outlined in this chapter.

Figure 1. Conceptual Framework



Knowledge Deficit Model

According to the Knowledge Deficit Model (KDM), providing information can have a direct effect on consumers' behavioural intentions and behaviour (Schultz, 2002). The KDM claims that when consumers have all the relevant knowledge about a behaviour, they are more likely to engage in this behaviour (Abrahamse, 2020). Hence, according to the KDM, information should only have an effect if consumers lack the relevant knowledge, and it should have no effect when consumers are already highly knowledgeable about the issue in question. A common criticism to the KDM or other information-deficit models (Simis et al., 2016) is that they overstate the knowledge-behaviour relationship and do not take other motives for performing a behaviour into account (Graham & Abrahamse, 2017; Buttlar et al., 2020).

Associative Propositional Evaluation Model

The Associative Propositional Evaluation Model (APEM) describes several mechanisms that can lead to a change in attitudes (Gawronski & Bodenhausen, 2006). An attitude is a psychological construct that describes how positively or negatively consumers evaluate objects, persons, or situations (Eagly & Chaiken, 1993). Attitudes are of interest in the behaviour change literature, because attitudes have high predictive accuracy for behavioural frequencies (Glasman & Albarracín, 2006), especially in the domain of food consumption (McEachan et al., 2011). Two different facets of attitudes can be distinguished, namely implicit and explicit attitudes (Greenwald & Banaji, 1995). According to the APEM, information provision (i.e. persuasive communication) can directly impact explicit attitudes through changes in the existing propositional knowledge and beliefs about the attitudinal object. Similarly, implicit attitudes can be influenced by information provision by changing the automatic evaluation of the attitudinal object (Gawronski & Bodenhausen, 2006). Moreover, changes in implicit attitudes can onset changes in explicit attitudes, and vice versa (Gawronski & Bodenhausen, 2006; Whitfield & Jordan, 2009).

Theory of Planned Behaviour

The relevance of attitudes in the prediction of behaviour is also acknowledged in the Theory of Planned Behaviour (TPB). The TPB is an extensively applied model in the food choice behaviour literature (Biasini et al., 2021; McDermott et al., 2015). The main assumption of the TPB is that behaviour is predicted by consumers' intention to perform the behaviour. The intention to perform the behaviour is predicted by the attitude towards the behaviour, perceived social norms, and perceived behavioural control (Ajzen, 1991; Fishbein & Ajzen, 2010). The provision of information can therefore indirectly affect behaviour by changing consumers' attitudes and intentions. Similarly, information can indirectly impact behaviour by improving consumers' perceived behavioural control, for example by giving practical recommendations on how to perform a behaviour. A construct closely related to perceived behavioural control is self-efficacy (Fishbein & Ajzen, 2010; Bandura 1986). According to Armitage and Conner (1999), self-efficacy can be considered as a subdimension of perceived behavioural control that focuses on the perceived ability to perform a behaviour. In contrast, perceived behavioural control is a broader construct, that also includes the perception of external barriers to a behaviour. Therefore, one can assume that information provision rather affects self-efficacy instead of perceived behavioural control in general. A common criticism to the TPB is the so-called 'intention-behaviour' or 'attitude-behaviour' gap (Carrington et al., 2010; Grimmer & Miles, 2017).

Theory of Cognitive Dissonance

In addition to the TPB, the Theory of Cognitive Dissonance (TCD) can also explain an indirect effect of information on food choice behaviour. Cognitive dissonance describes an unpleasant mental state resulting from a conflict between one's beliefs, attitudes, and behaviour (Festinger, 1962). For example, meat-eaters can experience cognitive dissonance because of their meat consumption on the one hand, and the slaughter of animals on the other hand (Loughnan et al., 2010). When experiencing cognitive dissonance, people are motivated to reduce this mental state and reach consonance between the incongruent elements (Festinger, 1962). In the case of meat-eaters, a possible dissonance reduction strategy is a behavioural adaptation in the form of meat avoidance (Rothgerber, 2020). Hence, according to the TCD, information provision can have an indirect effect on consumers' behaviour by triggering cognitive dissonance. The TCD has been broadly used by previous research to explain food-related consumption behaviour, but is rarely measured in empirical studies (Lin-Schilstra & Fischer, 2020; Ong et al., 2017).

Determinants of information effectiveness

The previous theories establish support for an (in)direct information-behaviour and information-attitude relationship. This subchapter describes several frameworks that delineate which factors might influence the effectiveness of information. A frequently used model is the Elaboration Likelihood Model (ELM) by Petty and Cacioppo (1986). The ELM is a dual process theory that describes two different pathways with which information can be processed: the central route and the peripheral route. Processing with the former route is associated with a careful elaboration of the message, leading to an enduring attitudinal change, whereas the latter is associated with superficial processing and weak attitude change (Petty & Cacioppo, 1986). Whether the central or peripheral route is used is determined by the *recipient* of information (Petty & Briñol, 2011). Hence, the same information campaign might be more persuasive for one consumer compared to another. Which information processing route is selected, depends on the cognitive abilities and the motivation of the recipient are of relevance (Petty & Cacioppo, 1986). In this regard, the prior knowledge of the recipient can also play a role. Moreover, the recipient's motivation to process the information can depend on the information *design*. The design of information refers to the selection of arguments (Petty & Wegener, 1999) or whether the information is framed as a cognitive or affective appeal (Haddock et al., 2008). Research on matching effect has shown that persuasion is most effective when the information design matches the characteristics of the information recipient (Teeny et al., 2021; Hirsh et al., 2012; Noar et al., 2009). Thus, whether cognitive or affective appeals

are processed more carefully is determined by the personality characteristics of the information recipient (Teeny et al., 2021). Another design aspect that can determine the effectiveness of information is the inclusion of different communication mediums. As mentioned earlier, information campaigns usually constitute not only textual information but also images. Images differ from textual information, as they do not contain linguistic features and can therefore onset different internal responses. For instance, images lead to higher arousal (Houts et al., 2006) and are somewhat more memorable (David, 1998) compared to purely textual information. This is also termed the image-superiority effect (McBride & Doshier, 2002). Hence, whether the information consists of textual information or images might also influence its effectiveness.

Furthermore, the degree of *exposure* to information can affect the influence of information. According to the ELM, information repetition can increase persuasiveness as it enhances a person's capacity to process the information (Petty & Cacioppo, 1986). Hence, information that is presented more often to consumers is more likely to be centrally processed, compared to information that is received only once. This phenomenon is also related to the mere exposure effect, which assumes that repetitive exposure to a stimulus leads to increased liking (Zajonc, 1968). However, according to the repetition-variation hypothesis, repetition of information only increases persuasiveness if there is a substantial variation of the information, and not a pure repetition of the exact same content (Schumann et al., 1990).

To sum up, from a theoretical point of view information can directly influence attitudes, intentions, and behaviour. Moreover, information can influence behaviour also indirectly through changes in attitude, intention, self-efficacy, or cognitive dissonance. Factors that can determine the persuasiveness of information are the design of information, the recipient of information, and the degree of exposure to information.

1.3. Objective and structure of the thesis

This cumulative thesis investigates the effect of information provision on consumers' attitude, intention, and food choice behaviour. Related to contemporary challenges of the agricultural and food sector, this thesis investigates the effect of information in the domain of acceptance of animal husbandry (Christoph-Schulz & Rovers, 2020; Birkle et al., 2022; Weible et al., 2016), meat consumption (Tubiello et al., 2015; IPCC 2013; Umweltbundesamt, 2018; Dinu et al., 2017; Godfray et al., 2018), and whole grain consumption (Tang et al., 2015; Meier et al., 2019; Tieri et al., 2020; O'Donovan et al., 2019; Sandvik et al., 2014). The first research question that this thesis seeks to answer is: *'What is the effect of information provision on*

attitude, intention, and food choice behaviour?'. Based on the KDM and APEM, this thesis examines the direct effects of information provision on attitude, intention, and behaviour (Schultz, 2002; Gawronski & Bodenhausen, 2006). In addition, the indirect effects of information provision on behaviour through changes in attitude, intention, self-efficacy, and cognitive dissonance are investigated (Ajzen, 1991; Festinger, 1962). Second, this thesis investigates the research question '*Which factors determine the effectiveness of information?*'. Based on the ELM and related effects, this thesis examines how the information design, the information recipient, and the degree of information exposure influence the effectiveness of information (Petty & Cacioppo, 1986; Zajonc, 1968).

Chapter 2 provides a summary of each experimental study and the main findings. Chapter 3 describes the limitations of the thesis and gives recommendations for future research. Chapter 4 describes the implications of the thesis and Chapter 5 draws a conclusion. The Appendix consists of the related research articles.

2. Summary of experimental studies

To research the effect of information provision, four studies were conducted. An overview of the experimental studies is presented in Table 1. To test whether information provision causally leads to changes in attitude, intention, and food choice behaviour, an experimental methodology was chosen as the research design (Bordens & Abbot, 2014). As analytical approach, this thesis utilizes mediation and moderation analysis. Mediation analysis seeks to investigate causal effect chains between three or more variables (Rucker et al., 2011; Hayes, 2018). Moderation analysis tests whether the effect of a relationship between two variables varies depending on a moderating variable (Hayes & Rockwood, 2017). The main difference between mediation and moderation is that the former latter can demonstrate how an effect operates, whereas the latter seeks to show under which circumstances an effect exists (Hayes & Rockwood, 2017). Consequently, mediation analysis is mainly used to answer the first research question and moderation analysis to answer the second research question. The analysis of mediation and moderation effects is a common statistical procedure in psychological science (Hayes & Preacher, 2014) and many examples can be found in contemporary information provision and consumer behaviour literature (Carfora et al., 2019b; Grummon et al., 2022; Koch et al., 2022; Macht et al., 2021; Vainio et al., 2018).

Table 1. Summary of Experimental Studies

	Weingarten and Hartmann (2022a)	Weingarten et al. (2022)	Weingarten and Hartmann (2022b)	Weingarten and Lagerkvist (2023)
Research design				
Research topic	pig husbandry	meat consumption	whole grain consumption	meat consumption
Design	3 x 2 mixed	3 x 2 mixed	2 x 2 x 3 mixed	2 x 2 BS
BS factor 1	cognitive vs. affective vs. control	health vs. environment vs. control	health vs. control	health vs. control
BS factor 2	n.a.	n.a.	competence vs. control	meat-animal vs. meat-only
WS factor 2	pre vs. post	pre vs. post	pre vs. post vs. follow-up	n.a.
Conditions	3	3	4	4
Setting	lab study	online & field study	online study	online study
Information				
Design	cognitive vs. affective	health vs. environment	health vs. competence	text vs. image
Recipient	NFA and NFC	prior knowledge	n.a.	n.a.
Exposure	low (one-time)	low (one-time)	high (two weeks)	low (one-time)
Sample				
Sample size	$n = 185$	$n = 194$	$n = 329$	$n = 379$
Target population	German consumers	students from Bonn	German young adults	international consumers
Main findings				
Attitude	Positive effect	Partly effective	Positive effect of health	n.a.
Intention	n.a.	No effect	Positive effect of health	n.a.
FCB	n.a.	No effect	Positive effect of health	Positive effect mediated by CD

Note. BS = Between-subject; WS = Within-subject; n.a. = not applicable; NFA = Need for Affect; NFC = Need for Cognition; FCB = Food choice behaviour; CD = Cognitive dissonance.

2.1. Weingarten and Hartmann (2022a)

Background and objective

The first paper of this thesis investigated the effect of information provision on consumers' implicit and explicit attitudes towards different pig husbandry methods. German consumers increasingly criticize conventional pig husbandry (Birkle et al., 2022; Christoph-Schulz & Rovers, 2020). As a potential reason for this dissatisfaction, several studies have highlighted that consumers hold strongly negative evaluations of slatted flooring in pig stalls and prefer straw flooring (Busch et al., 2019; Wildraut et al., 2015). Although both methods pose certain advantages and disadvantages for pig welfare and meat production (Ludwiczak et al., 2021), consumers have strongly polarized attitudes. Previous research has shown that information provision can be an effective strategy to influence consumers' evaluation of animal husbandry methods (Altmann et al., 2022; Risius & Hamm, 2017; Verbeke & Liu, 2014; Wille et al., 2017). However, these studies all relied on explicit measures as the dependent variable which can be subject to response biases, such as social desirability. This can lead to an inaccurate representation of attitudes (Van de Mortel, 2008). Therefore, this study includes an implicit and explicit measure of attitude. The goal of the paper is to depolarize consumers' attitudes towards the different pig husbandry methods by providing information about the benefits of slatted flooring and the drawbacks of straw flooring in pig stalls.

This paper contributes to the first research question of this thesis by investigating the effect of information provision on attitudes. Based on the APEM, the paper hypothesized that information provision affects both implicit and explicit attitudes (Gawronski & Bodenhausen, 2006). In relation to the second research question, this study investigates how information design and recipient characteristics influence the effectiveness of information. In accordance with the ELM, the paper investigated the interaction of cognitive and affective information design with cognitive and affective recipient personality traits (Petty & Cacioppo, 1986; Teeny et al., 2021; Haddock et al., 2008). The authors expected that cognitive information design is more persuasive among participants with a high Need for Cognition (NFC) and affective information design among participants with a high Need for Affect (NFA).

Experimental design

The experimental lab study was conducted with $n = 185$ German consumers and followed a 3 x 2 mixed design with the between-subjects factor information design (affective vs. cognitive vs. control) and the within-subjects factor measure (pre vs. post). To measure explicit attitudes, participants were asked to rate ten pictures of pigs on straw or slatted floors.

The same images were used in an Implicit Association Test to capture the implicit attitude (Greenwald et al., 1998).

Main findings and discussion

The results show that both cognitive and affective information significantly influence participants' explicit and implicit attitudes towards pig husbandry. On the explicit attitude measure, cognitive information showed a slightly stronger effect compared to the affective information, but this effect was only marginally significant. Furthermore, a moderation analysis was performed to investigate whether the effect of cognitive and affective information design is moderated by NFA and NFC. In contrast to the assumptions based on the ELM (Petty & Cacioppo, 1986) and the empirical literature (Clarkson et al., 2011; Edwards, 1990; Haddock et al., 2008; Petty & Wegener, 1998; Teeny et al., 2021), there was no support for a moderation effect. Regardless of whether participants scored high or low on NFA and NFC, their attitudes were equally susceptible to cognitive and affective information provision.

To conclude, the results from the first paper show that information provision has a positive effect on consumers' attitudes. Moreover, the results indicate that a cognitive information design has a slightly superior effect on explicit attitudes.

2.2. Weingarten et al. (2022)

Background and objective

The second paper investigated the effect of information provision on students' meat consumption behaviour in the university canteen. As current levels of global meat consumption are associated with negative effects on environmental sustainability (Tilman & Clark, 2014) and human health (Bronzato & Durante, 2017), a transition towards a vegetarian or plant-based diet is beneficial. The prior literature on meat-related information provision found mixed evidence regarding the effectiveness of meat-related health and environmental information to influence attitudes and intentions (e.g. Cordts et al., 2014; Palomo-Vélez et al., 2018). Moreover, the great majority of previous research in this field relied on attitudinal, intentional, or self-reported measures of meat consumption behaviour (Bianchi et al., 2018; Harguess et al., 2020). These measures can be subjective to several biases, for instance, the social desirability bias (Hebert et al., 1995), the recall bias (Freedman et al., 2014), or situational underreporting in experimental contexts (Rothgerber, 2019), therefore, this study included a field measure of behaviour. The goal of the paper was to examine whether information provision about the negative meat-health and meat-environment relationships influences

students' attitude, intention, and observable meat consumption behaviour in the university canteen.

This paper contributes to the first research question of this thesis by investigating the effect of information on attitude, intention, and food choice behaviour. Based on the APEM and KDM, the authors expected that health and environmental information impacts the attitude towards consuming meat as well as the intention to consume meat and observable meat consumption behaviour (Schultz, 2002; Gawronski & Bodenhausen, 2006). Furthermore, the authors tested whether information provision also has an indirect effect on behaviour through a serial mediation by attitude and intention, as postulated by the TPB (Ajzen, 1991; Fishbein & Ajzen, 2010). Related to the second research question of the thesis, the authors tested whether prior knowledge moderated the effectiveness of health and environmental information provision. Based on the KDM, they assumed that information provision exerts a stronger influence on participants with low prior knowledge as compared to high prior knowledge (Schultz, 2002). The inclusion of this moderator might explain why previous studies found mixed evidence regarding the effectiveness of health and environmental information (e.g. Cordts et al., 2014; Palomo-Vélez et al., 2018).

Experimental design

The experimental study ($n = 194$ students) followed a 3 x 2 mixed design with the between-subjects factor information design (health vs. environmental vs. control) and the within-subjects variable measure (pre vs. post). Participants filled out an online survey that included the randomized information treatment and the measures of prior knowledge, attitude, and intention. Meat consumption behaviour was measured based on participants' purchases in the university canteen for two weeks prior to and after participating in the experiment, which were recorded with an individual purchase card.

Main findings and discussion

The results show that health and environmental information influenced neither attitude, intention, nor meat consumption behaviour. This finding contrasts other previous research by Carfora et al. (2019a) and Wolstenholme et al., (2020). However, both of these studies examined the effect of repeated information provision for two weeks, whereas this paper tested the effect of a single exposure to information. Another potential reason for the lack of an effect of health information is that health motives might not be key drivers of students' dietary behaviour (Deliens et al., 2014). With regards to the second research question of this thesis, this paper found that environmental information only influenced the attitudes of participants with low prior knowledge. This finding is in line with the authors' predictions and the

assumptions of the KDM (Schultz, 2002), and can explain the heterogenous results of previous research regarding the effectiveness of environmental information (Palomo-Vélez et al., 2018; Stea & Pickering, 2019). In contrast, prior knowledge did not moderate the effect of environmental information on intentions and behaviour. Seemingly, environmental information can lead to a more positive attitude towards reducing meat consumption among those who are less knowledgeable, but it does not affect the intentions and behaviour of these participants.

To conclude, the second paper showed that information provision only has an effect on the attitudes of specific consumer segments but not on intention or behaviour. One possible explanation for the absence of an effect on intention and behaviour is that a too short exposure to information provision is not sufficient to generate changes in intentions and behaviour. Therefore, the following paper investigates the effect of an intervention with repeated exposure to information.

2.3. Weingarten and Hartmann (2022b)

Background and objective

The third paper investigated the effect of information provision on whole grain consumption of young adults in Germany. Whole grain consumption is associated with positive health effects such as lower risk of developing type 2 diabetes (Tieri et al., 2020) and lower weight (Sanders et al., 2021). However, consumers' intake of whole grain products is lower than recommended by different health authorities (O'Donovan et al., 2019; Sandvik et al., 2014), especially among young adults (Sette et al., 2017). Common barriers to whole grain consumption are negative evaluations of whole grain products and a low level of competence to incorporate whole grain intake into the daily diet (Barrett et al., 2020; Kamar et al., 2016; Kuznesof et al., 2012; Magalis et al., 2016; Sandvik et al., 2018). Previous research has shown that information provision can be an effective intervention to increase whole grain selection at the point of sale (POS; Sogari et al., 2019). However, in order to generate an enduring increase in consumers' whole grain consumption, the exposure to an intervention needs to be sufficiently long (Meynier et al., 2020). In line with this, a two-week messaging intervention was found to be effective towards attitudes and meat consumption behaviour by a number of studies (Carfora et al., 2019a, 2019b; Wolstenholme et al., 2020), whereas a single exposure had no effect (Weingarten et al., 2022). Therefore, this approach was adopted and applied in the domain of whole grain consumption. The goal of this study was to examine the effect of daily information provision on whole grain consumption with a daily information intervention.

This paper contributes to the first research question of this thesis by investigating the effect of information provision on attitude, intention, and food choice behaviour. The authors expected that health-related information influences attitudes and intentions towards whole grain consumption and competence-related information influences self-efficacy and intention. (Gawronski & Bodenhausen, 2006; Schultz, 2002). Furthermore, the authors expected that health-related information needs to be combined with competence-related information to influence whole grain consumption behaviour (Ajzen, 1991; Bandura, 1986). In addition, the authors analysed whether the effect of information provision on food choice behaviour is serially mediated by attitude and intention, and by self-efficacy and intention (Fishbein & Ajzen, 2010). The paper contributes to the second research question of this thesis by investigating the effect of a high degree of exposure to information provision. In line with the mere exposure effect and the ELM, repeated information provision is assumed to be more effective compared to a single exposure (Zajonc, 1968; Petty & Cacioppo, 1986).

Experimental design

The experimental online study followed a 2 x 2 x 3 mixed design with the between-subjects factors health information (health vs. control), competence information (competence vs. control), and the within-subjects factor measure (pre- vs. post-intervention vs. follow-up). The pre-measure was collected prior to the intervention, the post-intervention measure immediately after the intervention, and the follow-up measure one month later. Whole grain consumption was assessed through self-report at each measurement. The information was provided to participants on a daily basis for a period of fourteen days via email.

Main findings and discussion

The results demonstrate that daily health information provision led to a significant improvement in consumers' attitude towards whole grain consumption. This effect remains persistent until (at least) one month after participating in the intervention. Similarly, health information increased the intention to consume whole grain products at the post-intervention, but this effect decreased considerably in magnitude at the follow-up measure. Moreover, health information was effective in increasing whole grain consumption behaviour at the follow-up measure. The mediation analysis revealed that the effect of health information provision on whole grain consumption behaviour is serially mediated by attitudes and intentions at the post-intervention measure. This finding is in line with the previous empirical literature (Carfora et al., 2019a; Sogari et al., 2019) and theoretical frameworks (Ajzen, 1991; Schultz, 2002). Contrary to the authors' expectations, competence information did not influence self-efficacy nor intentions and had no (in)direct effect on whole grain consumption behaviour. Although a

lack of procedural knowledge was identified as a barrier to whole grain consumption (e.g. Kamar et al., 2016; Sandvik et al., 2018), providing product and recipe suggestions did not affect the intention nor behaviour. One explanation for the absence of an effect of competence information is that recipe and product suggestions alone were not sufficient to enable more whole grain consumption. Other studies indicated that more interactive interventions, such as cooking workshops, have superior effects than purely practical recommendations (Hollywood et al., 2018). In addition, no interaction between competence and health information could be observed. Seemingly, health information can increase whole grain consumption behaviour independently of competence information.

To conclude, the results of the third paper of this thesis show that information provision over a period of fourteen days can influence consumers' attitude, intention, and food choice behaviour. An additional mediation analysis showed that changes in attitude and intention are the mechanisms underlying behaviour change. The results from the third paper indicate that information can only lead to a behaviour change if the degree of exposure is high.

2.4. Weingarten and Lagerkvist (2023)

Background and objective

Contrary to the first three papers of this thesis, the fourth paper compares the effect of information when provided as textual information or images. Textual information and images are both common stimuli in the meat-reduction literature (Benningstad & Kunst, 2020; Harguess et al., 2020), but little research has been conducted to compare the effect of both to reduce meat consumption. The goal of this paper was to examine whether meat reduction appeals in the form of images and textual information can lead to meat avoidance.

This paper contributes to the first research question of this thesis by investigating the effect of information provision on food choice behaviour. This paper analyses the indirect effect of information provision on food choice behaviour in light of the TCD (Festinger, 1962). The authors argue that information can lead to cognitive dissonance in two ways; first, similar to the line of reasoning in the previous paper, information can add new knowledge or disconfirm existing beliefs (Ong et al., 2017; Schultz, 2002). Second, information can inhibit the suppression of existing unpleasant knowledge, for instance, that consuming meat requires the slaughter of animals (Kunst & Hohle, 2016). Consequently, the authors hypothesized that both images and textual information trigger cognitive dissonance (Festinger, 1962). According to TCD, one strategy to reduce meat-related cognitive dissonance is through a behavioural adaptation such as meat avoidance (Festinger, 1962; Rothgerber, 2020). Hence, the authors

expected that cognitive dissonance would mediate the relationship between information provision and meat avoidance; information provision increases cognitive dissonance, which increases the likelihood of meat avoidance. Furthermore, this paper contributes to the second research question by comparing different designs of information with regard to images and textual information. Images might be a more powerful tool to trigger cognitive dissonance compared to textual information (David, 1998; Houts, 2006).

Experimental design

The experimental online study was performed with $n = 379$ international consumers that were recruited through Prolific¹. The experiment followed a 2 x 2 between-subjects design with the experimental factors textual information (health vs. control) and image (meat-animal vs. meat-only). Meat avoidance was measured through a hypothetical choice task, in which participants could either select a meat sandwich, a vegetarian sandwich, or the opt-out option. In addition, this study contributes to the academic literature as it proposes a modified measure of cognitive dissonance. Although cognitive dissonance theory is well-established in the literature, empirical measures are scarcely used (Lin-Schilstra & Fischer, 2020). To measure cognitive dissonance, the authors proposed a modified scale based on Sweeney et al. (2000) and Elliot and Devine (1994).

Main findings and discussion

The mediation analysis revealed a significant indirect effect of information provision on meat avoidance through cognitive dissonance. Triggering cognitive dissonance with images or texts leads to meat avoidance, which is in line with the theoretical framework (Festinger, 1962; Ong et al., 2017; Rothgerber, 2020). Contrary to the authors' expectations, the effects of images and textual information were of equal magnitude. A possible explanation for the lack of such a difference is offered by Nissen et al. (2021), who compared the underlying neural processes that occurred when participants viewed either textual information, animated images, or photographs. Nissen et al. (2021) showed that photographs are processed similarly to text and that only viewing animated images led to a different neural processing pattern. The images used in the fourth paper consisted of photographs and not animated images, which might explain why the effects of texts and images were of the same magnitude.

¹ Within the scope of this research, three experiments were conducted. The publication by Weingarten & Lagerkvist (2023) reports only the results of one study. The data of all three experiments is published elsewhere (Weingarten, N., Lagerkvist, C.-J., Meraner, M., Hartmann, M. (2023). Triggering cognitive dissonance with textual information and images: Data from three experiments with meat-eaters. *Data in Brief*, 48, 109116. <https://doi.org/10.1016/j.dib.2023.109116>).

To conclude, the fourth paper showed that information provision has an indirect effect on food choice behaviour by triggering cognitive dissonance. Both images and textual information lead to an indirect effect of the same magnitude.

3. Limitations and future research

Evidently, the present thesis is not free of limitations. First, this thesis tested the effect of information provision in four different settings. As outlined in Table 1, the papers focused on different topics (pig husbandry vs. meat consumption vs. whole grain consumption) and targeted different consumer segments (German population vs. students in Bonn vs. international consumers vs. German young adults). In addition, each paper investigated a unique manipulation of information provision and applied different measurements of the dependent variable. This high degree of heterogeneity between the papers makes it difficult to draw a joint conclusion regarding the effectiveness of information provision. To illustrate this issue, the papers by Weingarten et al. (2022) and Weingarten and Hartmann (2022b) both investigate the effect of health information. The former found no effect of information provision on food choice behaviour, whereas the latter clearly found an effect. A plausible reason for this conflicting finding is that low exposure has no effect (Weingarten et al., 2022), but high exposure does have an effect (Weingarten & Hartmann, 2022b). However, an alternative explanation is that information only influences whole grain consumption, but not meat consumption; or it only influences consumers but not students. Therefore, the thesis can only speculate about the causality of differences when making cross-paper comparisons.

Second, the thesis aimed at investigating the determinants of effectiveness of information provision, but some determinants have not been considered. For example, none of the studies manipulated the source of information. According to the ELM, this factor can be an important element regarding the persuasiveness of information (Petty & Cacioppo, 1986). Although no study explicitly mentioned a source of information, prior to each experiment participants were informed that the study was conducted by a university. This might have served as a credence attribute, as scientists are usually perceived as rather trustworthy and competent (O'Brien et al., 2021). Therefore, the effectiveness of information provision could have been higher, compared to when the same information was communicated by another source. Thus, the present thesis might overestimate the effect of information.

Third, this thesis always targeted information provision and behaviour change on an individual level and did not include a social component. Appealing to social norms in information campaigns can be an effective tool to influence consumers' behaviour according

to the empirical literature (Cialdini & Jacobson, 2021). Similarly, the TPB also includes perceived social norms as an important element in predicting behavioural intentions (Fishbein & Ajzen, 2010). The relevance of further research regarding social norm-based interventions in the domain of meat consumption was also highlighted in a recent review by Kwasny et al. (2022). Therefore, this thesis recommends future research in this area. Using information to illustrate vegetarian or vegan role models would be an interesting avenue for future research, especially in light of global movements such as Fridays for Future.

The fourth limitation refers to the context in which participants received the information. In three papers, information was given during the experiment, and in one paper, information was sent to participants on a daily basis via e-mail. These contexts are rather artificial and are separated from the decision context, for example, the POS. Information can be presented at the POS as well, for example in the form of banners or labels (Sogari et al., 2019, 2022). At the POS, information might have a direct effect, because it reduces the gap in the timing between the information provision and food choices and makes the information salient during the choice. Thus, this thesis encourages future research of the effect of information provision at the POS. This could also be combined with the previous mentioned limitation: information provision at the POS could appeal to social norms, for instance, in a university canteen. By highlighting the increasing prevalence of vegetarian or vegan students, visitors of the university canteen might be less inclined to select meat.

Fifth, most measures in this thesis are based on self-report. This is problematic for several reasons, such as social desirability (Van de Mortel, 2008), recall biases (Freedman et al., 2014), or situational underreporting (Rothgerber, 2019). The only study to use an objectively observable measure of food choice behaviour was Weingarten et al. (2022), which is the only study that observed neither a direct nor an indirect effect of information on food choice behaviour. Although there are several explanations for why Weingarten et al. (2022) found no effect, it cannot be known for sure to what extent the self-reported and non-incentivized measures produced a biased result in Weingarten and Hartmann (2022b) and Weingarten and Lagerkvist (2023). The use of self-reported measures is a common practice in research. As noted by Bianchi et al. (2018) and Harguess et al. (2020), the majority of research in the domain of meat consumption rely on attitude, intention, self-reported measurements or other non-incentivized dependent variables. Measuring behaviour might not always be easy, as it is time-consuming and more expensive compared to self-reported measures. However, considering the limitations of self-reported measures, the benefits of behavioural measures might outweigh these costs. There are other methods that can also be used to evaluate the effect

of information provision, for instance ecological momentary assessment (Dohle & Hofmann, 2019). In this method, participants report their eating behaviour, attitudes or similar measures at several points in time on their smartphone. Although this method still might be subject to social-desirability bias, it can at least overcome limitations related to recall biases (Freedman et al., 2014). In cases where behavioural data is not available, we encourage future research to use innovative methods with high external validity, for example a virtual supermarket (Hoenink et al., 2020; van Herpen et al., 2016; Waterlander et al., 2015) or a fake food buffet (Bucher et al., 2012; Hartmann et al., 2021).

Lastly, all papers that form the basis of this thesis are single-experiment studies. This is, in light of the replication crisis, a methodological concern. While awareness of the replication crisis has been growing in the domain of social psychology since 2011 (for a review see Wiggins & Christopherson, 2019), the agricultural economics community has joined the debate rather recently (Heckelei et al., 2021). Factors that can contribute to low replicability are a low statistical power due to a small sample size (Maxwell et al., 2015) or malpractices such as p-hacking or HARKing (Heckelei et al., 2021). As a result of the replication crisis, certain practices like a-priori power analysis and pre-registration (Lakens et al., 2018; Simmons et al., 2021) have gained more relevance. Although these practices were fully or partly adopted to avoid low replicability, no paper explicitly tested for replicability. Nevertheless, future research is encouraged to test replicability and to follow the aforementioned practices to prevent future replication crises.

4. Implications

4.1. First research question

Related to the first research question, the results from this cumulative thesis indicate that information provision can have beneficial effects on consumers' attitude, intention, and food choice behaviour, which supports the use of information provision as a policy tool. Hence, to achieve a transition towards higher societal acceptance of animal husbandry, reduced levels of meat consumption, and increased whole grain consumption, information provision is a promising avenue for the agricultural and food sector. This has important implications for future strategies to attain the Sustainable Development Goals (SDG) that were adopted by the United Nations (2015). In particular, attaining SDG 3 'Good Health and Well-Being', SDG 12 'Sustainable Consumption and Production', and SDG 13 'Climate Action' can be supported through information provision. Yet, it should be noted that the effect of information provision on food choice behaviour was of rather small magnitude ($\eta_p^2 = 0.01$ in Weingarten &

Hartmann, 2022b). Larger effects might be attained through the combination of information provision and other policy instruments (Mazzocchi, 2017; Suthers et al., 2018). Moreover, the thesis has shown that changes in attitude, intention, and cognitive dissonance were identified as important mechanisms that lead to a change in behaviour. This finding is in line with a common criticism of the KDM, that adding knowledge is not the key mechanism that underlies behaviour change (Graham & Abrahamse, 2017; Buttlar et al., 2020). This implication is of importance for the future design and evaluation of information campaigns by policymakers, governmental authorities, non-governmental organizations, and marketers. Moreover, this insight is of relevance for the Regional Committee for Europe of the World Health Organization (WHO), which recently released a resolution to take insights from research in the field of behavioural sciences stronger into account (Regional Committee for Europe of WHO, 2022).

4.2. Second research question

Related to the second research question, three factors that influence the effectiveness of information were investigated: the *design*, the *recipient*, and different degrees of *exposure*. The following *design* elements were investigated: textual information versus images; health, environmental, versus competence information; and cognitive versus affective framing. With regard to the usage of images and textual information, the thesis found that both formats can yield an effect on food choice behaviour by triggering cognitive dissonance. Although they did not interact with each other, the combination of both mediums is recommended in order to generate additive effects. Health information appear to have a superior effect, as compared to competence or environmental information. Hence, in the future communication of maladaptive dietary patterns, governments, marketers, and policymakers can generate larger effects on consumers when using health as compared to environmental information. Although some research suggested that emotional appeals are more effective than cognitive appeals (Carfora et al., 2019a), the results of this thesis rather suggest the opposite. Reporting information about animal husbandry conditions in a cognitive frame yielded slightly larger effects on explicit attitude measures compared to an affective frame. This finding is of relevance for the future communication of various stakeholders such as retailers or governmental authorities when they introduce new labels for animal husbandry to the market.

The following *recipient* characteristics were investigated: prior knowledge and personality traits. Taken together, the recipient factor played a mixed role in the effectiveness of information provision. Consumers with less knowledge were more likely to change their

attitudes as a result of environmental information provision, compared to highly knowledgeable consumers. Hence, when addressing the environmental impact of meat consumption, a target group-oriented approach tailored to participants' prior knowledge might be superior to a 'one-size-fits-all' approach. This implication is of importance for the future design of meat-reduction campaigns by policymakers, governmental authorities, non-governmental organizations, and marketers. On the contrary, personality traits NFC and NFA did not influence how consumers reacted to cognitive or affective frames. Hence, the need for an information tailoring according to NFC and NFA is not supported by this thesis.

