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# **Changing Attitudes and Intentions toward Insect-Based Foods through Social Learning and Goals**

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## Abstract

Understanding how evaluations can be reliably measured and effectively modified remains a central challenge in psychological science, particularly when such evaluations are long-standing ones. This doctoral thesis investigates the measurement and modification of attitudes and intentions, with a specific focus on insect-based foods as a theoretically stringent and practically relevant case. Indeed, in Western contexts, insect-based foods are typically associated with disgust and rejection, despite their environmental and nutritional benefits.

The thesis is organised into five chapters. Chapter 1 situates the work within the context of research on learning and social learning approaches to attitude change. It reviews evidence showing that attitudes can be shaped through conditioning and vicarious strategies, while identifying a key area to which the present work can contribute: many existing paradigms rely on initially neutral targets or on newly experimentally acquired evaluations. This chapter therefore motivates the need to test whether learning-based interventions can shift long-standing negative attitudes that participants bring into the laboratory.

Chapter 2 addresses the methodological challenge of assessing evaluations. It combines the adaptation of existing instruments with the development of new direct and indirect measures, which are used to assess evaluations toward insect-based foods. The chapter examines the psychometric properties of these measures, providing the methodological foundation for the subsequent empirical studies.

Chapter 3 presents a series of experimental studies. Across studies, learning-based and social learning interventions are implemented to modify evaluations toward insect-containing

products. The results demonstrate that it is possible to modify pre-existing negative evaluations through brief, scalable, and applicable interventions.

Chapter 4 introduces classical and contemporary models of behavior to clarify how interventions targeting attitudes and intentions may acquire behavioral relevance. By reviewing attitude- and intention-based models, dual-process frameworks, and more recent goal-directed accounts, the chapter examines how contextual constraints, competing goals, and belief structures shape the translation of evaluative change into action.

Chapter 5 synthesizes the thesis's findings and integrates their theoretical, methodological, and practical implications. It discusses the limitations of the present work and outlines directions for future research, with particular attention to refining intervention strategies that can support behavior change.

Overall, this thesis contributes to a more nuanced understanding of how pre-existing negative attitudes can be measured and modified, as well as a conceptual discussion of how such changes may acquire behavioral relevance, offering empirically grounded and theoretically informed guidance for the design of psychologically viable interventions.

*Keywords:* attitude change, indirect measures, social learning, goal-directed perspective, insect-based foods.

# Chapter 1. General introduction

## Outline of the present chapter

This first chapter of this doctoral thesis explores the formation and modification of attitudes through conditioning and vicarious learning processes. It begins by situating attitudes as central constructs in psychological research, highlighting their significance across diverse domains. The discussion then turns to evaluative conditioning, a procedure for shaping attitudes, illustrating how the repeated pairing of different stimuli can alter evaluative responses. Both early and more recent studies are reviewed, demonstrating the robustness of evaluative conditioning across a wide range of contexts. Complementing this, vicarious learning paradigms are presented as pathways for attitude acquisition and change through observation, emphasizing how individuals' evaluations can be shaped by observing others' behavior without direct experience. The analysis of a variety of studies highlights the reliability of vicarious learning across different models, stimuli, and contexts, establishing it as a robust framework for influencing attitudes and assessing interventions in the absence of direct personal experience. Although decades of research have demonstrated the flexibility of conditioning and vicarious learning procedures in shaping novel evaluations of neutral stimuli, comparatively little work has examined how these methods operate when applied to long-standing negative evaluations.

Insect-based foods are then introduced as a particularly suitable case. These foods are generally perceived negatively in Western countries, evoking disgust and rejection and making them ideal targets for testing intervention strategies aimed at modifying pre-existing negative evaluations. In addition, unlike the abstract stimuli often used in laboratory research, insect-

based foods are directly linked to real consumption behaviors and offer tangible benefits in nutritional, environmental, and ethical terms. However, despite various tested interventional approaches (from educational marketing to informational sessions), attitudes and willingness to consume remain poor, suggesting the inadequacy of current strategies, which are primarily based on information provision.

Therefore, developing and testing more effective strategies to address consumer reluctance toward insect-based foods is particularly valuable. Theoretically, these foods offer a valid target for studying attitude change toward long-standing, negatively evaluated stimuli, and practically, successful interventions could promote meaningful changes at both individual and societal levels.

## **The study of attitudes and attitude change**

Attitudes can be conceptualized as mental representations that determine how we evaluate stimuli; that is, whether we respond in positive or negative ways to stimuli in our environment (De Houwer et al., 2021). The stimuli, also referred to as the object or target of the attitude, can be concrete, such as an object or a person, or an abstract construct, such as an idea or a value (Albarracin & Shavitt, 2018).

Research on attitudes has permeated nearly every area of psychology, establishing attitudes as one of the most widely studied constructs in the field (Cacioppo et al., 1997; Ajzen, 2001; Gawronski & Bodenhausen, 2007). In social psychology, attitudes have been examined to gain insight into social influence, persuasion, and opinion formation (Eagly, 1992; Hogg & Smith, 2007). In cognitive psychology, research has focused on the information-processing mechanisms underlying evaluation and attitude change (Wilson et al.,

2000). In health psychology, attitudes have been examined as key determinants of intentions and preventive health behaviors (Sheeran et al., 2016). For example, individuals who hold positive attitudes toward exercising (e.g., believing it is enjoyable) are more likely to form strong intentions to engage in regular physical activity. Political psychology has analyzed how attitudes shape ideological orientations, partisan identity, and political participation (Weiss, 2020; Lüders et al., 2024). This breadth of applications demonstrates the centrality of the attitude construct as a fundamental lens through which to understand how people interpret, evaluate, and respond to the world around them.

Although some evaluations may have a genetic component (Poulton & Menzies, 2002), the majority are acquired through experience rather than being innate (Rozin & Millman, 1987). Understanding how attitudes are formed, maintained, and modified is therefore a central concern in psychological science, with significant implications for fostering both individual and collective well-being.

In this thesis, specific attention will be devoted to evaluative conditioning and vicarious learning as strategies for the acquisition and modification of attitudes. These approaches were selected for two main reasons. First, these techniques are relatively easy to implement, as they typically rely on simple perceptual cues, most commonly visual pairings or the observation of others interacting with a stimulus. In many EC paradigms, evaluations are shaped through repeated co-occurrence between stimuli, often presented as pictures or short exposure sequences. Similarly, vicarious learning procedures typically involve observing models interacting with a product, through videoclips or very simple descriptive scenarios (e.g., short narratives indicating that a person tried a product and liked it). In contrast, techniques such as persuasive communication or educational interventions are often more demanding to implement as they typically require more structured intervention formats.

A second, related reason is that these characteristics also contribute to making these approaches relatively easy to scale in applied contexts. Because they primarily rely on visual cues and observational information, they can be readily embedded in communication materials such as advertisements, product packaging, or point-of-purchase displays, both in online environments and in physical retail settings.

## **Evaluative conditioning**

In one of the first experiments of what later became known as evaluative conditioning (EC), neutral words representing nationalities were paired with words conveying either positive or negative meanings. Participants read the nationality words on a screen while simultaneously hearing the positive or negative words aloud. One set of nationality words was consistently paired with positive words, while another set was paired with negative words. After this learning phase, participants rated the words paired with positive terms as more pleasant than those paired with negative terms (Staats & Staats, 1958). The first stimulus is typically designated as the conditioned stimulus (CS), while the second is referred to as the unconditioned stimulus (US). As a result of the EC procedure, the CS typically shows a change in valence depending on its pairing with the US: it tends to acquire a more positive evaluation when paired with a positive US and a more negative evaluation when paired with a negative US (De Houwer, 2007). In the last decades, EC has been widely applied, demonstrating its versatility in shaping evaluations across multiple contexts (Gast et al., 2012; Moran et al., 2023). For instance, Baeyens et al. (1988) investigated the effectiveness of the EC paradigm by examining how pairing neutral human faces with liked or disliked faces could alter the evaluation of the former. Their findings showed that the mere co-occurrence was sufficient to

change the valence of initially neutral faces, with these effects remaining detectable after two months. Similar studies have demonstrated the EC effect using CS consisting of computer-generated shapes with different color patterns (Gawronski et al., 2014), fictional brand names and logos (Van Dessel et al., 2025), and pseudowords (Ando & Kambara, 2023).

## **Vicarious learning**

Another widely studied and applied paradigm is vicarious learning. The historical development of vicarious learning research and its applications to attitude change represents one of the most significant advancements in experimental psychology, evolving from early theories of imitation to more sophisticated social cognitive frameworks that have informed intervention strategies for decades (Bandura et al., 1963; Bandura, 1977).

Albert Bandura's systematic research program, which began in the early 1960s, fundamentally transformed the understanding of learning processes and their relation to attitude change. The well-known Bobo doll experiments (Bandura, Ross, & Ross, 1961, 1963) demonstrated that children could acquire complex behavioral repertoires through observation alone. These studies provided experimental evidence that learning can occur without direct reinforcement of the observer's behavior, a principle considered essential in operant conditioning. The theoretical significance of these findings led to the formulation of Social Learning Theory (Bandura, 1977), which extended beyond stimulus-response associations that were the base for the theoretical explanations of EC in 1970-1990s' (e.g., Staats & Staats, 1958; Levey & Martin, 1975) to incorporate representational and cognitive processes, thereby establishing the theoretical foundation for understanding how attitude change can occur through observational learning.

Research has also shown that exposure to models displaying positive or negative reactions toward specific stimuli can systematically influence observers' responses, leading them to adopt similar evaluations. As a result, vicarious learning has emerged as a powerful pathway for attitude change in experimental psychology, operating through observational mechanisms that allow individuals to modify their evaluative responses without direct experience with the attitudinal target.

A well-studied domain in which vicarious learning plays a central role is fear acquisition, where witnessing others' responses to threatening stimuli can shape the observer's fear responses. For example, Dunne and Askew (2013) investigated the relative efficacy of maternal versus stranger models in children's fear acquisition. In their experiment, children viewed unfamiliar animal images paired with photographs of either their mother or a stranger displaying fearful or happy facial expressions. The results showed that fear beliefs increased equally for animals associated with fearful expressions, regardless of whether the model was familiar or unfamiliar to the participants. These findings demonstrate the robustness of vicarious fear learning and suggest that school-aged children are equally susceptible to acquiring fear from both familiar and unfamiliar social models. Further extending this line of research, Olsson and colleagues (2016) provided further evidence that a CS can acquire emotional significance through vicarious learning. In their study, participants observed a demonstrator receiving electric shocks paired with colored stimuli (CS). As a result, participants learnt to fear the CS even though they never experienced the shocks themselves.

Altogether, these studies provide initial evidence that participants can acquire negative responses to initially neutral CS through vicarious learning, highlighting the robustness of this mechanism across different ages, models, and experimental paradigms.

## Theoretical accounts of evaluative learning

Theoretical explanations of evaluative learning are often organized around a distinction between associative and propositional accounts. Regarding EC, associative perspectives assume that evaluative responses emerge from the formation or activation of mental associations between stimuli (Gawronski & Bodenhausen, 2018), typically as a result of repeated co-occurrence or other forms of spatiotemporal contiguity. According to this view, EC effects arise because the conditioned stimulus becomes linked in memory to the valence of the unconditioned stimulus, such that the evaluation of the latter is automatically activated when the former is encountered. In contrast, propositional accounts propose that evaluative learning depends on the formation of propositions about the relation between stimuli (e.g., that two stimuli co-occur or that a stimulus has a certain evaluative property, De Houwer, 2018).

Besides EC, this distinction can also be applied to other forms of evaluative learning, including vicarious learning. Associative accounts suggest that the simple co-occurrence of an object with approach- or avoidance-related behavior may create mental links between the stimulus and the valence typically associated with those behaviors, thereby shaping preferences through purely associative learning mechanisms. Vicarious learning effects can also be explained in terms of propositional learning processes (De Houwer et al., 2020; Zogmaister et al., 2023). People typically approach targets they like and avoid those they dislike. Therefore, when an observer learns that another person has approached an object, the observer may infer that the model likes that object. According to this account, such an inference unfolds through a series of propositional steps. First, the observer forms a proposition linking the object to the observed behavior (e.g., “The model approached the object”). Second, the observer retrieves relevant background knowledge connecting the behavior with its evaluative meaning (e.g.,

“People usually approach things they like”). Finally, by integrating these propositions, the observer may form an evaluation of the object (e.g., “The object is likeable”). Similar inferences can arise from avoidance behaviors, leading to negative evaluations of the target object.

## **Enhancing attitudes**

Both EC and vicarious learning approaches provide a framework for understanding how evaluative responses can be shaped and modified. However, despite the extensive literature on these paradigms, most research has focused either on neutral CS or on negative evaluations that are themselves experimentally induced within the laboratory.

## **Evaluative conditioning**

Most of the classic and contemporary EC studies use neutral stimuli as CSs. This approach allows researchers to clearly measure the direction and magnitude of attitude change, as the starting point is a (assumed) neutral one. A smaller portion of the literature, however, also focuses on valenced CSs. In counterconditioning paradigms, a valenced CS is paired with an opposite valence US, with the aim of altering previously learned evaluations (De Houwer, 2011).

Baeyens and colleagues (1989) were among the first to employ a counterconditioning paradigm, applying it to change previously conditioned images. First, they replicated the EC effect by showing that neutral pictures (CS) paired repeatedly with positive or negative faces (US) shifted in liking accordingly. Crucially, pairing the same CSs later with opposite-valence US reduced or reversed the acquired valence, indicating that new co-occurrences can alter evaluative responses. However, Stevenson and colleagues (2000) failed to replicate these

findings. In a subsequent picture–taste experiment, Kerkhof and colleagues (2011) directly compared three post-acquisition procedures applied to recently conditioned stimuli, measuring both explicit liking and indirect affect via affective priming, thus testing whether new CS-US pairings can shift evaluative responses. Six abstract cookie-shaped images served as CSs and were paired during acquisition with appetitive versus aversive cookie tastes. Critically, counterconditioning abolished and partly reversed the acquired valence, demonstrating that substituting an opposite-valence US can neutralize learned evaluations.