Two different degrees of *exposure* to information were investigated: low exposure, where participants received the information only once, and high exposure, where information was received for a period of fourteen days. The amount of exposure appears to be an important factor in shaping the effectiveness of information. The results of this thesis indicate that repeated exposure has a superior effect on consumers' attitude, intention, and food choice behaviour, compared to single exposure. In order to generate an enduring behavioural change, repeated communication and reminders appear to be more promising than a single piece of information. This finding bears important implications for public information campaigns, but also for the health communication by general practitioners, nutritional advisors, and other health authorities.

5. Conclusion

The goal of the present thesis was to investigate the effectiveness of information as intervention to influence consumers' attitude, intention, and food choice behaviour. Moreover, it was examined how the information design, the information recipient, and the degree of information exposure influenced the effectiveness of information. Overall, the results of four experimental studies showed that information provision is an effective tool to influence attitude, intention, and food choice behaviour. The inclusion of health-related information and repeated exposure to the information have been shown to increase the effectiveness of information provision. Furthermore, for certain types of information such as environmental information, target group-oriented information tailoring might be superior in order to change attitudes. Hence, to achieve a transition towards higher societal acceptance of animal husbandry, reduced levels of meat consumption, and increased whole grain consumption, information provision is a promising avenue for the agricultural and food sector.

6. References

- Abrahamse, W. (2020). How to effectively encourage sustainable food choices: A Mini-Review of available evidence. *Frontiers in psychology, 11*, 589674.
<https://doi.org/10.3389/fpsyg.2020.589674>
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Altmann, B. A., Anders, S., Risius, A., & Mörlein, D. (2022). Information effects on consumer preferences for alternative animal feedstuffs. *Food Policy, 106*, 102192.
<https://doi.org/10.1016/j.foodpol.2021.102192>
- Armitage, C. J., & Conner, M. (1999). The theory of planned behaviour: Assessment of predictive validity and 'perceived control'. *The British Journal of Social Psychology, 38*(1), 35–54. <https://doi.org/10.1348/014466699164022>
- Aykan, N. F. (2015). Red Meat and Colorectal Cancer. *Oncology Reviews, 9*(1), 288.
<https://doi.org/10.4081/oncol.2015.288>
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice Hall.
- Banerjee, S., Savani, M., & Shreedhar, G. (2021). Public support for 'soft' versus 'hard' public policies: Review of the evidence. *Journal of Behavioral Public Administration, 4*(2).
<https://doi.org/10.30636/jbpa.42.220>
- Barrett, E. M., Foster, S. I., & Beck, E. J. (2020). Whole grain and high-fibre grain foods: How do knowledge, perceptions and attitudes affect food choice? *Appetite, 149*, 104630. <https://doi.org/10.1016/j.appet.2020.104630>
- Benningstad, N. C. G., & Kunst, J. R. (2020). Dissociating meat from its animal origins: A systematic literature review. *Appetite, 147*, 104554.
<https://doi.org/10.1016/j.appet.2019.104554>
- Bianchi, F., Dorsel, C., Garnett, E., Aveyard, P., & Jebb, S. A. (2018). Interventions targeting conscious determinants of human behaviour to reduce the demand for meat: a systematic review with qualitative comparative analysis. *International Journal of Behavioral Nutrition and Physical Activity, 15*, 102. <https://doi.org/10.1186/s12966-018-0729-6>
- Biasini, B., Rosi, A., Giopp, F., Turgut, R., Scazzina, F., & Menozzi, D. (2021). Understanding, promoting and predicting sustainable diets: A systematic review. *Trends in Food Science & Technology, 111*, 191–207.
<https://doi.org/10.1016/j.tifs.2021.02.062>

- Birkle, I., Klink-Lehmann, J., & Hartmann, M. (2022). Different and alike: Level and determinants of public acceptance of fattening pig, beef cattle and broiler farming in Germany. *Meat Science*, *193*, 108946. <https://doi.org/10.1016/j.meatsci.2022.108946>
- Blondin, S. A., Cash, S. B., Griffin, T. S., Goldberg, J. P., & Economos, C. D. (2022). Meatless Monday National School Meal Program Evaluation: Impact on Nutrition, Cost, and Sustainability. *Journal of Hunger & Environmental Nutrition*, *17*(1), 1–13. <https://doi.org/10.1080/19320248.2020.1842283>
- Bordens, K., & Abbot, B. B. (2014). *Research design and methods: A Process Approach*. McGraw Hill.
- Bronzato, S., & Durante, A. (2017). A Contemporary Review of the Relationship between Red Meat Consumption and Cardiovascular Risk. *International Journal of Preventive Medicine*, *8*, 40. https://doi.org/10.4103/ijpvm.IJPVM_206_16
- Bucher, T., van der Horst, K., & Siegrist, M. (2012). The fake food buffet – a new method in nutrition behaviour research. *British Journal of Nutrition*, *107*, 1553–1560. <https://doi.org/10.1017/S000711451100465X>
- Busch, G., Gauly, S., von Meyer-Höfer, M., & Spiller, A. (2019). Does picture background matter? People's evaluation of pigs in different farm settings. *PLoS ONE*, *14*(2), e0211256. <https://doi.org/10.1371/journal.pone.0211256>
- Buttlar, B., Rothe, A., Kleinert, S., Hahn, L., & Walther, E. (2020). Food for Thought: Investigating Communication Strategies to Counteract Moral Disengagement Regarding Meat Consumption. *Environmental Communication*, 1–14. <https://doi.org/10.1080/17524032.2020.1791207>
- Carfora, V., Bertolotti, M., & Catellani, P. (2019a). Informational and emotional daily messages to reduce red and processed meat consumption. *Appetite*, *141*, 104331. <https://doi.org/10.1016/j.appet.2019.104331>
- Carfora, V., Catellani, P., Caso, D., & Conner, M. (2019b). How to reduce red and processed meat consumption by daily text messages targeting environment or health benefits. *Journal of Environmental Psychology*, *65*, 101319. <https://doi.org/10.1016/j.jenvp.2019.101319>
- Carrington, M. J., Neville, B. A., & Whitwell, G. J. (2010). Why ethical consumers don't walk their talk: Towards a framework for understanding the gap between the ethical purchase intentions and actual buying behaviour of ethically minded consumers. *Journal of Business Ethics*, *97*, 139–158. <https://doi.org/10.1007/s10551-010-0501-6>

- Christoph-Schulz, I., & Rovers, A.-K. (2020). German citizens' perception of fattening pig husbandry—Evidence from a mixed methods approach. *Agriculture, 10*(8), 342. <https://doi.org/10.3390/agriculture10080342>
- Cialdini, R. B., & Jacobson, R. P. (2021). Influences of social norms on climate change-related behaviors. *Current Opinion in Behavioral Sciences, 42*, 1–8. <https://doi.org/10.1016/j.cobeha.2021.01.005>
- Clarkson, J. J., Tormala, Z. L., & Rucker, D. D. (2011). Cognitive and affective matching effects in persuasion: An amplification perspective. *Personality and Social Psychology Bulletin, 37*(11), 1415–1427. <https://doi.org/10.1177/0146167211413394>
- Cordts, A., Nitzko, S., & Spiller, A. (2014). Consumer Response to Negative Information on Meat Consumption in Germany. *International Food and Agribusiness Management Review, 17*(A), 83–106. <https://doi.org/10.22004/ag.econ.164599>
- David, P. (1998). News concreteness and visual-verbal association: Do news pictures narrow the recall gap between concrete and abstract news? *Human Communication Research, 2*(25), 180–201. <https://doi.org/10.1111/j.1468-2958.1998.tb00442.x>
- Deliens, T., Clarys, P., de Bourdeaudhuij, I., & Deforche, B. (2014). Determinants of eating behaviour in university students: A qualitative study using focus group discussions. *BMC Public Health, 14*(1), 53. <https://doi.org/10.1186/1471-2458-14-53>
- Dinu, M., Abbate, R., Gensini, G., Casini, A., & Sofi, F. (2017). Vegetarian, vegan diets and multiple health outcomes: A systematic review with meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition, 57*(17), 3640–3649. <https://doi.org/10.1080/10408398.2016.1138447>
- Dohle, S., & Hofmann, W. (2019). Consistency and balancing in everyday health behaviour: An ecological momentary assessment approach. *Applied Psychology: Health and Well-Being, 11*(1), 148–169. <https://doi.org/10.1111/aphw.12148>
- Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Harcourt Brace Jovanovich College Publishers.
- Edwards, K. (1990). The interplay of affect and cognition in attitude formation and change. *Journal of Personality and Social Psychology, 59*(2), 202–216. <https://doi.org/10.1037/0022-3514.59.2.202>
- Elliot, A. J., & Devine, P. G. (1994). On the motivational nature of cognitive dissonance: Dissonance as psychological discomfort. *Journal of Personality and Social Psychology, 67*(3), 382–394. <https://doi.org/10.1037/0022-3514.67.3.382>

- Eurobarometer. (2006). *Special Eurobarometer 270: Attitudes of EU citizens towards animal welfare*. European Parliament.
https://data.europa.eu/data/datasets/s470_66_1_ebs270?locale=en
- Eurobarometer. (2016). *Special Eurobarometer 442: Attitudes of Europeans Attitudes of Europeans towards Animal Welfare*. European Parliament.
<https://europa.eu/eurobarometer/surveys/detail/2096>
- Festinger, L. (1962). *A theory of cognitive dissonance*. Stanford University Press.
- Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior. The reasoned action approach*. Psychology Press.
- Forscher, P. S., Lai, C. K., Axt, J. R., Ebersole, C. R., Herman, M., Devine, P. G., & Nosek, B. A. (2019). A Meta-Analysis of Procedures to Change Implicit Measures. *Journal of Personality and Social Psychology*, *117*(3), 522–559.
<https://doi.org/10.1037/pspa0000160>
- Foster, S., Beck, E., Hughes, J., & Grafenauer, S. (2020). Whole grains and consumer understanding: Investigating consumers' identification, knowledge and attitudes to whole grains. *Nutrients*, *12*(8), 2170. <https://doi.org/10.3390/nu12082170>
- Freedman, L. S., Commins, J. M., Moler, J. E., Arab, L., Baer, D. J., Kipnis, V., Midthune, D., Moshfegh, A. J., Neuhausser, M. L., Prentice, R. L., Schatzkin, A., Spiegelmann, D., Subar, A., Tinker, L. F., & Willet, W. (2014). Pooled results from 5 validation studies of dietary self-report instruments using recovery biomarkers for energy and protein intake. *American Journal of Epidemiology*, *180*(2), 172–188.
<https://doi.org/10.1093/aje/kwu116>
- Gawronski, B., & Bodenhausen, G. V. (2006). Associative and propositional processes in evaluation: An integrative review of implicit and explicit attitude change. *Psychological Bulletin*, *132*(5), 692–731. <https://doi.org/10.1037/0033-2909.132.5.692>
- Glasman, L. R., & Albarracín, D. (2006). Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. *Psychological Bulletin*, *132*(5), 778–822. <https://doi.org/10.1037/0033-2909.132.5.778>
- Godfray, H. C. J., Aveyard, P., Garnett, T., Hall, J. W., Key, T. J., Lorimer, J., Pierrehumbert, R. T., Scarborough, P., Springmann, M., & Jebb, S. A. (2018). Meat consumption, health, and the environment. *Science*, *361*(6399), DOI: 10.1126/science.aam532

- Graham, T., & Abrahamse, W. (2017). Communicating the climate impacts of meat consumption: The effect of values and message framing. *Global Environmental Change, 44*, 98–108. <https://doi.org/10.1016/j.gloenvcha.2017.03.004>
- Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: attitudes, self-esteem, and stereotypes. *Psychological Review, 102*(1), 4–27. <https://doi.org/10.1037/0033-295X.102.1.4>
- Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74*(6), 1464–1480. <https://doi.org/10.1037/0022-3514.74.6.1464>
- Griffiths, P. E., & West, C. (2015). A balanced intervention ladder: promoting autonomy through public health action. *Public Health, 129*(8), 1092–1098. <https://doi.org/10.1016/j.puhe.2015.08.007>
- Grimmer, M., & Miles, M. P. (2017). With the best of intentions: a large sample test of the intention-behaviour gap in pro-environmental consumer behaviour. *International Journal of Consumer Studies, 41*(1), 2–10. <https://doi.org/10.1111/ijcs.12290>
- Grummon, A. H., Musicus, A. A., Salvia, M. G., Thorndike, A. N., & Rimm, E. B. (2022). Impact of health, environmental, and animal welfare messages discouraging red meat consumption: An online randomized experiment. *Journal of the Academy of Nutrition and Dietetics*. <https://doi.org/10.1016/j.jand.2022.10.007>
- Haddock, G., Maio, G. R., Arnold, K., & Huskinson, T. (2008). Should persuasion be affective or cognitive? The moderating effects of need for affect and need for cognition. *Personality and Social Psychology Bulletin, 34*(6), 769–778. <https://doi.org/10.1177/0146167208314871>
- Hagmann, D., Siegrist, M., & Hartmann, C. (2018). Taxes, labels, or nudges? Public acceptance of various interventions designed to reduce sugar intake. *Food Policy, 79*, 156–165. <https://doi.org/10.1016/j.foodpol.2018.06.008>
- Harguess, J. M., Crespo, N. C., & Hong, M. Y. (2020). Strategies to reduce meat consumption: A systematic literature review of experimental studies. *Appetite, 144*, 104478. <https://doi.org/10.1016/j.appet.2019.104478>
- Hartmann, C., Lazzarini, G., Funk, A., & Siegrist, M. (2021). Measuring consumers' knowledge of the environmental impact of foods. *Appetite, 167*, 105622. <https://doi.org/10.1016/j.appet.2021.105622>

- Hawkes, C. (2013). *Promoting healthy diets through nutrition education and changes in the food environment: an international review of actions and their effectiveness. Background paper for the international conference on nutrition (ICN2)*. Food and Agriculture Organization. Available at <https://www.fao.org/3/i3235e/i3235e.pdf>
- Hayes, A. F. (2018). *Introduction to mediation, moderation and conditional process analysis: A regression-based approach* (2nd ed.). The Guilford Press.
- Hayes, A. F., & Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, 67(3), 451–470. <https://doi.org/10.1111/bmsp.12028>
- Hayes, A. F., & Rockwood, N. J. (2017). Regression-based statistical mediation and moderation analysis in clinical research: Observations, recommendations, and implementation. *Behaviour Research and Therapy*, 98, 39–57. <https://doi.org/10.1016/j.brat.2016.11.001>
- Hebert, J. R., Clemow, L., Pbert, L., Ockene, I. S., & Ockene, J. (1995). Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. *International Journal of Epidemiology*, 24(2), 389–398. <https://doi.org/10.1093/ije/24.2.389>
- Heckelei, T., Hüttel, S., Odening, M., & Rommel, J. (2021). The replicability crisis and the p-value debate—what are the consequences for the agricultural and food economics community? *Food and Resource Economics, Discussion Paper*, 2. <https://doi.org/10.22004/ag.econ.316369>
- Hirsh, J. B., Kang, S. K., & Bodenhausen, G. V. (2012). Personalized Persuasion: Tailoring Persuasive Appeals to Recipients' Personality Traits. *Psychological Science*, 23(6), 578–581. <https://doi.org/10.1177/0956797611436349>
- Hoenink, J. C., Mackenbach, J. D., Waterlander, W., Lakerveld, J., van der Laan, N., & Beulens, J. W. J. (2020). The effects of nudging and pricing on healthy food purchasing behavior in a virtual supermarket setting: A randomized experiment. *International Journal of Behavioral Nutrition and Physical Activity*, 17(1), 98. <https://doi.org/10.1186/s12966-020-01005-7>
- Hollywood, L., Surgenor, D., Reicks, M., McGowan, L., Lavelle, F., Spence, M., Raats, M., McCloat, A., Mooney, E., Caraher, M., & Dean, M. (2018). Critical review of behaviour change techniques applied in intervention studies to improve cooking skills and food skills among adults. *Critical Reviews in Food Science and Nutrition*, 58(17), 2882–2895. <https://doi.org/10.1080/10408398.2017.1344613>

- Houts, P. S., Doak, C. C., Doak, L. G., & Loscalzo, M. J. (2006). The role of pictures in improving health communication: A review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling*, 2(61), 173–190. <https://doi.org/10.1016/j.pec.2005.05.004>
- IPCC (2013). *Climate change 2013: The physical science basis: Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Available at <https://www.ipcc.ch/report/ar5/wg1/>
- Jalil, A. J., Tasoff, J., & Bustamante, A. V. (2020). Eating to save the planet: Evidence from a randomized controlled trial using individual-level food purchase data. *Food Policy*, 95, 101950. <https://doi.org/10.1016/j.foodpol.2020.101950>
- Jalil, A. J., Tasoff, J., & Bustamante, A. V. (2022). Low-cost climate-change informational intervention reduces meat consumption among students for years. *Research Square* (pre-print). <https://doi.org/10.21203/rs.3.rs-2047134/v1>
- Kamar, M., Evans, C., & Hugh-Jones, S. (2016). Factors influencing adolescent whole grain intake: A theory-based qualitative study. *Appetite*, 101, 125–133. <https://doi.org/10.1016/j.appet.2016.02.154>
- Koch, J. A., Bolderdijk, J. W., & van Ittersum, K. (2022). Can graphic warning labels reduce the consumption of meat? *Appetite*, 168, 105690. <https://doi.org/10.1016/j.appet.2021.105690>
- Kunst, J. R., & Hohle, S. M. (2016). Meat eaters by dissociation: How we present, prepare and talk about meat increases willingness to eat meat by reducing empathy and disgust. *Appetite*, 105, 758–774. <https://doi.org/10.1016/j.appet.2016.07.009>
- Kuznesof, S., Brownlee, I. A., Moore, C., Richardson, D. P., Jebb, S. A., & Seal, C. J. (2012). WHOLEheart study participant acceptance of wholegrain foods. *Appetite*, 59(1), 187–193. <https://doi.org/10.1016/j.appet.2012.04.014>
- Kwasny, T., Dobernig, K., & Riefler, P. (2022). Towards reduced meat consumption: A systematic literature review of intervention effectiveness, 2001–2019. *Appetite*, 168, 105739. <https://doi.org/10.1016/j.appet.2021.105739>
- Lakens, D., Adolphi, F. G., Albers, C. J., Anvari, F., Apps, M. A., Argamon, S. E., ... & Zwaan, R. A. (2018). Justify your alpha. *Nature human behaviour*, 2(3), 168–171. <https://doi.org/10.1038/s41562-018-0311-x>
- Latka, C., Kuiper, M., Frank, S., Heckelei, T., Havlik, P., Witzke, H.-P., Leip, A., Cui, H. D., Kuijsten, A., Geleijnse, J. M., & van Dijk, M. (2021). Paying the price for

- environmentally sustainable and healthy EU diets. *Global Food Security*, 28, 100437. <https://doi.org/10.1016/j.gfs.2020.100437>
- Lin-Schilstra, L., & Fischer, A. R. H. (2020). Consumer moral dilemma in the choice of animal-friendly meat products. *Sustainability*, 12(12), 4844. <https://doi.org/10.3390/su12124844>
- Loughnan, S., Haslam, N., & Bastian, B. (2010). The role of meat consumption in the denial of moral status and mind to meat animals. *Appetite*, 55(1), 156–159. <https://doi.org/10.1016/j.appet.2010.05.043>
- Ludwiczak, A., Skrzypczak, E., Składanowska-Baryza, J., Stanisz, M., Ślósarz, P., & Racewicz, P. (2021). How Housing Conditions Determine the Welfare of Pigs. *Animals*, 11(12), 3484. <https://doi.org/10.3390/ani11123484>
- Macdiarmid, J. I., Kyle, J., Horgan, G. W., Loe, J., Fyfe, C., Johnstone, A., & McNeill, G. (2012). Sustainable diets for the future: Can we contribute to reducing greenhouse gas emissions by eating a healthy diet? *The American Journal of Clinical Nutrition*, 96(3), 632–639. <https://doi.org/10.3945/ajcn.112.038729>
- Macht, J., Klink-Lehmann, J., Piqueras-Fiszman, B., & Hartmann, M. (2021). Insights into the organic labelling effect: the special case of wine. *British Food Journal*. Vol. ahead-of-print, No. ahead-of-print. <https://doi.org/10.1108/BFJ-04-2021-0378>
- Magalis, R. M., Giovanni, M., & Silliman, K. (2016). Whole grain foods: is sensory liking related to knowledge, attitude, or intake? *Nutrition & Food Science*, 46(4), 488–503. <https://doi.org/10.1108/NFS-09-2015-0101>
- Maxwell, S. E., Lau, M. Y., & Howard, G. S. (2015). Is psychology suffering from a replication crisis? What does “failure to replicate” really mean?. *American Psychologist*, 70(6), 487. <https://doi.org/10.1037/a0039400>
- Mazzocchi, M. (2017). *Ex-post evidence on the effectiveness of policies targeted at promoting healthier diets*. Food and Agricultural Organization. Available at <https://www.fao.org/3/i8191e/i8191e.pdf>
- McBride, D. M., & Doshier, B. A. (2002). A comparison of conscious and automatic memory processes for picture and word stimuli: A process dissociation analysis. *Consciousness and Cognition*, 11(3), 423–460. [https://doi.org/10.1016/S1053-8100\(02\)00007-7](https://doi.org/10.1016/S1053-8100(02)00007-7)
- McDermott, M. S., Oliver, M., Svenson, A., Simnadis, T., Beck, E. J., Coltman, T., Iverson, D., Caputi, P., & Sharma, R. (2015). The theory of planned behaviour and discrete food choices: A systematic review and meta-analysis. *International Journal*

- of Behavioral Nutrition and Physical Activity*, 12, 162.
<https://doi.org/10.1186/s12966-015-0324-z>
- McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, 5(2), 97–144.
<https://doi.org/10.1080/17437199.2010.521684>
- Meier, T., Gräfe, K., Senn, F., Sur, P., Stangl, G. I., Dawczynski, C., März, W., Kleber, M. E., & Lorkowski, S. (2019). Cardiovascular mortality attributable to dietary risk factors in 51 countries in the WHO European Region from 1990 to 2016: a systematic analysis of the Global Burden of Disease Study. *European Journal of Epidemiology*, 34(1), 37–55. <https://doi.org/10.1007/s10654-018-0473-x>
- Meynier, A., Chanson-Rollé, A., & Riou, E. (2020). Main factors influencing whole grain consumption in children and adults — A narrative review. *Nutrients*, 12(8), 2217. <https://doi.org/10.3390/nu12082217>
- Nissen, A., Obermeier, G., Gier, N., & Auinger, A. (2021). Oh, what a cognitive relief! A NeuroIS study on visual designs of digital signages. *Presentation at ICIS 2021 proceedings*.
- Noar, S. M., Harrington, N. G., & Aldrich, R. S. (2009). The Role of Message Tailoring in the Development of Persuasive Health Communication Messages. *Annals of the International Communication Association*, 33(1), 73–133.
<https://doi.org/10.1080/23808985.2009.11679085>
- Nuffield Bioethics Council (2007). *Public health: ethical issues*. Nuffield Council on Bioethics.
- O'Donovan, C. B., Devlin, N. F., Buffini, M., Walton, J., Flynn, A., Gibney, M. J., Nugent, A. P., & McNulty, B. A. (2019). Whole grain intakes in Irish adults: Findings from the National Adults Nutrition Survey (NANS). *European Journal of Nutrition*, 58, 541–550. <https://doi.org/10.1007/s00394-018-1615-3>
- O'Brien, T. C., Palmer, R., & Albarracin, D. (2021). Misplaced trust: When trust in science fosters belief in pseudoscience and the benefits of critical evaluation. *Journal of Experimental Social Psychology*, 96, 104184.
<https://doi.org/10.1016/j.jesp.2021.104184>
- Ong, A. S.-J., Frewer, L., & Chan, M.-Y. (2017). Cognitive dissonance in food and nutrition – A review. *Critical Reviews in Food Science and Nutrition*, 57(11), 2330–2342.
<https://doi.org/10.1080/10408398.2015.1013622>

- Ottersen, I. S., Benningstad, N. C., & Kunst, J. R. (2022). Daily reminders about the animal-welfare, environmental and health consequences of meat and their main and moderated effects on meat consumption. *Cleaner and Responsible Consumption*, 5, 100068. <https://doi.org/10.1016/j.clrc.2022.100068>
- Palomo-Vélez, G., Tybur, J. M., & van Vugt, M. (2018). Unsustainable, unhealthy, or disgusting? Comparing different persuasive messages against meat consumption. *Journal of Environmental Psychology*, 58, 63–71. <https://doi.org/10.1016/j.jenvp.2018.08.002>
- Petty, R. E., & Briñol, P. (2011). The elaboration likelihood model. *Handbook of theories of social psychology*, 1, 224-245.
- Petty, R. E., & Wegener, D. T. (1999). The elaboration likelihood model: Current status and controversies. In S. Chaiken & Y. Trope (Eds.), *Dual-process theories in social psychology* (pp. 37–72). The Guilford Press.
- Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In R. E. Petty, & J. T. Cacioppo (Eds.), *Communication and persuasion. Central and peripheral routes to attitude change* (pp. 1–24). Springer. <https://doi.org/10.1007/978-1-4612-4964-1>
- Petty, R. E., & Wegener, D. T. (1998). Matching versus mismatching attitude functions: Implications for scrutiny of persuasive messages. *Personality and Social Psychology Bulletin*, 24(3), 227–240. <https://doi.org/10.1177/0146167298243001>
- Regional Committee for Europe of WHO. (2022). *Seventy-second regional committee for Europe: Tel Aviv, 12–14 September 2022: draft resolution: European regional action framework for behavioural and cultural insights for health, 2022–2027*. World Health Organization. Regional Office for Europe. Available at <https://apps.who.int/iris/handle/10665/361521>
- Risius, A., & Hamm, U. (2017). The effect of information on beef husbandry systems on consumers' preferences and willingness to pay. *Meat Science*, 124, 9–14. <https://doi.org/10.1016/j.meatsci.2016.10.008>
- Rothgerber, H. (2019). "But I don't eat that much meat". Situational underreporting of meat consumption by women. *Society & Animals*, 27(2), 150–173. <https://doi.org/10.1163/15685306-12341468>
- Rothgerber, H. (2020). Meat-related cognitive dissonance: A conceptual framework for understanding how meat eaters reduce negative arousal from eating animals. *Appetite*, 146, 104511. <https://doi.org/10.1016/j.appet.2019.104511>

- Rucker, D. D., Preacher, K. J., Tormala, Z. L., & Petty, R. E. (2011). Mediation analysis in social psychology: Current practices and new recommendations. *Social and Personality Psychology Compass*, 5(6), 359–371. <https://doi.org/10.1111/j.1751-9004.2011.00355.x>
- Ryffel, F. A., & Wirth, W. (2016). Heart Versus Mind: How Affective and Cognitive Message Frames Change Attitudes. *Social Psychology*, 47(1), 52–62. <https://doi.org/10.1027/1864-9335/a000257>
- Sanders, L. M., Zhu, Y., Wilcox, M. L., Koecher, K., & Maki, K. C. (2021). Effects of whole grain intake, compared with refined grain, on appetite and energy intake: A systematic review and meta-analysis. *Advances in Nutrition*, 12(4), 1177–1195. <https://doi.org/10.1093/advances/nmaa178>
- Sandvik, P., Kihlberg, I., Lindroos, A. K., Marklinder, I., & Nydahl, M. (2014). Bread consumption patterns in a Swedish national dietary survey focusing particularly on whole-grain and rye bread. *Food & Nutrition Research*, 58(1), 24024. <https://doi.org/10.3402/fnr.v58.24024>
- Sandvik, P., Nydahl, M., Kihlberg, I., & Marklinder, I. (2018). Consumers' health-related perceptions of bread – Implications for labeling and health communication. *Appetite*, 121, 285–293. <https://doi.org/10.1016/j.appet.2017.11.092>
- Schultz, P. W. (2002). Knowledge, information, and household recycling: Examining the knowledge-deficit model of behavior change. In National Research Council (Ed.), *New tools for environmental protection. Education, information, and voluntary measures* (pp. 67–82). National Academies Press.
- Schumann, D. W., Petty, R. E., & Scott Clemons, D. (1990). Predicting the effectiveness of different strategies of advertising variation: A test of the repetition-variation hypotheses. *Journal of Consumer Research*, 17(2), 192-202. <https://doi.org/10.1086/208549>
- See, Y. H. M., Petty, R. E., & Fabrigar, L. R. (2008). Affective and cognitive meta-bases of attitudes: Unique effects on information interest and persuasion. *Journal of Personality and Social Psychology*, 94(6), 938–955. <https://doi.org/10.1037/0022-3514.94.6.938>
- Sette, S., D'Addezio, L., Piccinelli, R., Hopkins, S., Le Donne, C., Ferrari, M., Mistura, L., & Turrini, A. (2017). Intakes of whole grain in an Italian sample of children, adolescents and adults. *European Journal of Nutrition*, 56, 521–533. <https://doi.org/10.1007/s00394-015-1097-5>

- Simis, M. J., Madden, H., Cacciatore, M. A., & Yeo, S. K. (2016). The lure of rationality: Why does the deficit model persist in science communication? *Public Understanding of Science (Bristol, England)*, 25(4), 400–414.
<https://doi.org/10.1177/0963662516629749>
- Simmons, J., D Nelson, L., & Simonsohn, U. (2021). Pre-registration: Why and how. *Journal of Consumer Psychology*, 31(1), 151-162. <https://doi.org/10.1002/jcpy.1208>
- Sogari, G., Li, J., Lefebvre, M., Menozzi, D., Pellegrini, N., Cirelli, M., Gómez, M. I., & Mora, C. (2019). The influence of health messages in nudging consumption of whole grain pasta. *Nutrients*, 11(12), 2993. <https://doi.org/10.3390/nu11122993>
- Sogari, G., Li, J., Wang, Q., Lefebvre, M., Huang, S., Mora, C., & Gómez, M. I. (2022). Toward a reduced meat diet: University North American students' acceptance of a blended meat-mushroom burger. *Meat Science*, 108745.
<https://doi.org/10.1016/j.meatsci.2022.108745>
- Spiller, A., Zühlsdorf, A., & Nitzko, S. (2017). Instrumente der Ernährungspolitik: Ein Forschungsüberblick - Teil 2. *Ernährungspolitik*, 4, 204–211.
<https://doi.org/10.4455/eu.2017.015>
- Statistisches Bundesamt (2020). Landwirtschaftszählung 2020, available at https://www.destatis.de/DE/Presse/Pressemitteilungen/2021/08/PD21_N051_41.html
- Stea, S., & Pickering, G. J. (2019). Optimizing messaging to reduce red meat consumption. *Environmental Communication*, 13(5), 633–648.
<https://doi.org/10.1080/17524032.2017.1412994>
- Suthers, R., Broom, M., & Beck, E. (2018). Key characteristics of public health interventions aimed at increasing whole grain intake: A systematic review. *Journal of nutrition education and behavior*, 50(8), 813-823. <https://doi.org/10.1016/j.jneb.2018.05.013>
- Sweeney, J. C., Hausknecht, D., & Soutar, G. N. (2000). Cognitive dissonance after purchase: A multidimensional scale. *Psychology & Marketing*, 17(5), 369–385.
[https://doi.org/10.1002/\(SICI\)1520-6793\(200005\)17:5<369::AID-MAR1>3.0.CO;2-G](https://doi.org/10.1002/(SICI)1520-6793(200005)17:5<369::AID-MAR1>3.0.CO;2-G)
- Tang, G., Wang, D., Long, J., Yang, F., & Si, L. (2015). Meta-analysis of the association between whole grain intake and coronary heart disease risk. *The American Journal of Cardiology*, 115(5), 625–629. <https://doi.org/10.1016/j.amjcard.2014.12.015>
- Teeny, J. D., Siev, J. J., Briñol, P., & Petty, R. E. (2021). A review and conceptual framework for understanding personalized matching effects in persuasion. *Journal of Consumer Psychology*, 31(2), 382–414. <https://doi.org/10.1002/jcpy.1198>

- Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press: New Haven and London
- Thow, A. M., Downs, S., & Jan, S. (2014). A systematic review of the effectiveness of food taxes and subsidies to improve diets: Understanding the recent evidence. *Nutrition Reviews*, 72(9), 551–565. <https://doi.org/10.1111/nure.12123>
- Tieri, M., Ghelfi, F., Vitale, M., Vetrani, C., Marventano, S., Lafranconi, A., Godos, J., Titta, L., Gambera, A., Alonzo, E., Sciacca, S., Riccardi, G., Buscemi, S., Del Rio, D., Ray, S., Galvano, F., Beck, E., & Grosso, G. (2020). Whole grain consumption and human health: an umbrella review of observational studies. *International Journal of Food Sciences and Nutrition*, 71(6), 668–677. <https://doi.org/10.1080/09637486.2020.1715354>
- Tilman, D., & Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature*, 515, 518–522. <https://doi.org/10.1038/nature13959>
- Tubiello, F. N., Salvatore, M., Ferrara, A. F., House, J., Federici, S., Rossi, S., Biancalani, R., Condor Golec, R. D., Jacobs, H., Flammini, A., Prosperi, P., Cardenas-Galindo, P., Schmidhuber, J., Sanz Sanchez, M. J., Srivastava, N., & Smith, P. (2015). The Contribution of Agriculture, Forestry and other Land Use activities to Global Warming, 1990–2012. *Global Change Biology*, 21(7), 2655–2660. <https://doi.org/10.1111/gcb.12865>
- Umweltbundesamt (2018). *Beitrag der Landwirtschaft zu den Treibhausgas-Emissionen*. <https://www.umweltbundesamt.de/daten/land-forstwirtschaft/beitrag-der-landwirtschaft-zu-den-treibhausgas#textpart-1> accessed on 10/11/2022.
- United Nations. (2015). *Transforming our world: The 2030 agenda for Sustainable Development*. Available at https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E
- Vainio, A., Irz, X., & Hartikainen, H. (2018). How effective are messages and their characteristics in changing behavioural intentions to substitute plant-based foods for red meat? The mediating role of prior beliefs. *Appetite*, 125, 217–224. <https://doi.org/10.1016/j.appet.2018.02.002>
- Van de Mortel, T. F. (2008). Faking it: social desirability response bias in self-report research. *The Australian Journal of Advanced Nursing*, 25(4), 40–48. <https://doi.org/10.3316/ielapa.210155003844269>
- Van Herpen, E., van den Broek, E., van Trijp, H. C., & Yu, T. (2016). Can a virtual supermarket bring realism into the lab? Comparing shopping behavior using virtual

- and pictorial store representations to behavior in a physical store. *Appetite*, *107*, 196–207. <https://doi.org/10.1016/j.appet.2016.07.033>
- Verain, M. C. D., Sijtsema, S. J., Dagevos, H., & Antonides, G. (2017). Attribute segmentation and communication effects on healthy and sustainable consumer diet intentions. *Sustainability*, *9*(5), 743. <https://doi.org/10.3390/su9050743>
- Verbeke, W., & Liu, R. (2014). The impacts of information about the risks and benefits of pork consumption on Chinese consumers' perceptions towards, and intention to eat, pork. *Meat Science*, *98*(4), 766–772. <https://doi.org/10.1016/j.meatsci.2014.07.023>
- Waterlander, W. E., Jiang, Y., Steenhuis, I. H. M., & Mhurchu, C. N. (2015). Using a 3D virtual supermarket to measure food purchase behavior: A validation study. *Journal of Medical Internet Research*, *17*(4), e3774. <https://doi.org/10.2196/jmir.3774>
- Wiggins, B. J., & Christopherson, C. D. (2019). The replication crisis in psychology: An overview for theoretical and philosophical psychology. *Journal of Theoretical and Philosophical Psychology*, *39*(4), 202. <https://doi.org/10.1037/teo0000137>
- Weible, D., Christoph-Schulz, I., Salamon, P., & Zander, K. (2016). Citizens' perception of modern pig production in Germany: a mixed-method research approach. *British Food Journal*, *118*(8), 2014–2032. <https://doi.org/10.1108/BFJ-12-2015-0458>
- Weingarten, N., & Hartmann, M. (2022a). Let's talk about straw: the effect of information provision on consumers' attitudes towards pig husbandry systems. *British Food Journal*. Vol. ahead-of-print, No. ahead-of-print
<https://doi.org/10.22004/ag.econ.30352>
- Weingarten, N., & Hartmann, M. (2022b). Fifty shades of grain - Increasing whole grain consumption through daily messages (*under Review at Appetite*).
- Weingarten, N., Meraner, M., Bach, L., & Hartmann, M. (2022). Can information influence meat consumption behaviour? An experimental field study in the university canteen. *Food Quality and Preference*, *97*, 104498.
<https://doi.org/10.1016/j.foodqual.2021.104498>
- Weingarten, N., & Lagerkvist, C.-J. (2023). Can images and textual information lead to meat avoidance? The mediating role of cognitive dissonance. *Food Quality and Preference*, *104*, 104747. <https://doi.org/10.1016/j.foodqual.2022.104747>
- Weiss, J. A., & Tschirhart, M. (1994). Public information campaigns as policy instruments. *Journal of Policy Analysis and Management*, *13*(1), 82–119.
<https://doi.org/10.2307/3325092>

- Whitfield, M., & Jordan, C. H. (2009). Mutual influence of implicit and explicit attitudes. *Journal of Experimental Social Psychology, 45*(4), 748–759.
<https://doi.org/10.1016/j.jesp.2009.04.006>
- Wildraut, C., Plesch, G., Härten, I., Simons, J., Hartmann, M., Ziron, M., & Mergenthaler, M. (2015). *Multimethodische Bewertung von Schweinehaltungsverfahren durch Verbraucher anhand von Videos aus realen Schweineställen*. Landwirtschaftliche Fakultät der Universität Bonn, Schriftenreihe des Forschungsschwerpunktes USL. Available at https://bonndoc.ulb.uni-bonn.de/xmlui/bitstream/handle/20.500.11811/1276/USL_Forschungsbericht_179.pdf?sequence=1&isAllowed=y
- Wille, S. C., Busch, G., & Spiller, A. (2017). Tiertransporte in der Schweinehaltung: Führen mehr Informationen und Wissen bei Verbrauchern zu einer positiveren Einstellung? *German Journal of Agricultural Economics, 66*(1), 1–12.
<https://doi.org/10.22004/ag.econ.303528>
- Wolstenholme, E., Poortinga, W., & Whitmarsh, L. (2020). Two Birds, one Stone: The effectiveness of health and environmental messages to reduce meat consumption and encourage pro-environmental behavioral spillover. *Frontiers in Psychology, 11*, 577111. <https://doi.org/10.3389/fpsyg.2020.577111>
- Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology, 9*(2p2), 1-27. <https://doi.org/10.1037/h0025848>

7. Appendix

1. Weingarten, N.* & Hartmann, M. (2022)^a. Let's talk about straw: the effect of information provision on consumers' attitudes towards pig husbandry systems. *British Food Journal*, Vol. ahead-of-print, No. ahead-of-print. doi.org/10.1108/BFJ-03-2022-0299

Nina Weingarten: Conceptualization, Methodology, Investigation, Formal analysis, Writing - Original Draft, Writing - Review & Editing. Monika Hartmann: Conceptualization, Methodology, Writing - Review & Editing.

2. Weingarten, N.*, Meraner, M., Bach, L., & Hartmann, M. (2022)^a. Can information influence meat consumption behaviour? An experimental field study in the university canteen. *Food Quality and Preference*, 97, 104498. doi.org/10.1016/j.foodqual.2021.104498

Nina Weingarten: Conceptualization, Methodology, Investigation, Formal Analysis, Writing - Original Draft, Writing - Review & Editing. Manuela Meraner: Conceptualization, Methodology, Writing - Review & Editing. Leonie Bach: Conceptualization, Methodology, Investigation, Data Curation, Writing - Review & Editing. Monika Hartmann: Conceptualization, Methodology, Writing - Review & Editing.

3. Weingarten, N.* & Hartmann, M. Fifty shades of grain (2022b)^a. Increasing whole grain consumption through daily messages (*Revised and resubmitted to Appetite*).

Nina Weingarten: Conceptualization, Methodology, Investigation, Formal analysis, Writing - Original Draft, Writing - Review & Editing. Monika Hartmann: Conceptualization, Methodology, Writing - Review & Editing.

4. Weingarten N.* & Lagerkvist, C.-J. (2023)^a. Can images and textual information lead to meat avoidance? The mediating role of cognitive dissonance. *Food Quality and Preference*, 104, 104747. doi.org/10.1016/j.foodqual.2022.104747

Nina Weingarten: Conceptualization, Methodology, Investigation, Formal analysis, Writing - Original Draft, Writing - Review & Editing. Carl-Johan Lagerkvist: Conceptualization, Methodology, Writing - Review & Editing.

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Let's talk about straw: The effect of information provision on consumers' attitudes towards pig husbandry systems

Nina Weingarten & Monika Hartmann

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24 **Abstract**

25 **Purpose** - The type of flooring in stalls is an important factor that shapes consumers' overall
26 perception of animal husbandry. Although slatted and straw floors have benefits and
27 drawbacks, consumers strongly prefer slatted over straw floors in pig husbandry. The present
28 study investigates whether information provision can depolarise consumers' implicit and
29 explicit attitudes towards both floor types to enable a more realistic evaluation of pig husbandry
30 systems. Furthermore, we examine the effectiveness of information depending on different
31 frames and consumers' personality traits.

32 **Design/methodology/approach** - We conducted an experimental laboratory study with 185
33 German consumers to investigate the effect of information on implicit and explicit attitudes
34 towards different flooring types. Participants received information on straw and slatted floors
35 in a cognitive or affective frame or about a control topic. Furthermore, we analysed whether
36 certain consumer groups respond differently to the cognitive or affective frame.

37 **Findings** - The results demonstrated that information provision is a successful tool for
38 depolarising consumers' implicit and explicit attitudes regarding straw and slatted floors.
39 Although consumers continued to prefer straw floors after receiving information, the
40 magnitude of this preference considerably decreased. Mediation analysis illustrated that
41 implicit and explicit attitudes are highly interconnected. We found no evidence that the
42 personality traits of consumers moderated the effectiveness of the cognitive or affective frame.

43 **Originality/Value** - The study proposes that information provision can be a potential avenue
44 for increasing the societal acceptance of conventional methods in pig husbandry and provides
45 recommendations for communicating conditions related to animal husbandry. Furthermore,
46 through the inclusion of an implicit measure, our study overcomes biases of other studies in an
47 agricultural context which usually rely only on explicit measures.

48

49 **Keywords:** explicit attitude, implicit attitude, information, pig husbandry, framing

50 **Paper type:** Research Paper

51 **1. Introduction**

52 The media, the meat industry, and retailers frequently use images of pigs on straw floors as a
53 marketing tool for signalling animal welfare. Indeed, using straw floors is associated with
54 certain benefits for pigs, such as increased physical comfort (van de Weerd and Day, 2009),
55 and species-specific behaviours like rooting (Ludwiczak *et al.*, 2021). However, it also presents
56 certain disadvantages to pig health, such as an increased frequency of respiratory diseases
57 (Scott *et al.*, 2006). Furthermore, applying straw floors is cost- and time-intensive for farmers
58 (Tuytens, 2005).

59 Most pig-fattening stalls in Germany consist of slatted floors, and only a minority use straw
60 floors (Statistisches Bundesamt, 2020). Slatted floors have cement bars with alternating narrow
61 gaps, allowing excrement and urine to pass directly into a manure canal below the stall. In this
62 regard, slatted floors overcome certain disadvantages exhibited by straw floors (Philippe *et al.*,
63 2007) and can be combined with environmental enrichment toys to promote species-specific
64 behaviour (Chou *et al.*, 2019). Under certain conditions, for instance, when the temperature is
65 high, pigs can even better cool off on slatted floors than on straw floors (Ludwiczak *et al.*,
66 2021). On the other hand, slatted floors pose certain disadvantages, such as increased
67 incidences of lameness (Scott *et al.*, 2006). However, Ludwiczak *et al.* (2021) concluded in a
68 recent review that ‘none of the described housing systems for pigs is perfect, and each has some
69 negative effects on welfare, management and food safety’ (p. 1).

70 Although the literature demonstrates that slatted and straw floors, pose advantages and
71 disadvantages, consumers exhibit strongly polarised attitudes. Straw floors are evaluated as
72 very positive, whereas slatted floors yield strong disapproval (Busch *et al.*, 2019; Wildraut *et al.*
73 *et al.*, 2015). This is problematic because focus group discussions with German consumers
74 showed that flooring type in stalls is an important factor in shaping consumers’ overall
75 perception of animal husbandry (Christoph-Schulz and Rovers, 2020). Consumers are typically
76 less knowledgeable about animal husbandry systems (Wildraut *et al.*, 2015); thus, providing
77 information about the drawbacks and benefits of different methods may be a promising mean
78 to enable consumers to evaluate the current production systems more realistically. In this
79 regard, information provision might be a promising strategy to reduce consumers’ criticism on
80 contemporary livestock husbandry (Christoph-Schulz and Rovers, 2020; Weible *et al.*, 2016)
81 and would satisfy consumers desire for additional information about animal husbandry
82 conditions (Eurobarometer, 2006, 2016).

83 In fact, previous studies demonstrated that information provision can be an effective tool for
84 increasing consumers’ acceptance of conventional animal husbandry methods (Altmann *et al.*,
85 2022; Risius and Hamm, 2017; Verbeke and Liu, 2014; Wille *et al.*, 2017). These studies used
86 a cognitive information frame, in which information was given in a factual manner. However,
87 the general effectiveness of cognitive framing is not fully understood. While some studies
88 found no effect of cognitive information (e.g. Weingarten *et al.*, 2022) other studies argued that
89 cognitive information provision only influences specific consumer segments (Teeny *et al.*,
90 2021). Another line of research suggests a higher effectiveness of affective information
91 framing, hence including emotional appeals compared to purely cognitive framing (e.g. Carfora
92 *et al.*, 2019). Thus, considering underlying processes and different message framings is
93 important in investigating whether or not information affects consumers’ attitudes.

94 Therefore, the present study seeks to investigate the effect of information as a strategy for
95 depolarising consumers' attitudes towards straw floors by explaining the benefits of slatted
96 floors and the drawbacks of straw floors. In this regard, the present studies focuses on explicit
97 and implicit attitudes. The inclusion of implicit measures is important as explicit measures of
98 attitudes can be subject to biases such as demand characteristics or the social desirability bias
99 (e.g., Van de Mortel, 2008). Hence, measuring implicit and explicit attitudes allows a more
100 comprehensive representation of consumers' evaluation of the different pig husbandry
101 methods. Furthermore, we differentiate between cognitive and affective framing of information
102 and consider consumers' personality traits. This, in addition, allows us to investigate whether
103 the way information is presented influences its effectiveness for (segments of) consumers.
104 The remainder of the paper is structured as follows. First, we presents the theoretical
105 background used to define implicit and explicit attitudes. Furthermore, the study describes the
106 framework of Gawronski and Bodenhausen (2006), which outlines the influence of information
107 provision on implicit and explicit attitudes. Moreover, we review different frames to design
108 information and their differential effects across specific consumer segments. Next, we describe
109 the present study, the methodology of the experiment and the results. Lastly, we discuss our
110 results and presents their limitations and implications.

111

112 **2. Theoretical background**

113 *2.1. Explicit and implicit attitude*

114 The present study's objective is to investigate the effect of information provision on
115 consumers' attitudes towards slatted and straw floors. An attitude is a psychological construct
116 that describes the degree of favour with which objects, persons or situations are evaluated
117 (Eagly and Chaiken, 1993). Two facets of attitudes are distinguished, namely, explicit and
118 implicit attitudes. Explicit attitudes are formed deliberately (Gawronski and Bodenhausen,
119 2006). Hence, consumers evaluate an object as positive or negative based on their knowledge
120 or beliefs. If consumers perceive straw floors as beneficial and slatted floors as harmful, these
121 beliefs form the basis of explicit attitudes (Fishbein and Ajzen, 2010). Explicit attitudes are
122 consciously available to consumers; thus, researchers can use self-report measures, such as
123 surveys, to measure them (Greenwald and Banaji, 1995). However, these measures can be
124 subject to response biases, such as social desirability, and can lead to an inaccurate
125 representation of attitudes (Van de Mortel, 2008).

126 In contrast to explicit attitudes, implicit attitudes are automatic evaluations of an object
127 (Greenwald and Banaji, 1995; Smith and DeCoster, 2000) and do not have to match consumers'
128 conscious beliefs (Brannon and Gawronski, 2017). They may result from a long-term learning
129 process (Rudman, 2004) or spontaneously develop and rapidly change, especially when
130 counter-additudinal information is presented (Brannon and Gawronski, 2017). Implicit
131 attitudes are measured using response-time tests and are therefore less susceptible to bias
132 (Bluemke and Friese, 2008; Gawronski and Hahn, 2019). Based on the response-time of
133 participants, inferences can be made about implicit attitudes. The most common measure
134 (Forscher *et al.*, 2019) is the implicit association test (IAT) developed by Greenwald *et al.*
135 (1998). Despite numerous studies on implicit attitudes, the application of the IAT to the
136 agricultural context is scarce (Forscher *et al.*, 2019). A few rare examples can be found in the
137 crop protection domain (e.g., Schaak *et al.*, 2021).

138 2.2. *Influencing attitudes through information provision*

139 In order to understand the process of how information provision influences consumers'
140 attitudes towards slatted and straw floor, different theoretical accounts can be considered. The
141 present study is based on the associative-propositional evaluation (APE) model by Gawronski
142 and Bodenhausen (2006) which elucidates how information provision influences both, explicit
143 and implicit attitudes.

144 According to the APE model, Figure 1 illustrates four pathways through which information
145 can influence implicit and explicit attitudes. The first pathway (Figure 1, Pathway A) indicates
146 that the provision of new information can directly influence explicit attitudes of consumers.
147 Providing new information leads to a change in existing knowledge and beliefs, causing a
148 deliberate re-evaluation of consumer attitudes (Gawronski and Bodenhausen, 2006). Several
149 studies propose that information can influence explicit attitudes towards different attitudinal
150 objects in the agricultural food sector, such as animal transportation systems (Wille *et al.*, 2017)
151 or organic food production (Shan *et al.*, 2020). The second pathway (Figure 1, Pathway B)
152 outlines how information changes implicit attitudes. Newly acquired information can change
153 the automatic evaluation that consumers associate with the attitudinal object. Hence, an
154 attitudinal object that initially elicits a positive evaluation can become less positive or even
155 negative through information or vice versa (Gawronski and Bodenhausen, 2006). Various
156 studies support this notion by demonstrating that information influences implicit attitudes, for
157 instance, towards crop protection (Schaak *et al.*, 2021) or genome-edited food (Nguyen *et al.*,
158 2022). The third and fourth pathways describe the indirect influence of information provision
159 through mutual influences of implicit and explicit attitudes on each other. According to the
160 APE model, a change in an implicit evaluation of the attitudinal object can serve as another
161 new belief, which can trigger a cognitive re-elaboration of explicit attitudes (Figure 1, Pathway
162 B*C). Correspondingly, Baum *et al.* (2021) found that implicit attitudes mediate the effect of
163 positive information about cultivated meat on explicit attitudes. Similarly, a change in explicit
164 attitudes can trigger a change in the automatic evaluation of the attitudinal object, thus, of the
165 implicit attitude (Figure 1, Pathway A*D). Whitfield and Jordan (2009), who found that
166 explicit attitudes mediate the effect of information provision on implicit attitudes, offer support
167 for this notion. Hence, according to the APE model and the empirical literature, information
168 provision can be an effective tool for directly and indirectly influencing consumers' implicit
169 and explicit attitudes.

170

171

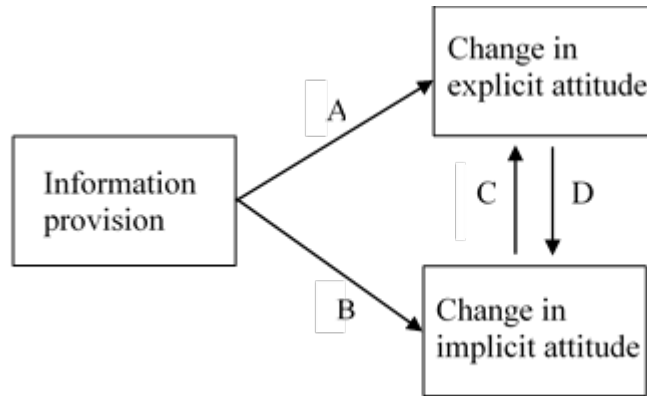


Figure 1 The effect of information on implicit and explicit attitude change.

Note. The illustration is based on Gawronski and Bodenhausen, 2006 (Figure 10, p. 708).

172

173 2.3. Cognitive and affective information provision

174 Various information frames can be applied to influence consumers' implicit and explicit
 175 attitudes towards slatted and straw floors. Framing refers to presenting one piece of information
 176 in various ways to evoke different responses (Kahneman, 2012). Hence, information about
 177 straw and slatted floors can be framed in a rational, factual manner. In contrast, information
 178 with an affective frame, is produced with emotional adjectives. Furthermore, an affective frame
 179 can include a message protagonist (See *et al.*, 2008); for example, a farmer who considers
 180 applying straw or slatted floors. The present study focuses on this distinction between cognitive
 181 and affective framing. Although some research suggests that affective framing may be more
 182 effective than cognitive framing (Carfora *et al.*, 2019), the information receiver also plays an
 183 important role. Theoretical models, such as the elaboration likelihood model (ELM), postulates
 184 that the extent to which a cognitive or affective frame is effective in changing attitudes depends
 185 on the personality of the message receiver. Specifically, individuals with a cognitive
 186 (affective)-oriented personality are more influenced by a cognitive (affective) information
 187 frame (Petty & Cacioppo, 1986; Teeny *et al.*, 2021). Different assessment methods can
 188 determine consumers' personality, such as the need for affect (NFA; describes the extent to
 189 which individuals are motivated to approach or avoid emotion-triggering situations; Maio and
 190 Esses, 2001) or need for cognition (NFC; describes the extent to which individuals 'engage in
 191 and enjoy effortful cognitive endeavours'; Cacioppo *et al.*, 1984, p. 306). In line with the ELM,
 192 previous studies demonstrate that affective frames are most effective for consumers with high
 193 levels of NFA and/or low levels of NFC; cognitive information frames are suitable for
 194 consumers with high levels of NFC and/or low levels of NFA (Haddock *et al.*, 2008; Kraichy
 195 and Chapman, 2014).

196

197 3. Present study

198 Based on the theoretical and empirical literature, the current study investigates whether
 199 information provision influences consumers' implicit and explicit attitudes towards slatted or
 200 straw flooring in pig husbandry. We hypothesize that both, cognitive and affective framing is
 201 effective in changing consumers' attitude. Furthermore, we investigate the interrelation
 202 between implicit and explicit attitudes changes by testing the mediating role of implicit

203 (explicit) attitudes on the relationship between information and explicit (implicit) attitudes.
204 Implicit and explicit attitudes are potential mediators; therefore, the study does not formulate
205 a specific hypothesis but explores the effect in both directions. Furthermore, we examine
206 whether cognitive and affective frames have differential effects for different consumer
207 segments. We hypothesise that a cognitive (affective)-oriented personality increases the
208 effectiveness of the cognitive (affective) frame. The study complied with all ethical guidelines
209 of the American Psychological Association and was conducted in accordance with the
210 Declaration of Helsinki. We share all materials and data through a folder on OSF, which can
211 be accessed here https://osf.io/d2jzc/?view_only=518d26a16596471f97e9bd7084d03cf8.

212

213 4. Method

214 4.1. Participants and design

215 We recruited 216 participants for an experimental laboratory study. The inclusion criteria were
216 following a non-vegetarian/vegan diet, lacking a background in agriculture and being of legal
217 age. Participants were recruited through a market research institute and received a monetary
218 reward. From an initial sample of 216 participants, 10 with missing data and 21 who
219 experienced technological failure were excluded. Thus, data from 185 participants were used
220 for analysis (99 men; 86 women; $M = 45.71$ years, $SD = 13.05$ years).

221 The experiment followed a 3x2 mixed design with the between-subject factor *framing*
222 (affective versus cognitive versus control) and within-subjects factor *measure* (pre versus post).

223

224 4.2. Procedure and materials

225 Four to six subjects participated in each lab session and were randomly assigned to one of the
226 three experimental conditions. We used *Lime Survey* and *Inquisit Lab* ro program the
227 experiment. In the beginning, the study measured sociodemographic and control variables,
228 followed by explicit and implicit attitudes towards pig husbandry. The participants then read
229 the information text. Afterwards, the study obtained data on explicit and implicit attitudes at
230 post-measure. Lastly, NFA and NFC were measured in a counterbalanced order, and the
231 participants were debriefed.

232

233 4.2.1. Control variables

234 We used one item to measure participants' mood ('*How is your current mood?*') using a 100-
235 mm visual analogue scale (VAS) ranging from 1 = *very bad* to 100 = *very good*. Referring to
236 Eurobarometer (2006), the study measured subjective knowledge about pig husbandry
237 conditions using one statement ('*How much do you think you know about the conditions in*
238 *which pigs are kept in Germany?*') with the following response categories: *a lot*, *a little* and
239 *nothing at all*. In order to measure attitudes toward animals, the study adopted five items from
240 the short scale of Herzog *et al.* (2015; e.g. '*I think it is perfectly acceptable for cattle and hogs*
241 *to be raised for human consumption*') and four additional items from the long version of the
242 scale (Herzog *et al.*, 1991), which were related to farm animal husbandry (e.g. '*The production*
243 *of inexpensive meat, eggs and dairy products justifies maintaining animals under crowded*
244 *conditions*'). The items were rated using a 7-point Likert scale, ranging from 1 = *strongly*
245 *disagree* to 7 = *strongly agree*. After reverse-coding negatively phrased items, the scale had

246 acceptable internal consistency ($\alpha = .70$). For the following analysis, we used mean scores of
247 the nine items.

248

249 4.2.2. Cognitive and affective frames

250 The information texts ($M_{\text{words}} = 331.33$, $SD_{\text{words}} = 7.51$) were short messages the participants
251 read on a computer screen. The affective and cognitive frames displayed a similar structure:
252 the first paragraph described the application of slatted floors in pig stalls; the second provided
253 positive information about slatted floors (e.g. increased hygiene); the third one presented
254 negative information about straw floors (e.g. increased fine-dust pollution). The control
255 information described a local university. The study adopted the approach that See *et al.* (2008)
256 outlined and embedded effective information in a narrative with a protagonist named ‘Farmer
257 Michael’. The protagonist recently inherited a pig farm and modernised the stalls by installing
258 slatted floors. To ensure that all information about pig farming was correctly presented, an
259 animal scientist proofread the texts.

260

261 4.2.3. Explicit attitudes

262 To measure explicit attitudes, the participants rated five images of pigs on straw floors and
263 another five on slatted floors in a randomised order. The following statement accompanied
264 each picture: ‘*In my opinion, the pig husbandry depicted in the picture is...*’ and a 100-mm
265 VAS ranging from 1 = *unacceptable* to 100 = *acceptable*. All ratings for slatted and straw
266 floors were averaged to formulate the score for explicit attitudes. By subtracting the scores for
267 straw floors from those of slatted floors, the study generated an explicit attitude difference-
268 score (d-score) (Friese *et al.*, 2008). A negative (positive) explicit attitude indicates a more
269 positive (negative) evaluation of straw floors than those for slatted floors. At pre- and post-
270 measures, all ratings exhibited excellent internal consistency (all α s > .95).

271

272 4.2.4. Implicit attitudes

273 The study measured implicit attitudes using a bipolar IAT (Greenwald *et al.*, 1998). In seven
274 blocks, the participants categorised stimuli into different target and evaluation categories by
275 pressing response keys. Table 1 illustrates the block sequence of the present IAT. The study
276 used 10 pictures and 10 words as stimuli. Pictures of pigs on straw and slatted floors had to be
277 sorted into two target categories, namely, ‘*straw floors*’ and ‘*slatted floors*’ and words (e.g.
278 *unbearable* and *tolerable*) into two evaluation categories, namely, ‘*unacceptable*’ and
279 ‘*acceptable*’. Stimuli were presented in the middle of the computer screen. The target and
280 evaluation categories and corresponding response keys appeared in the upper corners. When
281 the participants pressed the correct response key, the next stimulus appeared; if a false response
282 was given, then a red X appeared. In order to assess the internal consistency of IAT, the study
283 calculated Spearman–Brown’s split-half reliability with acceptable scores of $r_{\text{pre}} = .67$ and r_{post}
284 $= .77$. We calculated an implicit d-score using the improved scoring algorithm for the pre- and
285 post-measures of implicit attitude (Greenwald *et al.*, 2003). Similar to the explicit attitude
286 score, a negative (positive) implicit attitude score indicated a more positive (negative)
287 evaluation of straw floors than slatted floors.

288

289

290 **Table I**
 291 Block sequence in the IAT

Block	Trials	Items	Categories assigned to left-key ('E') response	Categories assigned to right-key ('I') response
1	20	Pictures	Straw floors	Slatted floors
2	20	Words	Acceptable	Unacceptable
3	20	Pictures + Words	Straw floors + Acceptable	Slatted floors + Unacceptable
4	40	Pictures + Words	Straw floors + Acceptable	Slatted floors + Unacceptable
5	20	Pictures	Slatted floors	Straw floors
6	20	Pictures + Words	Slatted floors + Acceptable	Straw floors + Unacceptable
7	40	Pictures + Words	Slatted floors + Acceptable	Straw floors + Unacceptable

The IAT in this study was counterbalanced, thus for half of the participants the blocks were assigned in the order 5, 2, 6, 7, 1, 3, 4

292

293

294 4.2.5. NFA and NFC

295 We measured NFA using the German short version of the NFA questionnaire (Appel *et al.*,
 296 2012; Maio and Esses, 2001). The scale consists of two subscales: approach emotion-triggering
 297 situations subscale (e.g. '*I feel that I need to experience strong emotions regularly*') and avoid
 298 emotion-triggering situations subscale (e.g. '*I do not know how to handle my emotions, so I*
 299 *avoid them*'). Each subscale contains five items rated using a 7-point Likert scale (1 = *strongly*
 300 *disagree* to 7 = *strongly agree*). To obtain an aggregate score of general NFA, items from the
 301 avoidance subscale were reverse-coded such that a high score expressed a tendency to approach
 302 emotions. The full scale with the reversed-coded items yielded a mediocre Cronbach's α of .73,
 303 which allowed the use of a mean score in the further analysis.

304 We measured NFC based on the German short version of the NFC scale (Bless *et al.*, 1994;
 305 Cacioppo and Petty, 1982). The scale consists of 15 items (e.g. '*I would prefer complex to*
 306 *simple problems*') rated on a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*).
 307 We formulated an aggregated mean score of all items for analysis. In summary, the scale with
 308 the reverse-coded items exhibited good reliability ($\alpha = .82$).

309

310 5. Results

311 5.1 Preliminary analysis

312 First, we performed a frequency analysis of participants' subjective knowledge of animal
 313 husbandry. The majority of participants claimed to know '*a little*' (80.5%) or '*nothing at all*'
 314 (6.5%), while only a minority reported to know '*a lot*' (13%). Hence, as expected participants
 315 in this study were on average not very knowledgeable about animal husbandry.

316 Second, we performed a randomisation check by testing for significant differences on
 317 demographics, pre-measures, and control variables between conditions. Analyses of variance

318 (ANOVAs) showed that the experimental conditions did not differ significantly in terms of
 319 age, attitudes towards animals, mood and pre-measures (all $ps > .18$). Similarly, chi-square
 320 tests produced no significant differences in the distribution of gender, occupation, education,
 321 and subjective knowledge (all $ps > .08$). Hence, we assume that the random assignment was
 322 successful.

323 Table 2 reports the correlations among key variables, means, and standard deviations of the
 324 explicit and implicit attitudes. The descriptive results illustrate that the participants in all
 325 conditions displayed negative implicit and explicit attitude difference scores at pre-
 326 measurement, thus, possess implicit and explicit preferences for straw floors over slatted floors.

327
 328 **Table II**

329 Correlations, means, and standard deviations of attitudes.

		<i>r</i>				<i>M</i>	<i>SD</i>
		1.	2.	3.	4.		
whole sample <i>n</i> = 185	1. E-pre	1				-49.40	27.28
	2. E-post	.45**	1			-34.97	45.52
	3. I-pre	.15*	.01	1		-.71	.39
	4. I-post	.14	.44**	.42**	1	-.40	.46
		<i>r</i>				<i>M</i>	<i>SD</i>
		1.	2.	3.	4.		
affective frame <i>n</i> = 60	1. E-pre	1				-44.06	27.83
	2. E-post	.43**	1			-23.13	42.66
	3. I-pre	.26*	-.06	1		-.71	.37
	4. I-post	.34**	.28*	.45**	1	-.33	.39
		<i>r</i>				<i>M</i>	<i>SD</i>
		1.	2.	3.	4.		
cognitive frame <i>n</i> = 61	1. E-pre	1				-51.57	28.34
	2. E-post	.42**	1			-14.66	47.29
	3. I-pre	.14	.07	1		-.71	.39
	4. I-post	.12	.53**	.28*	1	-.26	.54
		<i>r</i>				<i>M</i>	<i>SD</i>
		1.	2.	3.	4.		
control <i>n</i> = 64	1. E-pre	1				-52.32	25.37
	2. E-post	.77**	1			-65.44	27.25
	3. I-pre	.06	.03	1		-.70	.42
	4. I-post	-.09	.04	.65**	1	-.60	.38

Note. *** $p < .001$; ** $p < .01$; * $p < .05$. E = Explicit, I = Implicit.

330

331 5.2 Direct effect of information on explicit and implicit attitudes

332 To test whether information provision significantly influenced implicit and explicit attitudes
 333 (Figure 1, Pathways A and B), we estimated two analyses of covariances (ANCOVAs) using
 334 pre-measures as covariates. For explicit attitudes, the study found a significant main effect of

335 information provision ($F(2, 181) = 34.96, p < .001, \eta_p^2 = .28$; Figure 2) and a significant effect
 336 of the covariate ($F(1, 181) = 58.10, p < .001, \eta_p^2 = .24$). Post-hoc comparison of mean
 337 differences using Bonferroni's correction indicated that participants in the control frame
 338 displayed a significantly more negative explicit attitude compared with participants in the
 339 affective ($p < .001$) and cognitive ($p < .001$) frames. The cognitive frame did not differ
 340 significantly from the affective frame ($p = .09$); however, the mean direction suggested that the
 341 cognitive frame was slightly more effective than the affective frame. We found the same pattern
 342 in implicit attitudes. Similarly to the explicit attitude, ANCOCA showed a significant main
 343 effect of information provision ($F(2, 181) = 12.44, p < .001, \eta_p^2 = .12$; see Figure 2) and a
 344 significant effect of the covariate ($F(1, 181) = 6.83, p < .001, \eta_p^2 = .19$). Post-hoc test using
 345 Bonferroni's correction revealed that the participants in the control group displayed a
 346 significantly more negative implicit attitude compared with those in the affective ($p = .001$)
 347 and cognitive ($p < .0001$) frames. The affective and cognitive frames did not differ significantly
 348 from each other ($p = .95$).

349 Hence, participants in all conditions continuously preferred straw floors over slatted floors at
 350 post-measurement. However, the magnitudes of explicit and implicit attitudes at post-
 351 measurement were considerably reduced for the two experimental conditions.

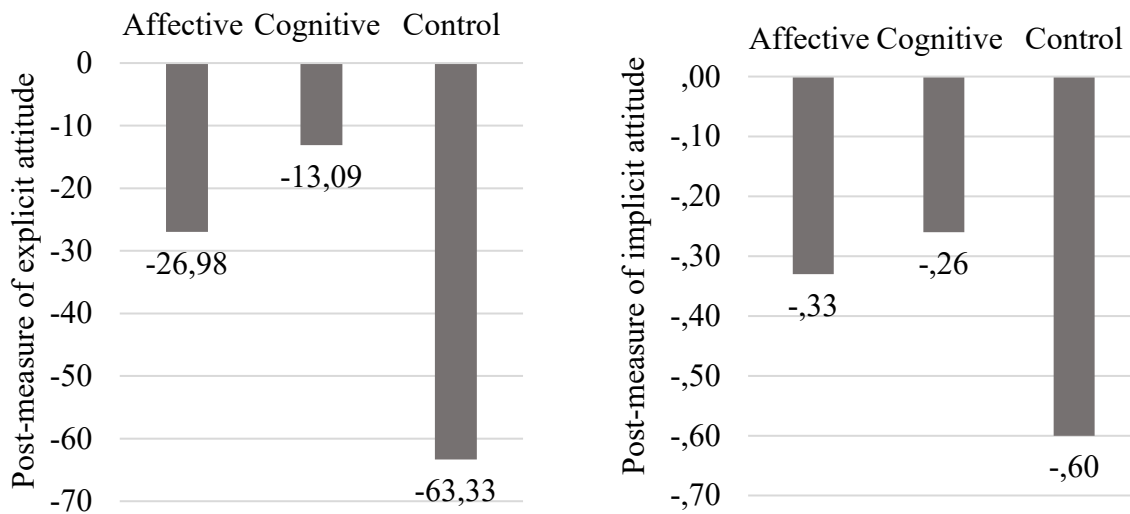


Figure 2 The effect of information on estimated marginal means of explicit and implicit attitude at the post-measure, while controlling for the pre-measure.