This approach has been particularly well studied in the domain of fear conditioning, where counterconditioning is used to reverse learned fear responses by establishing new valence contingencies. First studies evaluated whether counterconditioning adds value beyond exposure intervention for spider phobia by the assessment of three outcome variables: disgust, fear, and stimulus valence (De Jong et al., 2000). More precisely, in controlled treatment sessions with spider-phobic participants, extinction-based procedures were compared with counterconditioning that systematically paired spider cues (CS) with positive outcomes (e.g., pleasant images or reactions). Outcomes included self-reported disgust and fear, evaluative ratings of spiders, and behavioral/physiological indices across sessions and follow-up. Counterconditioning produced larger and more specific reductions in disgust and negative valence toward spiders than extinction-like exposure alone, indicating that rewriting evaluative meaning outperforms merely eliminating threat expectancy. Similarly, Raes and De Raedt (2012) directly compared counterconditioning with traditional extinction procedures using a fear conditioning paradigm. In their study, participants underwent acquisition training, where neutral human faces (CS) were initially paired with an aversive white noise (US), followed by one of three intervention conditions: extinction, neutral counterconditioning (pairing with a

neutral tone), or positive counterconditioning (pairing with a child's laughter). The results revealed that both forms of counterconditioning significantly reduced negative evaluative responses, as measured by an implicit affective priming task. However, these effects were not observed in self-report measures. Another study involving children compared extinction and counterconditioning as strategies for reducing learned fear (Newall et al., 2017). Children aged 7–12 first underwent a fear acquisition phase in which pictures of novel animals (CS) were paired with a scared human face (US). During the subsequent counterconditioning phase, the same CS were paired with happy faces. The findings revealed that counterconditioning effectively reduced both fear-related beliefs and avoidance behaviors toward the CS.

A more recent experiment investigated whether counterconditioning could reduce the negative valence of a CS and prevent the return of fear, in comparison with extinction training. Participants first completed an acquisition phase during which pictures (CSs) were paired with an electric shock. In the subsequent counterconditioning phase, positive film clips were employed as new US. Counterconditioning successfully reduced the negative valence of the stimuli relative to extinction interventions, but it did not prevent fear recovery or the reinstatement of fear. The authors concluded that these findings suggest that, although counterconditioning can modify stimulus evaluation, it does not appear to reduce the return of fear (Van Dis et al., 2019). Similar findings emerged in a study employing geometric shapes (CSs) and aversive and positive sounds (USs). Consistent with previous results, counterconditioning did not show increased effectiveness in preventing the return of threat expectancies or influence valence ratings when compared with standard extinction interventions (Quintero et al., 2024). Zenses et al. (2021; 2023) investigated the effect of a counterconditioning procedure on the mere thought of an aversive outcome. While standard

extinction training effectively reduced traditional measures, such as outcome expectancies, it was less successful in diminishing participants' thoughts of the aversive outcome. In contrast, a counterconditioning intervention was more effective. Finally, another line of counterconditioning research has investigated its effects on evaluative learned disgust. Engelhard and colleagues (2014) demonstrated that counterconditioning could reduce previously acquired disgust. In their study, participants first underwent an acquisition phase in which two colored symmetrical pictures (CSs) were paired with disgusting images (USs). In the subsequent counterconditioning phase, the co-occurrence of CSs with reversed USs reduced the previously conditioned disgust.

In sum, the reviewed literature suggests that counterconditioning represents a theoretically compelling approach for investigating evaluative change. Importantly, however, counterconditioning paradigms address the modification of attitudes that were *formed in the laboratory* through prior conditioning phases. In these studies, participants initially hold neutral evaluations of the CS, which are subsequently shifted in a negative direction through experimental pairings, and then subsequently reversed by introducing a US of opposite valence. Thus, in these cases, negative evaluative responses are recent and experimentally formed.

Research applying EC procedures to negative evaluations is comparatively scarce. Some relevant examples come from the literature on racial implicit bias. For instance, Olson and Fazio (2006) showed that EC could modify evaluations toward racial outgroups as assessed with the Implicit Association Test (IAT, Greenwald et al., 1998), although these changes did not generalize to self-report measures. Similarly, Lai and colleagues (2014) found that repeatedly pairing black faces with positive stimuli reduced racial preferences, again with effects observed primarily on indirect measures. While these studies demonstrate that EC can

operate on negative pre-existing attitudes, the evidence remains limited both in number and in scope. In line with this, Perugini and colleagues (2012) noted that, in a comprehensive meta-analysis on evaluative conditioning by Hofmann et al. (2010), studies employing initially-valenced CSs accounted for only a small fraction of the total sample (17 out of 191, corresponding to 8.9%).

## **Vicarious learning**

Contemporary research in vicarious learning has increasingly focused on modifying evaluative reactions toward specific stimulus categories, particularly in the context of fear reduction.

Several studies have investigated vicarious learning as a means of reducing fear, finding that positive vicarious experiences can reduce fear responses in both children and adults (Kelly et al., 2010; Newall et al., 2015; Reynolds et al., 2018). Importantly, in these paradigms, the fear-related evaluations targeted for change are themselves acquired within the experimental context, such that subsequent positive modelling functions as a form of counter-modelling rather than as a modification of pre-existing fear. For instance, Newall et al. (2015) demonstrated that fear acquired through threatening verbal information can be reduced using positive information and observational modelling. In their study, participants first developed fear beliefs about a novel, fictitious animal through verbal threat information and then underwent a fear reduction phase, during which they observed positive interactions with the animal. The findings indicated that combining observational modelling with positive information can reduce acquired fears.

In a recent review, Krause and Askew (2022) examined fourteen experiments employing vicarious learning procedures to reduce fear in child samples. Although the specific procedures varied across studies, they shared a common feature: fear reduction was implemented through positive modelling, whereby participants observed models interacting positively with the conditioned stimulus. Importantly, across the reviewed experiments, fear reduction targeted either neutral conditioned stimuli or stimuli toward which participants had acquired fear evaluations within the laboratory. In addition, only 48% of the fear reduction experiments demonstrated a positive modeling effect, indicating the need for further research to clarify the variability in outcomes.

Beyond fear reduction, vicarious learning has been shown to influence a range of attitudes and preferences. For instance, research on attitudes toward the police showed that vicarious experiences, such as learning about others' encounters with police, can influence attitudes (Rosenbaum et al., 2005). Similarly, Buckley and Malouff (2005) demonstrated that observing models express positive attitudes toward psychological therapy, especially when these behaviors are socially reinforced, leads participants to develop more favorable evaluations of mental health services.

Zogmaister et al. (2023) investigated whether observing others' brand-directed influences observers' preferences. Participants read scenarios in which a character consistently approached Brand A and avoided Brand B, and then rated the brands using both explicit measures and indirect categorization tasks. Observers consistently favored the brand approached by the model, both when the model's behavior was explicitly instructed and when it was described as random, indicating a robust vicarious effect.

Results from a recent review about eating habits (Suwalska & Bogdański, 2021) also confirm that social learning is a robust phenomenon, not limited to laboratory settings. It can

occur when another person is physically present, but also when the model is not present, for instance, when others' behavior is conveyed through textual information, such as reports of the amounts consumed by others. Finally, the flexibility of vicarious learning also extends to intergroup attitudes. Preuß and Steffens (2021) tested a brief video-based vicarious contact intervention to improve heterosexual men's attitudes toward gay men. Participants watched short videos depicting positive interactions with gay men, then reported explicit and implicit attitudes. The intervention increased positive attitudes overall, suggesting scalable media interventions can shift intergroup attitudes by vicarious contact.

The reviewed literature suggests that vicarious learning serves as a flexible and widely applicable mechanism for influencing evaluations across various domains, ranging from fear reduction to consumer preferences and intergroup attitudes. At the same time, much of this evidence derives from studies targeting evaluative change toward initially neutral conditioned stimuli, or toward stimuli that elicit negative evaluations only as a result of prior experimental learning. Moreover, although positive modelling and related vicarious procedures have been shown to influence negative evaluations in diverse settings, their effectiveness appears variable when applied to pre-existing evaluations, as highlighted by the mixed findings reported. Consequently, it remains an open question as to what extent vicarious learning can be applied to modifying long-standing, well-established negative evaluations embedded within broader belief systems.

## **Why do we need more research?**

The reviewed evidence highlights the need for further research that moves beyond experimentally induced evaluations to address the modification of negative attitudes as they occur outside the laboratory. In particular, two considerations motivate closer investigations. First, long-standing attitudes differ from recently formed evaluations in their stability, learning history, and degree of integration within broader belief systems, which may fundamentally constrain their susceptibility to learning-based interventions. Second, negative attitudes are not merely the inverse of positive ones, but often exhibit distinctive affective, motivational, and cognitive properties. Addressing these two features, long-standingness and negativity, is therefore essential for developing a more complete understanding of when and how learning-based interventions can effectively alter entrenched evaluative responses.

### **Long-standing attitudes**

Most research employing EC and vicarious learning paradigms has focused on evaluations of initially neutral CS, with comparatively few studies targeting negative attitudes. Studies addressing negative evaluations have predominantly done so within counterconditioning or similar paradigms. In these designs, participants initially acquire a negative evaluation of the CS through an experimental learning procedure, and this evaluation is subsequently modified by either pairing the stimulus with a positive US or by exposure to models interacting positively with the CS. Although such approaches provide important insights into how experimentally induced evaluations can be modified, they differ in critical respects from attempts to modify pre-existing, long-standing negative attitudes. Specifically, in counterconditioning paradigms, the negative evaluation targeted for change is recently acquired, artificially induced within the laboratory context, and likely to be only weakly

integrated into participants' broader belief systems. As a consequence, effective strategies involved in reversing such evaluations may not generalize to attitudes that are long-standing, repeatedly reinforced, and deeply embedded in individuals' belief networks, as they are more resistant to change (Albarracin & Shaivitt, 2018).

Moreover, long-standing beliefs may be less malleable to new information, such that when deciding whether and which behavior to enact, information sampling may retrieve inaccurate or outdated action-outcome links. This is consistent with the idea that information sampling during action preparation is thought to be stochastic rather than exhaustive (Sanborn & Chater, 2016). As a result, information sampled at the moment of choice is disproportionately influenced by prior experiences and expectations. For example, in the case of insect-based foods, rejection may have been repeatedly reinforced if negative reactions are perceived as appropriate or normative, or because protein choices have long been associated with meat-based options. Even when new information, such as the nutritional or environmental advantages of insect-based foods, becomes available, meat-based options may continue to be preferred due the reliance on previously learned action-outcome contingencies (Buabang et al., 2023) and to the information sampling that occurs at the moment of choice. In principle, if individuals had unlimited time and cognitive resources to sample exhaustively, all the relevant information could be taken into account (Chater et al., 2020). Moreover, another difference between long-standing and newly formed evaluations lies in the fact that the information underlying the former may be acquired across multiple contexts. In the case of insect-based foods, this may involve repeated exposure to negative messages on different occasions, such as learning at school, at home, or through culturally shared narratives that portray insects as inappropriate food sources. This may limit later interventions, as the effectiveness seems context-specific (Bouton et al., 2002).

## Negative attitudes

Although an extensive body of research has examined moderators of (evaluative) learning paradigms (see De Houwer & Hughes, 2020), the specific role played by the nature of the stimuli involved has received comparatively little attention. Relatively little work has directly targeted the modification of evaluative responses to initially negative stimuli, with notable exceptions in the domain of fear reduction. Instead, most experimental programs have focused on how to establish novel evaluative responses toward initially neutral CS, thereby prioritizing acquisition paradigms over valence change for pre-negatively evaluated targets.

One reason for this emphasis may be the considerable flexibility of these paradigms: EC has demonstrated robustness across an impressively diverse set of CS materials, including nonwords, pseudowords, geometric and abstract shapes, pictures, auditory stimuli, and foods, suggesting broad procedural generality in both laboratory and applied contexts (De Houwer et al., 2001; Hofmann et al., 2010; Moran et al., 2023). Likewise, interventions based on vicarious learning have proven versatile across formats, including live demonstrations, recorded videos of expert or peer performance, dialogue- and discourse-based instructional footage, computer-based instruction, and virtual-reality simulations, further reinforcing the perception of method-level generalizability.

From this perspective, one might be tempted to assume that if a learning procedure reliably shifts evaluations for a neutral CS by a given magnitude, the same procedure should, in principle, operate similarly even with negative evaluations of CS. Some findings from vicarious learning research appear to support this conclusion: studies in developmental contexts report vicarious fear learning for both negative fear-relevant (e.g., snakes) and neutral or positive fear-irrelevant (e.g., flowers or unfamiliar animals) CSs, with comparable speed,

magnitude, and robustness across categories that differ in a priori baseline evaluation (Dunne et al., 2017).

However, extending this inference wholesale would be unwarranted, because negative evaluations might not be merely the quantitative inverse of positive ones along a single bipolar valence dimension; instead, they may belong to different evaluative spaces with unique characteristics and boundary conditions for change (Cacioppo et al., 1997). Consequently, the assumption of evaluations-invariant efficacy risks obscures meaningful differences.

This asymmetry becomes even more evident when considering attitudes toward a specific behavior. There is a broad consensus that behavior is often goal-driven, with actions functioning as means to attain desired end-states (Moors et al., 2017). Crucially, the goals associated with acting and not acting are often different rather than strictly opposite (Richetin et al., 2011). For instance, choosing a plant-based meal may reflect goals related to health promotion or environmental concern, whereas *not* opting for a plant-based option may serve goals such as taste satisfaction or the preservation of familiar eating routines, without implying opposition to health or sustainability goals.

Another reason to anticipate asymmetries in evaluative change between positive and negative stimuli is the well-documented negativity bias (Rozin & Royzman, 2001), which indicates that negative information is typically more salient, memorable, and influential than positive information across evaluation, affect, and behavior. For instance, negative behaviors and even unfulfilled intentions are judged as more diagnostic of a person's morality (Mendes-Siedlecki et al., 2013; Hirozawa et al., 2020), and negative feedback or events often exert greater weight on belief updating and decision-making than equivalently strong positive inputs (Cone & Ferguson, 2015; Falkowski & Jabłońska, 2018). For instance, Falkowski & Jabłońska (2018) analyzed how additional valenced information about a political candidate affects

subsequent evaluations. The results showed that additional unfavorable traits had a stronger effect than comparable positive traits of similar strength. Evidence for negativity bias also appears in conditioning research, though early findings were mixed regarding its presence and magnitude in EC (Hütter et al., 2012; Landwehr et al., 2017). While prior work debated whether EC exhibits a consistent negativity bias, more recent evidence shows that when positive and negative US compete within the same learning context, negative US tend to receive greater weighting than positive US (Ingendahl et al., 2024).

Whether common manipulations are effective with negatively evaluated stimuli is ultimately an empirical question, not merely a theoretical conclusion. One example can be found in approach-avoidance research. A large body of work suggests that approaching a target, whether through overt action, instructed meaning, or even an imagined approach, typically yields more positive evaluations (Cacioppo et al., 1993; Woud et al., 2013; Van Dessel et al., 2015; Chen & Van Dessel, 2024). The positive shift in evaluation is not solely due to the physical act of moving toward the stimulus, but also depends on how the action is interpreted; when participants are told their actions mean "approach", the effect is stronger (Chen & Van Dessel, 2024; Rougier et al., 2025). However, when CS possess negative valence, some findings (Centerbar & Clore, 2006) indicate that avoidance can lead to relatively more positive attitudes. In contrast, the approach can exacerbate negativity, suggesting boundary conditions on the usual approach-positivity link for negatively valenced targets.