352 5.3 Indirect effect of information provision

353 We then explored whether or not implicit (explicit) attitude mediated the effect of information
 354 on explicit (implicit) attitude (Figure 1, Pathways B*C and A*D). We estimated the mediation
 355 model using PROCESS (Hayes, 2018, model 4). To determine the presence of mediational
 356 effects, we evaluated the 95% bootstrap confidence interval of relative indirect effects (based
 357 on 5,000 bootstrap samples). The information frame was entered into the model with two
 358 dummy variables representing the frame (1 = affective/cognitive, 0 = other). Both pre-measures
 359 of attitude were included as covariates. The results of the two mediation analyses are depicted
 360 in Figure 3.

361 We found that explicit attitude significantly mediated the effect of affective ($a_1*b_1 = .16$; $CI =$
 362 $[-.10; .24]$) and cognitive ($a_2*b_1 = .23$; $CI = [.13; .34]$) framed information on implicit attitude.
 363 The relative direct effects of affective ($c'_1 = .09$; $CI = [-.05; .23]$) and cognitive ($c'_2 = .11$; $CI =$
 364 $[-.04; .26]$) framed information do no longer significantly predict the implicit attitude, when
 365 the mediator is included ($b_1 = .005$, $CI = .003; .006$). We then explored whether implicit
 366 attitudes mediated the relationship between information and explicit attitudes. Implicit attitude
 367 significantly mediated the effect of affective ($a_3*b_2 = 8.90$; $CI = [4.23; 14.64]$) and cognitive
 368 frame ($a_4*b_2 = 11.69$; $CI = [5.36; 19.67]$) on explicit attitude. The relative direct effects of the
 369 affective ($c'_3 = 27.32$, $CI = [15.51; 39.13]$) and cognitive ($c'_4 = 38.49$, $CI = [26.53; 50.45]$)
 370 frames remained significant when the mediator was included ($b_2 = 34.93$, $CI = [23.09; 46.78]$).

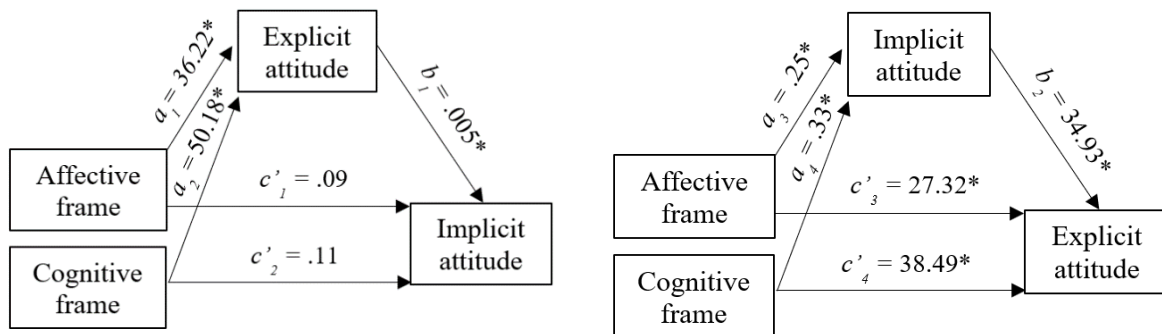


Figure 3. Mediation model.

Note. Estimates for covariates have been omitted to improve readability. * $p < .001$

371 5.4 Moderation analysis

372 Lastly, we tested whether or not consumers' personality traits (NFA and NFC) influenced the
 373 effectiveness of cognitive and affective information framing. We estimated two OLS
 374 regression models, one with the post-measure of explicit attitudes and the other with a post-
 375 measure of implicit attitudes as the dependent variable. As predictors, we used two dummy
 376 variables to represent the information frame (1 = affective/cognitive; 0 = other); mean-centred
 377 scores on NFC and NFA; the product terms of the information frames and NFC and NFA,
 378 respectively; and the pre-measured attitude. Analysis indicated no support for the moderation
 379 hypothesis. Moreover, neither NFC nor NFA moderated the effectiveness of the affective or
 380 cognitive frame. The results of the moderation analysis can be found in the Appendix.

381

382 6. Discussion and conclusion

383 The present study examines the effects of information provision as a strategy for influencing
 384 consumers' attitudes towards slatted and straw floors. The objective is to depolarise such
 385 attitudes by elucidating the benefits of slatted floors and the drawbacks of straw floors. We
 386 tested the effect of cognitive and affective framing on explicit and implicit attitudes.
 387 Furthermore, we investigated whether consumer segments responded differently to the
 388 cognitive and affective frames.

389 Similar to previous studies (Busch *et al.*, 2019; Wildraut *et al.*, 2015), the current findings
 390 indicate that although consumers report medium to low knowledge about animal husbandry
 391 conditions, they strongly prefer straw over slatted floors. This preference remains even after
 392 obtaining knowledge about the advantages of slatted floors and the disadvantages of straw

393 floors. However, the preferences is less strong after receiving information. Thus, the current
394 findings demonstrate that information provision can effectively depolarise attitudes and enable
395 consumers to evaluate pig husbandry systems more realistically. This result is consistent with
396 Wille *et al.* (2017), who reported that information can improve attitudes towards certain animal
397 transportation systems but cannot inverse pre-existing preferences. In contrast to previous
398 studies in an agricultural context, which usually rely only on explicit measures, we also
399 included an implicit measure of attitude. Our findings indicate that the participants possessed
400 convergent implicit and explicit attitudes and that both were similarly influenced by
401 information provision. Hence, this infers that our findings do not result from response biases
402 or demand characteristics.

403 Apart from investigating the direct effect of information provision on implicit and explicit
404 attitudes, we also analysed the mediating role of implicit (explicit) attitudes on the effect of
405 information on explicit (implicit) attitudes. The data demonstrated no clear path of attitude
406 change. Thus, our empirical findings provide support for the APE model by Gawronski and
407 Bodenhausen (2006), in that we show that changes in explicit and implicit attitudes mutually
408 influence each other.

409 Furthermore, we investigated whether or not the effect of cognitive and affective frames
410 increases according to consumer personality. Contrary to previous literature (Teeny *et al.*,
411 2021), the current study found no support for this hypothesis. Although it was not the primary
412 objective of our research, we found that the cognitive frame was slightly more effective
413 compared with the affective frame in changing explicit attitudes, which contrast other existing
414 research (Carfora *et al.*, 2019). However, this effect did not reach statistical significance, but
415 this needs to be evaluated against the small sample size and the application of a conservative
416 Bonferroni post-hoc correction. No such trend was observed for implicit attitudes.

417 The present study has its limitations. First, the content of the information texts was simplified
418 to avoid overwhelming consumers with new information. We did not mention other systems in
419 pig husbandry, such as partially slatted floors, which combine straw and slatted floors or
420 outdoor housing. Furthermore, we only measured the short-term effects of information
421 provision and cannot draw conclusions on the long-term effects of changes in explicit and
422 implicit attitudes. This is a common issue in implicit research (Forscher *et al.*, 2019) and should
423 be addressed by future research.

424 This study presents several implications for the agricultural sector. Despite consumers' low
425 level of knowledge about animal husbandry, they exhibit clear preferences towards different
426 flooring types. Although flooring type is an important factor for shaping consumers' overall
427 perception of animal husbandry, consumers' negative evaluation is not limited to the
428 application of slatted floors. Instead, consumers increasingly criticise contemporary livestock
429 husbandry in general (Christoph-Schulz and Rovers, 2020; Weible *et al.*, 2016), where pig
430 husbandry in particular yields a strong disapproval (Kayser *et al.*, 2012; Faletar and Christoph-
431 Schulz, 2022). Our study showed that information provision can be a suitable tool for
432 depolarising such evaluations. Specifically, consumers' evaluation of slatted floors, which
433 initially yielded strong disapproval, improved strongly after receiving information. Hence,
434 information provision can be a potential avenue for increasing the societal acceptance of
435 conventional methods in pig husbandry in the future. Moreover, the results suggest that
436 providing information in the cognitive frame with a focus on facts may be slightly more

437 effective than the affective frame. This finding bears important implications for the future
 438 communication of animal husbandry conditions issued by various stakeholders, such as
 439 retailers or governmental authorities when introducing new labels for animal husbandry into
 440 the market.

441 In summary, the study demonstrates that informing consumers ‘about all the good things and
 442 the bad things’ (Salt ‘n’ Pepa, 1990) about straw and slatted floors in pig husbandry is effective
 443 for depolarising attitudes and to enable more realistic evaluations of pig husbandry methods.

444 **References**

- 445 Altmann, B. A., Anders, S., Risius, A., & Mörlein, D. (2022). Information effects on
 446 consumer preferences for alternative animal feedstuffs. *Food Policy*, Vol. 106,
 447 102192. <https://doi.org/10.1016/j.foodpol.2021.102192>
- 448 Appel, M., Gnambs, T. and Maio, G.R. (2012), “A short measure of the need for affect”,
 449 *Journal of Personality Assessment*, Vol. 94 No. 4, pp. 418–426.
 450 <https://doi.org/10.1080/00223891.2012.666921>
- 451 Baum, C.M., Bröring, S. and Lagerkvist, C.J. (2021), “Information, attitudes, and consumer
 452 evaluations of cultivated meat”, *Food Quality and Preference*, Vol. 92, p. 104226.
 453 <https://doi.org/10.1016/j.foodqual.2021.104226>
- 454 Bless, H., Wänke, M., Bohner, G., Fellhauer, R.F. and Schwarz, N. (1994), “Need for
 455 Cognition: Eine Skala zur Erfassung von Engagement und Freude bei
 456 Denkaufgaben”, *Zeitschrift Für Sozialpsychologie*, No. 25, pp. 147–154.
- 457 Bluemke, M. and Friese, M. (2008), “Reliability and validity of the Single-Target IAT (ST-
 458 IAT): assessing automatic affect towards multiple attitude objects”, *European Journal
 459 of Social Psychology*, Vol. 38 No. 6, pp. 977–997. <https://doi.org/10.1002/ejsp.487>
- 460 Brannon, S.M. and Gawronski, B. (2017), “A second chance for first impressions? Exploring
 461 the context-(in)dependent updating of implicit evaluations”, *Social Psychological and
 462 Personality Science*, Vol. 8 No. 3, pp. 275–283.
 463 <https://doi.org/10.1177/1948550616673875>
- 464 Busch, G., Gaulty, S., Meyer-Höfer, M. von and Spiller, A. (2019), “Does picture background
 465 matter? People’s evaluation of pigs in different farm settings”, *PLOS ONE*, Vol. 14
 466 No. 2, pp. 1–19. <https://doi.org/10.1371/journal.pone.0211256>
- 467 Cacioppo, J.T. and Petty, R.E. (1982), “The need for cognition”, *Journal of Personality and
 468 Social Psychology*, Vol. 42 No. 1, pp. 116–131. [https://doi.org/10.1037/0022-
 469 3514.42.1.116](https://doi.org/10.1037/0022-3514.42.1.116)
- 470 Cacioppo, J.T., Petty, R.E. and Kao, C.F. (1984), “The efficient assessment of need for
 471 cognition”, *Journal of Personality Assessment*, Vol. 48 No. 3, pp. 306–307.
 472 https://doi.org/10.1207/s15327752jpa4803_13
- 473 Carfora, V., Bertolotti, M., & Catellani, P. (2019). Informational and emotional daily
 474 messages to reduce red and processed meat consumption. *Appetite*, Vol. 141,
 475 pp. 104331. <https://doi.org/10.1016/j.appet.2019.104331>
- 476 Chou, J. Y., Driquet, C., Sandercock, D. A., D’Eath, R. B., and O’Driscoll, K. (2019),
 477 “Rearing undocked pigs on fully slatted floors using multiple types and variations of
 478 enrichment”, *Animals*, Vol. 9 No. 4, pp. 139. <https://doi:10.3390/ani9040139>

- 479 Christoph-Schulz, I. and Rovers, A.K. (2020), “German citizens’ perception of fattening pig
480 husbandry—evidence from a mixed methods approach”, *Agriculture*, Vol. 10 No. 8,
481 p. 342. <https://doi.org/10.3390/agriculture10080342>
- 482 Eagly, A.H. and Chaiken, S. (1993), *The psychology of attitudes*, Harcourt Brace Jovanovich
483 College Publishers.
- 484 Eurobarometer. (2016). Attitudes of Europeans Attitudes of Europeans towards Animal
485 Welfare: Special Eurobarometer 442.
486 <https://europa.eu/eurobarometer/surveys/detail/2096>
- 487 Eurobarometer (2006), “Attitudes of EU citizens towards animal welfare: special
488 Eurobarometer 270”, available at:
489 https://data.europa.eu/data/datasets/s470_66_1_ebs270?locale=en
- 490 Faletar, I., & Christoph-Schulz, I. (2022). The relationship between citizens’ perceptions of
491 farmers and the overall assessment of farm animal husbandry in Germany: a case of
492 four animal types and two production systems. *Proceedings in Food System*
493 *Dynamics*, 75-95.
- 494 Fishbein, M., & Ajzen, I. (2010). *Predicting and Changing Behavior - The Reasoned Action*
495 *Approach*. Psychology Press.
- 496 Forscher, P.S., Lai, C.K., Axt, J.R., Ebersole, C.R., Herman, M., Devine, P.G. and
497 Nosek, B.A. (2019), “A meta-analysis of procedures to change implicit measures”,
498 *Journal of Personality and Social Psychology*, Vol. 117 No. 3, pp. 522–559.
499 <https://doi.org/10.1037/pspa0000160>
- 500 Friese, M., Hofmann, W. and Wänke, M. (2008), „When impulses take over: moderated
501 predictive validity of explicit and implicit attitude measures in predicting food choice
502 and consumption behaviour”, *The British Journal of Social Psychology*, Vol. 47 No.
503 3, pp. 397–419. <https://doi.org/10.1348/014466607X241540>
- 504 Gawronski, B. and Bodenhausen, G.V. (2006), “Associative and propositional processes in
505 evaluation: an integrative review of implicit and explicit attitude change.
506 *Psychological Bulletin*, Vol. 132 No. 5, pp. 692–731. [https://doi.org/10.1037/0033-](https://doi.org/10.1037/0033-2909.132.5.692)
507 [2909.132.5.692](https://doi.org/10.1037/0033-2909.132.5.692)
- 508 Gawronski, B., & Hahn, A. (2019). Implicit measures: Procedures, use, and interpretation. In
509 Blanton, H., LaCroix, J. M., and Webster, G. D. *Measurement in social psychology*.
510 (Taylor & Francis) 29–55.
- 511 Greenwald, A.G. and Banaji, M.R. (1995), “Implicit social cognition: attitudes, self-esteem,
512 and stereotypes”, *Psychological Review*, Vol. 102 No. 1, pp. 4–27.
513 <https://doi.org/10.1037/0033-295X.102.1.4>
- 514 Greenwald, A.G., McGhee, D.E. and Schwartz, J.L.K. (1998), “Measuring individual
515 differences in implicit cognition: the implicit association test”, *Journal of Personality*
516 *and Social Psychology*, Vol. 74 No. 6, pp. 1464–1480. [https://doi.org/10.1037/0022-](https://doi.org/10.1037/0022-3514.74.6.1464)
517 [3514.74.6.1464](https://doi.org/10.1037/0022-3514.74.6.1464)
- 518 Greenwald, A.G., Nosek, B.A. and Banaji, M.R. (2003), “Understanding and using the
519 Implicit Association Test: I. An improved scoring algorithm”, *Journal of Personality*
520 *and Social Psychology*, Vol. 85 No. 2, pp. 197–216. [https://doi.org/10.1037/0022-](https://doi.org/10.1037/0022-3514.85.2.197)
521 [3514.85.2.197](https://doi.org/10.1037/0022-3514.85.2.197)

- 522 Haddock, G., Maio, G.R., Arnold, K. and Huskinson, T. (2008), “Should persuasion be
523 affective or cognitive? The moderating effects of need for affect and need for
524 cognition”, *Personality and Social Psychology Bulletin*, Vol. 34 No. 6, pp. 769–778.
525 <https://doi.org/10.1177/0146167208314871>
- 526 Hayes, A.F. (2018), *Introduction to Mediation, Moderation and Conditional Process*
527 *Analysis: A Regression-Based Approach*, (2nd ed.), The Guilford Press, New York,
528 NY.
- 529 Herzog, H.A., Betchart, N.S. and Pittman, R.B. (1991), “Gender, sex role orientation, and
530 attitudes toward animals”, *Anthrozoös*, Vol. 4 No. 3, pp. 184–191.
- 531 Herzog, H.A., Grayson, S. and McCord, D. (2015), “Brief measures of the animal attitude
532 scale”, *Anthrozoös*, Vol. 28 No. 1, pp. 145–152.
533 <https://doi.org/10.2752/089279315X14129350721894>
- 534 Kahneman, D. (2012). *Thinking, fast and slow*. Penguin Books.
- 535 Kayser, M., Schlieker, K. and Spiller, A. (2012), “Die Wahrnehmung des Begriffs
536 „Massentierhaltung“ aus Sicht der Gesellschaft”, *Berichte Über Landwirtschaft*, Vol.
537 90 No. 3, pp. 417–428, available at:
538 [https://www.bmel.de/SharedDocs/Downloads/Service/BerichteLandwirtschaft/2012_](https://www.bmel.de/SharedDocs/Downloads/Service/BerichteLandwirtschaft/2012_Heft3_Band90.pdf?__blob=publicationFile)
539 [Heft3_Band90.pdf?__blob=publicationFile](https://www.bmel.de/SharedDocs/Downloads/Service/BerichteLandwirtschaft/2012_Heft3_Band90.pdf?__blob=publicationFile)
- 540 Kraichy, D. and Chapman, D.S. (2014), “Tailoring web-based recruiting messages: individual
541 differences in the persuasiveness of affective and cognitive messages”, *Journal of*
542 *Business and Psychology*, Vol. 29 No. 2, pp. 253–268.
543 <https://doi.org/10.1007/s10869-013-9311-z>
- 544 Ludwiczak, A., Skrzypczak, E., Składanowska-Baryza, J., Stanis, M., Ślósarz, P., &
545 Racewicz, P. (2021). How Housing Conditions Determine the Welfare of Pigs.
546 *Animals*, 11(12), 3484.
- 547 Maio, G.R. and Esses, V.M. (2001), “The need for affect: individual differences in the
548 motivation to approach or avoid emotions”, *Journal of Personality*, Vol. 69 No. 4, pp.
549 583–614. <https://doi.org/10.1111/1467-6494.694156>
- 550 Nguyen, T. H., Ben Taieb, S., Moritaka, M., & Fukuda, S. (2022). Implicit and Explicit
551 Attitudes toward Foods Derived from Genome Editing and Genetic Modification
552 Technologies under Different Information Treatments. *Journal of Food Products*
553 *Marketing*, 28(1), 1–30. <https://doi.org/10.1080/10454446.2022.2037487>
- 554 Petty, R.E and Cacioppo, JT (1986), “The elaboration likelihood model of persuasion”,
555 *Communication and Persuasion*, Springer, pp. 1–24.
- 556 Philippe, F.X., Laitat, M., Canart, B., Vandenheede, M. and Nicks, B. (2007), “Comparison
557 of ammonia and greenhouse gas emissions during the fattening of pigs, kept either on
558 fully slatted floor or on deep litter”, *Livestock Science*, Vol. 111 No. 1–2, pp. 144–
559 152.
- 560 Risius, A. and Hamm, U. (2017), “The effect of information on beef husbandry systems on
561 consumers’ preferences and willingness to pay”, *Meat Science*, Vol. 124, pp. 9–14.
- 562 Rudman, L.A. (2004), “Sources of implicit attitudes”, *Current Directions in Psychological*
563 *Science*, Vol. 13 No. 2, pp. 79–82. <https://doi.org/10.1111/j.0963-7214.2004.00279.x>
- 564 Salt ‘n’ Pepa (1990), “Let’s talk about sex”, [Song], *Black’s Magic*, London Records

- 565 Schaak, H., Römer, U., Musshoff, O. and Montero Vega, M. (2021), “A comparison of
566 explicit and implicit attitudes towards crop protection methods in Costa Rica and
567 Germany”, *NJAS: Impact in Agricultural and Life Sciences*, Vol. 93 No. 1, pp. 152–
568 171.
- 569 Scott, K., Chennells, D.J., Campbell, F.M., Hunt, B., Armstrong, D., Taylor, L., Gill, B.P.
570 and Edwards, S.A. (2006), “The welfare of finishing pigs in two contrasting housing
571 systems: fully-slatted versus straw-bedded accommodation”, *Livestock Science*, Vol.
572 103 No. 1, pp. 104–115. <https://doi.org/10.1016/j.livsci.2006.01.008>
- 573 See, Y.H.M., Petty, R.E. and Fabrigar, L.R. (2008), “Affective and cognitive meta-bases of
574 attitudes: unique effects on information interest and persuasion”, *Journal of*
575 *Personality and Social Psychology*, Vol. 94 No. 6, pp. 938–955.
576 <https://doi.org/10.1037/0022-3514.94.6.938>
- 577 Shan, L., Diao, H. and Wu, L. (2020), “Influence of the framing effect, anchoring effect, and
578 knowledge on consumers' attitude and purchase intention of organic food”, *Frontiers*
579 *in Psychology*, Vol. 11. <https://doi.org/10.3389/fpsyg.2020.02022>
- 580 Smith, E.R. and DeCoster, J. (2000), “Dual-process models in social and cognitive
581 psychology: conceptual integration and links to underlying memory systems”,
582 *Personality and Social Psychology Review*, Vol. 4 No. 2, pp. 108–131.
- 583 Statistisches Bundesamt. (2020), “Landwirtschaftszählung 2020”, available at:
584 https://www.destatis.de/DE/Presse/Pressemitteilungen/2021/08/PD21_N051_41.html
- 585 Teeny, J.D., Siev, J.J., Briñol, P and Petty, R.E. (2021), “A review and conceptual framework
586 for understanding personalized matching effects in persuasion”, *Journal of Consumer*
587 *Psychology*, Vol. 31 No. 2, pp 382–414.
- 588 Tuytens, F.A.M. (2005), “The importance of straw for pig and cattle welfare: a review”,
589 *Applied Animal Behaviour Science*, Vol. 92 No. 3, pp. 261–282.
590 <https://doi.org/10.1016/j.applanim.2005.05.007>
- 591 Van de Mortel, T.F. (2008), “Faking it: social desirability response bias in self-report
592 research”, *Australian Journal of Advanced Nursing, the*, Vol. 25 No. 4, pp. 40–48.
- 593 van de Weerd, H.A. and Day, J.E. (2009), “A review of environmental enrichment for pigs
594 housed in intensive housing systems”, *Applied Animal Behaviour Science*, Vol. 116
595 No. 1, pp. 1–20. <https://doi.org/10.1016/j.applanim.2008.08.001>
- 596 Verbeke, W. and Liu, R. (2014), “The impacts of information about the risks and benefits of
597 pork consumption on Chinese consumers’ perceptions towards, and intention to eat,
598 pork”, *Meat Science*, Vol. 98 No. 4, pp. 766–772.
599 <https://doi.org/10.1016/j.meatsci.2014.07.023>
- 600 Weible, D., Christoph-Schulz, I, Salamon, P. and Zander, K. (2016), “Citizens’ perception of
601 modern pig production in Germany: a mixed-method research approach”, *British*
602 *Food Journal*, Vol. 118 No.8, pp. 2014–2032.
- 603 Weingarten, N., Meraner, M., Bach, L., & Hartmann, M. (2022). Can information influence
604 meat consumption behaviour? An experimental field study in the university canteen.
605 *Food Quality and Preference*, Vol. 97, pp. 104498.
606 <https://doi.org/10.1016/j.foodqual.2021.104498>

- 607 Whitfield, M. and Jordan, C.H. (2009), “Mutual influence of implicit and explicit attitudes”,
608 *Journal of Experimental Social Psychology*, Vol. 45 No. 4, pp. 748–759.
609 <https://doi.org/10.1016/j.jesp.2009.04.006>
- 610 Wildraut, C., Plesch, G., Ziron, M., Mergenthaler, M , Härten, I., Simons, J. and
611 Hartmann, M. (2015), “Multimethodische Bewertung von Schweinehaltungsverfahren
612 durch Verbraucher anhand von Videos aus realen Schweineställen (Nr. 179)”,
613 Landwirtschaftliche Fakultät der Universität Bonn, Schriftenreihe des
614 Forschungsschwerpunktes USL.
- 615 Wille, S.C., Busch, G. and Spiller, A. (2017), “Tiertransporte in der Schweinehaltung: Führen
616 mehr Informationen und Wissen bei Verbrauchern zu einer positiveren Einstellung?”,
617 *German Journal of Agricultural Economics*, Vol. 66 No. 1, pp. 1–12.
618 <https://doi.org/10.22004/ag.econ.30352>

619 **Appendix I**

620 Results of the moderation analysis

	Explicit attitude (Post)					Implicit attitude (Post)				
	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	<i>95% CI</i>	<i>b</i>	<i>SE</i>	<i>t</i>	<i>p</i>	<i>95% CI</i>
<i>constant</i>	-27.63	7.17	-3.85	.00	[-41.79; -13.47]	-.24	.08	-3.08	.00	[-.40; -.09]
Affective frame	36.40	7.14	5.10	.00	[22.31; 50.48]	.27	.08	3.27	.00	[.11; .43]
Cognitive frame	48.71	7.00	6.96	.00	[34.90; 62.52]	.32	.08	4.06	.00	[.17; .48]
NFC	-2.44	6.59	-.37	.71	[-15.45; 10.58]	.08	.08	1.11	.27	[-.07; .23]
NFC*affective	7.72	9.65	.80	.42	[-11.32; 26.75]	-.11	.11	-1.04	.30	[-.33; .10]
NFC*cognitive	5.65	8.74	.65	.52	[-11.61; 22.91]	-.10	.10	-1.04	.30	[-.30; .09]
NFA	1.67	5.54	.30	.76	[-9.27; 12.60]	-.07	.06	-1.06	.29	[-.19; .06]
NFA*affective	-5.28	8.53	-.62	.54	[-22.11; 11.56]	.06	.10	.57	.57	[-.14; .25]
NFA*cognitive	4.22	7.82	.54	.59	[-11.22; 19.66]	.11	.09	1.19	.23	[-.07; .28]
Pre-measure	.73	.10	7.46	.00	[.54; .92]	.49	.08	6.41	.00	[.34; .64]
<i>F (df)</i>	15.02 (9, 175)					7.62 (9, 175)				
<i>R</i> ²	.44					.28				

NFC = Need for cognition, NFA = Need for affect, CI = Confidence interval



Can information influence meat consumption behaviour? An experimental field study in the university canteen

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ABSTRACT

The present study investigates the effectiveness of health and environmental information provision as an intervention to reduce meat consumption behaviour. In an experimental online survey ($n = 194$), we tested how information about the negative effects of meat consumption on health or the environment influence attitude and intention to reduce meat consumption. In the following two weeks, we measured participants' meat consumption behaviour in the university canteen, which we accessed through an individual purchase card. Contrary to our hypotheses, our results show that there is no direct effect of health or environmental information on attitude, intention, or meat consumption behaviour compared to the control group. However, our results indicate that for participants with low subjective knowledge, environmental information is effective in influencing attitude. Neither attitude nor intention mediates the relationship between information and behaviour. Our findings highlight that information provision has limited effectiveness in changing attitude, but does not influence intention or behaviour. We conclude that more research is needed that includes a direct measure of meat consumption behaviour to evaluate the effectiveness of information provision as an intervention.

1. Introduction

High rates of meat consumption are associated with negative consequences for environmental sustainability, such as climate change (Tilman & Clark, 2014), and for human health, such as increased risks for cardiovascular diseases (Bronzato & Durante, 2017). In contrast, meat-reduced and vegetarian diets are beneficial for environmental sustainability and human health (Dinu, Abbate, Gensini, Casini, & Sofi, 2017; Macdiarmid et al., 2012). Nevertheless, many consumers continue to associate meat with rather positive outcomes (Michel, Hartmann, & Siegrist, 2021; Neff et al., 2018) and lack knowledge about the detrimental impacts of meat consumption (Macdiarmid, Douglas, & Campbell, 2016; Stubbs, Scott, & Duarte, 2018). Therefore, it is necessary to develop effective communication strategies in order to reduce current levels of meat consumption and contribute towards achieving the UN Sustainability Development Goals (United Nations, 2015).

Many studies have already investigated the effect of health and environmental information on meat consumption predictors, such as attitude, intention, or self-reported behaviour (e.g. Cordts, Nitzko, & Spiller, 2014; Wolstenholme, Poortinga, & Whitmarsh, 2020), but research that includes a measurement of observable meat consumption

behaviour is scarce (Harguess, Crespo, & Hong, 2020). In the present study, we investigate the effect of health and environmental information on reducing meat consumption behaviour. Contrary to the majority of previous research, we investigate the effect of information on attitude and intention, measured with an experimental survey, and combine it with a follow-up behavioural measure of individual meat consumption in the university canteen.

1.1. Effect of information on attitude, intention, and behaviour

Providing information can influence behaviour via two possible routes, the first focusing on the influence of information on attitude, thus an indirect influence of information on behaviour. The second refers to increasing knowledge, which can have a direct impact on behaviour.

The effect of persuasive communication on changing attitudes is well-established in the literature (Briñol, Petty, & McCaslin, 2009; Eagly & Chaiken, 1993; Hovland, Janis, & Kelley, 1953; Petty, Wegener, & Fabrigar, 1997; Petty & Cacioppo, 1986). Attitudes are often the target of information-based behaviour change approaches, because the attitude has a high prediction accuracy for the occurrence of the behaviour

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(Glasman & Albarracín, 2006; McEachan, Conner, Taylor, & Lawton, 2011). For example, several studies have demonstrated that participants' attitude towards meat consumption can predict their levels of meat consumption (e.g. Lentz, Connelly, Miroso, & Jowett, 2018; McCarthy, O'Reilly, Cotter, & de Boer, 2004). Hence, providing information (i.e. persuasive communication) about the negative consequences of meat consumption leads to a less favourable evaluation of meat consumption, which results in reduced meat consumption (Carfora, Catellani, Caso, & Conner, 2019). Other theories such as the theory of planned behaviour (TPB) further specified the attitude-behaviour relationship by demonstrating how behavioural intentions mediate the effects of attitude on behaviour (Ajzen, 1991; McEachan et al., 2011). Hence, changing the attitude can have a direct impact on behaviour and the effect can be mediated by behavioural intentions.

Furthermore, providing information can have a direct impact on behaviour. According to the knowledge deficit model (KDM), knowledge about the negative consequences of a behaviour directly predicts behavioural frequency. Hence, when people have a lack of knowledge regarding the consequences of their behaviour, this influences how often the behaviour will be executed. Therefore, eliminating this lack of knowledge through information provision should lead to reduced behavioural intentions and behaviour frequency (Schultz, 2002). Several studies indicate that a majority of consumers underestimate the negative impact of meat consumption on environmental sustainability (Lentz et al., 2018; Macdiarmid et al., 2016) and do not perceive changes in meat consumption as a helpful tool to tackle climate change (Lea & Worsley, 2008; Sanchez-Sabate & Sabaté, 2019). Similarly, a meat-containing diet is considered rather healthy and necessary (Neff et al., 2018) and meat is overall positively evaluated (Michel et al., 2021). Hence, providing information about the negative consequences of meat consumption should reduce meat consumption and this effect might be especially prominent among those who are less knowledgeable about the negative consequences of meat consumption.

1.2. The effect of health and environmental information on meat consumption predictors

The overall effect of information provision as an intervention to reduce meat consumption has been described in two systematic reviews (see Bianchi, Dorsel, Garnett, Aveyard, & Jebb, 2018; Harguess et al., 2020). Both reviews conclude that information provision is an effective tool to influence meat consumption, but that the majority of studies primarily focused on attitude, intention, or self-reported behaviour (Bianchi et al., 2018; Harguess et al., 2020). In the following literature review, we describe studies that have focused on investigating the effect of health and environmental information on meat consumption predictors.

The effectiveness of health and environmental information in changing meat-consumption predictors has received mixed support in previous research. Several studies found positive effects of health information provision on attitude (Carfora, Catellani, et al., 2019; Gaspar et al., 2015), intention (Cordts et al., 2014), and self-reported behaviour (Carfora, Bertolotti, & Catellani, 2019), whereas other research found no such evidence (Berndsen & van der Pligt, 2005; Palomo-Vélez, Tybur, & van Vugt, 2018). Results on environmental information draw a similar picture, with some studies reporting a positive effect (Stea & Pickering, 2019; Wolstenholme et al., 2020) and other studies demonstrating no effect (Palomo-Vélez et al., 2018; Verain, Sijtsema, Dagevos, & Antonides, 2017) on meat consumption predictors. One study indicated that health information is more effective than environmental information (Cordts et al., 2014), but this effect could not be observed in other studies (e.g. Vainio, Irz, & Hartikainen, 2018; Wolstenholme et al., 2020).

Furthermore, some studies investigated whether the combination of health and environmental information is superior to providing one single type of information. Two studies concluded that combining health

and environmental arguments did not significantly improve the information effectiveness compared to a single argument (Vainio et al., 2018; Wolstenholme et al., 2020), whereas another study found that the combination is even less effective than a single argument (Carfora, Catellani, et al., 2019).

Other research has focused on investigating possible mechanisms and circumstances under which information influences meat consumption predictors. A study by Carfora, Catellani, et al. (2019) tested whether the effect of information on self-reported behaviour is mediated by attitude. They found support for a full mediation of attitude, indicating that information has no direct impact on behaviour. Several other studies showed that the effect of information can increase when it is tailored to different consumer segments, for example, based on value-orientations (Graham & Abrahamse, 2017), the importance attached to sustainability (Verain et al., 2017), or prior beliefs about meat consumption (Vainio et al., 2018).

1.3. Self-reported behaviour versus observable behaviour

Most literature in the field, including the results of the previously reported studies, only investigates the effect of information on meat consumption predictors. Despite the body of evidence for the predictive power of attitude and intention on behaviour (Glasman & Albarracín, 2006; McEachan et al., 2011), we find also instances of an intention-behaviour gap or attitude-behaviour gap in the literature (e.g. Carlington, Neville, & Whitwell, 2010; Grimmer & Miles, 2017). Self-report measures of meat consumption, such as food frequency questionnaires or 24-hour recalls, can only partly bridge this gap. These measurements are subjective to certain biases, for instance, the social desirability bias (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995) or the recall bias (Freedman et al., 2014), both leading to inaccurate reports of food intake. Furthermore, a study by Rothgerber (2019) showed how situational contexts in experimental studies can lead to an underreporting of meat consumption. When meat consumption was made salient to female participants, they reported lower amounts of meat consumption compared to the control condition. This can further reduce the validity of self-reported meat consumption behaviour for female participants.

Possible reasons for the lack of research on observable meat consumption behaviour include the difficulties in collecting this form of data. It is more time-consuming and more expensive compared to self-report measurements or it may not be accessible for researchers at all. However, to evaluate the effectiveness of a behaviour change intervention, it is essential to also investigate observable behaviour rather than simply its predictors. To the best of our knowledge, only one experimental study has investigated the effect of providing health and environmental information on observable meat consumption behaviour. In a recent study, Jalil, Tasoff, and Bustamante (2020) tested the effect of information provision on participants' meat consumption behaviour in the university canteen. Participants either received combined information regarding the health and environmental effects of meat consumption or about a control topic. The information was provided in a 50-minute lecture within the scope of a course in which all participants were enrolled. During the following semester, participants' meat purchases in the university canteen were tracked with an individual purchase card which recorded all purchases. They found that providing information led to a persistent decrease in participants' meat consumption behaviour compared to both the control condition and the baseline meat consumption. The effects attenuated over time, but remained significantly lower compared to the control measures.

2. Present study

In the present study, we build upon previous research by further investigating the effect of health and environmental information on attitude, intention, and meat consumption behaviour. Our experimental study consisted of two parts: i) an online experimental survey in which

participants received either health, environmental, or control information, including a post-measure of attitude and intention to reduce meat consumption and ii) a two-week assessment of participants' observable meat consumption behaviour in the university canteen collected through an individual purchase card. This experimental setup enabled us to evaluate the effectiveness of information provision to influence attitude, intention, and observable meat consumption behaviour.

We formulated three research questions. Firstly, what is the effect of health and environmental information on attitude, intention, and meat consumption behaviour? We expected that receiving information would both increase the attitude and intention to reduce meat consumption, and reduce meat consumption behaviour (Carfora, Catellani, et al., 2019; Wolstenholme et al., 2020). We did not make any predictions regarding differences in the effectiveness of health or environmental information. Secondly, how is the effect of information moderated by participants' subjective knowledge about the negative consequences of meat consumption? We expected that for participants with low subjective knowledge, information would be more influential compared to participants with high subjective knowledge (Schultz, 2002). We decided to measure subjective knowledge instead of actual knowledge as it is more closely linked to behavioural frequencies (Aertsens, Mondelaers, Verbeke, Buysse, & van Huylenbroeck, 2011; Pieniak, Aertsens, & Verbeke, 2010). Thirdly, how do attitude and intention mediate the effects of information on behaviour? We expected that the effect of information on behaviour to be partially mediated by attitude and intention (Ajzen, 1991; Carfora, Catellani, et al., 2019; McEachan et al., 2011). Fig. 1 illustrates the research model.

3. Method

3.1. Design

We conducted the present study in a German university canteen in November 2019. Participants were recruited through flyer distribution during lunchtime in university facilities and via social media. Eligibility criteria for participation were a regular visit to the university canteen, using the individual purchase card as payment method, consuming meat in the canteen, and living in Germany for at least one year. Participants who did not meet these criteria were automatically directed to the end of the experimental survey. All participants who completed the experiment could participate in a lottery and win one of ten 10€ vouchers for the university canteen. The study was conducted in full accordance with the Declaration of Helsinki and all participants gave their informed consent before participation.

The experiment followed a mixed design with the between-subjects variable information (health, environmental, control) and the within-subjects variable meat consumption behaviour (pre vs post). The mediator variables attitude and intention were obtained only as a post-

measure, after receiving the information. To determine our required minimal sample size, we conducted an a priori power analysis with G*Power v.3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). With a power of $1 - \beta = 0.90$ and $\alpha = 0.05$, 180 participants are needed to detect a medium effect size (Carfora, Catellani, et al., 2019; Carfora, Bertolotti, et al., 2019). However, we decided to recruit approximately twice as many participants to account for possible exclusions or missing canteen data.

3.2. Procedure and materials

In this section, we describe the set-up of the experimental study, followed by a description of the corresponding material in the subsequent paragraphs. In the first part of our study, participants performed an online experimental survey. Upon giving informed consent, participants were randomly assigned to one of the three conditions. First, we obtained the number of the individual purchase card and screened out those participants who were not eligible for participation. Next, we measured subjective knowledge about the negative consequences of meat consumption. Then, participants received one of the three information treatments. To increase the exposure to the information, we asked participants to evaluate and summarize the information. Next, attitude to reduce meat consumption was measured. Then, participants received an unrelated filler question, in which we asked them to describe their favourite meal in the university canteen. Lastly, intention to reduce meat consumption was assessed. During the following two weeks, all participants' purchases in the university canteen were recorded. Our materials and data can be accessed at: <https://osf.io/2qzum/>.

3.2.1. Subjective knowledge

Subjective knowledge about the negative consequences of meat consumption was measured with three items, adapted from Gaspar et al. (2015), e.g. "I am confident that I know enough about the risks of meat consumption". Items were answered on a 5-point Likert scale (1 = I disagree, 5 = I agree), with a Cronbach's alpha of $\alpha = 0.41$. A factor analysis confirmed that all three items loaded on the same factor. In the following analysis, we used an average score of subjective knowledge created by all three items.

3.2.2. Information

Each text was structured in four paragraphs ($M_{\text{words}} = 194$, $SD_{\text{words}} = 10.97$). The first paragraph was identical in the health and environmental condition and informed about high meat consumption rates in Germany. The second and third paragraph described either negative impacts of meat consumption on the environment (e.g. greenhouse gas emissions and deforestation) or health (e.g. increased risk of non-communicable diseases). The last paragraph recommended a reduction of current levels of meat consumption. The control information

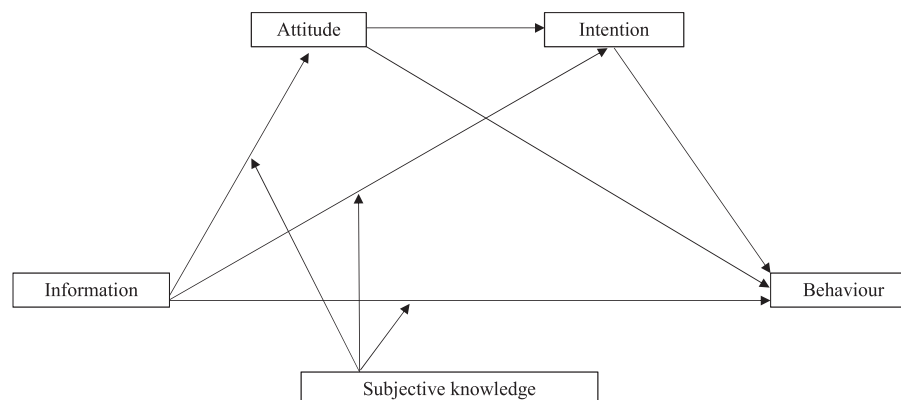


Fig. 1. The research model.

described the company that is responsible for the university canteen and included a recommendation to visit their website to get information about ongoing activities.

We conducted a qualitative pre-study to test the suitability of the health and environmental information. In a series of thirteen semi-structured qualitative interviews and a focus group discussion (10 female, 8 male, $M_{age} = 26.20$, $SD_{age} = 3.40$), we explored whether the health and environmental information were understandable, suitable for students, trustworthy, convincing, and interesting. Based on interview transcripts, small adjustments were made to the texts, e.g. difficult words were removed and a source was added underlining the recommendation to reduce meat consumption.

3.2.3. Information evaluation

Information evaluation was measured with six items adapted from Cordts et al. (2014), Quintiliani and Carbone (2005), and Vainio et al. (2018), e.g. "The text is understandable". Items were answered on a 5-point Likert scale (1 = I disagree, 5 = I agree), with a good Cronbach's alpha of $\alpha = 0.73$. A factor analysis confirmed that all items loaded on the same factor. In the following analysis, we used an average score of information evaluation from the six items.

Furthermore, to ensure that participants read the information, we asked them to write a summary (Quintiliani & Carbone, 2005). We determined summary quality by two criteria: Firstly, whether the key message "meat reduction for health/environmental reasons" was mentioned and secondly, whether the experimental condition could be inferred from reading the summary. Two authors coded whether the summaries fulfilled the criteria and excluded all participants whose summaries did not meet the criteria. The interrater reliability indicated a high agreement between the coders ($\kappa = 0.81$) and discrepancies were resolved through a discussion.

3.2.4. Attitude

Attitude to reduce meat consumption was measured with six items, adapted from Hayley, Zinkiewicz, and Hardiman (2015). Items were answered on a semantic 5-point Bipolar scale and assessed different attitudinal features of meat consumption (e.g. "I think, eating less meat in the canteen would be..." 1 = bad, 5 = good). The scale had high reliability with a Cronbach's alpha of $\alpha = 0.92$. A factor analysis confirmed that all six items loaded on one factor. In the following analysis, we included an average score of all six items.

3.2.5. Intention

Intention to reduce meat consumption in the canteen in the upcoming month was measured with three items, adapted from Graham and Abrahamse (2017) (e.g. "I intend to eat less meat in the canteen in the next month") and were answered on a 5-point Likert scale (1 = I disagree, 5 = I agree). The scale had good reliability with a Cronbach's Alpha of $\alpha = 0.89$. A factor analysis confirmed that all items loaded on the same factor. We calculated an average score of all three items for the analysis. Additionally, we included an attention check item that urged participants to click on the answer option "I rather disagree". Those who failed to respond as requested were excluded.

3.2.6. Meat consumption behaviour

Meat consumption behaviour was measured based on purchases of participants in the university canteen. The canteen is open from Monday-Friday for lunch and sells approximately 6000 meals per day (Studierendenwerk Bonn, 2020). The canteen offers several different main meals, every day at least two different vegetarian/vegan meals and two meat meals (on some days with a fish option). Additionally, students can select side dishes (e.g. vegetables or potatoes), salad from a buffet (including meat ingredients), vegetarian or vegan stew (with the option of a separate sausage), or snacks (e.g. sandwich or dessert). As payment method, an individual purchase card is used by the majority of students that saves all purchased items with a code. With this code, the majority

of purchases can be categorized as, for instance, "meat" or "vegetarian". However, some meals cannot be categorized. For example, purchases from the salad buffet are recorded by weight, but single ingredients are not recorded. Those meals were excluded from the analysis.

For every participant, we analysed all purchases two weeks prior to study participation (10 working days) and two weeks after study participation (10 working days). The day of study participation was not included. We coded the purchases in different categories "meat", "vegetarian", "fish", "not identifiable", "beverage only", and "dessert only". First, we calculated the number of visits in two weeks during which participants purchased food from the relevant categories "meat" + "vegetarian" + "fish". Next, we calculated the number of visits in two weeks during which participants purchased food from the category "meat". Then, we divided the latter by the former, thereby, deriving our meat consumption variable. Hence, the behaviour variable reflects the percentage of relevant canteen visits on which meat was consumed (0% = on no visit meat was consumed, 100% = on all visits meat was consumed). In the later analysis, we expressed the variable on a range from 0 to 1. We performed the calculation for both the pre- and post-phase.

4. Results

4.1. Preliminary analysis

A total of 383 participants completed the experimental survey. We excluded 107 participants from the study because they either failed to accurately summarize the information or failed to correctly answer the attention check item. In addition, we excluded 82 participants, who did not visit the canteen during the post-phase or whose dishes could not be identified. Thus, our final sample consisted of 194 participants ($M_{age} = 23.07$, $SD_{age} = 4.11$, 1 diverse, 99 female, 94 male).

In the preliminary analysis, we tested for differences in sample composition, pre-measures, and information evaluation between conditions. Several analyses of variance (ANOVAs) showed that conditions did not differ statistically in age, subjective knowledge, pre-canteen visits, and pre-consumption (all $ps > 0.41$). A chi-square test yielded no significant difference in gender distribution ($\chi^2 = 2.20$, $p = 0.70$). As expected, we found no significant difference in information evaluation between the health and environmental condition ($p > 0.63$).

The descriptive results demonstrate that participants in all groups showed a rather positive attitude towards reducing meat consumption in the university canteen ($M = 4.02$, $SD = 0.82$), but did not report a clear intention to reduce their level of meat consumption ($M = 3.31$, $SD = 1.23$). All participants reduced their meat consumption slightly in the post-phase ($M = 0.34$, $SD = 0.36$), compared to the pre-phase ($M = 0.41$, $SD = 0.39$). In Table 1, we report correlations, means, and standard deviations of our key variables for the different conditions.

4.2. Multivariate analysis

To test the direct effects of information on the dependent variables attitude, intention, and behaviour, we conducted a multivariate analysis of covariance (MANCOVA) with the between-subjects factor information (health, environment, and control). Pre-consumption was entered as a covariate. We observed a significant multivariate effect of pre-consumption ($F(3, 188) = 40.44$, $p < 0.001$, $\eta_p^2 = 0.39$), but not of the factor information ($F(6, 378) = 0.46$, $p = 0.84$, $\eta_p^2 = 0.01$). This indicates that there was no direct effect of information on attitude, intention, and meat consumption behaviour. The follow-up analysis of the significant multivariate effect of pre-consumption revealed that higher meat consumption in the pre-phase was associated with a less positive attitude to reduce meat consumption ($F(1, 194) = 37.05$, $p < 0.001$, $\eta_p^2 = 0.16$) and higher meat consumption in the post-phase ($F(1, 194) = 104.35$, $p < 0.001$, $\eta_p^2 = 0.35$). There was no significant relationship between the pre-phase consumption and the intention to reduce

Table 1
Correlations, means and standard deviations of key variables.

Variables	r					Health (n = 72)		Environment (n = 55)		Control (n = 67)	
	1.	2.	3.	4.	5.	M	SD	M	SD	M	SD
1. SK	1					4.09	0.72	4.16	0.63	4.25	0.71
2. Attitude	0.34***	1				4.02	0.85	4.02	0.72	4.01	0.86
3. Intention	0.16*	0.07	1			3.47	1.18	3.22	1.40	3.21	1.14
4. Pre-consumption	-0.11	-0.40***	-0.01	1		0.41	0.40	0.41	0.40	0.39	0.37
5. Post-consumption	-0.12	-0.37***	0.00	0.59***	1	0.32	0.37	0.34	0.36	0.36	0.36

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

meat consumption ($F(1, 194) = 0.01, p = 0.92, \eta_p^2 < 0.001$).

4.3. Conditional process analysis

In the further analysis, we examined the effect of information on meat consumption behaviour through testing a moderation of subjective knowledge and a mediation of attitude and intention. To test this, we conducted a conditional process analysis, including a moderation and a bias-corrected mediation analysis (Model 8 of the PROCESS macro v.3.4 in IBM SPSS v.25, Hayes, 2018). We entered information with two dummy variables (1 = health/environment and 0 = control), a mean-centred score of subjective knowledge, the interaction terms of subjective knowledge and health/environmental information, attitude and intention as serial mediators, post-consumption as the dependent variable, and pre-consumption as a covariate. Table 2 shows the results of the three OLS regressions of the conditional process analysis.

The moderation analysis showed that the effect of environmental information on attitude is moderated by subjective knowledge ($b = -0.42, p = 0.04, CI = [-0.81; -0.03]$). A simple effects analysis indicated that environmental information has a marginally significant impact on attitude for participants with low subjective knowledge ($b = 0.41, p = 0.054, CI = [-0.01; 0.84]$), but not for participants with medium ($b = -0.001, p = 0.98, CI = [-0.26; 0.26]$), or high ($b = -0.28, p = 0.17, CI = [-0.69; 0.12]$) subjective knowledge (see Fig. 2). We found no support for a moderating effect of subjective knowledge in the case of health information, neither concerning attitude, intention, nor behaviour.

In the mediation analysis, we tested for indirect effects of information on behaviour, through analysing mediating effects of attitude and intention. We evaluated the 95% confidence interval of conditional relative indirect effects that should not contain zero in case of a significant mediation (Hayes, 2018). Table 3 presents three indirect pathways that we tested, but none of them yielded a significant result. This indicates that neither attitude, nor intention, nor the serial combination of both, significantly mediated the effect of information on behaviour.

Additionally, we inspected the direct relationship of attitude and behaviour and intention and behaviour. The results of the conditional process analysis suggest that attitude significantly predicted meat-

consumption behaviour in the post-phase ($b = -0.07, p = 0.02, CI = [-0.13; -0.01]$). Based on a median split, we categorized participants' attitude into negative or positive towards reducing meat consumption and tested for differences in post-behaviour, while controlling for pre-behaviour. Our results showed a significant difference between the two groups ($F(1, 191) = 7.29, p = 0.01, \eta_p^2 = 0.04$). Participants with a positive attitude towards reducing meat consumption consumed significantly less meat in the post-phase ($M = 0.28, SE = 0.03$), compared to those with a more negative attitude ($M = 0.40, SE = 0.03$). Contrary to the main assumption of the TPB, intention did not predict behaviour in the post-phase ($b = 0.10, p = 0.76, CI = [-0.03; 0.04]$).

5. Discussion

The present study aims to demonstrate how health and environmental information influence attitude, intention, and meat consumption behaviour. Thereby, we tested subjective knowledge as a moderator, and attitude and intention as mediators for information effectiveness. The first hypothesis could not be supported, as in our study health and environmental information did not directly influence attitude, intention, and meat consumption behaviour. This is partly in line with previous research that also failed to find a significant impact of health and/or environmental information on meat consumption predictors (e.g. Berndsen & van der Pligt, 2005; Palomo-Vélez et al., 2018), but contrasts other studies which did find a significant impact (e.g. Carfora, Catellani, et al., 2019; Jalil et al., 2020; Wolstenholme et al., 2020). A possible explanation for these contrary results is that the studies differed in the extent to which participants were exposed to the message. While the present study tested the effect of a single exposure to information, the studies by Carfora, Catellani, et al. (2019) and Wolstenholme et al. (2020) involved multiple exposures to the information via a chatbot for two weeks. Similarly, Jalil et al. (2020) tested the effect of in-depth exposure to the information by providing a lecture about the topic to participants. Hence, in our study, the exposure could have been too short in order to generate changes in attitude, intention, and behaviour. Although our information treatments were not effective in reducing meat consumption behaviour, our findings show that all participants consumed less meat in the post-phase, compared to the pre-phase. It is

Table 2
Results of the conditional process analysis.

Variables	Attitude			Intention			Behaviour		
	b	t	95% CI	b	t	CI	b	t	95% CI
constant	4.26	41.56***	[4.06; 4.47]	3.02	5.33	[1.9; 4.14]	0.42	2.87***	[0.13; 0.71]
Health	0.09	0.71	[-0.15; 0.32]	0.30	1.46	[-0.11; 0.72]	-0.05	-0.90	[-0.15; 0.05]
Environment	0.07	0.51	[-0.19; 0.32]	0.02	0.09	[-0.42; 0.46]	-0.03	-0.60	[-0.14; 0.07]
SK	0.53	4.29***	[0.29; 0.78]	0.07	0.32	[-0.37; 0.51]	-0.01	-0.12	[-0.11; 0.10]
Health*SK	-0.18	-1.09	[-0.52; 0.15]	0.48	1.64	[-0.10; 1.06]	0.01	0.10	[-0.13; 0.15]
Environment*SK	-0.42	-2.12*	[-0.81; -0.03]	0.14	0.42	[-0.54; 0.82]	-0.02	-0.24	[-0.18; 0.14]
Pre-Consumption	-0.75	-5.55***	[-1.01; -0.48]	0.05	0.21	[-0.44; 0.55]	0.50	8.37***	[0.38; 0.62]
Attitude	-	-	-	0.04	0.32	[-0.21; 0.29]	-0.07	-2.27*	[-0.13; -0.01]
Intention	-	-	-	-	-	-	0.01	0.31	[-0.03; 0.04]
F (df)	11.51***	(6;187)		1.54	(7;186)		13.97***	(8;185)	
R ²	0.27			0.05			0.38		

Note. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. SK = Subjective knowledge, CI = Confidence interval.

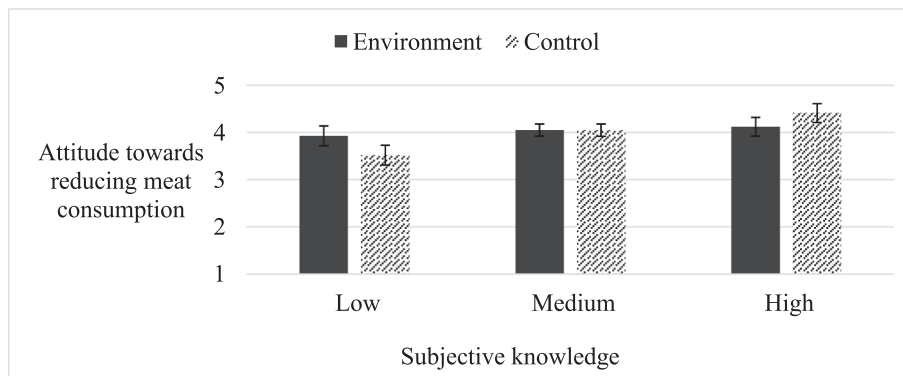


Fig. 2. The moderation effect of environmental information and subjective knowledge on attitude. Note. Low (high) is one SD below (above) the mean. Error bars indicate standard errors.

Table 3
Overview of mediation pathways.

Mediation pathways		Conditional relative indirect effects (b)	Bootstrap CI
Information → Attitude → Behaviour	Health	0.00	[-0.02; 0.01]
	Environment	0.00	[-0.02; 0.02]
Information → Intention → Behaviour	Health	0.00	[-0.01; 0.02]
	Environment	0.00	[-0.01; 0.01]
Information → Attitude → Intention → Behaviour	Health	0.00	[0.00; 0.00]
	Environment	0.00	[0.00; 0.00]

Note. Subjective knowledge is fixed at an average score of 0.17, CI = Confidence interval.

possible that the survey participation in itself caused a reduction of meat consumption, for instance, by making meat-reduction salient through the measures of attitude and intention. However, due to the lack of a control group who did not participate in the survey, we cannot assume a causal relationship here.

Our second hypothesis could partly be confirmed. We found that the effect of environmental information on attitude was moderated by subjective knowledge, indicating that for participants with low subjective knowledge, the environmental information was effective to change attitudes. This is in line with the predictions from the KDM (Schultz, 2002) that information has a greater impact on participants with low knowledge. Since negative consequences of meat consumption on the environment are to some extent unknown to consumers, (Lentz et al., 2018; Macdiarmid et al., 2016) our study indicates that information provision can be effective to change the attitude of less knowledgeable consumers. Furthermore, this finding is consistent with established theories of persuasive communication such as the elaboration likelihood model which states that the effectiveness of information depends on the characteristics of the information receiver. In contrast, we did not find a significant moderation of the health information. Although the KDM was originally developed in order to explain environmental-related behaviour, Schultz (2002) argued that it can also be extended to other domains of behaviour, such as health behaviour. However, previous studies come to different conclusions with regard to dietary knowledge as a relevant predictor of university students' eating behaviour. On the one hand, Deliens, Clarys, de Bourdeaudhuij, and Deforche (2014) found that dietary knowledge is not a key determinant of a healthy diet, whereas Sogari, Velez-Argumedo, Gómez, and Mora (2018) found opposing results. Therefore, subjective knowledge might not be a relevant moderator for the effectiveness of health information.

Our third hypothesis could not be supported. We found no evidence for a mediating effect of attitude or intention. Similar to prior research, our results indicate that meat consumption behaviour was significantly predicted by attitude (Carfora, Catellani, et al., 2019; McEachan et al., 2011). Although the present study failed to convincingly influence attitude with information, our findings demonstrate that attitude is an important determinant of meat consumption behaviour and can be an appropriate target for behaviour change interventions. In contrast to the TPB, the intention did not significantly predict meat consumption behaviour. Similar to other studies, our results indicate an intention-behaviour gap (Carrington et al., 2010).

Evidently, our study was not free of limitations. Firstly, our sample consisted of university students. Compared to other populations, studies have shown that younger people with higher education have a lower level of meat consumption (Sanchez-Sabate & Sabaté, 2019). In our study, participants ate meat approximately at one-third of all canteen visits in the post-phase. Along similar lines, participants in all conditions, including the control group, showed a rather positive attitude towards reducing meat consumption. Therefore, the limited effectiveness of information on changing attitude and behaviour and the small impact of knowledge need to be evaluated in this context. With a more diverse sample, we might have observed significant effects of our information provision, similarly to other studies with a diverse consumer sample (e.g. Cordts et al., 2014). Secondly, we did not evaluate whether the effect of information on meat consumption behaviour differed in the first week after the intervention compared to the second week. We could not perform such an analysis because of the relatively small amount of obtainable behaviour data. Hence, we could not test whether there was an initial reduction of meat consumption behaviour during the first days after the intervention. As Jalil et al. (2020) demonstrate, the effects of information attenuate over time, therefore, a two-week interval in our study together with the one-time exposure to the information could explain the overall insignificant result. The third limitation refers to the design of the information. We only used cognitive-oriented messages, which did not include an affective component. Other studies showed that emotional appeals can be effective in reducing meat consumption predictors (Amiot, El Hajj Boutros, Sukhanova, & Karelis, 2018; Berndsen & van der Pligt, 2005; Carfora, Bertolotti, et al., 2019; Hunter & Röss, 2016; Palomo-Vélez et al., 2018). Hence, the limited effectiveness of information in the present study refers only to cognitive-oriented messages. Lastly, we did not measure how other variables apart from subjective knowledge could moderate information effectiveness. Other psychological constructs, like participants' health consciousness or environmental awareness, could also moderate the effectiveness of health and environmental information. For example, a study by Verain et al. (2017) showed that the combination of health and environmental information led to a change in dietary intentions of sustainable conscious consumers, but not of other consumer segments.

Some implications for future research can be drawn from the present study. First, more research is required that investigates the joint effect of information on attitude, intention, and meat consumption behaviour. This could be realized in an experimental lab study, or in a field setting, for instance a supermarket or a restaurant in which behavioural choices between a vegetarian and a meat product can be analysed upon receiving either health or environmental information. Along similar lines, the effect of information provision could be differently tested in the university canteen itself, by providing health and/or environmental information at the point of purchase in the canteen, for instance, through information banners or paper sheets on the trays. Secondly, more research is needed that investigates how the effectiveness of information provision in canteen settings is influenced by the individual decision-making context, e.g. the liking of different food options. When participants are generally willing to select a vegetarian dish, but do not like the option that is available, this could be an additional burden to reduce meat consumption. Third, we encourage more research that investigates other information provision formats, such as complementing purely textual information with pictures. Previous research has shown that pictures are differently processed than words (e.g. see Lang, Bailey, & Connolly, 2015), which might also be of relevance in the domain of meat consumption information. Similarly, more research should focus on the effect of repetitive exposure to information, as for example in Wolstenholme et al. (2020), and test its effect on observable meat consumption. Repetitive exposure of information might produce sustainable effects on meat consumption and could overcome the attenuation effect that Jalil et al. (2020) observed in their university canteen study. In this regard, also other mediator variables than attitude and intention could be investigated, for instance moral disengagement (e.g. Graça et al., 2014, 2016). Lastly, our study has implications for policymakers and designers of information campaigns. Our results highlight that subjective knowledge can be a moderator for the environmental information. To influence attitude towards meat consumption with environmental information most effectively, a target group-oriented approach might be superior to a “one-size-fits-all” approach.

6. Conclusion

To conclude, our study failed to find compelling evidence for an effect of a one-time provision of information in reducing students’ meat consumption behaviour in the university canteen. Our results indicate that subjective knowledge moderates the effectiveness of environmental information in influencing participant’s attitude, but this effect did not translate into a change in behaviour. Further research is required that examines observable meat consumption behaviour, rather than relying solely on the investigation of meat consumption predictors such as attitude, intention, or self-reported meat consumption.

Declaration of Competing Interest

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

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References

- Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., & van Huylenbroeck, G. (2011). The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food. *British Food Journal*, 113(11), 1352–1378. <https://doi.org/10.1108/00070701111179988>
- Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Amiot, C. E., El Hajj Boutros, G., Sukhanova, K., & Karelis, A. D. (2018). Testing a novel multicomponent intervention to reduce meat consumption in young men. *PLoS ONE*, 13(10), Article e0204590. <https://doi.org/10.1371/journal.pone.0204590>
- Berndsen, M., & van der Pligt, J. (2005). Risks of meat: The relative impact of cognitive, affective and moral concerns. *Appetite*, 44(2), 195–205. <https://doi.org/10.1016/j.appet.2004.10.003>
- Bianchi, F., Dorsel, C., Garnett, E., Aveyard, P., & Jebb, S. A. (2018). Interventions targeting conscious determinants of human behaviour to reduce the demand for meat: A systematic review with qualitative comparative analysis. *International Journal of Behavioural Nutrition and Physical Activity*, 15(102), 1–25. <https://doi.org/10.1186/s12966-018-0729-6>
- Briñol, P., Petty, R. E., & McCaslin, M. J. (2009). Changing attitudes on implicit versus explicit measures: What is the difference?. In *Attitudes: Insights from the new implicit measures* (pp. 285–326). Psychology Press.
- Bronzato, S., & Durante, A. (2017). A contemporary review of the relationship between red meat consumption and cardiovascular risk. *International Journal of Preventive Medicine*, 8, 40. https://doi.org/10.4103/ijpvm.IJPVM_206_16
- Carfora, V., Catellani, P., Caso, D., & Conner, M. (2019). How to reduce red and processed meat consumption by daily text messages targeting environment or health benefits. *Journal of Environmental Psychology*, 65, Article 101319. <https://doi.org/10.1016/j.jenvp.2019.101319>
- Carfora, V., Bertolotti, M., & Catellani, P. (2019). Informational and emotional daily messages to reduce red and processed meat consumption. *Appetite*, 141, Article 104331. <https://doi.org/10.1016/j.appet.2019.104331>
- Carrington, M. J., Neville, B. A., & Whitwell, G. J. (2010). Why ethical consumers don’t walk their talk: Towards a framework for understanding the gap between the ethical purchase intentions and actual buying behaviour of ethically minded consumers. *Journal of Business Ethics*, 97(1), 139–158. <https://doi.org/10.1007/s10551-010-0501-6>
- Cordts, A., Nitzko, S., & Spiller, A. (2014). Consumer response to negative information on meat consumption in Germany. *International Food and Agribusiness Management Review*, 17(A), 83–106. <https://doi.org/10.22004/ag.econ.164599>
- Deliens, T., Clarys, P., de Bourdeaudhuij, I., & Deforche, B. (2014). Determinants of eating behaviour in university students: A qualitative study using focus group discussions. *BMC Public Health*, 14(1), 53. <https://doi.org/10.1186/1471-2458-14-53>
- Dinu, M., Abbate, R., Gensini, G. F., Casini, A., & Sofi, F. (2017). Vegetarian, vegan diets and multiple health outcomes: A systematic review with meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition*, 57(17), 3640–3649. <https://doi.org/10.1080/10408398.2016.1138447>
- Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes*. Harcourt Brace Jovanovich College Publishers.
- Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41(4), 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>
- Freedman, L. S., Commins, J. M., Moler, J. E., Arab, L., Baer, D. J., Kipnis, V., ... Willet, W. (2014). Pooled results from 5 validation studies of dietary self-report instruments using recovery biomarkers for energy and protein intake. *American Journal of Epidemiology*, 180(2), 172–188. <https://doi.org/10.1093/aje/kwu116>
- Gaspar, R., Luís, S., Seibt, B., Lima, M. L., Marcu, A., Rutsaert, P., ... Barnett, J. (2015). Consumers’ avoidance of information on red meat risks: Information exposure effects on attitudes and perceived knowledge. *Journal of Risk Research*, 19(4), 533–549. <https://doi.org/10.1080/13669877.2014.1003318>
- Glasman, L. R., & Albarracín, D. (2006). Forming attitudes that predict future behaviour: A meta-analysis of the attitude-behaviour relation. *Psychological Bulletin*, 132(5), 778–822. <https://doi.org/10.1037/0033-2909.132.5.778>
- Graça, J., Calheiros, M. M., & Oliveira, A. (2014). Moral disengagement in harmful but cherished food practices? An exploration into the case of meat. *Journal of Agricultural and Environmental Ethics*, 27(5), 749–765. <https://doi.org/10.1007/s10806-014-9488-9>
- Graça, J., Calheiros, M. M., & Oliveira, A. (2016). Situating moral disengagement: Motivated reasoning in meat consumption and substitution. *Personality and Individual Differences*, 90, 353–364. <https://doi.org/10.1016/j.paid.2015.11.042>
- Graham, T., & Abrahamse, W. (2017). Communicating the climate impacts of meat consumption: The effect of values and message framing. *Global Environmental Change*, 44, 98–108. <https://doi.org/10.1016/j.gloenvcha.2017.03.004>
- Grimmer, M., & Miles, M. P. (2017). With the best of intentions: A large sample test of the intention-behaviour gap in pro-environmental consumer behaviour. *International Journal of Consumer Studies*, 41(1), 2–10. <https://doi.org/10.1111/ijcs.12290>
- Harguess, J. M., Crespo, N. C., & Hong, M. Y. (2020). Strategies to reduce meat consumption: A systematic literature review of experimental studies. *Appetite*, 144, Article 104478. <https://doi.org/10.1016/j.appet.2019.104478>
- Hayes, A. F. (2018). *Introduction to Mediation, Moderation and Conditional Process Analysis: A Regression-Based Approach* (2nd ed.). New York, NY: The Guilford Press.
- Hayley, A., Zinkiewicz, L., & Hardiman, K. (2015). Values, attitudes, and frequency of meat consumption. Predicting meat-reduced diet in Australians. *Appetite*, 84, 98–106. <https://doi.org/10.1016/j.appet.2014.10.002>