These asymmetries underscore the importance of empirically testing counter-attitudinal manipulations on negatively evaluated stimuli, as the nature of the evaluation itself warrants consideration. Interventions aimed at improving evaluative responses to negative stimuli should therefore be developed and validated for those specific targets.

## **Insect-based foods as a case for research on long-standing negative evaluations**

Building on the theoretical and empirical considerations outlined above, insect-based foods provide a particularly suitable case for investigating long-standing negative evaluations. First, insect-based foods are a negative attitudinal target for many consumers from Western countries (Castro & Chambers, 2019; Ribeiro et al., 2024). Insects can evoke negative emotions such as disgust, and their consumption is considered a “primitive behavior” (Huis, 2013). A substantial body of research has examined the factors influencing the acceptance or rejection of entomophagy (i.e., the practice of consuming insects), with disgust toward insects and food neophobia emerging as the primary determinants (see Kröger et al., 2022, for a review on the acceptance of insect-based foods).

Second, the negative attitudes toward insect consumption are particularly relevant because they represent prejudice-based rather than experience-based evaluation. Indeed, apart from unpleasant tastes, there are no universal inherent qualities of foods that elicit disgust per se but rather may result from the perception that such foods deviate from the norm, causing consumers to intuitively reject them even without direct personal experience with eating insects (Looy et al., 2014; Koch et al., 2021). The strength of these negative evaluative responses, combined with their basis in learned rather than innate associations, makes insect-based foods a suitable attitudinal object for testing intervention strategies.

Moreover, employing insect-based foods as stimuli for conditioning and vicarious learning research is particularly valuable because, unlike many neutral or abstract stimuli commonly used in evaluative conditioning and vicarious learning paradigms, they carry real-world meaning and relevance. These foods elicit strong evaluative responses that are directly

linked to concrete behavior, namely, the act of consumption, allowing researchers to examine how learned evaluations translate into real-life choices. This potential for straightforward assessment of translation into the real world distinguishes insect-based foods from the stimuli often used in laboratory studies, providing a unique opportunity to investigate the effectiveness of intervention strategies in shaping attitudes toward meaningful, behaviorally relevant targets.

Finding effective ways to encourage the consumption of insect-based foods is particularly valuable, as these foods are inherently connected to tangible outcomes for health, environmental sustainability, and ethical food choices. Their high nutritional value provides an alternative source of protein, vitamins, and essential micronutrients (Batat et al., 2020; Oonincx & Finke, 2021), while their production requires fewer natural resources, generates lower greenhouse gas emissions, and produces less waste than conventional livestock farming (Van Huis & Oonincx, 2017; Abbasi, 2025). Additionally, according to some authors, consuming insects helps mitigate the ethical concerns associated with animal suffering (see Pali-Schöll et al., 2019 for a detailed discussion on the issue). The peculiar characteristics of these foods make insect-based products an especially useful target for research on attitude change.

Several strategies have been employed to enhance evaluative responses toward insect-based foods. Some studies focused on specific marketing interventions related to the product packaging (e.g., removing the image of the insects or making it less realistic, adding a nutritional claim) (Pozharliev et al., 2023; Pascucci & Magistris, 2013), or including celebrities as testimonials (Park et al., 2022) while others tested the effectiveness of educational sessions (Szczepanski et al., 2022), seminars and tasting sessions (Sogari et al., 2017), persuasive messages (Verneau et al., 2016), writing short essays (Stone et al., 2023), positive information and social norm nudges (Suzuki & Park, 2018); Bao & Song, 2022).

However, attitudes toward and willingness to try insect-based foods remain poor (Modlinska et al., 2021; Kröger et al., 2022; Pacholek et al., 2025). As addressed by the European Union during the event “How to make sustainable diets the norm?”, one reason lies in the inadequacy of policies that solely focus on providing people with food information about health and sustainability. Moreover, studies investigating the impact of information regarding the advantages of entomophagy have revealed conflicting findings. While some studies have proven the effectiveness of this approach (e.g., Ardoin & Prinyawiwatkul, 2020; Naranjo-Guevara et al., 2021), others have not. For instance, Arena et al. (2020) found that consumers' perceptions about insect-based foods were not altered by receiving information about these products. Additionally, while educational sessions, seminars, and writing essays can be effective methods, their scalability is inherently limited. These interventions require significant time and individualized attention, making it challenging to reach broader audiences.

Given the current state of knowledge, insect-based foods offer a valuable opportunity for both theoretical and applied research. They allow us to examine whether and under what conditions pre-existing, long-standing negative evaluations can change, while also providing a practical testbed for interventions that could foster healthier, more sustainable, and ethically conscious food choices at both the individual and societal levels.

## **Organization of the thesis**

The aim of this doctoral thesis is to investigate attitudes toward negatively evaluated stimuli, specifically insect-based foods. More specifically, it focuses on developing and validating measures to assess these attitudes, both self-reported and indirect, and on testing intervention strategies aimed at modifying evaluations of these targets. In addition, some of

these interventions will be evaluated by measuring participants' behavior in real-life consumption contexts. Finally, findings from this work will be integrated into a theoretical framework that can inform the design of effective interventions for behavioral change.

Chapter 2 examines the development and testing of indirect measurement approaches for assessing attitudes toward insect-based foods, with the aim of providing more comprehensive assessments of evaluative responses. Specifically, this chapter tests the psychometric properties of adapted indirect measures, including the Brief Implicit Association Test (BIAT, Sriram & Greenwald, 2009), the Manikin Task (De Houwer et al., 2001), and the Swipe-AAT, a new mobile version of the Approach-Avoidance Task. Across four experiments, we manipulate administration modes, training phases, stimulus types, number of blocks and trials, and assessing the reliability and association with other variables.

Chapter 3 shifts focus to intervention strategies, systematically examining the effectiveness of multiple attitude change paradigms applied to negatively evaluated targets. Across eight studies, this chapter explores how different learning and social learning interventions can modify evaluative responses toward insect-based foods, while identifying their boundary conditions.

Chapter 4 introduces a range of theoretical frameworks concerned with the prediction of behavior, spanning classic attitude-based models as well as more recent goal-directed accounts. These frameworks are discussed to examine how changes in psychological constructs, such as attitudes and intentions, may acquire behavioral relevance. In the second part of the chapter, particular attention is devoted to the Goal-Directed Predictive Processing (GDPP; Van Dessel et al., 2025) framework, with the aim of outlining how individual goals, beliefs, and action predictions dynamically interact to guide behavior. To illustrate its practical utility, the chapter includes a focused application to insect-based food consumption,

demonstrating how the framework can inform strategies for fostering sustainable dietary choices.

Finally, Chapter 5 synthesizes the empirical and theoretical contributions across all studies, reflecting on the strengths and limitations of the present research program and identifying future research directions aimed at developing more effective and behaviorally relevant intervention strategies.



## Chapter 2. Measuring evaluations: Psychometric assessment of direct and indirect measures

### Introduction

Assessing consumer evaluations toward foods, particularly novel or unconventional food sources such as insect-based products, requires the availability of valid and reliable measurement tools. Hence, the overarching goal of this chapter is to develop and evaluate the psychometric properties of multiple measures designed to assess both direct and indirect evaluations of foods, with a particular focus on insect-based foods. The rationale stems from the idea that, to investigate how attitudes toward these food targets may change through experimental manipulations, it is first necessary to establish instruments that can accurately capture these changes. Without accurate measurement, it would be impossible to determine whether interventions or manipulations effectively change attitudes.

To achieve a holistic understanding of food evaluations, it is essential to employ measures that capture these attitudes under diverse conditions, as real-life situations differ and evaluations can be expressed in different ways. To investigate such evaluative processes in laboratory settings, various measures have been developed. Some of these are referred to as direct, explicit or self-report measures, typically involving questionnaires where respondents express their evaluations on predefined scales (e.g., Likert-type items). Participants usually complete these measures at their own pace, with the opportunity to reflect carefully before answering.

Another class of measures is implicit or indirect measures. Unlike direct measures, they do not require participants to report their evaluations directly. A subgroup of these measures, arguably the most widely used, requires participants to perform speeded categorization tasks, such as the Implicit Association Test (Greenwald et al., 1998), the Brief Implicit Association Test (Sriram & Greenwald, 2009), or the Manikin Task (De Houwer et al., 2001). For these measures, indices of automatic evaluation are typically derived from response latencies and accuracy rates. These types of indirect measures typically differ from self-report measures not only in their response format, rating scales versus task performance, but also in the conditions under which evaluations are expressed. Direct measures typically capture judgments made under unconstrained time conditions, whereas indirect measures are used to assess evaluations under conditions of automaticity (e.g., under time pressure; see Moors & De Houwer., 2006 for a compelling discussion on automaticity). Because of these differences, each type of measure may provide unique predictive value. Indeed, the ability of an attitude measure to predict behavior depends on how closely the processing conditions of the measure match those of the behavior being predicted (Gawronski, 2019). Thus, indirect measures tend to predict behaviors performed quickly or other constrained conditions, while direct measures better predict behaviors that involve slow unconstrained reasoning (Perugini et al, 2010; Gawronski & De Houwer, 2014; Gawronski, 2019). These differences in measurement conditions have also been proposed as one reason why indirect and direct measures are often weakly correlated or uncorrelated (Gawronski et al., 2020). Importantly, dissociation between these measures should not be seen as a limitation, but rather as providing valuable information, since each measure captures evaluations assessed under different conditions, thereby offering complementary insights for predicting behavior across situations.

Furthermore, an essential prerequisite for drawing meaningful conclusions from any empirical research is the use of reliable measurement tools. Reliability directly influences the confidence we can place in the observed results and without sufficient reliability, observed differences or associations may reflect measurement error rather than true variation. This issue is particularly salient for indirect measures, which are best understood as procedural paradigms rather than standardized instruments. Their psychometric characteristics depend on implementation details, such as the device used, the number of trials, and the specific stimuli (Bar-Anan & Nosek, 2014; Machulska & Klucken, 2023). Therefore, empirical assessment of their reliability is required for each new implementation, including the versions used in the present research, to ensure that subsequent analyses are based on trustworthy evidence.

The present chapter addresses this objective by presenting two projects, each comprising two empirical studies, designed to evaluate the psychometric properties of both direct and indirect measures of (insect-based) food evaluations. By testing the psychometric properties of these instruments, this chapter provides a necessary foundation for the subsequent experimental work presented in Chapter 3, where these measures will be used to assess changes in evaluations resulting from the developed manipulations.

## **Project 1: Assessing Spontaneous Responses to Insect-Based Foods Using BIAT and Manikin Task<sup>1</sup>**

### **Abstract**

Integrating insect-derived ingredients into Western diets presents a sustainable protein alternative but encounters cultural resistance and spontaneous aversion. Assessing automatic reactions to insect-based foods remains challenging. Here, we psychometrically evaluated two indirect measures—the Brief Implicit Association Test (BIAT) and the Manikin Task—using visually similar insect-based and traditional burger stimuli differing only in branding. Across two studies (Study 1: recruited = 123, analyzed = 103; Study 2: recruited = 145, analyzed = 136), these tasks demonstrated acceptable-to-good reliability and captured distinct facets of spontaneous evaluative and approach-avoidance responses. While correlations between indirect and explicit measures were low, some associations aligned with theoretical expectations, indicating these tools assess automatic reactions beyond self-report. These findings provide a reliable toolkit for consumer research, facilitating a nuanced understanding of implicit attitudes toward insect-based foods. Both measures are suitable for online administration, enhancing their applicability in diverse research contexts.

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<sup>1</sup> Project 1 is based on Zogmaister, C., Fedeli, F., Albertoni, D., Alparone, F., Aquino, A., Talò, C., & Mari, S. (2025, November 11). Assessing Spontaneous Responses to Insect-Based Foods Using BIAT and Manikin Task. [https://doi.org/10.31234/osf.io/x3yhj\\_v1](https://doi.org/10.31234/osf.io/x3yhj_v1). The manuscript was approved for publication at Food Quality and Preference.

## Introduction

Insect-based foods are sustainable, nutritious alternatives to traditional proteins (van Huis et al., 2021). Growing sustainability and food security concerns have increased interest in their adoption in Western diets. However, the practice of insect eating often conflicts with Western cultural norms and perceptions of what is considered “normal” or “edible” (Kröger et al., 2022, Syartiwidya et al., 2025). In many Western contexts, insects are associated with dirt, disease, or survival situations, leading to their categorization as contaminants rather than food (Kröger et al., 2022). In contrast, numerous non-Western cultures normalize the consumption of insects (Olivandese & Dindo, 2023; Syartiwidya et al., 2025). Western consumers generally prefer processed products over whole insects; visible insects often trigger aversion, whereas discreetly incorporated ingredients – such as cricket powder in cookies – are more readily accepted (Kröger et al., 2022; Syartiwidya et al., 2025). This increased acceptance is largely due to the mitigation of sensory-based disgust, as the absence of visible insect features prevents the immediate activation of perceptual rejection cues (Syartiwidya et al., 2025). Nevertheless, even when insect components are hidden, ‘ideational disgust’—a rejection based on the food’s perceived essence or origin—remains a significant barrier (Rozin & Fallon, 1987; Söylemez & Kapucu, 2024). For example, Modlinska and colleagues (2020) found that labelling alone significantly deterred consumption regardless of a product's appearance, highlighting a contamination-based psychological barrier.

Research concerning Western consumers’ reactions to insect-based foods has predominantly relied on self-reports (Berlianti Puteri et al., 2023; Dagevos, 2020; Mancini et al., 2019; Ribeiro et al., 2024; Syartiwidya et al., 2025). These studies highlight a complex

interplay between sensory perceptions, cultural norms, and psychological barriers. Ultimately, dietary selection is governed by a multidimensional framework where sensory attributes, cultural beliefs, and the 'disgust-neophobia' axis constitute the primary hurdles to acceptability (Syartiwidya et al., 2025).

This misalignment between intentions and behavior toward insect food may arise because self-reports primarily capture reflective reasoning, whereas actual food choices are frequently driven by impulsive, automatic processes (Fujita & Han, 2009; Hofmann et al., 2009). For example, Fürtjes and colleagues (2020) demonstrated that self-control influences eating behavior mainly indirect, through habit modulation, while automatic processes have a significant direct impact on outcomes. In their comprehensive review, Fernqvist and colleagues (2024) concluded that a substantial share of food choices is intuitive and guided by heuristics rather than by reflective deliberation. Consequently, understanding these spontaneous reactions is essential for accurately predicting and shaping consumer behavior, particularly in the context of novel food sources (Marteau, Hollands, & Fletcher, 2012).