- Hebert, J. R., Clemow, L., Pbert, L., Ockene, I. S., & Ockene, J. (1995). Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. *International Journal of Epidemiology*, 24(2), 389–398. <https://doi.org/10.1093/ije/24.2.389>
- Hovland, C. I., Janis, I. L., & Kelley, H. H. (1953). *Communication and persuasion*. Yale University Press.
- Hunter, E., & Rööß, E. (2016). Fear of climate change consequences and predictors of intentions to alter meat consumption. *Food Policy*, 62, 151–160. <https://doi.org/10.1016/j.foodpol.2016.06.004>
- Jalil, A. J., Tasoff, J., & Bustamante, A. V. (2020). Eating to save the planet: Evidence from a randomized controlled trial using individual-level food purchase data. *Food Policy*, 95, Article 101950. <https://doi.org/10.1016/j.foodpol.2020.101950>
- Lang, A., Bailey, R. L., & Connolly, S. R. (2015). Encoding systems and evolved message processing: Pictures enable action, words enable thinking. *Media and Communication*, 3(1), 34–43. <https://doi.org/10.17645/mac.v3i1.248>
- Lea, E., & Worsley, A. (2008). Australian consumers' food-related environmental beliefs and behaviours. *Appetite*, 50, 207–214. <https://doi.org/10.1016/j.appet.2005.07.012>
- Lentz, G., Connelly, S., Miroso, M., & Jowett, T. (2018). Gauging attitudes and behaviours: Meat consumption and potential reduction. *Appetite*, 127, 230–241. <https://doi.org/10.1016/j.appet.2018.04.015>
- Macdiarmid, J. I., Douglas, F., & Campbell, J. (2016). Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite*, 96, 487–493. <https://doi.org/10.1016/j.appet.2015.10.011>
- Macdiarmid, J. I., Kyle, J., Horgan, G. W., Loe, J., Fyfe, C., Johnstone, A., & McNeill, G. (2012). Sustainable diets for the future: Can we contribute to reducing greenhouse gas emissions by eating a healthy diet? *The American Journal of Clinical Nutrition*, 96(3), 632–639. <https://doi.org/10.3945/ajcn.112.038729>
- McCarthy, M., O'Reilly, S., Cotter, L., & de Boer, M. (2004). Factors influencing consumption of pork and poultry in the Irish market. *Appetite*, 43(1), 19–28. <https://doi.org/10.1016/j.appet.2004.01.006>
- McEachan, R. R. C., Conner, M., Taylor, N. J., & Lawton, R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. *Health Psychology Review*, 5(2), 97–144. <https://doi.org/10.1080/17437199.2010.521684>
- Michel, F., Hartmann, C., & Siegrist, M. (2021). Consumers' associations, perceptions and acceptance of meat and plant-based meat alternatives. *Food Quality and Preference*, 87, Article 104063. <https://doi.org/10.1016/j.foodqual.2020.104063>
- Neff, R. A., Edwards, D., Palmer, A., Ramsing, R., Righter, A., & Wolfson, J. (2018). Reducing meat consumption in the USA: A nationally representative survey of attitudes and behaviours. *Public Health Nutrition*, 21(10), 1835–1844. <https://doi.org/10.1017/S1368980017004190>
- Palomo-Vélez, G., Tybur, J. M., & van Vugt, M. (2018). Unsustainable, unhealthy, or disgusting? Comparing different persuasive messages against meat consumption. *Journal of Environmental Psychology*, 58, 63–71. <https://doi.org/10.1016/j.jenvp.2018.08.002>
- Petty, R. E., & Cacioppo, J. T. (1986). The elaboration likelihood model of persuasion. In *Communication and persuasion* (pp. 1–24). Springer.
- Petty, R. E., Wegener, D. T., & Fabrigar, L. R. (1997). Attitudes and attitude change. *Annual Review of Psychology*, 48, 609–647. <https://doi.org/10.1146/annurev.psych.48.1.609>
- Pieniak, Z., Aertsens, J., & Verbeke, W. (2010). Subjective and objective knowledge as determinants of organic vegetables consumption. *Food Quality and Preference*, 21(6), 581–588. <https://doi.org/10.1016/j.foodqual.2010.03.004>
- Quintiliani, L. M., & Carbone, E. T. (2005). Impact of diet-related cancer prevention messages written with cognitive and affective arguments on message characteristics, stage of change, and self-efficacy. *Journal of Nutrition Education and Behaviour*, 37(1), 12–19. [https://doi.org/10.1016/S1499-4046\(06\)60254-6](https://doi.org/10.1016/S1499-4046(06)60254-6)
- Rothgerber, H. (2019). "But I Don't Eat that Much Meat" situational underreporting of meat consumption by women. *Society & Animals*, 27(2), 150–173. <https://doi.org/10.1163/15685306-12341468>
- Sanchez-Sabate, R., & Sabaté, J. (2019). Consumer attitudes towards environmental concerns of meat consumption: A systematic review. *International Journal of Environmental Research and Public Health*, 16(7), 1220. <https://doi.org/10.3390/ijerph16071220>
- Schultz, P. W. (2002). Knowledge, information, and household recycling: Examining the knowledge-deficit model of behaviour change. In National Research Council/National Research Council (Ed.), *New Tools for Environmental Protection: Education, Information, and Voluntary Measures* (pp. 67–82). The National Academies Press.
- Sogari, G., Velez-Argumedo, C., Gómez, M. I., & Mora, C. (2018). College students and eating habits: A study using an ecological model for healthy behaviour. *Nutrients*, 10(12), 1823. <https://doi.org/10.3390/nu10121823>
- Stea, S., & Pickering, G. J. (2019). Optimizing messaging to reduce red meat consumption. *Environmental Communication*, 13(5), 633–648. <https://doi.org/10.1080/17524032.2017.1412994>
- Stubbs, R. J., Scott, S. E., & Duarte, C. (2018). Responding to food, environment and health challenges by changing meat consumption behaviours in consumers. *Nutrition Bulletin*, 43(2), 125–134. <https://doi.org/10.1111/nbu.12318>
- Studierendenwerk Bonn (2020). Geschäftsbericht 2019. Available online at https://www.studierendenwerk-bonn.de/fileadmin/Dateien/Stwb/Downloads/Gesch%C3%A4ftsberichte/2019_Gesch%C3%A4ftsbericht_Studierendenwerk-Bonn_web.pdf last accessed 17.12.2021.
- Tilman, D., & Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature*, 515(7528), 518–522. <https://doi.org/10.1038/nature13959>
- United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. <https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E>.
- Vainio, A., Irz, X., & Hartikainen, H. (2018). How effective are messages and their characteristics in changing behavioural intentions to substitute plant-based foods for red meat? The mediating role of prior beliefs. *Appetite*, 125, 217–224. <https://doi.org/10.1016/j.appet.2018.02.002>
- Verain, M. C. D., Sijtsema, S. J., Dagevos, H., & Antonides, G. (2017). Attribute segmentation and communication effects on healthy and sustainable consumer diet intentions. *Sustainability*, 9(5), 743. <https://doi.org/10.3390/su9050743>
- Wolstenholme, E., Poortinga, W., & Whitmarsh, L. (2020). Two birds, one stone: The effectiveness of health and environmental messages to reduce meat consumption and encourage pro-environmental behavioural spillover. *Frontiers in Psychology*, 11, Article 577111. <https://doi.org/10.3389/fpsyg.2020.577111>

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Fifty shades of grain – Increasing whole grain consumption through daily messages

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Abstract

Despite numerous health benefits, the majority of consumers, in particular young adults, show low levels of whole grain consumption behaviour (WGCB). In order to increase WGCB, this pre-registered experimental study investigates the effect of a two weeks message intervention. Participants ($n = 329$) received either information about health benefits, recipe suggestions, a combination of both, or about a control topic. We evaluated WGCB at three time points: prior to, immediately after (post), and one month after the intervention (follow-up). Our findings show that participants read the message on most of the days and on average, evaluate the health-only message most positively. Furthermore, we found that health messages, but not recipe suggestions significantly increase WGCB at the follow-up measure. This effect was serially mediated by attitudes and behavioural intentions at the post-intervention measure, with more positive attitudes and higher intentions leading to more WGCB. Although health messages are an effective tool to influence WGCB, the effect is small in magnitude and consumption levels remain rather low. We discuss implications for future research and for the communication of whole grain related health benefits among different stakeholders in the health sector.

Keywords: whole grain, food consumption, health information, behaviour change, message

1. Introduction

53
54 Whole grain products have a high nutritional quality, as they are rich in dietary fibres,
55 minerals, and vitamins (Slavin, 2004). Accordingly, the consumption of whole grain products
56 is associated with a number of positive health outcomes, such as reduced risk of developing
57 non-communicable diseases like type 2 diabetes (Tieri et al., 2020) or coronary heart diseases
58 (Tang et al., 2015). Moreover, whole grain products can help to reduce overweight, as they
59 prolong digestive processes, which leads to longer feelings of satiety (Sanders et al., 2021).
60 Despite these various health benefits of whole grain products, consumers' intake of whole
61 grains rarely meets the recommended levels (O'Donovan et al., 2019; Sandvik et al., 2014).
62 Young adults especially show low rates of whole grain product and dietary fibre intake (Max
63 Rubner-Institute, 2008; Sette et al., 2017). Therefore, especially for this consumer segment
64 effective strategies to increase whole grain consumption behaviour (WGCB) are needed.

65 Previous research has shown that interventions at the point of consumption (POC) can
66 increase the selection of whole grain products, for example, through making whole grain
67 products more appealing (van Kleef et al., 2014; Sogari et al., 2019), more accessible (de
68 Wijk et al., 2016), or by using default nudges (van Kleef et al., 2018). However, little is
69 known whether effective interventions at the POC also produce spill-over effects to other
70 contexts such as at-home-cooking and how long-lasting the effects on WGCB are (Vecchio &
71 Cavallo, 2019). Furthermore, common barriers to whole grain consumption are a lack of
72 knowledge about the health benefits of whole grain consumption as well as a lack of skills to
73 identify and prepare whole grain products (Meynier et al., 2020). These barriers can only
74 partly be addressed at the POC (for instance, Sogari et al., 2019). In contrast, providing
75 consumers with detailed information about food products can be an effective tool to achieve
76 long-lasting consumption-related health behaviour changes (Jalil et al., 2020). In the domain
77 of meat-consumption, several studies have shown that daily messages for a period of two
78 weeks could lead to a meat-reduction (Carfora et al., 2019; Wolstenholme et al., 2020).
79 Therefore, this pre-registered study examines the effect of a two weeks message intervention
80 to increase consumers' WGCB. In order to overcome common barriers to WGCB, the
81 intervention in this study is built on two pillars: first, providing positive information about the
82 health benefits of regular whole grain consumption and second, increasing consumers'
83 competence to prepare and consume whole grain products. To evaluate the effectiveness of
84 the messaging intervention, we measure participants' WGCB at three points in time: prior to
85 receiving the messages, immediately after the two weeks messaging period (post), and one
86 month later (follow-up).

87 **2. Health behaviour change through information provision**

88 **2.1. Determinants of health behaviour change**

89 A plethora of psychological theories explain the determinants of health behaviour
90 change. The theory of planned behaviour (TPB; Ajzen, 1991), the information-motivation-
91 behavioural skills model (IMB; Fisher et al., 2003), social cognitive theory (SCT, Bandura,
92 1986), and the capability-opportunity-motivation-behaviour model (COM-B; Michie et al.,
93 2011) are prominent examples and all gained high relevance in research. Two common
94 determinants of health behaviour change can be identified in all those theories.

95 First, people need to hold positive evaluations of the outcome of the behaviour (e.g.
96 outcome beliefs and outcome evaluations leading to attitudes in the TPB; motivation in the
97 IMB model; outcome expectancies in SCT; motivation in the COM-B). Indeed, the more
98 beneficial consumers evaluated whole grain consumption, the more willing they were to select
99 whole grain pasta in the university canteen (Wongprawmas et al., 2021). However, a great
100 deal of previous studies showed that consumers tend to be sceptical towards whole grain
101 products, driven by the high proportion of carbohydrates (Barrett et al., 2020; Kamar et al.,
102 2016) and negative taste expectations (Kuznesof et al., 2012). Although there seems to be a
103 general awareness that whole grain products contribute to a healthy diet, consumers lack
104 specific knowledge about the specific long-term health benefits (Barrett et al., 2020). Hence,
105 consumers might not hold strongly positive evaluations towards WGCB, which can hinder the
106 consumption (Ajzen, 1991; Michie et al., 2011).

107 Second, people need to be psychologically and physically capable of performing the
108 behaviour (e.g. perceived behavioural control in TPB; behavioural skills in the IBM model;
109 self-efficacy in SCT; capability in the COM-B model). A number of studies showed that
110 consumers lack the competence to incorporate whole grain products in their daily diet.
111 Perceived barriers to whole grain consumption were the lack of cooking skills (Magalis et al.,
112 2016) as well as perceived low availability of whole grain products (Kantor et al., 2001).
113 Furthermore, consumers report difficulties in identifying and distinguishing whole grain
114 products from refined products (Chase et al., 2003). Hence, consumers ‘use their own cues to
115 identify’ (Sandvik et al., 2018, p.1) whole grain products, for instance, based on the product
116 name or colour of the product, which can lead to confusion and misjudgements. Overall, these
117 perceived barriers can cause low whole grain-related self-efficacy in some consumers
118 (Kuznesof et al., 2012), which hinders WGCB (Bandura, 1986; Fisher et al., 2003).

119 **2.2. Information-based interventions**

120 Several studies showed that food-related information provision can influence
121 consumers' evaluation of a behaviour (Gaspar et al., 2015), self-efficacy (Bouwman et al.,
122 2020), behavioural intentions (Cordts et al., 2014), and the behaviour itself (Jalil et al., 2020).
123 Especially, in the domain of whole grain, providing information seems promising considering
124 consumers' knowledge deficit regarding the health-benefits of whole grain products and their
125 low levels of competence in incorporating whole grain products in their diet. Consumers
126 themselves perceive whole grain-related information provision as a helpful tool to support
127 their respective consumption (Foster et al., 2020). In a narrative review, Meynier et al. (2020)
128 identified key factors that determine the failure or success of an intervention in increasing
129 whole grain consumption. The results support the relevance of providing both health- and
130 competence-related information to increase whole grain consumption. Furthermore, they
131 identify short exposure times to the information as a key factor for intervention failure, yet,
132 they do not specify how long the exposure should be (Meynier et al., 2020). Hence,
133 information provision will more likely lead to a behavioural change if the information is
134 provided at more than one occasion. Support for the effectiveness of repetitive information
135 exposure can be found in the domain of meat-consumption behaviour. Information provision
136 reduced the frequency of meat consumption when information is provided for a period of two
137 weeks on a daily basis (Carfora et al., 2019; Wolstenholme et al., 2020), but not when
138 information is provided a single time (Verain et al., 2017; Weingarten et al., 2022).

139 The relevance of whole grain-related information campaigns has been stressed by
140 several researchers in the field (Barrett et al., 2020; Foster et al., 2020; Jones et al., 2002;
141 Kamar et al., 2016; Toups, 2020; Wongprawmas et al., 2021) but has received little attention
142 in the experimental research literature. Preliminary evidence is provided by two experimental
143 studies from Sogari et al. (2019) and Stelick et al. (2021). Sogari et al. (2019) show that
144 information provision about health benefits of whole grain products in the university canteen
145 can lead to an increase in the consumption of whole grain pasta. However, while information
146 on vitamin content was successful information, focusing on fibre was not. In contrast Stelick
147 et al. (2021) show in a laboratory experiment that also information provision on the fibre
148 content of a cereal bar leads to an increase in consumers' purchase intention. Although
149 provision of nutritional and health information can enable short-term behavioural changes at
150 the POC, little is known whether this effect will persist over time or transfer to other contexts
151 (Vecchio & Cavallo, 2019). Considering people's lack of whole grain-related competence,

152 this can be an additional barrier to transitional effects of a POC-based health-based
153 information intervention to other contexts, such as at-home-cooking.

154 **3. Present Study**

155 The objective of this study is to test whether daily messages about whole grain
156 consumption over a period of two weeks can increase WGCB. We specifically target young
157 adults (from age 18-39), as this consumer segment shows the lowest levels of whole grain
158 intake (e.g. Sette et al., 2017; Max Rubner-Institute, 2008). Based on the theoretical
159 determinants of health behaviour change, the daily messages focus on two pillars: first,
160 enhancing consumers' evaluation of whole grain consumption by providing information about
161 the health benefits and second, increasing their competence to consume or prepare whole
162 grains by providing suggestions on incorporating whole grain products into the diet. To test
163 the effect of the two pillars separately and jointly, we exposed participants either only to
164 health-related information, only to competence-related information or a combination of both.
165 In addition, a fourth group of participants received information about a whole grain unrelated
166 topic. In order to generate sufficient exposure to the information, participants received the
167 information on a daily basis for a period of 14 days. The messages differed each day, thus,
168 participants in the health condition received 14 different pieces of information in the health
169 benefits of whole grain consumption. To assess the impact of our intervention, we analysed
170 the short-term (immediately after the intervention; post) and the long-term effects (one month
171 after the intervention; follow up).

172 We pre-registered three sets of hypotheses. First, we expected that information
173 provision about health benefits leads to a more positive attitude towards whole grain
174 consumption as well as higher stated behavioural intentions to consume whole grain products.
175 Second, we hypothesized that information about whole grain competences increases
176 participants' self-efficacy beliefs as well as their intention to consume whole grain products.
177 Third, we expected that the combination of both would lead to a more favourable attitude,
178 increased self-efficacy beliefs, higher behavioural intentions, and higher WGCB.
179 Furthermore, we performed exploratory mediation analyses to investigate if the effect of
180 messaging intervention on WGCB is mediated by attitudes, self-efficacy, and intention. We
181 share the pre-registration form, experimental material, and cleaned data on OSF
182 https://osf.io/us6yd/?view_only=37edfdab49fb4e09a46b4b6d2c8718a5.

183

4. Method

4.1. Design

185 We conducted the present study between November 2021 and January 2022 with
 186 German consumers from 18-39 years of age. Consumers with gluten intolerance (e.g. celiac
 187 disease) were not eligible for participation. The experiment followed a 2 x 2 x 3 mixed design
 188 with the between-subject factor health message (health vs control), the between-subjects
 189 factor competence message (competence vs control) and the within-subjects factor measure
 190 (pre-measure (T1) vs post-measure (T2) vs follow-up (T3)). Participants were randomly
 191 assigned to the four experimental conditions. We formulated two exclusion criteria, according
 192 to which we removed participants from the study. Participants needed to read the daily
 193 messages regularly (at least four out of 14 messages) and needed to correctly answer an
 194 attention check during the T1 survey. The study was approved by the ZEF Research Ethics
 195 Committee (Code: 13_ILR-21).

196 The recruitment was done through a market research agency that invited consumers
 197 from their panel to a study about food perception. We determined our minimal required
 198 sample size with an a-prior power analysis with G*Power (Faul et al., 2009). To detect a
 199 small effect size with a power of 90% at an alpha level of 5%, a minimal sample size of $n =$
 200 296 participants is necessary. In order to meet the required sample size at the follow-up
 201 measure, the market research agency recommended recruiting 615 participants at T1, based on
 202 their usual retention rates in longitudinal studies. However, the drop-out rate between T1 and
 203 T2 was higher than expected, since some participants failed to read the message regularly, as
 204 described above. Therefore, we continued sampling until $n = 836$ at T1. Table 1 shows the
 205 number of participants throughout the study and differentiated by treatment group.

206 **Table 1** Participation rates throughout the study

	Health message	Competence message	Combined message	Control message	Whole sample
Completed T1	$n = 208$	$n = 209$	$n = 210$	$n = 209$	$n = 836$
Completed T2	$n = 123$	$n = 107$	$n = 104$	$n = 94$	$n = 428$
Completed T3	$n = 97$	$n = 76$	$n = 85$	$n = 71$	$n = 329$

4.2. Procedure and Materials

207 The study was conducted in four parts through the online survey tool *Qualtrics*. First,
 208 participants completed the T1 survey. In this survey, we collected participants' private email
 209 addresses that we later used to send them the daily messages. Then, we provided participants
 210

211 with a definition of whole grain products, and obtained the pre-measure of the dependent
212 variables attitude, intention, self-efficacy, and WGCB. After completing the T1 survey, we
213 started the intervention period. Using participants' private email address, we sent them a daily
214 message about whole grain consumption (health message vs. competence message vs.
215 combined) or a control topic for a period of 14 days. The messages were sent every day at
216 11.00 am through the contact list feature of *Qualtrics*. Using this feature allowed us to pre-
217 program the sending of messages and in addition, we could automatically record whether
218 participants read the message or not. After the 14 days, participants were invited to the T2
219 survey. This survey included the measurement of all dependent variables and a message
220 evaluation scale. One month after completing the message period, participants performed the
221 T3 survey, in which we measured all dependent variables and provided participants with the
222 opportunity to receive a debriefing. In the following, we describe all the key materials for this
223 study¹.

224 4.2.1. Attitude

225 Attitude towards whole grain consumption was measured using six items (e.g.
226 “unsatisfied-satisfied; “unimportant-important”) on a 7-point semantic bipolar scale, ranging
227 from -3 to +3 (Fishbein & Ajzen, 2010). The scale had a good to excellent internal
228 consistency in all three surveys (pre-measure $\alpha = 0.86$, post-intervention $\alpha = 0.88$, follow-up α
229 = 0.91).

230 4.2.2. Intention

231 Intention to consume whole grain products was measured using three items (e.g. “I try
232 to include whole grain products in my daily diet”) on a 7-point Likert scale ranging from 1
233 (Strongly disagree) to 7 (Strongly agree) (Fishbein & Ajzen, 2010). The scale showed
234 excellent internal consistency across all three surveys (all $\alpha > 0.90$). In the T1 survey, we
235 included an attention check item (To demonstrate that you are not a robot, please press "I
236 rather disagree”). Participants who did not answer this item correctly were screened out from
237 the survey.

238 4.2.3. Self-efficacy

239 Self-efficacy beliefs about whole grain consumption were measured with three items
240 (e.g. “I’m confident that I’m able to eat whole grain products every day if I want to”) on a 7-

¹ The T1 survey included some additional measurements that are reported elsewhere. In addition, we included filler questions, for example, about meat, fruit, and vegetable consumption to make the focus on whole grain less obvious.

241 point Likert scale ranging from 1 (Strongly disagree) to 7 (Strongly agree), based on a scale
242 by (Armitage & Conner, 1999). The scale showed good to excellent internal consistency in all
243 surveys (T1 $\alpha = 0.89$, T2 $\alpha = 0.91$, T3 $\alpha = 0.92$).

244 4.2.4. *WGCB*

245 WBCG was measured with four items (“Please indicate on how many days you have
246 consumed whole grain products at the following occasions in the last two weeks – Breakfast/
247 Lunch/ Snacks/ Dinner) on a 7-point Likert scale ranging from 1 (On 0 days) to 7 (On 11-14
248 days). The scale showed good internal consistency at all three measurements (all $\alpha > 0.80$).

249 4.2.5. *Messages about whole grain products*

250 For each condition, we constructed 14 different messages. The experimental messages
251 described the various health benefits and/or consumption options of whole grain products.
252 The health condition received daily information about the relationship of whole grain
253 consumption and positive health outcomes, for instance, reduced risks of developing type 2
254 diabetes, high blood pressure and strengthen of the immune system. The content of the health
255 information was derived from systematic reviews and/or meta-analyses by Sanders et al.
256 (2021), Tieri et al. (2020), Tang et al. (2015), Aune et al. (2016), Chen et al. (2021), Barrett et
257 al. (2019), Sang et al. (2020), Seal et al. (2021), and Hajjhashemi and Haghghatdoost (2019).
258 The competences condition received information with practical advice on how to include
259 whole grain products in their daily lives, for example, in the form of product or recipe
260 suggestions. The combined condition received both information about the health outcomes as
261 well as practical advice on how to consume whole grain products. The control condition
262 group received daily information about the consumption of seasonal fruits and vegetables. We
263 applied gain-framing in all messages, as prior research has shown a superiority of grain-
264 framing above loss-framing in the domain of prevention behaviour (Gallagher et al., 2012).
265 Table 2 provides an example from one daily message for each message condition. All
266 messages can be found in the Appendix of this paper.

267 In order to assess how often a participant has read the messages, we collected actual
268 and self-reported message exposure. Actual message exposure was recorded automatically
269 through using the contact list feature of *Qualtrics*. We measured self-reported message
270 exposure at T2 with the statement “In the last 14 days, we have sent you daily information
271 about food. Have you read the messages?”, which was answered on a 5-point Likert Scale (1
272 = No, never to 5 = Yes, always).

273 In addition, we asked participants to summarize the content of the messages with an
 274 open-end answer to assess whether participants understood and remembered the messages
 275 (Please describe in 2-3 sentences the content of the messages and give an example of which
 276 message particularly stuck in your mind). The analysis of open-end answers showed that all
 277 participants read and understood the messages. Lastly, participants evaluated the messages on
 278 a 7-point Semantic Bipolar scale with 7 items (e.g. incomprehensible-comprehensible; boring-
 279 interesting). The 7 items had excellent internal consistency ($\alpha = 0.91$) and we created one
 280 average rating score for the messages.

281 **Table 2** Example of daily message per condition

	Message
Health message	Did you know that consuming whole grain products leads to a reduction in the risk of type 2 diabetes? Whole grain products increase the body's insulin sensitivity, which reduces susceptibility to high blood sugar levels.
Competence message	Start your day with whole grain products - Whole grain products can be integrated into your breakfast in many ways, for example in the form of oatmeal or through a slice of whole grain bread.
Combined message	Start your day with whole grain products - Whole grain products can be integrated into your breakfast in many ways, for example in the form of oatmeal or through a slice of whole grain bread. By starting the day this way, you can simultaneously reduce your risk of type 2 diabetes. Whole grain products increase the body's insulin sensitivity, which reduces susceptibility to high blood sugar levels.
Control message	Would you like to break the morning routine with new recipes? Try starting the day with fruit and vegetable smoothies. Apples, carrots, beet, oranges, carrots, or celery are recommended seasonal ingredients for this.

282

5. Results

283 5.1. Participants and preliminary analysis

284 The final sample consisted of $n = 329$ participants, from which 97 participants
 285 received the health messages, 76 received the competence messages, 85 received the
 286 combined messages, and 71 received the control message. Participants were on average 30.64
 287 years old ($SD = 5.60$) and slightly overweight ($M_{BMI} = 25.20$; $SD_{BMI} = 5.16$). See Table 3 for
 288 further sample characteristics.

289 To check whether the randomization was successful, we performed analyses of
 290 variances (ANOVAs) and chi-square tests on socio-demographics and pre-measures of
 291 dependent variables. We found no significant difference between the four conditions (all $ps >$
 292 0.08).

293 **Table 3** Socio-demographic characteristics of the sample

Gender	Women	47.42%
	Men	52.58%
Age	18-25	23.40%
	26-39	76.60%
Education	Apprenticeship	20.67%
	Low school degree	2.43%
	Medium school degree	14.29%
	University entrance qualification	22.49%
	University degree	40.12%
Income	Below or equal to 900 €	5.47%
	901 € - 1,300 €	6.38%
	1,301 € - 2,000 €	13.07%
	2,001 € - 3,600 €	32.22%
	3,601 € - 5,000 €	27.66%
	More than 5,000 €	10.94%
	I do not want to specify/ I don't know	4.26%
Occupation	Employed	70.21%
	Self-employed	3.34%
	Job-seeking	1.82%
	Unemployed	5.17%
	Retired/ pensioner	0.91%
	Pupil, apprentice, student	18.54%
Household Size	1-2 People	55.32%
	3-5 People	44.07%
	6-8 People	0.61%
BMI	Below 18.5	1.82%
	18.6-24.9	58.36%
	25-30	24.32%
	Above 30	15.50%

294

295 **5.2. Message exposure and evaluation**

296 Participants who took part in all three surveys read the messages on an average of 12.81 days
 297 ($SD = 2.37$) out of 14. Results from the self-reported message exposure during the T2 survey

298 draw the same picture. The majority of participants (92.40%) reported to have read the
 299 message “always” or “almost always” and only 7.60% had read the message occasionally.

300 Both measures are positively correlated ($r = 0.41, p < 0.001$). We found no significant
 301 differences between the groups concerning actual ($F(3,328) = 0.24, p = 0.87$) or self-reported

302 message exposure ($\chi^2(30) = 20.87, p = 0.89$). The analysis of open-end answers to the

303 message summary question showed that all participants read and understood the messages

304 Next, we analysed how participants evaluated the messages. Figure 1 shows the
 305 categories in which the message groups differ significantly. Bonferroni-corrected post-hoc
 306 tests showed that the health message was rated significantly more interesting, comprehensive,
 307 relevant, and informative compared to the control message. Along similar lines, the health
 308 message received a significantly higher average rating compared to the control message.
 309 Furthermore, the health message was perceived significantly more interesting, relevant, and
 310 informative compared to the competence message. Lastly, the combined message was rated
 311 significantly more informative compared to the control message. No other post-hoc
 312 comparisons yielded a significant result.

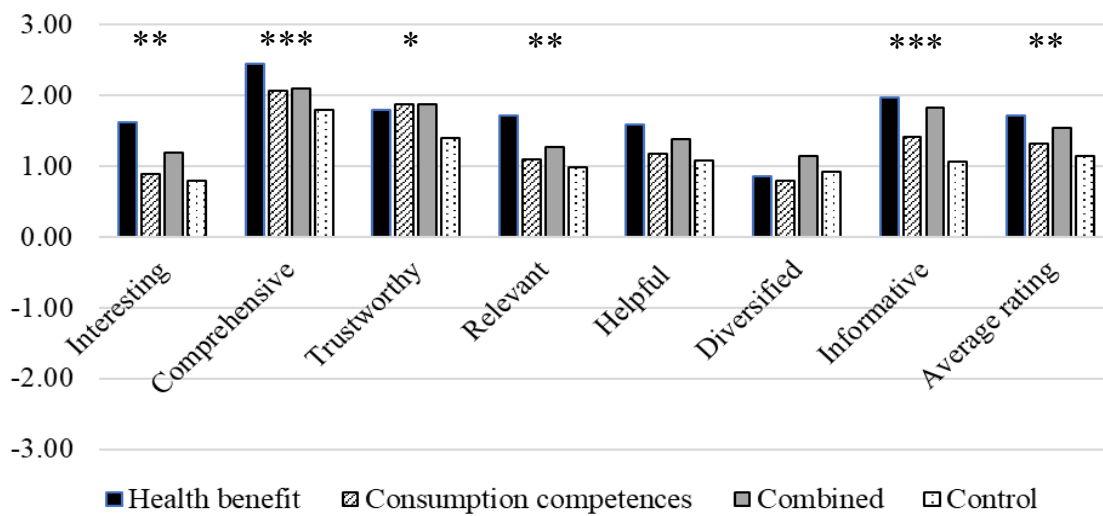


Figure 1. Message evaluation per condition.

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

313 5.3. Effect of messages over time

314 Table 4 provides means and standard deviations of all key variables per condition. To
 315 analyse the effect of messages over time, we conducted a 2 (health vs. control) x 2
 316 (competence vs. control) x 3 (T1 vs. T2 vs. T3) mixed ANOVA, separately for attitude,
 317 intentions, self-efficacy, and WGCB. In all mixed ANOVAs, we applied the Greenhouse-
 318 Geisser correction. The three-way interaction effect of health*competence*measure was not
 319 significant in any of the mixed ANOVA analysis (all p s > 0.79). The interaction effect of
 320 health*measure yielded a significant interaction effect for attitudes ($F(1,91; 621.80) = 3.86$, p
 321 $= 0.023$, $\eta_p^2 = 0.012$) and WGCB ($F(1,98; 644.35) = 5.09$, $p = 0.007$, $\eta_p^2 = 0.015$), but not for
 322 intention ($F(1,93; 626.73) = 2.39$, $p = 0.095$, $\eta_p^2 = 0.007$). The interaction of
 323 competence*measure showed no statistical significance for self-efficacy, intention, or WGCB

324 (all p s > 0.44). The mixed ANOVA result tables are placed in the Supplementary Materials
 325 (Table A1).

326 **Table 4** Means and standard deviations of key variables per condition

	Health message condition $n = 97$		Competence message condition $n = 76$		Combined message condition $n = 85$		Control message condition $n = 71$	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
T1 Attitude	1.29	1.01	0.98	1.02	1.08	1.12	1.06	1.10
T2 Attitude	1.60	0.88	1.11	1.10	1.45	1.00	1.09	1.15
T3 Attitude	1.66	0.91	1.15	1.06	1.46	1.14	1.25	1.19
T1 Self-Efficacy	5.36	1.04	5.01	1.35	5.25	1.18	5.17	1.23
T2 Self-Efficacy	5.41	1.07	5.07	1.40	5.32	1.32	5.06	1.19
T3 Self-Efficacy	5.44	1.12	5.13	1.30	5.29	1.45	5.24	1.24
T1 Intention	4.56	1.47	4.33	1.50	4.53	1.46	4.46	1.33
T2 Intention	4.99	1.33	4.41	1.55	4.79	1.48	4.62	1.38
T3 Intention	4.99	1.55	4.41	1.50	4.79	1.55	4.62	1.43
T1 WGCB	2.84	1.31	2.63	1.16	2.94	1.38	3.08	1.27
T2 WGCB	2.87	1.35	2.89	1.33	2.98	1.39	3.26	1.58
T3 WGCB	3.04	1.32	2.76	1.40	3.21	1.49	2.97	1.31

Note. T1 = Pre-measure, T2 = Post-intervention, T3 = Follow-up, WGCB = Whole grain consumption behaviour.

327

328 **5.4. Factorial analysis of health benefits and consumption competence at T2 and T3**

329 Next, we analysed the main and interaction effects of the message factors health and
 330 competence separately at the post-intervention (T2) and follow-up measures (T3). For this
 331 purpose, we performed factorial two-way ANOVAs on attitude, self-efficacy, intention and
 332 WGCB. The analysis indicated that health messages led to a more positive attitude at T2 (F
 333 (1; 328) = 13.67, $p < 0.001$, $\eta_p^2 = 0.027$) and T3 (F (1; 328) = 9.30, $p < 0.001$, $\eta_p^2 = 0.028$).
 334 Similarly, health messages lead to a higher intention to consume whole grain products at T2
 335 (F (1; 328) = 5.67, $p = 0.018$, $\eta_p^2 = 0.017$), but not at T3 (F (1; 328) = 3.64, $p = 0.06$, $\eta_p^2 =$
 336 0.011). The health messages did not influence WGCB at T2 (F (1; 328) = 0.90, $p = 0.345$,
 337 $\eta_p^2 = 0.003$), but a trend was visible at T3 (F (1; 328) = 0.28, $p = 0.095$, $\eta_p^2 = 0.009$) that
 338 turned significant when controlling for T1 WGCB (F (1; 328) = 4.11, $p = 0.04$, $\eta_p^2 = 0.013$).
 339 The inclusion of the T1 measure did not affect any other analyses. Neither the competence
 340 messages nor the interaction effects of competence*health message yielded a significant result
 341 in any of the analyses. All ANOVA and ANCOVA result tables can be found in the
 342 Supplementary Materials (Table A2-A5).

343 **5.5. Mediation analysis with serial indirect effects**

344 Lastly, we explored the serial indirect effect of messages on WGCB. We performed a
345 mediation analysis with PROCESS using a percentile approach (Model 6, Hayes, 2018). We
346 tested two separate models. The first model investigated the effect of health messages (1 =
347 health and combined, 0 = competence and control) on T3 WGCB, serially mediated by the T2
348 attitude and T2 intention, while controlling for T1 WGCB (see Figure 2). The second model
349 was estimated in a similar way but investigated the effect of competence messages (1 =
350 competence and combined, 0 = health and control) on T3 WGCB, serially mediated by T2
351 self-efficacy and T2 intention (See Figure 3). Both models are estimated with
352 heteroscedasticity-consistent standard errors (HC4). The results of the first model showed that
353 the effect of health messages on WGCB was serially mediated by attitude and intention ($b =$
354 $0.08; [0.03; 0.15]$). Hence, receiving messages for a period of 14 days leads to a more positive
355 evaluation of whole grain consumption at T2, which translates into an increased intention to
356 consume whole grain consumption at T2, which leads to increased WGCB at the follow-up
357 (T3). No such effect was found for the second model. Neither self-efficacy nor intention
358 mediated the effect of the competence messages on WGCB. However, the model indicates
359 that self-efficacy positively impacts intention which induces an increase in WGCB.