### **Indirect measures and spontaneous reactions to food**

Indirect measures have been successfully employed to study spontaneous food reactions and their modulation by both internal states and external interventions. For instance, Coricelli and colleagues (2022) demonstrated that implicit and explicit safety evaluations vary across food processing stages, while Piqueras-Fitzman and colleagues (2014) showed that hunger modulates approach-avoidance tendencies. Furthermore, Zogmaister and colleagues (2023a, 2023b) highlighted that social modelling (observing others approach or avoid certain foods) shifts participants' spontaneous evaluations. A recent comprehensive review by Gallucci and colleagues (2023) underscored that these measures capture automatic food evaluations that

self-reports often fail to reflect, accurately predicting spontaneous choice and everyday consumption.

To capture spontaneous reactions, paradigms such as the Implicit Association Test (IAT; Greenwald et al., 2003, 2022) and approach-avoidance tasks (Krieglmeyer & Deutsch, 2010) are utilized. These methods typically infer automatic attitudes and behavioral tendencies from response latencies, bypassing direct questioning and decreasing the reflective processing and inherent social desirability biases. In a pioneering application to insect food, Verneau and colleagues (2016) employed the flower-insect IAT (Greenwald et al., 1998), finding that stronger implicit dislike of insects predicted a lower likelihood of consuming insect-flour products, even when explicit intentions showed no such association. This was further supported by La Barbera and colleagues (2018), who found that implicit associations correlated with disgust toward entomophagy and subsequent resistance to consumption.

Because Western consumers show less resistance to food containing insect ingredients than to whole insects (Kröger et al., 2022; Syartiwidya et al., 2025), it is important for research on indirect reactions to insect food to incorporate this distinction. Doing so ensures ecological validity by accurately capturing the spontaneous evaluations that occur when consumers encounter the specific product formats they are most likely to accept in real-world settings. Recent efforts have moved toward food-specific indirect measures. Vanutelli and colleagues (2024) used verbal phrases (e.g., "larvae cookies") to identify a spontaneous preference for traditional foods. Brunner and colleagues (2025) employed a Single Category IAT (SC-IAT) to isolate attitudes toward insect-based foods from traditional ones, finding that implicit scores related positively to interest in entomophagy. However, both these studies primarily relied on verbal stimuli, which may not fully activate bottom-up sensory responses.

The sight of food is a primary driver of appetitive and inhibitory processes (van der Laan et al., 2025). Research indicates that pictorial food cues elicit more consistent rapid hedonic responses than abstract words (Avery et al., 2025; Luo et al., 2022; Freijy et al., 2014; Lee et al., 2022). For example, Ostende et al. (2023) found that visual images trigger stronger automatic responses that require greater cognitive control to inhibit than words do. Therefore, using visual stimuli is plausibly more effective than verbal phrases for accurately capturing spontaneous reactions.

In studying insect-based foods, it is valuable to quantify action tendencies (approach-avoidance) in addition to affective associations. While the IAT captures evaluations, approach-avoidance tasks assess behavioral readiness to engage with or withdraw from an object (Lender et al., 2018; Meule et al., 2019). Given the robust link between disgust and avoidance (Oaten et al., 2009), approach-avoidance measures are a useful indicator of the withdrawal responses that insects may trigger. Moreover, as these tasks are sensitive to internal states (Zech et al., 2023), they can reveal how factors such as hunger might override the "ick factor".

A final challenge is determining whether automatic reactions to novel foods are sufficiently stable for reliable measurement, since the accessibility of attitudes can influence their stability (Descheemaeker et al., 2014; Zogmaister et al., 2020). Achieving high internal consistency is essential to ensure that observed effects reflect stable psychological constructs rather than procedural noise (Perugini et al., 2010). Although Greenwald and colleagues (2022) suggest the IAT remains effective even for unfamiliar categories, the psychometric robustness of indirect measures specifically in the context of entomophagy has not yet been formally documented.

## **The present research**

The present research aimed to adapt indirect measures that utilize visual stimuli to assess spontaneous reactions toward foods containing insect-derived ingredients and to test the reliability of these measures. Standard indirect paradigms, such as the IAT and the Manikin Task, require stimuli that can be clearly and rapidly categorized. This represents a methodological challenge for insect-based foods, which are often visually indistinguishable from traditional alternatives. Although using images of whole insects might simplify stimulus differentiation, this approach is suboptimal because whole and processed insect products elicit different levels of consumer acceptance (Kröger et al., 2022), and using whole insects would reduce ecological validity.

To address visual similarity between traditional and insect-based foods, we developed two fictitious burger brands: InsectoBite (insect-based) and ClassicGrill (conventional). The burger images were visually identical, differing only in their packaging labels and brand names. This design ensured that participant reactions were driven by knowledge of the ingredients rather than by perceptual differences, thereby maintaining high ecological validity for the study of processed sustainable foods.

### **A Multi-method approach to implicit reactions**

We employed two distinct paradigms to assess different cognitive and behavioral facets: the Brief IAT (BIAT, Sriram & Greenwald, 2009), which captures automatic evaluations (liking/disliking), and the Manikin Task (De Houwer et al., 2001), which focuses on action tendencies (approach/avoidance). Correlations among different indirect measures are typically low, reflecting the multidimensional nature of implicit reactions and other factors (Fazio &

Olson, 2003; Köllner & Schultheiss, 2014). Integrating both evaluative and behavioral measures establishes the psychometric groundwork for a multi-method assessment, enabling future investigations to reliably track different facets of the spontaneous reactions to insect food.

### **Measuring spontaneous evaluations: the Brief IAT**

The Brief IAT (BIAT; Nosek et al., 2014; Sriram & Greenwald, 2009) is a computer-administered categorization task in which participants classify stimuli as quickly and accurately as possible. The stimuli include target categories (e.g., traditional burgers and insect burgers) and attribute categories (e.g., positive and negative words). Participants are instructed to focus their attention on only two "focal" categories, pressing one key for instances of those categories (e.g., "press 'L' for InsectoBite and positive words") and another key for all other stimuli (e.g., "press 'A' for everything else"). These pairings are varied systematically across blocks so that the focal categories are paired differently; for example, InsectoBite is paired with positive words in one block and with negative words in another.

Unlike the standard IAT, the BIAT can measure attitudes toward individual targets rather than just relative preferences between opposite pairs (e.g., traditional vs. insect-based burgers). This is crucial in consumer research because identical relative preference scores can mask fundamentally different underlying attitudes. For instance, a relative measure cannot distinguish between a consumer who moderately likes both conventional and insect burgers and one who strongly dislikes both. By capturing these distinct reactions, the BIAT provides a more nuanced understanding of consumer responses.

Sriram and Greenwald (2009) validated the BIAT format, demonstrating convergent validity with standard IATs and self-reports across a series of topics, including attitudes,

identity, and stereotypes. Their findings evidenced that procedural factors, such as repeated administration, spacing, exemplar novelty, had only minor influences on the resulting scores. The BIAT demonstrates acceptable-to-high levels of internal consistency, with test-retest reliability comparable to standard IATs. The BIAT utilizes the same D-score algorithm, where the score is calculated as the difference in mean latencies between the two blocks, divided by the inclusive SD. Furthermore, Perugini and colleagues (2013) demonstrated the utility of computing separate BIAT scores for each attitudinal target. Using two food brands, they showed that a targeted manipulation specifically improved attitudes toward the intended brand without affecting the other. This approach allows researchers to disentangle specific attitudes from broader preferences.

### **Measuring action tendencies: the Manikin Task**

To assess behavioral predispositions, we employed the Manikin Task (De Houwer et al., 2001). In this task, participants move a human silhouette (manikin) on the screen toward or away from stimuli based on block-specific instructions, using keyboard keys. A major advantage of this task for consumer research is its adaptability to online settings, facilitating larger and more diverse samples than joystick-based variants. Krieglmeyer and Deutsch (2010) found the manikin task more sensitive to stimulus valence and more strongly related to self-reported fear than joystick variants, suggesting superior construct validity.

The procedural format generally demonstrates good psychometric properties, including high reliability and validity in measuring automatic action tendencies (Krieglmeyer & Deutsch, 2010). However, the literature shows some variability in this regard; while the foundational evidence is positive, recent reports (e.g., Fricke et al., 2023) have noted low internal consistency in specific contexts. Given that the reliability of indirect measures can be highly

sensitive to stimulus characteristics and the population sampled, establishing the psychometric stability of the Manikin Task within the novel domain of entomophagy was a primary objective of the present research. While the task has successfully captured shifts in motivation toward snacks following aversive labeling (Vensel et al., 2023) and changes in approach tendencies linked to emotional states (Van Alebeek et al., 2025), its reliability for assessing insect-derived food remains to be investigated.

### **Objectives of the present research**

Because the psychometric quality of indirect measures depends heavily on their specific implementation, each new application requires empirical verification. We conducted two studies to establish the reliability of the BIAT and the Manikin Task in the context of insect-based foods. Study 1 implemented the tasks in their standard format. Study 2 introduced two procedural refinements (an initial familiarization phase and an increased number of trials) to assess if these adjustments enhance internal consistency.

We included self-report measures to explore relationships between the two indirect scores and explicit evaluations. Typically, correlations between direct and indirect measures are low (Bar-Anan & Nosek, 2014; Bosson et al., 2000; Dang et al., 2020), likely due to the multifaceted nature of implicit constructs and their often low reliability. Including self-reports allows exploring whether and how automatic ‘gut’ reactions relate to explicit, deliberative attitudes, and highlights the different dimensions of cognitive and affective responses they capture.

## **Open science practices and ethical statement**

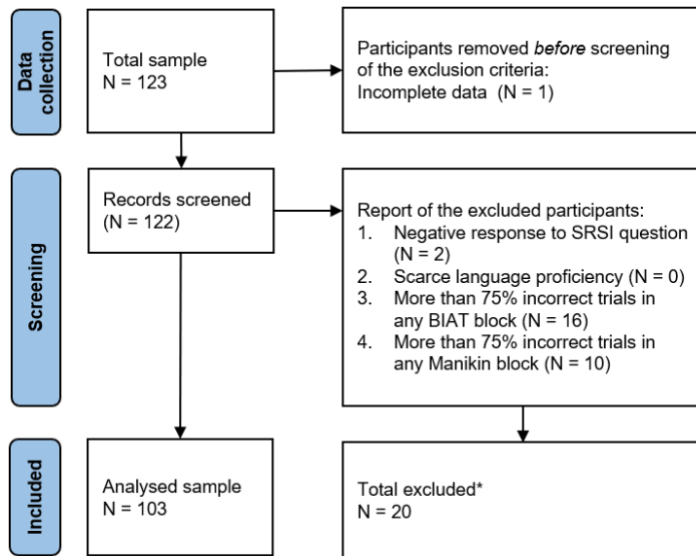
This research was preregistered, including hypotheses, design, and planned analyses. All preregistrations, materials, experimental scripts, and anonymized data are openly available at <https://osf.io/3r2dv> (Study 1) and <https://osf.io/udpzx> (Study 2). All procedures adhered to ethical guidelines for research with human participants and were approved as minimal-risk research by the Departmental Research Committee (Protocol no. RM-2024-781). Participants provided informed consent before participation.

## **Study 1**

### **Method**

#### **Participants and design**

This study employed a single-group correlational design. A total of 123 participants were recruited through the departmental participant management system, social media, and direct invitations. After applying pre-registered exclusion criteria - insufficient Italian proficiency (self-reporting 'Poor knowledge'), a negative response to the Self-Reported Single Item (SRSI), or error rates exceeding 25% in any BIAT or Manikin Task blocks. 103 participants were retained in the final sample (see Figure 1).



**Figure 1.** P1. Study 1: Data cleaning and exclusion criteria

Note: Exclusion criteria were not mutually exclusive, and some participants were excluded for multiple reasons.

An a priori sensitivity analysis with G\*Power (Faul et al., 2007) indicated that 100 participants provided sufficient power ( $1-\beta = .95$ ,  $\alpha = .05$ , unidirectional) to detect correlations of  $|\rho| \geq 0.32$ . Data collection was terminated upon reaching the target, resulting in a final sample of 103 valid participants. Participants were aged 18-66 years ( $M = 25.79$ ,  $SD = 8.87$ ). The gender distribution was 78.6% female, 20.3% male, and 1.1% nonbinary/other. Dietary habits were distributed as follows: 88 omnivores, 12 vegetarians, 2 vegans, and 1 reporting other diets.

## Materials

*Stimuli.* We created two burger brands: ClassicGrill (conventional hamburgers) and InsectoBite (insect-based ingredients). Stimuli comprised eight images per brand depicting burger packaging with prominent logos or logos in isolation.

Participants responded to the brand rather than explicit "insect" labels to reflect naturalistic decision-making and capture more ecologically valid evaluations. This allowed the

insect-derived ingredients to influence responses based on the subjective importance the participant assigns to that feature. Furthermore, while indirect measures typically require perceptually distinct stimuli for clear categorization (e.g., fruits vs. sweets), our stimuli were designed to be perceptually similar to conventional alternatives. This allows us to test whether the BIAT and Manikin Task can capture spontaneous responses to subtle, real-world product differences, where the aspect of the food might otherwise marginalize the insect component.

*BIAT.* Participants categorized images of ClassicGrill or InsectoBite burgers and evaluative words (Positive: tasty, good, appetizing, inviting, and tempting; Negative: disgusting, bad, nauseating, repulsive, and stomach-turning). Words targeted gustatory evaluation and disgust. In each of four 32-trial test blocks, one brand and one valence were designated as “focal”. Participants pressed the “I” key for focal stimuli and “E” for others. A built-in penalty required the correct answer to proceed.

Automatic attitudes were computed using the D-score algorithm with built-in penalty: The response latency was recorded from stimulus onset to correct response; therefore it included the extra time taken to correct the mistakes, thereby penalizing the score for errors without requiring subsequent adjustments (Greenwald et al., 2003; Nosek et al., 2014). Extreme latencies (<300 ms or >10,000 ms) were excluded (<0.03%). For each brand, the BIAT score was calculated as the difference between the mean latency between the “Brand + Negative” and “Brand + Positive” blocks, divided by the overall standard deviation of latencies across these blocks. Higher scores indicate more positive brand evaluations. A differential score (ClassicGrill minus InsectoBite) was also computed to reflect relative preference for traditional over insect-based products.

*Manikin Task.* Each trial presented a ClassicGrill or InsectoBite image centered on the screen with a human silhouette (manikin) above or below. Image order and manikin position

were randomized. Using two keyboard keys, participants moved the manikin toward (approach) and away from (avoidance) the brands. Approach/avoidance assignments to the brand were counterbalanced across two 56-trial blocks, preceded by 8-trial blocks.

As in the BIAT, a built-in penalty was utilized: Correct responses were required to proceed, with reaction times measured from stimulus onset to the correct response. Spontaneous approach tendencies for each brand were calculated as the difference between the mean latency in trials where the brand was to be avoided and the mean latency in trials where it was to be approached. Extreme latencies (<300 ms or >10,000 ms) were excluded (0.1%). Additionally, a differential score was calculated (ClassicGrill score minus InsectoBite score), where higher values indicate a stronger relative approach tendency to ClassicGrill.

*Entomophagy Attitude Questionnaire* (EAQ; La Barbera et al., 2020). Self-reported disgust (5 items, e.g., *I would be disgusted to eat any dish with insects*) and Interest (3 items, e.g., *I'd be curious to taste a dish with insects, if cooked well*) toward food with insects were assessed on a 5-point Likert scale. The Feeding Animals subscale was omitted because irrelevant to this study. Disgust (EAQ-D) and interest (EAQ-I) were computed as the mean of the respective subscale items.

*Revised Food Neophobia Scale* (Pliner & Hobden, 1992; Italian translation: Guidetti et al., 2018). This six-item scale assessed reluctance to try new or unusual foods (e.g., *I do not trust new foods*).

*Demographic questions.* Participants reported their age, gender (male, female, non-binary, prefer not to say), Italian proficiency (Participants self-reported their 'level of knowledge of the Italian language', with 5 response options: Native speaker, Excellent knowledge, Good knowledge, Sufficient knowledge, and Poor knowledge), student status, dietary habits, major food allergies, and political orientation.

*Data quality questions.* Participants indicated how much they adapted their responses to experimenters' expectations and whether their data should be used for analysis (SRSI question).

## **Procedure**

The study was conducted online. After providing informed consent, participants were introduced to the two brands: *ClassicGrill* (meat burgers) and *InsectoBite* (with insect ingredients). To ensure comprehension, participants were subsequently asked to identify the type of burgers each brand produced. All participants answered correctly. The task sequence followed a fixed order: BIATs, Manikin Tasks, self-report scales. This order was theory-driven. Based on the Reflective-Impulsive Model (RIM; Strack et al., 2006) the BIATs (measuring spontaneous evaluations) were placed before the Manikin Tasks (measuring behavioral tendencies). Indirect measures were prioritized at the start of the session to capture spontaneous reactions before reflective processes – typically triggered by explicit self-reports. Methodologically, meta-analytic evidence suggests that the effects of order are negligible (Nosek et al., 2005; see also Forscher et al., 2019). Furthermore, following Perugini et al. (2014), administering implicit tasks first can trigger ecologically valid reflection during subsequent explicit judgments.

Participants recruited through the participant management pool subsequently evaluated a third brand (cultured meat); those data will be reported separately. All participants concluded with demographics and data quality items. The study lasted approximately 15 minutes to complete.

## Hypotheses

While direct and indirect measures, and different implicit tasks, typically show weak or absent correlations (Bar-Anan & Nosek, 2014; Bosson et al., 2000), we formulated directional hypotheses to increase statistical sensitivity. This approach allows for targeted tests, maximizing the likelihood of detecting meaningful associations that might otherwise remain obscured.

We expected:

H1) Convergence between indirect measures: positive correlations between BIAT and Manikin Task scores for (a) the insect-based brand, (b) the traditional brand, and (c) the differential preference scores;

H2) Relationship between indirect scores and disgust: evaluations (BIAT) and approach tendencies (Manikin Task) toward the insect brand would correlate negatively with self-reported disgust (EAQ-D);

H3) Relationship between indirect scores and interest: evaluations (BIAT) and approach tendencies (Manikin Task) toward the insect brand would correlate positively with self-reported interest (EAQ-I);

H4) Specificity (Disgust): No significant correlations between spontaneous reactions toward the traditional brand and disgust toward entomophagy.

H5) Specificity (Interest): No significant correlations between spontaneous reactions toward the traditional brand and interest toward entomophagy.

## Results

### Deviations from preregistration

We conducted additional analyses beyond those preregistered. Although internal consistency was planned for each brand separately, we also evaluated the reliability of differential scores (BIAT preference and the differential Manikin score), as these differential measures capture relative preferences that offer an ecologically valid metric in real-life contexts. Moreover, as the BIAT and Manikin Task are inherently comparative, differential scores may exhibit adequate reliability even if single-brand measures are less consistent.

We reported McDonald's  $\omega$  alongside Cronbach's  $\alpha$ , as  $\omega$  more accurately estimates reliability when item contributions vary. This is particularly relevant for indirect measures, where reaction times are subject to task-related noise, such as stimulus characteristics, fluctuations in attention, fatigue, or motor variability.

### *Reliability*

Table 1 reports descriptive statistics and internal consistencies, which ranged from acceptable to excellent. The InsectoBite BIAT exhibited modest internal consistency, slightly below the conventional .70 threshold, possibly because the novelty of insect-based food may make spontaneous evaluative reactions more difficult to capture. The ClassicGrill BIAT, however, was only slightly more reliable, suggesting that the task itself might require refinement. The Manikin Task generally demonstrated higher consistency than the BIAT, although there remains room for improvement.

Two psychometric observations are noteworthy. First, McDonald's  $\omega$  was consistently higher than Cronbach's  $\alpha$ , suggesting that trials contributed unequally to the latent construct. Second, the Manikin Task differential score was more reliable than its single-brand counterpart, suggesting that it functions primarily as a comparative measure. Conversely, the

BIAT differential score did not show such an advantage. Self-report measures showed high reliability across both  $\alpha$  and  $\omega$ .

**Table 1.** P1. Descriptive statistics and internal consistency

Measure	M	SD	Cronbach's $\alpha$	McDonald's $\alpha$
<b>Study 1</b>				
InsectoBite Attitude BIAT	-0.03	0.44	.66	.69
ClassicGrill Attitude BIAT	0.29	0.49	.73	.80
ClassicGrill Preference BIAT	0.32	0.65	.72	.81
InsectoBite Manikin Task	66.04	242.44	.68	.73
ClassicGrill Manikin Task	75.11	294.03	.81	.88
Manikin Task Differential	9.07	502.90	.89	.90
EAQ Disgust	2.99	1.11	.92	.93
EAQ Interest	3.00	1.29	.92	.92
<b>Study 2</b>				
InsectoBite Attitude BIAT	-0.04	0.42	.77	.78
<i>Standard subsample</i>	-0.11	0.41	.75	.80
<i>Familiarization subsample</i>	0.04	0.42	.79	.86
ClassicGrill Attitude BIAT	0.21	0.42	.79	.81
<i>Standard subsample</i>	0.21	0.46	.82	.88
<i>Familiarization subsample</i>	0.21	0.38	.75	.78
ClassicGrill Preference BIAT	0.25	0.68	.85	.88
<i>Standard subsample</i>	0.32	0.72	.86	.90
<i>Familiarization subsample</i>	0.17	0.63	.85	.87
InsectoBite Manikin Task	73.27	170.93	.69	.82
<i>Standard subsample</i>	95.61	193.16	.70	.83
<i>Familiarization subsample</i>	48.86	140.21	.66	.81
ClassicGrill Manikin Task	35.86	175.85	.68	.78
<i>Standard subsample</i>	14.42	191.53	.62	.76
<i>Familiarization subsample</i>	59.28	155.06	.76	.85
DifferentialManikin Task	-37.41	298.44	.80	.88
<i>Standard subsample</i>	-81.19	318.44	.76	.87
<i>Familiarization subsample</i>	10.42	269.27	.84	.91
Behavioral Intentions to InsectoBite	2.87	1.19	.97	.98
Semantic Differential (Affective)	3.94	1.20	.95	.96
Semantic Differential (Cognitive)	4.85	1.28	.97	.98
Semantic Differential (Aggregate)	4.41	1.17	.97	.95
Intention to Taste Insect-Based Foods	4.26	3.08	.87	.92

### *Hypothesis Testing*

Pearson's correlations were computed between all primary measures: BIAT and Manikin Task scores for both brands, differential scores, and the self-reported Disgust-Interest composite (Table 2). We used a one-tailed tests ( $p < .05$ ), as all primary hypotheses were preregistered and, because we are assessing convergent validity, we tested for associations where the direction of the effect was theoretically pre-defined (e.g., positive for two attitude measures toward the same concept, or negative between attitude and disgust). Effects in the opposite direction would be non-informative for the research question; thus, a directional approach was used to maximize statistical power.

**Table 2.** P1. Study 1: Correlations among BIAT, Manikin Task, and self-reported disgust-interest scores

Measure	1	2	3	4	5	6	7	8
1. BIAT InsectoBite	—							
2. BIAT ClassicGrill	-.01 [-.20, .18]	—						
3. BIAT Preference for ClassicGrill	-.68*** [-.77, -.56]	.74*** [.64, .82]	—					
4. Manikin InsectoBite	-.05 [-.24, .15]	-.00 [-.20, .19]	.03 [-.17, .22]	—				
5. Manikin ClassicGrill	-.01 [-.20, .18]	-.02 [-.21, .17]	-.01 [-.20, .19]	-.76*** [-.83, -.66]	—			
6. Manikin Preference for ClassicGrill	.02 [-.18, .21]	-.01 [-.20, .18]	-.02 [-.21, .18]	-.92*** [-.95, -.89]	.95*** [.93, .97]	—		
7. EAQ disgust	-.018* [-.36, .01]	.16 [-.03, .35]	.24* [.05, .42]	-.11 [-.30, .08]	.08 [-.12, .27]	-.10 [-.09, .29]	—	
8. EAQ interest	.10 [-.10, .29]	-.12 [-.31, .07]	-.16 [-.34, .04]	.10 [-.10, .29]	-.029 [-.28, .10]	-.10 [-.29, .09]	-.85** [-.90, -.79]	—

Note. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$  (one-sided). Values in square brackets indicate 95% confidence intervals.

H1 was not supported; automatic evaluative (BIAT) and behavioral tendencies (Manikin) toward the same brand were uncorrelated.

Consistent with H2, a negative correlation emerged between the InsectoBite BIAT and disgust, indicating that higher disgust of insect food was linked to more negative spontaneous evaluation of insect burgers. Additionally, the BIAT differential score (meat preferences)

correlated positively with disgust. Regarding H3, the predicted positive correlation between the insect-based brand and interest did not reach significance.

Finally, supporting H4 and H5, automatic reactions toward ClassicGrill (BIAT and Manikin) did not correlate with either disgust or interest in insect food, confirming the expected null relationships for the traditional brand.

#### **3.5.4. Ancillary analyses**

Non-preregistered robustness checks evaluated whether demographics influenced findings. Partial correlations (Table S1) among primary measures controlling age, gender, diet (omnivores vs. veg\*ans), and recruitment source (departmental subject management system vs. other sources) showed substantially unchanged associations.

We also re-evaluated reliability and correlations exclusively within the omnivore subsample. The results remained substantially similar to those of the full sample (Supplementary Materials, Tables S2 and S3). Small sample sizes precluded separate analyses for vegetarian and vegan respondents.

This stability demonstrated that relationships are robust against dietary habits, recruitment channels, or the demographic skew toward younger women.

## **Discussion**

The measures showed promise, with acceptable-to-good reliability for attitudes (BIAT) and behavioral tendencies (Manikin Task), providing a foundation for investigating spontaneous responses to insect-based foods. While indirect measures exhibited lower reliability than the self-report measures, their internal consistency ( $\alpha$ : .66-.89;  $\omega$ : .69-.90) is in line with previous findings (Bar-Anan & Nosek, 2014; Krieglmeier & Deutsch, 2010).

The sample composition, predominantly young women, may have influenced these psychometric properties. As this demographic often holds more favorable views on entomophagy (Mancini et al., 2019), potential response homogeneity could have attenuated reliability and correlation estimates, which depend on variance (Schmidt & Hunter, 2015). However, substantial standard deviations relative to theoretical ranges suggest the measures retained meaningful variability. Thus, sample homogeneity likely produced conservative estimates rather than inflated effects (Sackett & Yang, 2000).

The absence of significant BIAT - Manikin Task associations aligns with evidence that different indirect measures often show low intercorrelations (Bar-Anan & Nosek, 2014). Similarly, low or absent implicit-explicit correlations are common (Gawronski et al., 2020), suggesting that these measures capture distinct cognitive facets.

The BIAT scores for InsectoBite and ClassicGrill were uncorrelated, whereas the Manikin scores showed a strong negative correlation. This suggests that the BIAT tasks captured two separate brand evaluations, while the Manikin task reflected a single underlying preference for meat over insects. This is further supported by the Manikin differential score exhibiting higher reliability than its individual brand scores, a pattern not observed in the BIAT.

Building on these findings, Study 2 seeks to test the replicability of the observed results and examine whether minor methodological adjustments can enhance internal consistency. We therefore defer a full interpretation of the findings until after the results of Study 2.

## Study 2

Study 2 reassessed the stability of the associations observed in Study 1 while refining the indirect measures (BIAT and Manikin Task). Refinements included a familiarization phase

with simple categorization because exclusions for excessive error rates were somewhat higher than typical for IATs, which include simple categorization blocks before the critical ones, and an increased number of trials to optimize internal consistency and task comprehension. While our primary hypotheses (H1–H4) were tested on the aggregate sample for power, the introduction of an additional familiarization phase allowed planned exploratory analyses into whether a more intensive training session could influence the psychometric properties of the measures, although the study was not primarily powered for between-group comparisons on this variable

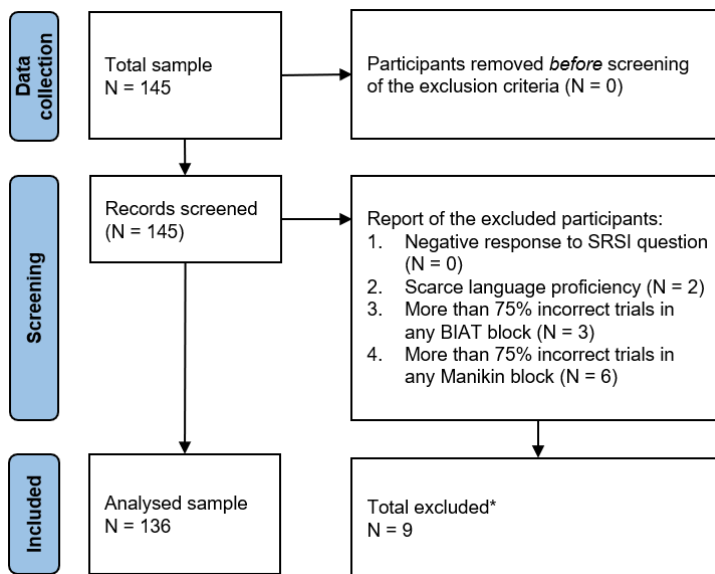
Study 2 also added two explicit measures to address the 'hypothetical bias' in research on insect-based foods, where abstract intentions diverge from concrete choices (Hajhamidiasl et al., 2025; Kamenidou et al., 2023). These additions included an Intention to Taste scale using specific food stimuli and a situational Willingness to Eat in Real Life item anchored to a concrete scenario ('if you had it in front of you'). This approach aims to bridge the gap between evaluative mindsets and contextualized behavioral intentions (Vizcaíno & Pohlmann, 2024), testing whether automatic associations align more closely with specific situational projections than with abstract self-reports.