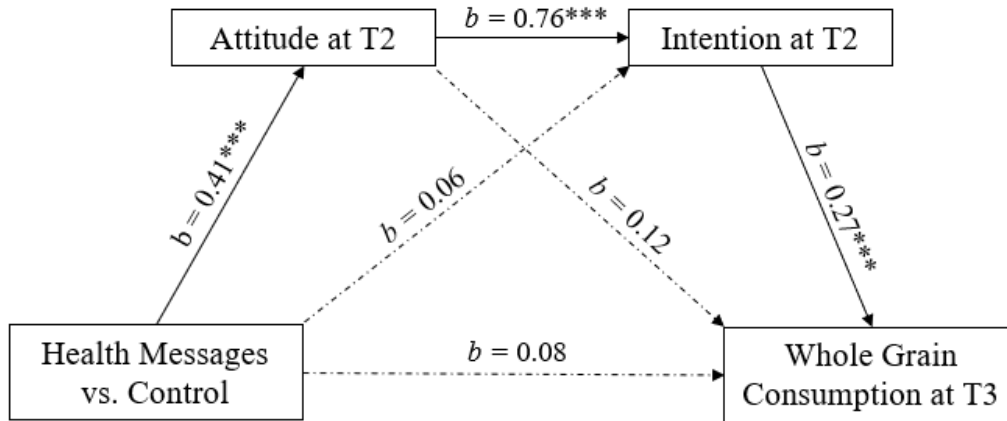


Figure 2 Mediation analysis of health messages on WGCB

Note. *** $p < 0.001$ Estimates of covariates are omitted to improve readability.

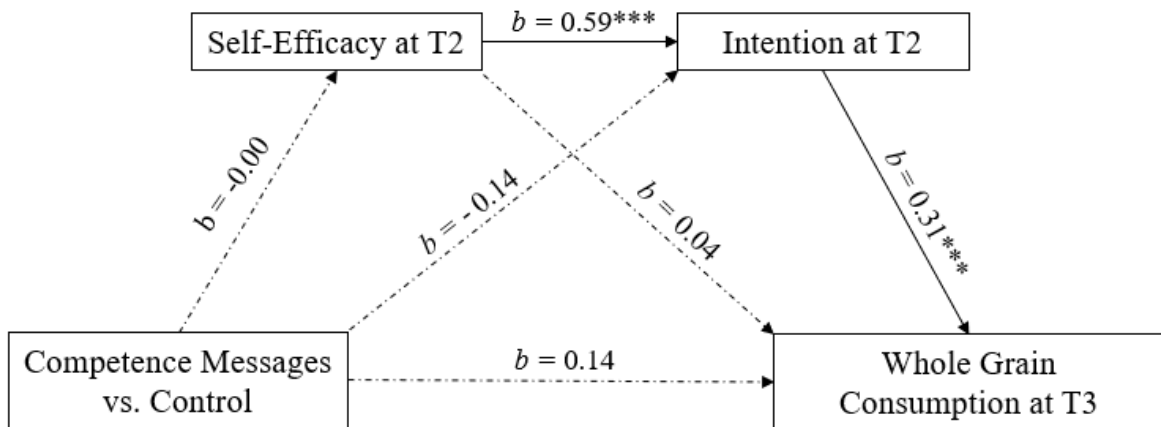


Figure 2 Mediation analysis of competence messages on WGCB

Note. *** $p < 0.001$. Estimates of covariates are omitted to improve readability

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6. Discussion and Conclusion

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The central aim of this study was to investigate the effect of messaging interventions on young adults' WGCB. Based on the theoretical determinants of health behaviour change (e.g. Bandura, 1986; Fishbein & Ajzen, 2010) and recommendations of previous research (e.g. Meynier et al., 2020), the intervention consisted of information about the health benefits of whole grain consumption and/or practical recommendations to integrate whole grain products in the diet. To make the information more salient, participants received daily messages for a period of 14 days.

Our findings demonstrate that informing participants about the health benefits of whole grain consumption leads to a more positive attitude and higher behavioural intentions to consume whole grain products. This finding is consistent with our first pre-registered hypothesis as well as other previous literature (Cordts et al., 2014; Gaspar et al., 2015). We

372 observe this effect at the post-intervention and at the follow-up measure, although the effect
373 size slightly decreases in magnitude over time, especially for intentions.

374 Contrary to our second hypothesis, the competence messages did not lead to an
375 increase in participants' whole grain related self-efficacy, nor did they lead to higher
376 intentions to consume whole grain. Although several studies showed that consumers lack the
377 competence to integrate whole grain products into their daily diet (Kuznesof et al., 2012;
378 Magalis et al., 2016), providing recipe and product suggestions was not sufficient to increase
379 respondents' self-efficacy and behavioural intentions. One explanation for the absence of an
380 effect is that providing purely recipe and product suggestions might affect only participants'
381 actual competence but not the perceived competence. Interventions to increase participants'
382 self-efficacy in the domain of fruit and vegetable consumption often included stimulations of
383 participants' perceived competence through positive recall exercises or feedback elements
384 (Kreausukon et al., 2012; Luszczynska et al., 2007).

385 Our third hypothesis was partly supported. According to behaviour change theories,
386 such as the TPB or the COM-B we expected that it is the combination of health and
387 competence information that would increase WGCB. However, we found no evidence for an
388 interaction effect of health and competence information, but for a main effect of health
389 information. Health information directly increased WGCB when controlling for pre-
390 consumption and indirectly through changes in attitudes and intentions. This finding is partly
391 in line with the study from Sogari et al. (2019), which showed that health messages about
392 vitamins benefits at the POC increase whole grain pasta selection. Contrary to the findings by
393 Carfora et al. (2019), in our study the health messages did not affect WGCB immediately after
394 the interventions but only one month later. Hence, participants did not change their behaviour
395 directly after receiving the first messages, but the effect of messages on behaviour likely grew
396 stronger the more information was received and the more time participants had to adjust their
397 behaviour. This assumption is consistent with the results Carfora et al. (2019) who find a
398 larger behaviour change at the follow-up compared to the post-intervention.

399 In line with the TPB (Ajzen, 1991), the results from the exploratory serial mediation
400 analysis showed that the effect of health messages on WGCB at the follow-up is mediated by
401 participants' attitude and intention at the post-intervention. Thus, health messages causally
402 lead to more positive attitudes towards WGCB, which leads to increased behavioural
403 intentions to perform the behaviour in the future, which translates into a behaviour change at
404 the follow-up. Although our results show that daily health messages have the potential to

405 increase WGCB, we have to note that the magnitude of this effect was rather small ($\eta_p^2 =$
406 0.01).

407 Some limitations should be considered when interpreting our findings. First, we
408 measured WGCB with a self-developed scale that assessed the frequency of whole grain
409 consumption for four meals (breakfast, lunch, snack, dinner), but not the size of these
410 portions. According to our scale, the intake frequency at the follow-up was still low and did
411 not exceed 3-4 intakes of whole grain products over a two-week period. However, we cannot
412 estimate what portion sizes participants consumed at the meals on these days. An example of
413 a measure that takes portion sizes into account is provided by Ross et al. (2015), but, due to
414 the complex nature of this measure, we refrained from using it. Along similar lines, our
415 WGCB assessment solely relied on self-report and these measures can be subjective to
416 different response biases, for instance, recall bias or social desirability (Freedman et al., 2014;
417 van de Mortel, 2008). Though more objective measures would be desirable, biases to self-
418 report likely affect all three time points to a similar extent and thus, the change in behaviour
419 from pre to post to follow up is likely less affected. Second, our study had a rather high drop-
420 out rate. Less than half of the participants who completed the pre-measure took part in the
421 follow-up survey, either because they had read the messages on fewer than four days and thus,
422 were not invited to the post-intervention survey or because they did not complete T2 or T3.
423 Other studies with a similar set-up reported higher retention rates (Carfora et al., 2019;
424 Wolstenholme et al., 2020), however, these experiments were performed with students and
425 not with consumers, as in the present study. Although we found no significant differences in
426 socio-demographic characteristics between the initial sample at T1 and the participants who
427 completed the intervention and the T2 survey, the high drop-out rate may have led to a
428 skewed sample with regard to other variables, such as health motivation or nutrition literacy
429 not measured in the survey.

430 Our study has important implications for future research. Although the competence
431 information was not effective in increasing self-efficacy, our findings demonstrate that self-
432 efficacy is a predictor of intentions and indirectly also of WGCB. We suggest more research
433 on increasing whole grain-related self-efficacy. These strategies could for example, include
434 positive feedback or recall exercises (Kreausukon et al., 2012; Luszczynska et al., 2007).
435 Similarly, more interactive interventions such as cooking workshops could be an effective
436 method to improve consumers' competence (Hollywood et al., 2018). Furthermore, we
437 suggest future research to replicate our study with an alternative method to measure WGCB,
438 such as ecological momentary assessment (e.g., Dohle & Hofmann, 2019). This method

439 allows a more accurate measurement of WGCB during participants' everyday life and is less
440 susceptible to certain biases of self-reported scales, such as the recall bias (Freedman et al.,
441 2014). Lastly, our intervention has implications for the future health communication of whole
442 grain benefits. Our findings stress that repeated exposure to health-related information about
443 whole grain products can be effective, which is an important insight for the future health
444 communication of general practitioners (GPs), nutritional advisors (NA), and other health
445 authorities. Since the consumption of whole grain products is linked to lower risks of
446 developing type 2 diabetes (Tieri et al., 2020), GPs and NAs should repeatedly stress these
447 health benefits when talking to patients or clients with a high type 2 diabetes risk. This study
448 used mails as communication channel, but a larger audience can be addressed through
449 launching public information campaigns on multiple channels such as through advertisements,
450 billboards, or on social media. As indicated by the message evaluation, participants rate health
451 information overall as positive, interesting, relevant, and show no problems in understanding
452 the content. However, to generate large effects on consumers' WGCB, interventions should
453 probably go beyond information provision, and address other barriers to whole grain
454 consumption such as increasing the availability, or reducing the price (Meynier et al., 2020).
455 Such multifaceted strategies that involve multiple stakeholders have been proposed by other
456 researchers as well (Suthers et al., 2018; Burgess-Champoux et al., 2008).

457 To conclude, our study shows that informing young adults about the health benefits of
458 whole grain products is an effective strategy to increase WGCB. This effect is mediated by
459 positive attitudes and high intentions to perform the behaviour. In contrast, providing recipe
460 suggestions did not lead to an increase in WGCB. Along similar lines, messages that
461 contained only information on health benefits were evaluated most positively. Hence, in order
462 to increase young adults WGCB, future communication of GPs, NAs and other health
463 authorities should focus on the health benefits of whole grain products.

464

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480 **References**

- 481 Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human*
482 *Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- 483 Aune, D., Keum, N., Giovannucci, E., Fadnes, L. T., Boffetta, P., Greenwood, D. C., Tonstad,
484 S., Vatten, L. J., Riboli, E., & Norat, T. (2016). Whole grain consumption and risk of
485 cardiovascular disease, cancer, and all cause specific mortality: Systematic review and
486 dose-response meta-analysis of prospective studies. *BMJ*, 353. doi: 10.1136/bmj.i2716
- 487 Armitage, C. J., & Conner, M. (1999). The theory of planned behaviour: Assessment of
488 predictive validity and 'perceived control'. *British Journal of Social Psychology*, 38(1),
489 35–54. <https://doi.org/10.1348/014466699164022>
- 490 Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*.
491 Prentice Hall.
- 492 Barrett, E. M., Batterham, M. J., Ray, S., & Beck, E. J. (2019). Whole grain, brand and cereal
493 fibre consumption and CVD: A systematic review. *British Journal of Nutrition*, 121,
494 914-937. 10.1017/S000711451900031X
- 495 Barrett, E. M., Foster, S. I., & Beck, E. J. (2020). Whole grain and high-fibre grain foods:
496 How do knowledge, perceptions and attitudes affect food choice? *Appetite*, 149,
497 104630. <https://doi.org/10.1016/j.appet.2020.104630>
- 498 Bouwman, E. P., Onwezen, M. C., Taufik, D., de Buissonjé, D., & Ronteltap, A. (2020). Brief
499 self-efficacy interventions to increase healthy dietary behaviours: evidence from two
500 randomized controlled trials. *British Food Journal*, 122(11), 3297–3311.
501 <https://doi.org/10.1108/BFJ-07-2019-0529>
- 502 Burgess-Champoux, T. L., Chan, H. W., Rosen, R., Marquart, L., & Reicks, M. (2008).
503 Healthy whole-grain choices for children and parents: a multi-component school-based
504 pilot intervention. *Public Health Nutrition*, 11(8), 849-859.

- 505 Carfora, V., Bertolotti, M., & Catellani, P. (2019). Informational and emotional daily
 506 messages to reduce red and processed meat consumption. *Appetite, 141*, 104331.
 507 <https://doi.org/10.1016/j.appet.2019.104331>
- 508 Chase, K., Reicks, M., & Jones, J. M. (2003). Applying the theory of planned behavior to
 509 promotion of whole-grain foods by dietitians. *Journal of the American Dietetic
 510 Association, 103*(12), 1639–1642. <https://doi.org/10.1016/j.jada.2003.09.026>
- 511 Chen, O., Mah, E., Dioum, E., Marwaha, A., Shanmugam, S. et al. (2021). The role of oat
 512 nutrients in the immune system: A narrative review. *Nutrients, 13*, 1048. doi:
 513 10.3390/nu13041048
- 514 Cordts, A., Nitzko, S., & Spiller, A. (2014). Consumer Response to Negative Information on
 515 Meat Consumption in Germany. *International Food and Agribusiness Management
 516 Review, 17*(A), 83–106. <https://doi.org/10.22004/ag.econ.164599>
- 517 De Wijk, R.A.; Maaskant, A.J.; Polet, I.A.; Holthuysen, N.T.E.; Van Kleef, E.; Vingerhoeds,
 518 M.H (2016). An In-Store Experiment on the Effect of Accessibility on Sales of
 519 Wholegrain and White Bread in Supermarkets. *Plos One, 11*, e0151915.
 520 <https://doi.org/10.1371/journal.pone.0151915>
- 521 Dohle, S., & Hofmann, W. (2018). Consistency and Balancing in Everyday Health Behaviour:
 522 An Ecological Momentary Assessment Approach. *Applied Psychology: Health and
 523 Well-Being, 11*(1), 148–169. <https://doi.org/10.1111/aphw.12148>
- 524 Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using
 525 G* Power 3.1: Tests for correlation and regression analyses. *Behavior Research
 526 Methods, 41*(4), 1149–1160. <https://doi.org/10.3758/BRM.41.4.1149>
- 527 Freedman, L. S., Commins, J. M., Moler, J. E., Arab, L., Baer, D. J., Kipnis, V.,
 528 Midthune, D., Moshfegh, A. J., Neuhouser, M. L., Prentice, R. L., Schatzkin, A.,
 529 Spiegelmann, D., Subar, A., Tinker, L. F., & Willet, W. (2014). Pooled results from 5
 530 validation studies of dietary self-report instruments using recovery biomarkers for
 531 energy and protein intake. *American Journal of Epidemiology, 180*(2), 172–188.
 532 <https://doi.org/10.1093/aje/kwu116>
- 533 Fishbein, M., & Ajzen, I. (2010). *Predicting and Changing Behavior - The Reasoned Action
 534 Approach*. Taylor & Francis Group. <https://doi.org/10.4324/9780203838020>
- 535 Fisher, W. A., Fisher, J. D., & Harman, J. (2003). The Information-Motivation-Behavioral
 536 Skills Model: A General Social Psychological Approach to Understanding and
 537 Promoting Health Behavior. In J. Suls & K. A. Wallston (Eds.), *Social Psychological
 538 Foundations of Health and Illness* (pp. 82–106). Blackwell Publishing.

- 539 Foster, S., Beck, E., Hughes, J., & Grafenauer, S. (2020). Whole Grains and Consumer
540 Understanding: Investigating Consumers' Identification, Knowledge and Attitudes to
541 Whole Grains. *Nutrients*, *12*(8), 2170. <https://doi.org/10.3390/nu12082170>
- 542 Freedman, L. S., Commins, J. M., Moler, J. E., Arab, L., Baer, D. J., Kipnis, V.,
543 Midthune, D., Moshfegh, A. J., Neuhouser, M. L., Prentice, R. L., Schatzkin, A.,
544 Spiegelmann, D., Subar, A., Tinker, L., & Willet, W. (2014). Pooled Results From 5
545 Validation Studies of Dietary Self-Report Instruments Using Recovery Biomarkers for
546 Energy and Protein Intake. *American Journal of Epidemiology*, *180*(2), 172–188.
547 <https://doi.org/10.1093/aje/kwu116>
- 548 Gallagher, K. M., & Updegraff, J. A. (2012). Health message framing effects on attitudes,
549 intentions, and behavior: a meta-analytic review. *Annals of Behavioral Medicine*,
550 *43*(1), 101–116. <https://doi.org/10.1007/s12160-011-9308-7>
- 551 Gaspar, R., Luís, S., Seibt, B., Lima, M. L., Marcu, A., Rutsaert, P., Fletcher, D.,
552 Verbeke, W., & Barnett, J. (2015). Consumers' avoidance of information on red meat
553 risks: information exposure effects on attitudes and perceived knowledge. *Journal of*
554 *Risk Research*, *19*(4), 533–549. <https://doi.org/10.1080/13669877.2014.1003318>
- 555 Hajhashemi, P. & Haghghatdoost, F. (2019). Effects of whole-grain consumption on selected
556 biomarkers of systemic inflammation: A systematic review and meta-analysis of
557 randomized controlled trials. *Journal of the American College of Nutrition*, *38*, 275-
558 285. doi: 10.1080/07315724.2018.1490935
- 559 Hayes, A. F. (2018). *Introduction to Mediation, Moderation and Conditional Process*
560 *Analysis: A Regression-Based Approach*. The Guilford Press.
- 561 Hollywood, L., Surgenor, D., Reicks, M., McGowan, L., Lavelle, F., Spence, M., Raats, M.,
562 McCloat, A., Mooney, E., Caraher, M., & Dean, M. (2018). Critical review of
563 behaviour change techniques applied in intervention studies to improve cooking skills
564 and food skills among adults. *Critical Reviews in Food Science and Nutrition*, *58*(17),
565 2882–2895. <https://doi.org/10.1080/10408398.2017.1344613>
- 566 Jalil, A. J., Tasoff, J., & Bustamante, A. V. (2020). Eating to save the planet: Evidence from a
567 randomized controlled trial using individual-level food purchase data. *Food Policy*,
568 *95*, 101950. <https://doi.org/10.1016/j.foodpol.2020.101950>
- 569 Jones, J. M., Reicks, M., Adams, J., Fulcher, G., Weaver, G., Kanter, M., & Marquart, L.
570 (2002). The Importance of Promoting a Whole Grain Foods Message. *Journal of the*
571 *American College of Nutrition*, *21*(4), 293–297.
572 <https://doi.org/10.1080/07315724.2002.10719226>

- 573 Kamar, M., Evans, C., & Hugh-Jones, S. (2016). Factors influencing adolescent whole grain
574 intake: A theory-based qualitative study. *Appetite, 101*, 125–133.
575 <https://doi.org/10.1016/j.appet.2016.02.154>
- 576 Kantor, L. S., Variyam, J. N., Allshouse, J. E., Putnam, J. J., & Lin, B.-H. (2001). Choose a
577 Variety of Grains Daily, Especially Whole Grains: A Challenge for Consumers. *The*
578 *Journal of Nutrition, 131*(2), 473S-486S. <https://doi.org/10.1093/jn/131.2.473S>
- 579 Kreausukon, P., Gellert, P., Lippke, S., & Schwarzer, R. (2012). Planning and self-efficacy
580 can increase fruit and vegetable consumption: a randomized controlled trial. *Journal of*
581 *Behavioral Medicine, 35*(4), 443–451. <https://doi.org/10.1007/s10865-011-9373-1>
- 582 Kuznesof, S., Brownlee, I. A., Moore, C., Richardson, D. P., Jebb, S. A., & Seal, C. J. (2012).
583 WHOLEheart study participant acceptance of wholegrain foods. *Appetite, 59*(1), 187–
584 193. <https://doi.org/10.1016/j.appet.2012.04.014>
- 585 Luszczynska, A., Tryburcy, M., & Schwarzer, R. (2007). Improving fruit and vegetable
586 consumption: a self-efficacy intervention compared with a combined self-efficacy and
587 planning intervention. *Health Education Research, 22*(5), 630–638.
588 <https://doi.org/10.1093/her/cyl133>
- 589 Magalis, R. M., Giovanni, M., & Silliman, K. (2016). Whole grain foods: is sensory liking
590 related to knowledge, attitude, or intake? *Nutrition & Food Science, 46*(4), 488–503.
591 <https://doi.org/10.1108/NFS-09-2015-0101>
- 592 Max Rubner-Institute (2008). *Nationale Verzehrsstudie II*.
593 <https://www.mri.bund.de/de/institute/ernaehrungsverhalten/forschungsprojekte/nvsii/>
- 594 Meynier, A., Chanson-Rollé, A., & Riou, E. (2020). Main Factors Influencing Whole Grain
595 Consumption in Children and Adults—A Narrative Review. *Nutrients, 12*(8), 2217.
596 <https://doi.org/10.3390/nu12082217>
- 597 Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new
598 method for characterising and designing behaviour change interventions.
599 *Implementation Science, 6*(1), 42. <https://doi.org/10.1186/1748-5908-6-42>
- 600 O'Donovan, C. B., Devlin, N. F., Buffini, M., Walton, J., Flynn, A., Gibney, M. J.,
601 Nugent, A. P., & McNulty, B. A. (2019). Whole grain intakes in Irish adults: findings
602 from the National Adults Nutrition Survey (NANS). *European Journal of Nutrition,*
603 *58*(2), 541–550. <https://doi.org/10.1007/s00394-018-1615-3>
- 604 Ross, A. B., Kristensen, M., Seal, C. J., Jacques, P., & McKeown, N. M. (2015).
605 Recommendations for reporting whole-grain intake in observational and intervention

- 606 studies. *The American Journal of Clinical Nutrition*, 101(5), 903–907.
607 <https://doi.org/10.3945/ajcn.114.098046>
- 608 Sanders, L. M., Zhu, Y., Wilcox, M. L., Koecher, K., & Maki, K. C. (2021). Effects of Whole
609 Grain Intake, Compared with Refined Grain, on Appetite and Energy Intake: A
610 Systematic Review and Meta-Analysis. *Advances in Nutrition*, 12(4), 1177–1195.
611 <https://doi.org/10.1093/advances/nmaa178>
- 612 Sandvik, P., Kihlberg, I., Lindroos, A. K., Marklinder, I., & Nydahl, M. (2014). Bread
613 consumption patterns in a Swedish national dietary survey focusing particularly on
614 whole-grain and rye bread. *Food & Nutrition Research*, 58(1), 24024.
615 <https://doi.org/10.3402/fnr.v58.24024>
- 616 Sandvik, P., Nydahl, M., Kihlberg, I., & Marklinder, I. (2018). Consumers' health-related
617 perceptions of bread—Implications for labeling and health communication. *Appetite*,
618 121, 285–293. <https://doi.org/10.1016/j.appet.2017.11.092>
- 619 Sang, S., Idehen, E., Zhao, Y., & Chu, Y. (2020). Emerging science on whole grain intake and
620 inflammation. *Nutrition Reviews*, 78, 21-28. doi: 10.1093/nutrit/nuz079
- 621 Seal, C. J., Courtin, C. M., Venema, K., & de Vries, J. (2021). Health benefits of whole grain:
622 Effects on dietary carbohydrate quality, the gut microbiome, and consequences of
623 processing. *Comprehensive Reviews in Food Science and Food Safety*, 20, 2742-2768.
624 10.1111/1541-4337.12728
- 625 Sette, S., D'Addezio, L., Piccinelli, R., Hopkins, S., Le Donne, C., Ferrari, M., Mistura, L., &
626 Turrini, A. (2017). Intakes of whole grain in an Italian sample of children, adolescents
627 and adults. *European Journal of Nutrition*, 56(2), 521–533.
628 <https://doi.org/10.1007/s00394-015-1097-5>
- 629 Slavin, J. (2004). Whole grains and human health. *Nutrition Research Reviews*, 17(1), 99–
630 110. <https://doi.org/10.1079/NRR200374>
- 631 Sogari, G., Li, J., Lefebvre, M., Menozzi, D., Pellegrini, N., Cirelli, M., Gómez, M. I., &
632 Mora, C. (2019). The Influence of Health Messages in Nudging Consumption of
633 Whole Grain Pasta. *Nutrients*, 11(12), 2993. <https://doi.org/10.3390/nu11122993>
- 634 Stelick, A., Sogari, G., Rodolfi, M., Dando, R., & Paciulli, M. (2021). Impact of sustainability
635 and nutritional messaging on Italian consumers' purchase intent of cereal bars made
636 with brewery spent grains. *Journal of Food Science*, 86(2), 531-539.
637 <https://doi.org/10.1111/1750-3841.15601>

- 638 Suthers, R., Broom, M., & Beck, E. (2018). Key characteristics of public health interventions
639 aimed at increasing whole grain intake: A systematic review. *Journal of nutrition*
640 *education and behavior*, 50(8), 813-823. <https://doi.org/10.1016/j.jneb.2018.05.013>
- 641 Tang, G., Wang, D., Long, J., Yang, F., & Si, L. (2015). Meta-Analysis of the Association
642 Between Whole Grain Intake and Coronary Heart Disease Risk. *The American Journal*
643 *of Cardiology*, 115(5), 625–629.
- 644 Tieri, M., Ghelfi, F., Vitale, M., Vetrani, C., Marventano, S., Lafranconi, A., Godos, J.,
645 Titta, L., Gambera, A., Alonzo, E., Sciacca, S., Riccardi, G., Buscemi, S., Del Rio, D.,
646 Ray, S., Galvano, F., Beck, E., & Grosso, G. (2020). Whole grain consumption and
647 human health: an umbrella review of observational studies. *International Journal of*
648 *Food Sciences and Nutrition*, 71(6), 668–677.
649 <https://doi.org/10.1080/09637486.2020.1715354>
- 650 Toups, K. E. (2020). Global approaches to promoting whole grain consumption. *Nutrition*
651 *Reviews*, 78(Supplement_1), 54-60. <https://doi.org/10.1093/nutrit/nuz067>
- 652 van de Mortel, T. F. (2008). Faking it: social desirability response bias in self-report research.
653 *The Australian Journal of Advanced Nursing*, 25(4), 40–48.
654 <https://doi.org/10.3316/ielapa.210155003844269>
- 655 van Kleef, E., Seijdell, K., Vingerhoeds, M. H., de Wijk, R. A., & van Trijp, H. C. (2018).
656 The effect of a default-based nudge on the choice of whole wheat bread. *Appetite*, 121,
657 179–185. <https://doi.org/10.1016/j.appet.2017.11.091>
- 658 van Kleef, E., Vrijhof, M., Polet, I. A., Vingerhoeds, M. H., & de Wijk, R. A. (2014).
659 Nudging children towards whole wheat bread: a field experiment on the influence of
660 fun bread roll shape on breakfast consumption. *BMC Public Health*, 14(1), 906.
661 <https://doi.org/10.1186/1471-2458-14-906>
- 662 Vecchio, R., & Cavallo, C. (2019). Increasing healthy food choices through nudges: A
663 systematic review. *Food Quality and Preference*, 78, 103714.
664 <https://doi.org/10.1016/j.foodqual.2019.05.014>
- 665 Verain, M. C. D., Sijtsema, S. J., Dagevos, H., & Antonides, G. (2017). Attribute
666 Segmentation and Communication Effects on Healthy and Sustainable Consumer Diet
667 Intentions. *Sustainability*, 9(5), 743. <https://doi.org/10.3390/su9050743>
- 668 Weingarten, N., Meraner, M., Bach, L., & Hartmann, M. (2022). Can information influence
669 meat consumption behaviour? An experimental field study in the university canteen.
670 *Food Quality and Preference*, 97, 104498.
671 <https://doi.org/10.1016/j.foodqual.2021.104498>

- 672 Wolstenholme, E., Poortinga, W., & Whitmarsh, L. (2020). Two Birds, One Stone: The
673 Effectiveness of Health and Environmental Messages to Reduce Meat Consumption
674 and Encourage Pro-environmental Behavioral Spillover. *Frontiers in Psychology, 11*,
675 577111. <https://doi.org/10.3389/fpsyg.2020.577111>
- 676 Wongprawmas, R., Sogari, G., Menozzi, D., Pellegrini, N., Lefebvre, M., Gómez, M. I., &
677 Mora, C. (2021). Determinants of US University Students' Willingness to Include
678 Whole Grain Pasta in Their Diet. *International Journal of Environmental Research*
679 *and Public Health, 18*(6), 3173. <https://doi.org/10.3390/ijerph180631734>

Appendix

Overview of messages per condition

	Health	Competences	Combined	Control
1	<p>Did you know that it is worth eating whole grain products on a daily basis? A diet rich in whole grains contains a lot of fibre, vitamins and minerals and can promote overall health. Over the next 14 days, you will receive daily advice on many of the health benefits associated with consuming whole grain products.</p>	<p>Did you know that it is very easy to eat whole grain products on a daily basis? A diet rich in whole grains can be integrated into your menu at breakfast, lunch, dinner and snack time. Over the next 14 days, you will receive daily recipe ideas as well as little tips and tricks for implementing a whole-grain diet. In addition, you will find many recipe ideas around the topic of whole grain products on the website https://eatsmarter.de/rezepte/ernaehrung/vollkorn.</p>	<p>Did you know that it is worth eating whole grain products on a daily basis and that it is also very easy to implement? A diet rich in whole grains contains a lot of fibre, vitamins and minerals and can promote overall health. Whole grain products can be integrated into your diet at breakfast, lunch, dinner and snack time. Over the next 14 days, you will receive daily tips on the many health benefits associated with consuming whole grain products, as well as recipe ideas and little tips and tricks to implement a diet rich in whole grains. In addition, you will find many recipe ideas around the topic of whole grain products on the website https://eatsmarter.de/rezepte/ernaehrung/vollkorn.</p>	<p>Do you know about seasonal foods? Over the next 14 days, you will receive daily recipe ideas for dishes prepared with seasonal fruits and vegetables. In addition, you will find many recipe ideas around the topic of fruits and vegetables on the website Eatsmarter https://eatsmarter.de/.</p>
2	<p>One of the many benefits of whole grain products is that they can help shed excess pounds. As whole grain products are very high in fibre, the body takes longer to digest whole grain products. This makes you feel full faster and longer, which means you eat less overall.</p>	<p>A little tip to get started with whole grain pasta is to try to mix whole grain pasta and normal pasta. This way you can gradually integrate more whole grain products into your everyday life and perhaps switch over completely at some point.</p>	<p>A little tip to get started with whole grain pasta is to try to mix whole grain pasta and normal pasta. This way you can gradually integrate more whole grain products into your everyday life and perhaps switch over completely at some point. One of the many benefits of whole grain products is that they can help shed excess pounds. As whole grain products are very high in fibre, the body takes longer to digest whole grain products. This makes you feel full faster and longer, which means you eat less overall.</p>	<p>If you need a few extra vitamins this winter, why not reach for mandarines. With one small mandarine you already cover 40% of your daily vitamin C requirements.</p>

3	<p>You can boost your immune system in the winter season by eating whole grain products daily. Besides fibre, whole grain products also contain many micronutrients such as selenium, zinc and magnesium, which strengthen the immune system and the body's defences.</p>	<p>Did you know that the classic butter biscuits from your childhood are also available as whole grain biscuits? Have a look for the whole grain version of biscuits or other pastries when you go shopping next time.</p>	<p>Did you know that the classic butter biscuits from your childhood are also available as whole grain biscuits? Whole grain biscuits are not only delicious but can also boost your immune system during the winter season. Besides fibre, whole grain products also contain many micronutrients such as selenium, zinc and magnesium, which can have a positive effect on your body's defences. Have a look for the whole grain version of biscuits or other pastries when you go shopping next time.</p>	<p>Do you like to eat mushrooms? Try this delicious recipe for stuffed mushrooms. https://www.chefkoch.de/rezepte/2381701377519700/Gefuellte-Champignons.html.</p>
4	<p>Did you know that consuming whole grain products leads to a reduction in the risk of type 2 diabetes? Whole grain products increase the body's insulin sensitivity, which reduces susceptibility to high blood sugar levels.</p>	<p>Start your day off with whole grain products -Whole grain products can be integrated into your breakfast in many ways, for example in the form of oatmeal in muesli or by eating a slice of whole grain bread.</p>	<p>Start your day off with whole grain products - Whole grain products can be integrated into your breakfast in many ways, for example in the form of oatmeal in muesli or by eating a slice of whole grain bread. By starting off the day this way, you can simultaneously reduce your risk of type 2 diabetes. Whole grain products increase the body's insulin sensitivity, which reduces susceptibility to high blood sugar levels.</p>	<p>Do you have potatoes and leeks left over? Prepare this delicious and healthy soup using these basic ingredients. https://biancazapatka.com/de/kartoffel-lauch-suppe/</p>
5	<p>High blood pressure can cause a variety of health problems. Consuming whole grain products can reduce the risk of high blood pressure and thus make an important contribution to better health.</p>	<p>Whole grain products in the restaurant? Next time you order, ask if your favourite pasta dish is also available as a whole grain version. L'Osteria and Vapiano are just two of many restaurants that offer their dishes as whole grain variants - also for delivery.</p>	<p>Whole grain products in the restaurant? Next time you order, ask if your favourite pasta dish is also available as a whole grain version. L'Osteria and Vapiano are just two of many restaurants that offer their dishes as whole grain variants - also for delivery. Doing so is good for you and your health. Whole grain products can reduce the risk of high blood pressure, which can cause a variety of health problems.</p>	<p>Do you like carrots? Carrots can be eaten raw, but also used as a side dish or baking ingredient. Try this carrot cake recipe. https://www.einfachmalene.de/der-perfekte-carrot-cake-mit-frischkaese/</p>