## **Method**

### **Participants and design**

A total of 145 participants were recruited via Prolific ([www.prolific.com](http://www.prolific.com)). Eligibility criteria required participants to be 18–45 years old, reside in Italy, and have an approval rate of 90% or higher in their previous Prolific studies. Following preregistered exclusion criteria—insufficient Italian proficiency (defined as selecting the 'Poor knowledge' option), negative SRSI response, or error rates exceeding 25% in one or more main blocks of the BIAT or

Manikin Task—136 participants remained in the final sample (see Figure 2). The target sample size was determined a priori using G\*Power (Faul et al., 2007). With  $\alpha = .01$  (one-tailed) and power  $(1-\beta) = .90$ , a minimum of 135 participants was required to detect medium-sized correlations ( $\rho \geq .30$ ).



**Figure 2.** P1. Study 2: Data cleaning and exclusion criteria

*Note.* Exclusion criteria were not mutually exclusive, and some participants were excluded for multiple reasons.

Participants were aged 18- 45 years ( $M = 29.72$ ,  $SD = 6.95$ ). The gender distribution was 49% female, 46% male, and 5% nonbinary/other. The sample comprised 103 omnivores, 23 vegetarians, 4 vegans, and 6 individuals reporting other dietary patterns.

A correlational design was employed with two conditions: a standard task format and an enhanced format including a familiarization phase. Participants completed both indirect measures (BIAT and Manikin Task) for the InsectoBite and ClassicGrill brands, followed by self-report scales assessing affective and cognitive attitudes, behavioral intentions, and willingness to consume insect-based foods.

## Materials

All materials were identical to those in Study 1 unless otherwise specified.

*BIATs.* Participants completed two BIATs (InsectoBite and ClassicGrill). The Standard Version mirrored Study 1 but with increased trials (critical blocks: 48; training blocks: 12). The familiarization version further added two 12-trial blocks (one with brand-only and one with valence-only categorizations) prior to the main tasks to enhance procedural understanding.

*Manikin Task.* The Standard Version mirrored the Study 1, with each main block increased to 84 trials preceded by 8 training trials. The Familiarization Version introduced two 8-trial blocks per brand (one for practicing approach and one for avoidance) before the standard sequence.

*Behavioral Intentions toward InsectoBite (Time Constrained).* Nine items assessed intentions to consume *InsectoBite* (e.g., “I would choose InsectoBite over a regular burger if given the option”) on a 7-point Likert scale (1 = “Strongly disagree”; 7 = “Strongly agree”). A 6-second countdown was displayed for each item; however, responses were recorded if participants responded after the timer expired. The time limit was set based on pilot testing and estimated reading speed. Across 1224 trials, only 44 responses (< 0.04%) exceeded the time limit (M = 3,736 ms, SD = 1,140 ms; median = 3,592 ms).

*Semantic Differential.* Ten 7-point bipolar scales assessed affective (Tasty–Disgusting, Appealing–Unappealing, Inviting–Repulsive, Pleasant–Unpleasant, Tempting–Unattractive) and cognitive evaluations of InsectoBite (Healthy–Harmful, Nutritious–Unhealthy, Safe–Risky, Beneficial–Detrimental, High-quality–Low-quality).

*Willingness to Eat in Real Life.* Single-item measure: “Now we ask you to imagine yourself in real life: If you had InsectoBite in front of you, would you try it?” (Options: Yes, I

would try them, No, because I am vegetarian, No, because I am vegan, No, because of personal aversion, No, for other reasons - please specify).

*Intention to Taste.* Participants provided binary (Yes/No) responses on whether they would taste 12 insect-based foods presented with images and names.

*Demographic and Data Quality Measures.* Same as in Study 1.

### **Procedure and hypotheses**

Following informed consent and brand introduction, participants were randomly assigned to complete either the Standard or the Familiarization Version of the indirect tasks. After the indirect measures, participants answered the self-reports in this order: behavioral intentions, semantic differentials, willingness to eat in real life, and intention to taste. Sessions concluded with demographics and data quality questions. Consistent with Study 1, we utilized directional hypotheses to maximize sensitivity for detecting meaningful associations between measures.

The preregistered hypotheses were:

H1) convergence between indirect measures: Positive correlations between BIAT and Manikin scores, specifically: (a) positive correlation for InsectoBite BIAT and Manikin differential score; (b) negative correlation between ClassicGrill BIAT score and Manikin differential score;

H2) relation between InsectoBite BIAT and self-reports concerning item consumption: (a) intentions, (b) semantic differentials, (c) willingness to eat in real-life, and (d) intention to taste;

H3) specificity: no correlation between ClassicGrill BIAT and self-reports concerning item consumption;

H4) relation between Manikin Task differential score and self-reports concerning insect consumption: (a) intentions, (b) semantic differentials, (c) willingness to eat in real-life, and (d) intention to taste.

## Results

Analyses tested main hypotheses on the full sample ( $N = 136$ ) and, following the preregistration, exploratory analyses were conducted stratified by condition (Standard,  $n = 71$ ; Familiarization,  $n = 65$ ). Because a priori power analysis required  $N = 135$ , condition-specific findings are preliminary.

Data were preprocessed according to preregistration. Participants were excluded for (a) insufficient knowledge of Italian, (b) a negative response to SRSI, or (c) error rates exceeding 25% in any BIAT or Manikin Task main block. After applying exclusion criteria, the Standard Version group (36 female, 33 male, 2 non-binary/other; age  $M = 29.73$ ,  $SD = 7.31$ ; 54 omnivores, 9 vegetarian, 3 vegan, 5 other) and Familiarization Version group (31 female, 30 male, 4 non-binary/other; age  $M = 29.71$ ,  $SD = 6.60$ ; 49 omnivores, 14 vegetarian, 1 vegan, 1 other) were closely matched across all primary demographic characteristics and dietary habits.

### Internal consistency

Cronbach's alpha ( $\alpha$ ) and McDonald's omega ( $\omega$ ) are reported in Table 1 alongside descriptive statistics. All BIAT scores showed clear improvements in internal consistency, reaching adequate levels in the full sample. Familiarization did not substantially improve internal consistency for either task. The reliability pattern remained similar across versions, suggesting that the familiarization had minimal impact on the stability of the measures. Self-reports exhibited very high reliability.

## Hypothesis testing

As Affective and Cognitive Semantic Differentials were highly correlated ( $r = .83, p < .001$ ), the 10 items were averaged into one composite score. Following preregistration, significance was evaluated at  $\alpha = .01$  (one-tailed) to account for multiple comparisons. Correlations relevant to hypotheses are reported in Table 3 (upper panel).

Consistent with Study 1, no correlation emerged between BIAT and corresponding Manikin scores in either version. Therefore, H1 a-b-c were not supported. Regarding H2, the InsectoBite BIAT showed positive correlations with time-constrained intention-to-taste and Semantic Differential ( $r = .23, p = .053$  for the Affective Semantic Differential and  $r = .24, p = .04$  for the Cognitive Semantic Differential), though these did not meet the conservative  $p < .01$  preregistered threshold. The ClassicGrill Attitude BIAT did not correlate with the self-reports, in line with H3 (specificity hypothesis). For the Manikin Task, differential scores did not correlate significantly with self-reports, hence H4 was not supported.

Exploratory analysis by version showed a consistent pattern: high self-report convergence and a complete lack of BIAT-Manikin association regardless of training. Minor fluctuations (e.g., sporadic nominal significance in one group) did not represent a systematic shift in task behavior.

**Table 3.** P1. Study 2: Correlations between BIATs, Manikin Task, and self-report measures

	1	2	3	4	5	6	7	8	9	10
1. BIAT InsectoBite	—									
2. BIAT ClassicGrill	-.31** [-.45, -.15]	—								
3. BIAT Preference ClassicGrill	-.81*** [-.86, -.74]	.81*** [.74, .86]	—							
4. Manikin InsectoBite	-.02 [-.19, .15]	-.10 [-.26, .07]	-.05 [-.22, .12]	—						
5. Manikin ClassicGrill	.08 [-.09, .24]	.08 [-.09, .24]	-.00 [-.17, .17]	-.48*** [-.60, -.34]	—					

6. Manikin Preference	.06 [-.11, .22]	.10 [-.07, .27]	.03 [-.14, .20]	-.86*** [-.90, -.80]	.86*** [.81, .90]	—			
7. Semantic Differential	.13 [-.04, .29]	-.02 [-.19, .15]	-.09 [-.26, .08]	.09 [-.08, .26]	.09 [-.08, .25]	-.00 [-.17, .17]	—		
8. Behavioral Intentions	.15* [-.02, .31]	-.06 [-.23, .11]	-.13 [-.29, .04]	.04 [-.13, .21]	.11 [-.06, .28]	.04 [-.13, .21]	.70*** [.61, .78]	—	
9. Willingness to Eat	-.08 [-.09, .25]	-.05 [-.22, .12]	-.08 [-.25, .09]	.02 [-.15, .19]	-.01 [-.16, .18]	-.00 [-.17, .16]	.47*** [.33, .59]	.45** [.31, .58]	—
10. Intention to Taste	.08 [-.09, .24]	-.04 [-.20, .13]	-.07 [-.24, .10]	-.00 [-.17, .17]	.05 [-.12, .21]	.03 [-.14, .20]	.59*** [.47, .69]	.75*** [.67, .82]	.34** [.19, .49]

Standard version subsample

1. BIAT InsectoBite	—								
2. BIAT ClassicGrill	-.35** [-.54, -.13]	—							
3. BIAT Preference ClassicGrill	-.80*** [-.87, -.69]	.85*** [.77, .90]	—						
4. Manikin InsectoBite	.04 [-.20, .27]	-.12 [-.34, .12]	-.10 [-.32, .14]	—					
5. Manikin ClassicGrill	-.04 [-.27, .20]	.09 [-.14, .32]	.08 [-.15, .31]	-.37*** [-.56, -.15]	—				
6. Manikin Preference ClassicGrill	-.05 [-.28, .19]	.13 [-.11, .35]	.11 [-.13, .33]	-.83*** [-.89, -.74]	.83*** [.73, .89]	—			
7. Semantic Differential	.25* [.02, .45]	-.08 [-.31, .15]	-.19 [-.41, .04]	.01 [-.23, .24]	.16 [-.08, .38]	.09 [-.14, .32]	—		
8. Behavioral Intentions	.27* [.03, .47]	-.17 [-.39, .07]	-.26* [-.46, -.03]	.02 [-.22, .25]	.12 [-.12, .34]	.06 [-.18, .29]	.70*** [.61, .78]	—	
9. Willingness to Eat	.14 [-.10, .36]	-.22 [-.43, .01]	-.22 [-.43, .01]	-.03 [-.26, .20]	.00 [-.23, .24]	-.02 [-.21, .25]	.47** [.33, .59]	.45*** [.31, .58]	—
10. Intention to Taste	.15 [-.08, .37]	-.05 [-.28, .19]	-.12 [-.34, .12]	-.02 [-.26, .21]	-.01 [-.24, .23]	-.01 [-.22, .24]	.59*** [.47, .69]	.75*** [.67, .82]	.34*** [.19, .49]

Familiarization version subsample

1. BIAT InsectoBite	—								
2. BIAT ClassicGrill	-.27* [-.49, -.03]	—							
3. BIAT Preference ClassicGrill	-.82*** [-.89, -.72]	.77*** [.65, .86]	—						
4. Manikin InsectoBite	-.05 [-.29, .20]	-.06 [-.30, .19]	-.00 [-.25, .24]	—					
5. Manikin ClassicGrill	.18 [-.07, .41]	.04 [-.20, .29]	-.09 [-.33, .16]	-.66*** [-.78, -.50]	—				
6. Manikin Preference	.13 [-.12, .36]	.05 [-.19, .30]	-.05 [-.29, .20]	-.90*** [-.94, -.84]	-.92*** [.87, .95]	—			
7. Semantic Differential	.00 [-.24, .25]	.07 [-.18, .31]	.04 [-.21, .28]	.24* [-.01, .46]	-.02 [-.26, .23]	-.13 [-.37, .11]	—		
8. Behavioral Intentions	.05 [-.20, .29]	.09 [-.16, .33]	.02 [-.22, .27]	.07 [-.18, .31]	.12 [-.13, .35]	.03 [-.22, .28]	.70*** [.61, .78]	—	
9. Willingness to Eat	-.06 [-.30, .19]	.22 [-.02, .45]	.17 [-.07, .40]	.18 [-.07, .41]	-.04 [-.28, .21]	-.12 [-.35, .13]	.47*** [.33, .59]	-.45** [.31, .58]	—
10. Intention to Taste	.00 [-.24, .25]	-.02 [-.27, .22]	-.02 [-.26, .23]	.03 [-.22, .27]	.13 [-.12, .36]	.06 [-.19, .30]	.59*** [.47, .69]	.75*** [.67, .82]	.34** [.19, .49]

Note. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$  (one-sided). Values in square brackets indicate 95% confidence intervals.

### *Ancillary analyses*

To ensure robustness, we calculated partial correlations controlling for age, gender, and dietary habits (see Supplementary Materials, Table S4). The results remained substantially unchanged. Since Study 2 was more balanced in terms of gender and age than Study 1, these results provide further evidence of the measures' stability across different population segments.

We also conducted parallel analyses focusing on the omnivore subsample, which mirrored those of the full sample (Supplementary Materials, Tables S3 and S5). A small number of vegetarians and vegans precluded subgroup analyses. A hierarchical regression (Supplementary materials, Table S6) further indicated that self-reported attitudes were the primary predictor of behavioral intentions, while indirect measures did not provide significant incremental predictive value.

### **Discussion**

Explicit measures revealed a cohesive cluster, with moderate-to-strong correlations. This convergence suggests that reflective evaluations remain internally consistent whether framed abstractly or anchored to concrete visual stimuli. In striking contrast, associations between this explicit core and indirect tasks (BIAT and Manikin Task) remained consistently low ( $r \leq .15$ ). Despite designing the situational measures 'Willingness to Eat in Real Life' and 'Intention to Taste' to bridge the gap toward situational behavior (Vizcaino & Pohlmann, 2024), they aligned with the reflective system rather than with automatic associations. These findings suggest that indirect measures of novel foods tap into evaluative processes distinct from self-reports, regardless of how realistically those intentions are framed.