6	Daily consumption of whole grain products is beneficial for a good digestion and can also prevent constipation due to the high fibre content.	Not only are bread and pasta available as whole grain variants - rice also offers this alternative. Cook your favourite rice or wok dish with whole grain rice (also called brown rice) and notice that it is just as convenient to prepare.	Not only are bread and pasta available as whole grain variants - rice also offers this alternative. Cook your favourite rice or wok dish with whole grain rice (also called brown rice) and notice that it is just as convenient to prepare. In addition, daily consumption of whole grain bread, pasta and rice is beneficial for a good digestion and can prevent constipation due to the high fibre content.	Would you like to break up the morning routine with new recipes? Try starting the day with fruit and vegetable smoothies. Apples, carrots, beets, oranges, carrots, or celery are recommended seasonal ingredients for this.
7	Whole grain products can support your health in the long term. Statistically, life expectancy increases with increased consumption of whole grain products.	No time for breakfast in the morning? Prepare your whole grain breakfast the night before. This recipe for overnight oats promises a good start to the day - whether at home, on the road or in the office. https://overnight-oats.de/so-gehts/?cookie-state-change=1635942292304	No time for breakfast in the morning? Prepare your whole grain breakfast the night before. This recipe for overnight oats promises a good start to the day - whether at home, on the road or in the office. By doing so, you can also support your health in the long term. Statistically, life expectancy increases with increased consumption of whole grain products. https://overnight-oats.de/so-gehts/?cookie-state-change=1635942292304	Have you tried parsnips yet? This underrated vegetable is comparable to carrots but isn't quite as sweet. Try this recipe for baked parsnips. https://eatsmarter.de/rezepte/geb-ackene-pastinaken-2
8	Coronary heart disease is a common cause of death in Germany. Daily consumption of whole grain products can reduce the risk of coronary heart disease.	Whole grain products as an event? - Next time you have friends or family over, try the whole grain variant of tortilla wraps (available for example at Rewe, Lidl or Alnatura).	Whole grain products as an event? - Next time you have friends or family over, try the whole grain variant of tortilla wraps (available for example at Rewe, Lidl or Alnatura). Daily consumption of whole grain products can reduce the risk of coronary heart disease, which is a common cause of death in Germany.	Do you like beets? This tuber is not only low in calories, but also has a positive effect on blood pressure. Try this recipe for a beet cake. https://www.einfachbacken.de/rezepte/rote-bete-kuchen-schnell-so-saftig
9	Daily consumption of whole grain products contributes to better intestinal health. Due to the high fibre content, a diet rich in whole grains	Whole grain bread or whole grain buns from the bakery? Ask for whole grain products the next time you go shopping. Not only large bakeries like Kamps or Kraus but also small local	Whole grain bread or whole grain buns from the bakery? Ask for whole grain products the next time you go shopping. Not only large bakeries like Kamps or Kraus but also small local bakeries have a large selection of whole grain products - probably more than you think. In	Have you ever tried sweet potatoes? This trendy vegetable is very diverse and can also be prepared in different ways - you can find recipe ideas here.

	can improve the intestinal flora and prevent intestinal diseases such as diverticulitis.	bakeries have a large selection of whole grain products - probably more than you think.	doing so, you are also doing something for better intestinal health. Due to the high fibre content, a diet rich in whole grains can improve the intestinal flora and prevent intestinal diseases such as diverticulitis.	https://www.lecker.de/rezepte/suesskartoffel
10	Inflammatory processes in one's own body can sometimes go unnoticed due to a lack of symptoms. Whole grain products are considered anti-inflammatory, and their daily consumption can reduce inflammatory processes in the body.	In your Christmas baking, have you ever tried replacing half the flour in baking recipes with a whole grain variant? Try this waffle recipe or your own favourite recipe. https://eatsmarter.de/rezepte/dinkelwaffeln-mit-kirschsauce Of course, this also works with other baked goods such as cakes or bread.	In your Christmas baking, have you ever tried replacing half the flour in baking recipes with a whole grain variant? Try this waffle recipe or your own favourite recipe. https://eatsmarter.de/rezepte/dinkelwaffeln-mit-kirschsauce Of course, this also works with other baked goods such as cakes or bread and is good for your health at the same time. Due to the anti-inflammatory effects of whole grain food, you can reduce inflammatory processes in your body that sometimes go unnoticed.	Are you still looking for a starter for your Christmas menu? Try this recipe for a winter chestnut soup. https://www.chefkoch.de/rezept/e/1857511300993833/Winterliche-Maronensuppe.html
11	Daily consumption of whole grain products helps to bind cholesterol and removes it. This helps to reduce the risk of high cholesterol levels.	Do you like to eat crispbread? You can also buy a whole grain variant of this crunchy classic in the shop. Look for whole grain crispbread the next time you go shopping.	Do you like to eat crispbread? You can also buy a whole grain variant of this crunchy classic in the shop. Look for whole grain crispbread the next time you go shopping – it is not only crunchy, but also good for your blood lipid levels. Daily consumption of whole grain products helps to bind cholesterol and removes it. This helps to reduce the risk of high cholesterol levels.	Do you fancy a typical winter dish? Try this kale recipe https://www.lecker.de/grandiose-r-gruenkohl-77036.html
12	Did you know that whole grain products can reduce the risk of cancer? Daily consumption of whole grain products can reduce in particular the risk of	Do you like burgers? Then be sure to try this recipe for homemade whole grain burger buns for your next burger or buy the whole grain burger buns directly at Rewe or Edeka	Do you like burgers? Then be sure to try this recipe for homemade whole grain burger buns for your next burger or buy the whole grain burger buns directly at Rewe or Edeka. By choosing whole grain products, you can reduce your risk of cancer in the long term. Daily consumption of whole grain products can	Cabbage comes in many different varieties, and all of them contain many valuable nutrients. You can find an overview of different cabbage recipes here. https://www.chefkoch.de/magaz

	developing colorectal cancer.	https://www.burnhard.de/magazin/vollkorn-burger-buns-260	especially reduce the risk of developing colorectal cancer https://www.burnhard.de/magazin/vollkorn-burger-buns-260	in/artikel/1664,0/Chefkoch/Kohl-Rezepte-Vielfaltiger-Vitaminkick-im-Winter.html
13	Daily consumption of whole grain products can protect against developing obesity. Those who rely on whole grain products are fuller for longer and boost their metabolism.	Need another recipe suggestion for your next dinner? - This recipe for homemade whole wheat tagliatelle is very easy to recreate (with or without a pasta machine). https://www.kochbar.de/rezept/202229/Vollkornnudeln-selbstgemacht.html	Need another recipe suggestion for your next dinner? - This recipe for homemade whole grain tagliatelle is very easy to recreate (with or without a pasta machine). Because whole grains keep you fuller longer and boost your metabolism, consuming whole grains daily can help protect you from developing obesity. https://www.kochbar.de/rezept/202229/Vollkornnudeln-selbstgemacht.html	Are you still looking for a dessert for your Christmas menu? Try this delicious recipe for pear Helene. https://www.kochmit.de/kueche/birne-helene/
14	Whole grain products are good for the blood vessels. Daily consumption of whole grain products reduces the risk of stroke, because whole grain products can reduce the concentration of triglycerides and LDL cholesterol in the blood.	Do you like to eat pizza? You can also use whole wheat flour for the preparation of pizza dough - You can find instructions for a whole wheat pizza here. https://julesbalancedrecipes.com/gesunde-vollkornpizza/	Do you like to eat pizza? You can also use whole wheat flour for the preparation of pizza dough - You can find instructions for a whole wheat pizza here. https://julesbalancedrecipes.com/gesunde-vollkornpizza/ Whole grain pizza is not only easy to prepare, but the whole grain content is also good for your blood vessels. Daily consumption of whole grain products reduces the risk of stroke, because whole grain products can lower the concentration of triglycerides and LDL cholesterol in the blood.	Do you like to eat pumpkin? Try this recipe for pumpkin gnocchi. https://www.chefkoch.de/rezepte/1953131317830499/Saftiger-Kuerbis-Gnocchi-Auflauf.html



Short Communication

Can images and textual information lead to meat avoidance? The mediating role of cognitive dissonance

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ABSTRACT

The central research objective of this paper is to investigate cognitive dissonance as a mechanism to explain the effect of information provision on meat avoidance. As communication medium, we investigate the effect of images and textual information. We introduce a cognitive dissonance measure in an experimental online study with a between-subjects design ($n = 379$). Participants were regular meat-eaters and they received either textual information about the meat-health relationship, an animal-meat image, a combination of both, or a control stimulus. Our results show that images and textual information are effective at triggering dissonance in meat-eaters and that cognitive dissonance mediates the relationship between information provision and meat avoidance. Contrary to previous research, we found no support for a direct effect of images and textual information on meat avoidance. Our study shows potential avenues to reduce meat consumption of regular meat-eaters, which contributes to improving consumers' health and can reduce the negative impact of current meat production levels on animal welfare and environmental sustainability. When creating public information campaigns, policy makers and marketers should design information to trigger cognitive dissonance in consumers, because that is needed to yield an effect on meat avoidance.

1. Introduction

Global levels of meat consumption are rising with associated negative effects on human health, environmental sustainability, and animal welfare (Bonnet et al., 2020). There is growing consensus that a transition in consumers' dietary behaviour towards a meat-reduced or vegetarian diet is necessary to circumvent these negative effects (Dinu et al., 2017; Macdiarmid et al., 2012). Several lines of evidence suggest that information provision in form of images and text can reduce meat consumption (Carfora et al., 2019; Kunst & Hohle, 2016). Research regarding the underlying psychological processes which may enable information provision to reduce meat consumption remains relatively sparse. One mechanism that can explain the effects of information provision on meat avoidance is rooted in the theory of cognitive dissonance (Festinger, 1962). In meat-eaters, cognitive dissonance can arise from the inconsistency between the cognition that meat consumption is harmful for aspects of animal welfare, human health, and/or environmental sustainability on the one hand, and their meat consumption behaviour on the other hand. Although the application of cognitive

dissonance theory is widespread in food-related research, the inclusion of a direct measurement of cognitive dissonance in empirical research remains scarce, as pointed out in recent review papers (Lin-Schilstra & Fischer, 2020; Ong et al., 2017). Therefore, the central research objective of this paper is to investigate cognitive dissonance as a mechanism to explain the effect of information provision on meat avoidance behaviour. To operationalise cognitive dissonance, we introduce a new measurement.

2. Cognitive dissonance in meat-eaters

2.1. Cognitive dissonance: Theoretical basis

Cognitive dissonance theory postulates that holding inconsistent cognitions or behaviours causes psychological discomfort to people (Festinger, 1962). Conversely, behavioural and cognitive elements can be aligned: a state referred to as cognitive consonance. As theorised by Festinger (1962, p.17) "...if the overwhelming majority of relevant elements are consonant with, say, a behavioural element, then the

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dissonance with this behavioural element is slight. If in relation to the number of elements consonant with the behavioural element the number of dissonant elements is large, the total dissonance will be of appreciable magnitude'; the states of dissonance and consonance can be understood as a bipolar construct that ranges from inconsistency to consistency. The higher the magnitude of cognitive dissonance, the stronger people's motivation to reduce it and reach consonance. Based on the original cognitive dissonance theory by Festinger (1962), several researchers have further developed and specified the application of cognitive dissonance, amongst others, to food consumption in general (Ong et al., 2017) and meat consumption (Rothgerber, 2020). In order to reduce cognitive dissonance, consumers can engage in perceptual strategies and behavioural changes that can both reduce cognitive dissonance (Rothgerber, 2020). Perceptual strategies include, for instance, rationalising or justifying meat consumption for normality or necessity motives (Piazza et al., 2015). In contrast, cognitive dissonance reduction through behavioural changes leads to avoiding meat or at least reducing the current meat consumption (Rothgerber, 2020).

2.2. Triggering cognitive dissonance in meat-eaters

Cognitive dissonance can arise whenever consumers receive information that is inconsistent with or challenges their current beliefs, attitudes, values or self-view (Festinger, 1962). We argue that information provision can trigger cognitive dissonance via two possible routes: First, information can add new knowledge or disconfirm existing beliefs (Ong et al., 2017). For example, as many consumers evaluate meat eating rather positively (Piazza et al., 2015), providing consumers with information about the negative health-meat link creates a conflict between their knowledge and their behaviour, thereby creating cognitive dissonance. Second, information provision can inhibit the suppression of consumers' existing knowledge (Rothgerber, 2020). It is common knowledge that meat comes from animals and that this requires animal slaughter. However, multiple experiments have shown that consumers suppress this knowledge by dissociating meat from animals (e.g. Kunst & Hohle, 2016). By making the animal-meat link explicit to consumers, suppressing this knowledge is no longer possible which results in cognitive dissonance.

In order to trigger cognitive dissonance, with information different communication mediums can be used, such as textual information or images. Previous research has shown that both, textual information and images can be effective mediums to trigger meat avoidance (e.g. Carfora et al., 2019; Kunst & Hohle, 2016; Koch et al., 2022). But textual information and images may differ in their potential to trigger cognitive dissonance. Images are different from textual information, as they do not contain linguistic features and can therefore onset different internal responses. For instance, images lead to higher arousal (Houts et al., 2006) and are somewhat more memorable (David, 1998) compared to purely textual information. Therefore, images might be a more powerful tool to trigger cognitive dissonance compared to textual information. To the best of our knowledge no study yet has tested cognitive dissonance as a causal mechanism to explain the effect of information provision on meat avoidance.

2.3. Measuring cognitive dissonance

Different approaches can be identified among the few empirical studies that measure cognitive dissonance. Elliot and Devine (1994) focused on delineating multiple but unidimensional survey items that were assumed to reflect dissonance as a general feeling through associated cognitive and emotional indicators. They extracted three items 'uncomfortable, uneasy, and bothered' (p.389) using a Likert scale approach. This has two limitations: First, the application of a Likert scale might be not suitable to detect cognitive dissonance. Likert scales are constructed in such a way that they always begin with a zero point, which indicates that subjects show no intensity of the intended target

construct. Thus, a Likert scale cannot correctly capture constructs that lack a well-defined zero point and are instead conceptualised as a continuum (Schiffstein, 2012). Cognitive dissonance does not have a well-defined zero point but instead ranges on a continuum from consonance to dissonance. Furthermore, assessing psychological constructs with Likert scales can produce biased responses. An example of a documented bias is the acquiescence bias, i.e. that people tend to agree rather than disagree to survey items (Friborg et al., 2006). A semantic bipolar scale could overcome these disadvantages. A semantic bipolar scale uses polar adjectives as end-point anchors (e.g. warm-cold or good-bad), which do not have a well-defined zero point. It thereby overcomes the limited applicability of a Likert scale to measure cognitive dissonance by allowing the expression of cognitive dissonance as a continuous construct. In addition, this approach can lead to reduced response-biases, such as the acquiescence bias, without decreasing the psychometric quality of the measurement (Friborg et al., 2006). The second limitation of the scale by Elliot and Devine (1994) refers to measuring cognitive dissonance as a general feeling. According to the theoretical conceptualization of cognitive dissonance by Festinger (1962), cognitive dissonance is a context-dependent state, which is related to a specific situation. The latter limitation was addressed by Sweeney et al. (2000) who developed a context-dependent measure of cognitive dissonance in the domain of post purchase behaviour. The proposed scale is multidimensional and consists of three subscales, that targeted both, affective and cognitive aspects of cognitive dissonance. The cognitive aspect of this scale dealt with evaluating the purchase decision, whereas the affective dimension focused on the psychological discomfort related to the decision. Based on the previous scales from Elliot and Devine (1994) and Sweeney et al. (2000), the present study presents a modified cognitive dissonance measure.

3. The present research

The aim of the present study is twofold: First, we investigate the mediating role of cognitive dissonance as a causal mechanism to explain the effect of information provision on meat avoidance behaviour. We test the central hypothesis that information provision in the form of images and text triggers cognitive dissonance, which leads to meat avoidance. Second, we introduce a measure of cognitive dissonance by modifying existing scales from Elliot and Devine (1994) and Sweeney et al., (2000). Similar to Elliot and Devine (1994), we used multiple affect-related items to capture the psychological discomfort that are related to cognitive dissonance, but contrary we applied a semantic bipolar scale to overcome the limitations of a Likert scale (e.g. Friborg et al., 2006).

Similar to Sweeney et al., (2000), we created a context-dependent measure of cognitive dissonance related to meat consumption but we only focused on the affective dimension of the multidimensional scale and did not address the cognitive dimensions.

The present study focuses on regular meat-eaters and excludes consumers who are already following a meat-free diet. To trigger cognitive dissonance of meat-eaters, we have selected common stimuli from the meat reduction literature: textual information and images (e.g. Carfora et al., 2019; Kunst & Hohle, 2016). The content of the image sought to evoke cognitive dissonance by making the animal-meat relationship salient. As consumers tend to dissociate meat from its animal origin as a strategy to prevent cognitive dissonance (Kunst & Hohle, 2016), making this relationship salient through images should lead to increased cognitive dissonance. As content of the information treatment, we selected health-related information because existing research suggests that consumers perceive meat as rather beneficial for their diet (Piazza et al., 2015). As a measurement of meat avoidance, we have used a food choice task, in which participants could select between a vegetarian and meat option. We included a measurement of expected meat liking as a covariate in the experiment because expected food liking is typically an important driver of food choice (e.g. Bolos et al., 2021). The experiment

was conducted in full accordance with the declaration of Helsinki and all participants gave informed consent prior to study participation.

4. Method

4.1. Participants

We recruited 379 participants (Age $M = 27.77$, $SD = 8.58$; 225 men, 152 women, 2 non-binary) from Prolific (<https://www.prolific.co/>) who all received a financial incentive in exchange for their participation. Participants had an international profile, with 76 % being from Europe, 12 % from America, 8 % from Africa, 1 % from Australia, and 3 % who gave no information. All participants meet the eligibility criteria which were non-adherence to a vegetarian/vegan diet, regular pork consumption, and no food allergies/intolerances that would prevent participants from selecting a sandwich in the food choice task (e.g. gluten intolerance). Ineligible participants were screened out directly.

4.2. Study design and materials

The experiment followed a 2x2 between-subject design with the experimental factors image (conflict vs control) and text (conflict vs control). All materials from this study are available at: <https://osf.io/drf93/>. Participants in the conflict-text condition received the health text and a control image, participants in the conflict-image condition read the control text and the animal-meat image, while the conflict-combined group received the health text and the animal-meat image. The control group saw the control text and control image. Table 1 gives an overview of all experimental conditions.

The experimental survey was programmed in Qualtrics. After collecting socio-demographic data, we assessed participants' expected liking of two food products: A vegetarian sandwich (tomato and mozzarella) and a meat sandwich (ham and cheese). Both sandwiches were rated separately with five items each (e.g. 'I think this sandwich would taste good') on a 7-point Likert scale (1 = Strongly disagree, 7 = Strongly agree). The ratings for both products yielded excellent internal consistency ($\alpha_{\text{meat}} = 0.94$; $\alpha_{\text{vegetarian}} = 0.95$) and were merged into two average scores of expected liking.

The animal-meat image was designed in accordance with Kunst and Hohle (2016) by combining a pig with a pork product. In the experimental image, the pig was presented together with a ham sandwich. In the control group, the image contained only the ham sandwich. The texts were adapted from Weingarten et al. (2022) with the conflict-text describing negative health effects of red and processed meat consumption, as well as the positive effects of a meat-reduced diet and the control text an unrelated topic, i.e. the local university.

Next, we measured cognitive dissonance ('How do you feel about your own meat consumption') with five items on a 7-point semantic bipolar scale (relaxed-distressed; easy-uneasy; comfortable-uncomfortable; pleased-bothered; calm-upset) based on existing measurements of Elliot and Devine, (1994) and Sweeney et al., (2000). The cognitive dissonance scale yielded excellent internal consistency ($\alpha = 0.93$). For the analysis, we combined all five items into an average score.

Lastly, we measured participants' meat avoidance with a food choice task. Participants were asked to make a stated choice between the two food products (a vegetarian vs a meat sandwich), ('Please indicate which

one of them would be your preferred option') or choose the opt-out alternative. We defined meat avoidance as not choosing the meat option, hence, selecting the vegetarian option or selecting the opt-out alternative. To increase the realism of this choice, we asked participants to imagine themselves in a situation in which they usually eat sandwiches and to assume that both products are sold at the same price.

4.3. Data analysis

To analyse whether cognitive dissonance mediates the effect of information provision on meat avoidance of meat-eaters, we estimated two mediation models in PROCESS (Model 4, Hayes, 2018). The mediation analyses separately tested if the effect of conflict-image or conflict-text (compared to the respective control condition) on meat avoidance was mediated by cognitive dissonance. Both mediation models combined a linear regression model to estimate the effect of information provision on the mediator cognitive dissonance, and a logistic regression model to estimate the effect of information and the mediator on the dependent variable meat avoidance. To define meat avoidance in the model, we binary-coded the results from the choice scenario in order to categorise who approached and who avoided the meat sandwich (0 = meat approached, 1 = meat avoided). The independent variable was a dummy coded variable (0 = control condition, 1 = conflict-image/conflict-text). We controlled for expected liking scores of meat and vegetarian sandwiches and applied a heteroscedasticity-consistent standard error estimator (HC4; Cribari-Neto, 2004). Additionally, we explored interaction effects of images and text with a two-way ANOVA on cognitive dissonance and meat avoidance behaviour.

5. Results

Table 2 gives an overview of all means and standard deviation of cognitive dissonance and the frequencies of the outcomes in the food choice task. As shown in Fig. 1A, participants presented with the conflict-image showed an increase in cognitive dissonance compared to participants in the control group ($a_1 = 0.42$, $p = 0.004$). Similarly, the conflict-text increased participant's cognitive dissonance, relative to the control group ($a_2 = 0.41$, $p = 0.004$, Fig. 1B) and the magnitude of this effect was equal to the conflict-image. As expected, higher scores of cognitive dissonance increased the likelihood of avoiding meat ($b_1 \text{ and } 2 = 0.38$, $p < 0.001$). To investigate a significant mediational effect of cognitive dissonance, we analysed the 95% bootstrap confidence intervals of the relative indirect effects. The analysis showed that cognitive dissonance mediated the effects of conflict-image ($a_1 * b_1 = 0.16$, $CI = [0.05; 0.31]$), conflict-text ($a_2 * b_2 = 0.18$, $CI = [0.05; 0.30]$). Hence, information provision has an indirect effect on meat avoidance, which is mediated by cognitive dissonance. There was no evidence that information provision influenced meat avoidance independent of its effects on cognitive dissonance. Neither the total, nor direct effects of information provision had a significant impact on meat avoidance. Furthermore, the analysis of a two-way interaction effects of images and text yielded no significant result.

6. Discussion and conclusion

The central research objective of this paper was to investigate cognitive dissonance as a mechanism to explain the effect of information provision on meat avoidance. We focused on consumers who are regular meat-eaters and excluded participants that already follow a meat-free diet. To conceptualise cognitive dissonance, we introduce a new measurement of cognitive dissonance. The results from this study support the central research hypothesis that cognitive dissonance mediated the effect of information provision on meat avoidance. Information provision in the form of images and textual information were effective at triggering cognitive dissonance in meat-eaters. Our finding in relation to the mediating role of cognitive dissonance are in line with the cognitive

Table 1
Overview of experimental conditions of the 2x2 between-subjects design.

		Factor text	
		Control	Conflict
Factor image	Control	Control group	Treatment 1 "Conflict-text"
	Conflict	Treatment 2 "Conflict-image"	Treatment 3 "Conflict-combined"

Table 2
Means and standard deviations of key variables per experimental condition.

		Information provision				Whole sample 379
		Control 94	Conflict-text 90	Conflict-image 95	Conflict-combined 100	
Cognitive dissonance	<i>M</i>	2.53	2.98	2.99	3.35	2.97
	<i>SD</i>	1.28	1.31	1.37	1.47	1.39
Food choice outcome frequencies	Meat	57	47	51	52	207
	Vegetarian	33	35	37	39	144
	Opt-Out	4	8	7	9	28

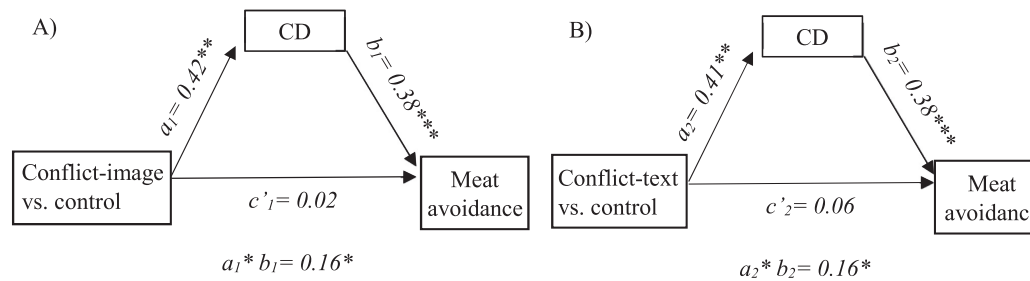


Fig. 1. Mediation models for image (panel A) and for text (panel B) stimuli with direct and indirect effects. Note. CD = Cognitive dissonance. Estimates for covariates have been omitted to improve readability. * ≤ 0.05 , ** ≤ 0.01 , *** ≤ 0.001 .

dissonance theory by Festinger (1962) and the meat-related cognitive dissonance framework by Rothgerber (2020). When consumers receive information that challenges their current beliefs, this leads to cognitive dissonance which was resolved by a behavioural adaptation in form of meat avoidance.

Interestingly, the results showed that the effect of conflict-images and conflict-text was of the same magnitude in triggering cognitive dissonance. These results do not correspond to other studies, that suggested a superior effect of images compared textual information (Houts et al., 2006; David, 1998). A possible explanation for a potential lack of such a difference is offered by Nissen et al. (2021), who compared the underlying neural processes when participants viewed either textual information, animated images, or photographs. Their results showed that photographs are processed similarly to text. In contrast, viewing animated images led to a different neural processing pattern (Nissen et al., 2021). Our conflict-image consisted of photographs rather than animated images, which might explain why the observed effects of the conflict-image were of the same magnitude as the conflict-text.

Furthermore, we found no direct effect of neither images, nor text on meat avoidance. This finding contrasts with previous research (Carfora, 2019; Kunst & Hohle, 2016). Possible reasons for the absence of significant direct and total effects might be that other variables had an opposing effect on the dependent variable (Hayes, 2018). For example, participants might have shown reactance in response to the information provision (Brehm, 1966). If participants perceived their freedom of choice to be threatened by the information provision, they may have explicitly exhibited a behaviour that preserved their freedom of choice by approaching the meat option instead of the vegetarian option. Support for this notion was offered in a recent study that showed that graphical warning labels could simultaneously trigger disgust and reactance in meat-eaters (Koch et al., 2022). Along similar lines, participants might have engaged in perceptual strategies, such as meat justification or denial to maintain their meat consumption behaviour (Rothgerber, 2020). This can also explain why some studies in the past failed to observe total effects of textual information provision on meat avoidance (e.g. Weingarten et al., 2022).

Some limitations of our study design should be noted. Meat avoidance was measured as a non-consequential stated choice question, which may have led to a biased response. More research is needed that replicates our findings with other measures of meat avoidance that have

higher external validity; for instance, with a behavioural measure that involves receiving an actual food product. Moreover, we only measured momentary meat avoidance. We do not know whether the effects on meat avoidance will persist to future food choices or whether the effect will attenuate over time. In addition, we did not measure the effect of moderating variables such as personal values for the effect of the information provision on cognitive dissonance. The relevance of personal values, such as, compassion in explaining meat avoidance, has been shown by several studies (e.g. Pohlmann, 2021). While moral appeals might have a universal effect in triggering cognitive dissonance, the effect of health appeals could be stronger in consumers who are highly health-consciousness (Rothgerber, 2020).

To conclude, the present study demonstrates that textual information and images have an indirect effect on meat avoidance of meat-eaters that is mediated by cognitive dissonance. Our study shows potential avenues to reduce meat consumption of regular meat-eaters, which can improve consumers' health and as well reduce the negative impact of meat production on animal welfare and environmental sustainability. Therefore, our findings yield important implications for policy making and future research. When creating public information campaigns, policy makers and marketers should design information to trigger cognitive dissonance in consumers, because according to our findings, that is needed to yield an effect on meat avoidance. Similarly, food packaging or restaurant décor (e.g. banners or menu design) can be created in a way that they trigger cognitive dissonance and thereby leading to meat avoidance. Moreover, we encourage future research to replicate our findings in other context, for example, by testing the effect of a congruent image and text in a different topical domain (e.g. environmental aspects of meat consumption). Lastly, more research is needed that empirically tests our measurement of cognitive dissonance as part of more complex frameworks, such as the meat-related cognitive dissonance framework by Rothgerber (2020) or the food cognitive dissonance framework by Ong et al., (2017). For example, individual differences in cognitive dissonance due to gender, dietary styles or values could be explored with the present scale.

CRediT authorship contribution statement

Nina Weingarten: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing.

Carl-Johan Lagerkvist: Conceptualization, Methodology, Writing – review & editing.

Declaration of Competing Interest

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

Data availability

We share our data via OSF and made the link available in the manuscript.

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References

- Bolos, L. A., Lagerkvist, C.-J., Normann, A., & Wendin, K. (2021). In the eye of the beholder: Expected and actual liking for apples with visual imperfections. *Food Quality and Preference*, 87, Article 104065. <https://doi.org/10.1016/j.foodqual.2020.104065>
- Bonnet, C., Bouamra-Mechemache, Z., Réquillart, V., & Treich, N. (2020). Regulating meat consumption to improve health, the environment and animal welfare. *Food Policy*, 101847. <https://doi.org/10.1016/j.foodpol.2020.101847>
- Brehm, J. W. (1966). *A theory of psychological reactance*. New York: Academic Press.
- Carfora, V., Catellani, P., Caso, D., & Conner, M. (2019). How to reduce red and processed meat consumption by daily text messages targeting environment or health benefits. *Journal of Environmental Psychology*, 65, Article 101319. <https://doi.org/10.1016/j.jenvp.2019.101319>
- Cribari-Neto, F. (2004). Asymptotic inference under heteroskedasticity of unknown form. *Computational Statistics & Data Analysis*, 45(2), 215–233. [https://doi.org/10.1016/S0167-9473\(02\)00366-3](https://doi.org/10.1016/S0167-9473(02)00366-3)
- David, P. (1998). News concreteness and visual-verbal association: Do news pictures narrow the recall gap between concrete and abstract news? *Human Communication Research*, 2(25), 180–201. <https://doi.org/10.1111/j.1468-2958.1998.tb00442.x>
- Dinu, M., Abbate, R., Gensini, G., Casini, A., & Sofi, F. (2017). Vegetarian, vegan diets and multiple health outcomes: A systematic review with meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition*, 57(17), 3640–3649. <https://doi.org/10.1080/10408398.2016.1138447>
- Elliot, A. J., & Devine, P. G. (1994). On the motivational nature of cognitive dissonance: Dissonance as psychological discomfort. *Journal of Personality and Social Psychology*, 67(3), 382. <https://doi.org/10.1037/0022-3514.67.3.382>
- Festinger, L. (1962). *A theory of cognitive dissonance*. Stanford University Press.
- Friborg, O., Martinussen, M., & Rosenvinge, J. H. (2006). Likert-based vs. semantic differential-based scorings of positive psychological constructs: A psychometric comparison of two versions of a scale measuring resilience. *Personality and Individual Differences*, 40(5), 873–884. <https://doi.org/10.1016/j.paid.2005.08.015>
- Hayes, A. F. (2018). *Introduction to mediation, moderation and conditional process analysis: A regression-based approach* (2nd ed.). The Guilford Press.
- Houts, P. S., Doak, C. C., Doak, L. G., & Loscalzo, M. J. (2006). The role of pictures in improving health communication: A review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling*, 2(61), 173–190. <https://doi.org/10.1016/j.pcc.2005.05.004>
- Koch, J. A., Bolderdijk, J. W., & van Ittersum, K. (2022). Can graphic warning labels reduce the consumption of meat? *Appetite*, 168, Article 105690. <https://doi.org/10.1016/j.appet.2021.105690>
- Kunst, J. R., & Hohle, S. M. (2016). Meat eaters by dissociation: How we present, prepare and talk about meat increases willingness to eat meat by reducing empathy and disgust. *Appetite*, 105, 758–774. <https://doi.org/10.1016/j.appet.2016.07.009>
- Lin-Schilstra, L., & Fischer, A. R. H. (2020). Consumer moral dilemma in the choice of animal-friendly meat products. *Sustainability*, 12(12), 4844. <https://doi.org/10.3390/su12124844>
- Macdiarmid, J. I., Kyle, J., Horgan, G. W., Loe, J., Fyfe, C., Johnstone, A., & McNeill, G. (2012). Sustainable diets for the future: Can we contribute to reducing greenhouse gas emissions by eating a healthy diet? *The American Journal of Clinical Nutrition*, 96(3), 632–639. <https://doi.org/10.3945/ajcn.112.038729>
- Nissen, A., Obermeier, G., Gier, N., & Auinger, A. (2021, December). Oh, what a cognitive relief! A NeuroIS study on visual designs of digital signages. *Presentation at ICIS 2021 proceedings*.
- Ong, A. S. J., Frewer, L. J., & Chan, M.-Y. (2017). Cognitive dissonance in food and nutrition—A conceptual framework. *Trends in Food Science & Technology*, 59, 60–69.
- Piazza, J., Ruby, M. B., Loughnan, S., Luong, M., Kulik, J., Watkins, H. M., & Seigerman, M. (2015). Rationalizing meat consumption. The 4Ns. *Appetite*, 91, 114–128. <https://doi.org/10.1016/j.appet.2015.04.011>
- Pohlmann, A. (2021). Lowering barriers to plant-based diets: The effect of human and non-human animal self-similarity on meat avoidance intent and sensory food satisfaction. *Food Quality and Preference*, 93, Article 104272. <https://doi.org/10.1016/j.foodqual.2021.104272>
- Rothgerber, H. (2020). Meat-related cognitive dissonance: A conceptual framework for understanding how meat eaters reduce negative arousal from eating animals. *Appetite*, 146, Article 104511. <https://doi.org/10.1016/j.appet.2019.104511>
- Schifferstein, H. N. (2012). Labelled magnitude scales: A critical review. *Food Quality and Preference*, 26(2), 151–158. <https://doi.org/10.1016/j.foodqual.2012.04.016>
- Sweeney, J. C., Hausknecht, D., & Soutar, G. N. (2000). Cognitive dissonance after purchase: A multidimensional scale. *Psychology & Marketing*, 17(5), 369–385. [https://doi.org/10.1002/\(SICI\)1520-6793\(200005\)17:5:3.CO:2-7](https://doi.org/10.1002/(SICI)1520-6793(200005)17:5:3.CO:2-7)
- Weingarten, N., Meraner, M., Bach, L., & Hartmann, M. (2022). Can information influence meat consumption behaviour? An experimental field study in the university canteen. *Food Quality and Preference*, 97, Article 104498. <https://doi.org/10.1016/j.foodqual.2021.104498>