## General discussion

Automatic cognition in sustainable food choices is understudied (Fernqvist et al., 2024). Research on consumers' automatic reactions to insect-based foods is rare, partly due to the lack of reliable measures.

Unlike prior studies using non-food insects (Verneau et al., 2016; La Barbera et al., 2018) or words (Brunner et al., 2025; Vanutelli et al., 2024), we used visual stimuli, which are critical for eliciting automatic food reactions (Avery et al., 2025; Freijy et al., 2014; Lee et al., 2022; Luo et al., 2022; Ostende et al., 2023; van der Laan et al., 2025). Across two studies, our BIAT and Manikin Task demonstrated acceptable to excellent internal consistency, providing a toolkit to address this research gap.

For the BIAT, Study 2 showed good reliability, potentially due to the increased number of trials per block (which increased overall completion time by less than 1 minute). While samples and recruitment differences across studies caution against direct comparisons, these findings suggest that increasing trial number is an efficient optimization strategy. Crucially, the BIAT scores for the two brands were uncorrelated in Study 1 and only weakly correlated in Study 2. This independence, combined with the fact that only the insect-based BIAT significantly correlated with disgust (Study 1) and intentions (Study 2), confirms that the BIAT can capture evaluations of separate brands rather than merely relative preferences. This target-specific BIAT application (Perugini et al., 2010) is valuable for food research, where understanding specific product reactions is often more useful than simple relative preferences.

Regarding the Manikin Task, most prior research has employed familiar stimulus categories, such as chocolate or snack foods (Neimeijer et al., 2015). Although this work has demonstrated the task's utility and reliability in food-related contexts, the present research is

the first to apply an approach-avoidance task to examine responses to genuinely novel foods. While used for non-habitual yet familiar foods (Knight et al., 2020), this is the first application to genuinely novel foods. Overall, the investigation of automatic approach-avoidance tendencies toward novel foods with the Manikin Task or other approach-avoidance tasks remains unexplored and represents a novel contribution of the present study. The results showed that the Manikin Task demonstrated stable, good reliability across both studies, even with novel foods. The differential measure—reflecting the preferential tendency to approach the meat- versus insect-based burger—demonstrated excellent reliability. Highly negative Manikin scores for the two brands suggest that our Manikin Task implementation functions as a comparative measure rather than a target-specific assessment.

The lack of correlation between the BIATs and Manikin Task aligns with evidence that indirect measures tap into distinct constructs rather than a single underlying factor (Bosson et al., 2000; Bar-Anan & Nosek, 2014). In the present research, the BIAT aimed at assessing participants' spontaneous associations between products and valence, whereas the Manikin Task indexed spontaneous motivational tendencies to approach or avoid the stimuli. While research indicates faster approach to positive stimuli and faster avoidance of negative ones (Phaf et al., 2014; Kozlik & Neumann, 2015), evaluative and behavioral tendencies remain distinct constructs. This distinction is particularly relevant for novel attitude objects like insect-based food; due to a lack of consumer experience, evaluative reactions may not yet be well integrated with corresponding behavioral tendencies, reflecting what Dalege and colleagues (2017) describe as weakly connected attitude networks.

Associations with explicit measures were also largely absent, with only a few small, context-specific correlations that, while theoretically meaningful, lacked consistent replication. These patterns suggest that the BIAT, Manikin Task, and self-reports capture different facets

of consumers' reactions, underscoring the value of multi-method approaches for a comprehensive assessment of cognitive and affective responses.

### **5.1. Limitations and future directions**

The present research has limitations that offer avenues for future inquiry. To begin with, although we observed improved reliability in Study 2, which used a larger number of trials, future research should systematically manipulate trial numbers to confirm this effect. Second, both studies employed a fixed task order (indirect measures followed by self-reports, with the BIAT always preceding the Manikin Task). Although order effects on indirect measures are typically negligible (Forscher et al., 2019; Nosek et al., 2005; Perugini et al., 2014), future counterbalanced designs would be beneficial to confirm that task divergence is not an order artifact.

Moreover, while we focused on establishing reliability, investigating the predictive validity of these tools regarding actual consumption is essential. Implicit attitudes can significantly predict insect-eating behavior (La Barbera et al., 2018; Verneau et al., 2016), which is critical given that self-reports often misalign with action. Recent findings of misaligned intentions and behavioral choices (Hajhamidi et al., 2025; Kamenidou et al., 2023) highlight the need to test whether indirect measures provide incremental validity over traditional reports.

A further limitation concerns the visual stimuli we used. Participants reacted to visually identical products and only knew of the insect content through labeling. This design specifically isolated ideational disgust—the rejection based on the food's essence—from sensory-based disgust triggered by visual cues (Rozin & Fallon, 1987), based on the observation that insect ingredients are more readily accepted than whole insects by Western consumers (Kröger et al., 2022; Syartiwidya et al., 2025). Whether the automatic reactions

observed here would be amplified by the presence of 'whole' insects remains an open question. Future research should systematically manipulate visibility to disentangle the relative contributions of perceptual rejection cues versus conceptual contamination (Modlinska et al., 2020).

Finally, this framework could be extended to other novel foods with similar psychological barriers, such as cultured meat, and could integrate socio-contextual factors, including social perceptions, stigma, and certification (Owusu et al., 2025). Combining these social variables with implicit measures would provide a holistic understanding of how fear of social judgment and automatic reactions interact to facilitate or hinder sustainable food innovations.

## **5.2. Methodological and procedural considerations**

Several factors regarding our sample and experimental environment warrant discussion. Both studies relied on relatively young Italian participants, recruited through university channels and social media (Study 1), and the Prolific platform (Study 2). While Study 2 achieved gender balance, Study 1 was predominantly female. Furthermore, Italy's cultural context is characterized by a strong culinary tradition and food identity (Fontefrancesco, 2023), which may influence insect-food acceptance. Consequently, these findings may not be fully generalizable to older cohorts or to cultures with different culinary orientations. The online nature of the data collection also introduces constraints. While web-based reaction-time measurements facilitate larger, more diverse samples, they lack the high-precision environmental control of a laboratory (e.g., hardware-related latency or environmental distractions). However, modern platforms provide sufficient accuracy for the millisecond-level differences typically observed in indirect tasks (Anwyl-Irvine et al., 2020). Furthermore, although demand characteristics are generally less pervasive in reaction-time paradigms than

in self-reports, due to their speeded nature and absence of an explicit request to evaluate the attitudinal object, we cannot completely rule out their presence.

Finally, we emphasize the reduced statistical power for subgroup analyses regarding the familiarization manipulation. Given the smaller sample sizes within these divisions, these findings were intended as exploratory, should be interpreted with caution, and serve primarily as a basis for generating hypotheses in future, larger-scale investigations.

### **5.3. Synthesis: a reliable toolkit for sustainable food research**

In conclusion, this research demonstrates that the BIAT and the Manikin Task provide reliable, conceptually distinct paradigms for assessing spontaneous reactions to foods containing imperceptible insect derivatives. By tapping into automatic evaluative and behavioral facets often inaccessible via self-report, these tools provide a necessary complement to explicit measures. Crucially, they offer a framework for assessing specific attitudes, providing psychometric tools for future investigations into the drivers of consumer acceptance for novel and sustainable food innovations.



## **Project 2: Measuring Food Approach–Avoidance with a Mobile Swipe Task: Psychometric Evaluation<sup>2</sup>**

### **Abstract**

Behavioral approach–avoidance tendencies are critical for understanding spontaneous food evaluations but are challenging to measure outside laboratory settings. This article introduces the swipe Approach–Avoidance Task (swipeAAT), a novel smartphone-based task that uses swipe gestures to assess spontaneous approach–avoidance tendencies toward conventional and alternative foods. Across two preregistered online studies (N = 297), the swipeAAT was administered alongside a mobile Brief Implicit Association Test (BIAT) and several self-report measures targeting attitudes, experiences, and intentions regarding meat-, insect-, and legume-based foods. The swipeAAT showed acceptable to good internal consistency across Studies 1 and 2. The swipeAAT and the BIAT scores were uncorrelated, suggesting that the two paradigms capture distinct facets of spontaneous reactions. Similarly, correlations with self-reported measures were absent, likely reflecting differences in task modality (verbal versus visuo-motor) and the constructs assessed. These findings support the swipeAAT as a reliable, scalable mobile instrument for assessing approach–avoidance tendencies toward food, offering a practical approach for large-scale research on consumer attitudes and sustainable food choices.

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<sup>2</sup> Project 2 is based on: Fedeli, F., Zogmaister, C., Gabbiadini, A., Vanutelli, M. E., & Steca, P. (2025, December 9). Measuring Food Approach–Avoidance with a Mobile Swipe Task: Psychometric Evaluation. [https://doi.org/10.31234/osf.io/4ctrv\\_v1](https://doi.org/10.31234/osf.io/4ctrv_v1). The manuscript is currently under review at Behavior Research Methods.



## Introduction

Behavioral approach–avoidance tendencies play an adaptive role by guiding humans toward stimuli perceived as beneficial and away from those perceived as potentially harmful (Elliot, 2006; Corr, 2013). Such approach-avoidance tendencies are difficult to measure using self-reports, particularly those that arise spontaneously or automatically. To address this challenge, researchers have developed approach-avoidance tasks (AATs) in which participants are instructed to approach or avoid target stimuli across multiple trials. For example, participants might be asked to approach images of healthy foods while avoiding images of junk foods. Spontaneous behavioral tendencies toward the two food categories are then inferred from the error rates and reaction times that emerge from their performance. However, existing AATs are often limited in their ecological validity and scalability. To overcome these limitations, we present the swipeAAT, a novel approach–avoidance task designed for use on smartphone devices.

In the first study using an AAT paradigm (Solarz et al., 1960), participants were instructed to move printed word cards either toward themselves (approach) or away from themselves (avoidance) depending on whether the words were positive or negative (e.g., happy vs. unhappy, good vs. bad). Results showed shorter response latencies for compatible trials (i.e., approaching positive words and avoiding negative words) compared with incompatible trials (i.e., approaching negative words or avoiding positive ones). Since this initial work, many computer-based variants of the AAT have been developed, differing primarily in how they operationalize approach and avoidance behaviors. For example, in the Manikin task (De Houwer et al., 2001), participants use keyboard keys to move a small figure on the screen either toward or away from affective stimuli, simulating approach or avoidance tendencies through

symbolic motion. In joystick-based versions (Rinck & Becker, 2007), participants physically pull or push a joystick to move stimuli closer or further away. Pulling the joystick caused the picture to gradually enlarge, creating the impression of the image moving closer, whereas pushing it made the picture shrink, giving the impression of it moving away. Participants were instructed to categorize each image and respond with the assigned behavioral response. More recently, Wittekind et al. (2021) directly compared different response modalities (i.e., using a joystick, a computer mouse, and a touchscreen) to assess behavioral tendencies toward chocolate. While these studies demonstrate the versatility of different implementations, a practical limitation is that they are typically conducted in controlled laboratory settings, which may restrict their use in more naturalistic contexts.

Consequently, recent AAT research has increasingly aimed to enhance the ecological validity and ease of administration of the task. For instance, Meule and colleagues (2019, 2020) introduced a touchscreen-based AAT that simulates grasping movements (see also, Wittekind et al., 2021). Similarly, Rinck et al. (2021) and Van Alebeek et al. (2023) employed touchscreen variants to assess avoidance of spiders, while Kahveci et al. (2021) used a comparable setup to measure food-related approach tendencies. Wang and colleagues (2022) further examined the impact of a swipe-based AAT training on valence judgments of emotional images. Notably, however, all these implementations relied on fixed, laboratory-based tablet devices. This means that their higher ecological validity comes mainly from the motor pattern they rely on, since the approach and avoidance gestures more closely resemble those enacted in everyday situations, rather than from the context in which the task is performed. To further extend the applicability of these tasks beyond laboratory settings, mobile-based versions of the AAT have been developed (Kakoschke et al., 2018; Meule et al., 2019; Zech et al., 2020), allowing

participants to complete the task on their own devices. These versions typically adapt the classic push–pull logic of joystick-based AATs to mobile interaction, having users tilt or move the phone to simulate approach and avoidance responses. This preserves the basic structure and the conceptual logic of the AAT while relying on portable device-mediated movements. Meule and colleagues (2019) employed a smartphone-based approach-avoidance training to reduce chocolate craving and consumption, testing the feasibility of the paradigm outside the laboratory. Similarly, Kakoschke and colleagues (2018) applied this approach to healthy and unhealthy foods. These studies demonstrate that approach–avoidance behaviors can be implemented on a smartphone, but because the tasks were used as interventions rather than as measurement tools, they do not provide direct evidence regarding the suitability of the mobile format for assessing behavioral tendencies.

Measuring behavioral tendencies with the AAT through smartphone-based implementation offers several important advantages. First, it increases scalability and accessibility, enabling researchers to recruit larger and more geographically diverse samples than is typically feasible with laboratory- or PC-based implementations. Second, it may enhance ecological validity by allowing data collection in real-life contexts; for instance, these tasks could be administered at moments directly relevant to the target behavior, such as during a meal or while making food choices in a restaurant. Third, smartphone platforms readily support repeated and longitudinal measurements, allowing for the examination of fluctuations in behavioral tendencies over time. Although responsive web design technologies have long made it possible to adapt interfaces to smaller screens, translating a paradigm typically administered on a desktop or tablet to a smartphone presents challenges that extend far beyond simple visual resizing. Response modalities often need to be rethought (e.g., device push–pull

movements or swipe gestures instead of keyboard presses), and changes in device size, handling, and interaction style can alter the cognitive and motor processes engaged by the task. Additionally, smartphone administration introduces potential sources of noise, such as distractions or interruptions from other apps and notifications. For these reasons, it is essential to reassess the psychometric properties of the mobile-adapted measure rather than assuming that they automatically carry over from the computer-based format.

An important step toward implementing a measure based on AAT paradigm on smartphones was made by Zech and colleagues (2020). In their mobile AAT, participants approached stimuli by physically pulling the smartphone toward themselves and avoided stimuli by pushing it away. The task included congruent and incongruent blocks, with reaction times and movement intensity recorded via the phone's accelerometer and gyroscope. Results indicated that participants pulled positive stimuli faster and with greater force than negative stimuli, demonstrating that approach–avoidance behaviors can be reliably captured using a mobile device. This study illustrates that the core mechanics of the AAT measures can be translated to a smartphone, offering the flexibility of in-field testing. Building on this concept, we aim to implement participant responses using swipe gestures, which have become a natural form of approach and avoidance in everyday smartphone use. The studies by Meule and Kakoschke demonstrate that swipe movements are effective in inducing approach–avoidance behaviors in intervention contexts (i.e., when AAT is used as a training). Here, we extend this approach by using swipe gestures as a *measurement tool*, testing their reliability in capturing behavioral tendencies rather than manipulating them. Swiping is a deeply ingrained and highly routinized smartphone behavior, used daily to scroll through feeds, dismiss notifications, close apps, or navigate dating apps. Leveraging such a familiar motor pattern may facilitate task

engagement and reduce learning demands. Moreover, the mapping between movement direction and motivational meaning can be intuitively interpretable: in many common interfaces, upward swipes often function as a gesture for dismissing or removing content, whereas downward swipes can serve to reveal or bring content closer. This familiar functional pattern may help participants quickly understand the task's response structure. Beyond its ecological plausibility, the swipe gesture offers additional methodological opportunities, as it allows the capture of multiple kinematic parameters. Future versions can investigate not only response latencies, but also touch onset times, velocity and acceleration profiles, and even mid-movement trajectory corrections.

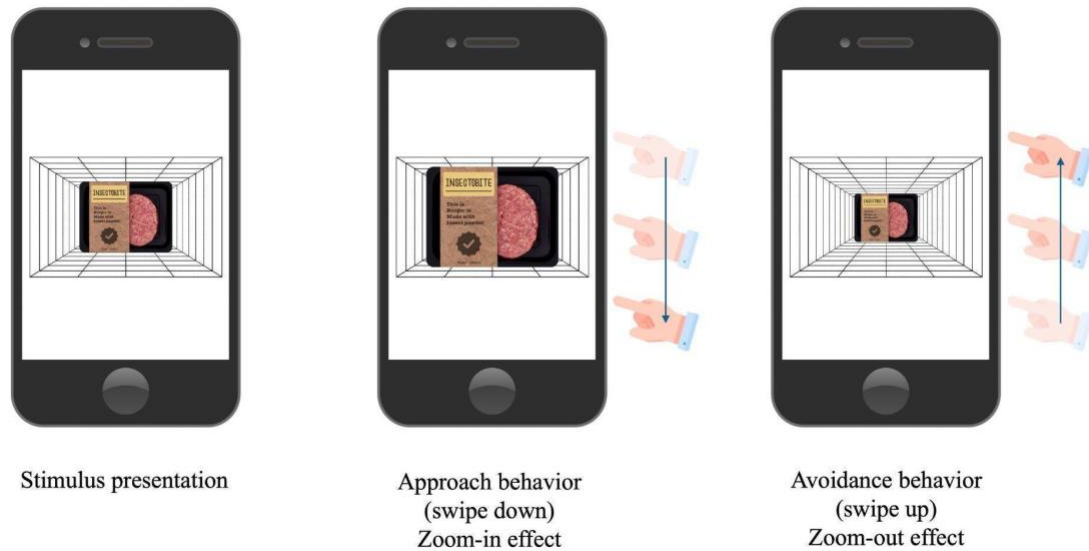
### **The present research**

The present research aimed to develop and test a novel smartphone-based approach–avoidance task, designed to measure approach–avoidance tendencies via swipe gestures. In the swipeAAT, each trial begins with the presentation of a picture stimulus on the smartphone screen, overlaid on a three-dimensional grid designed to provide a sense of depth. Participants are instructed to either approach or avoid the stimulus by performing a swipe gesture: swiping from top to bottom brings the stimulus closer (approach), causing it to gradually enlarge on the screen, while swiping from bottom to top pushes it away (avoidance), causing it to shrink (Figure 3). The task is organized into two blocks. In the first block, participants are assigned one mapping, for example, approaching meat-based foods and avoiding legumes. In the second block, the instruction is reversed, so that the previous approach stimuli must now be avoided, and vice versa. Instructions were worded as follows (translation from Italian): “You will now complete a series of categorization tasks. In each task, images will appear on the screen, one at a time. Using the touchscreen, you should bring the images closer (swipe from top to bottom)

or push them away (swipe from bottom to top). Classify the images as quickly as possible while making as few errors as you can. If you respond too slowly or make too many mistakes, your score will not be interpretable. If you make an incorrect response, a red “X” will appear: correct your response quickly by performing the correct swipe”.

The swipeAAT provides a novel contribution by leveraging mobile delivery and a natural swipe gesture to measure approach–avoidance tendencies in a more ecologically valid and accessible manner. Indeed, most of the existing implementations of the AAT as a measurement tool have relied on lab-based tablets and controlled settings (Rinck et al., 2021; Kahveci et al., 2021; Wang et al., 2022; Van Alebeek et al., 2023). The use of non-personal devices and the lack of evidence on how they perform in real-world settings limit the extent to which such implementation can be considered scalable or suitable for use outside the lab. Moreover, the existing approach–avoidance tasks, which have been adapted for administration outside the lab (e.g., Meule et al., 2019; Blomberg et al., 2025; Aulbach et al., 2025), were used as an experimental manipulation rather than as a measurement tool. One exception is the work by Zech and colleagues (2020), which employed a mobile approach-avoidance task as a measure of approach-avoidance tendencies outside laboratory settings. However, Zech and colleagues relied on physical device movements. In this work, we implement a swipe gesture as the response modality. Since swipe movements are familiar in everyday smartphone use, we believe they may provide an intuitive interaction format for participants. At the same time, whether such response modality truly increases ecological validity remains an empirical

question that needs explicit validation research (Boddez et al., 2023).



**Figure 3.** P2. Schematic representation of the swipeAAT

Together with the swipeAAT, we implemented a smartphone version of the Brief Implicit Association Test (BIAT; Sriram & Greenwald, 2009). The BIAT is a shorter version of the Implicit Association Test (IAT) and, unlike the IAT, can provide an absolute measure of attitudes toward a single target category, rather than a relative measure comparing two categories (Sriram & Greenwald, 2009; Nosek et al., 2014). Whereas the IAT typically yields a relative preference score (e.g., a preference for one brand over another), the BIAT allows for the assessment of attitudes toward single target categories (see Perugini et al., 2013; Zogmaister et al., 2025, for examples). In a traditional computer-based BIAT, each trial requires participants to categorize a stimulus, such as an image of a burger or a positive/negative word, by pressing a corresponding keyboard key. The task is organized into blocks in which specific target categories are paired with either positive or negative attributes. For example, one block

might require participants to respond to meat-related images and positive words with one key, while another block pairs meat-related images with negative words. Similarly, legumes would be paired with positive or negative words in different blocks.

In the present research, we adapted the mobile version of the BIAT from Maimon (2020). Instead of using keyboard keys, participants responded by pressing two dedicated areas located on the left and right sides of the screen using the smartphone touchscreen. This adaptation allowed participants to complete the task directly on their personal devices while maintaining the basic structure and logic of the original BIAT.

Although the focus of this paper is the swipeAAT, we included the mobile BIAT to illustrate how different aspects of spontaneous reactions can be investigated using smartphone-based approaches. The swipeAAT was designed to measure spontaneous behavioral tendencies, with response errors and swipe directions indicating participants' approach or avoidance tendencies. The mobile BIAT, on the other hand, was used to assess spontaneous evaluations, with reaction times providing an index of participants' automatic evaluations toward the stimuli. Including the BIAT in our study allowed us to directly compare the spontaneous behavioral tendencies captured by the swipeAAT with a measure of implicit evaluation, highlighting the complementary information that different smartphone-based indirect measures can provide. This is particularly informative because different indirect measures are thought to tap distinct cognitive processes and often exhibit low intercorrelations (Fazio & Olson, 2003; Köllner & Schultheiss, 2014; Vuletic & Payne, 2025).

In previous literature, both the AAT and the BIAT have demonstrated satisfactory psychometric properties (Sriram & Greenwald, 2009; Nosek et al., 2014; Krieglmeyer & Deutsch, 2010; Zech et al., 2020). Nonetheless, both are procedural paradigms rather than standardized instruments; their psychometric characteristics depend on implementation details,

such as the device used, the number of trials, and the specific stimuli. Therefore, empirical investigation of their psychometric qualities is required for each new implementation. To this end, we conducted two studies to evaluate the reliability of these smartphone-based indirect measures in assessing spontaneous reactions to foods. Study 1 implemented the BIAT and swipe-AAT to test their reliability using food stimuli representing conventional (meat-based) and novel (insect-based) products. Study 2 built on Study 1 and examined the generalizability of these measures across food categories by maintaining the meat stimuli while replacing insect-based foods with legume-based dishes. Across the two studies, self-report instruments were administered to examine how the scores of the two indirect measures relate to explicit evaluations. Previous research has generally found weak associations between direct and indirect measures (e.g., Bosson et al., 2000; Bar-Anan & Nosek, 2014), a pattern that likely reflects differences in the characteristics of the measures as well as variability in the reliability of implicit tasks. The inclusion of self-reports thus offers a useful reference point for interpreting the indirect measures.

### **Open science practices and ethical statement**

Both studies were preregistered, including hypotheses or research questions, design, and planned analyses (Study 1: <https://osf.io/pz4sv>; Study 2: <https://osf.io/hvskn>). All materials, stimuli, scripts, power analyses, and anonymized data are openly available at [https://osf.io/jg3bn/overview?view\\_only=b38406c585554591bfd1017e99f3a5ca](https://osf.io/jg3bn/overview?view_only=b38406c585554591bfd1017e99f3a5ca), ensuring transparency, reproducibility, and adherence to open science principles. All procedures were conducted in accordance with ethical guidelines for research with human participants and were reviewed and approved as minimal-risk research by the Departmental Research Committee (Protocol no. RM-2024-781). Participants provided informed consent before participation.

## Departures from preregistration

In Study 1, we also reported McDonald's  $\omega$  alongside Cronbach's  $\alpha$ . In Study 2, both  $\alpha$  and  $\omega$  were preregistered. Moreover, we also computed the swipeAAT bootstrapped split-half reliability.

## Study 1

### Method

#### Participants and design

The study employed a single-group correlational design. A total of 112 participants took part in the experiment. Participants were recruited through the Prolific platform (<https://www.prolific.com/>). Participants were 18 to 45 years old and were sampled from the Italian population. Only participants with a high approval rate (ranging from 95% to 100%) on previous Prolific studies were selected. Vegans and vegetarians were excluded from participation. Participants received the recommended compensation on Prolific, corresponding to 9£/12\$ per hour.

After applying exclusion criteria -negative response to the Self-Reported Single Item (SRSI), or error rates exceeding 25% in one or more blocks of the BIAT or swipeAAT- the final sample resulted in 102 participants (35 women, 62 men, 4 non-binary, 1 chose not to answer,  $M_{age} = 31.37$  years,  $SD_{age} = 8.40$ ). As preregistered, we computed the main analysis with and without participants with high scores (i.e.,  $\geq 4$ ) on the demand characteristics question, and the results did not differ substantially. These analyses are reported in the supplementary materials.

We conducted a sensitivity power analysis using G\*Power3 (Faul et al., 2007), to determine the minimum effect size that our design could reliably detect given the achievable

sample size, and provide transparency about the strength of effects that our sample size could reasonably detect. This analysis indicated that, with directional hypotheses, a sample size of 100 participants is adequate to detect correlations with an effect size  $|\rho| = 0.35$ , with  $\alpha = .05$ , Power  $(1-\beta) = .95$ . Although this study was exploratory and no formal hypotheses were preregistered, some observed correlations would be conceptually meaningful (e.g., higher disgust scores plausibly associated with more negative attitudes toward insects), whereas others, even if statistically significant, would be less theoretically interpretable. Accordingly, the sensitivity power analysis was conducted using a unidirectional framework, not to test a specific hypothesis, but to provide a transparent estimate of the effect sizes that our sample could reliably detect.

## Materials

### *Stimuli*

For this study, two fictitious burger brands were selected (from Zogmaister et al., 2025): *ClassicGrill*, which features conventional hamburgers, and *InsectoBite*, representing burgers with insect-based ingredients. For each brand, a set of eight distinct images was used, depicting either one or multiple burger packages with a prominently displayed logo, or the logo alone.

### *SwipeAAT*

The swipeAAT was implemented by the Bicocca Center for Applied Psychology (BICAPP).

In each trial, an image depicting either *ClassicGrill* or *InsectoBite* was presented at the center of the screen. The order of image presentation was randomized for each participant.

Participants were instructed to approach one brand and avoid the other. To perform an approach response, they swiped the image toward themselves (downward motion on the touchscreen), whereas to perform an avoidance response, they swiped the image away from themselves (upward motion on the touchscreen). Across two separate blocks, we counterbalanced which brand was to be approached and which was to be avoided. Each block consisted of 40 trials and was preceded by an 8-trial practice block. The order of the blocks was counterbalanced across participants. To enhance the sense of movement, a zooming effect was implemented: images grew larger during approach movements and shrank during avoidance movements, thereby simulating the perceptual experience of bringing stimuli closer or pushing them away.

As in the BIAT, a built-in penalty was implemented, requiring participants to provide the correct response to continue, and response latency was recorded from the moment of the correct response.

### ***BIAT***

In each trial, participants were presented with one of four stimulus types: images of *ClassicGrill* or *InsectoBite* burgers, or positive or negative words. There were eight positive words in total, including the Italian equivalents of Tasty, Good, Appetizing, Attractive, Mouthwatering, Exquisite, Delicious, Inviting, and eight negative words, including the equivalent of Disgusting, Bad, Nauseating, Sickening, Vomit-inducing, Unpleasant, Repellent, and Gross. Four test blocks were administered, each presented twice in a counterbalanced order. In each block, one brand and one word category (positive or negative) served as the focal categories. Participants responded by tapping one of two clickable areas on the screen: the area on the right if the stimulus belonged to the focal category, and the area on the left for all other stimuli. In case of an incorrect response, participants were required to provide the correct

response to continue, and reaction time was recorded from stimulus onset to the correct response (i.e., the built-in penalty). Each test block consisted of 32 trials, with four trials per stimulus type. Images and words were presented in random order. The critical blocks were preceded by 20 practice trials to familiarize participants with the task.

### ***Entomophagy Attitude Questionnaire (EAQ; La Barbera et al., 2020)***

We assessed participants' self-reported attitudes toward insect-based foods using the EAQ. Specifically, we administered the Disgust subscale (5 items; e.g., "I would be disgusted to eat any dish containing insects") and the Interest subscale (3 items; e.g., "I would be curious to try a dish with insects, if properly prepared"). Responses were provided on a 5-point Likert scale. The Feeding Animals subscale (2 items; e.g., "Using insects as feed is an effective way to produce meat") was not included in this study.

### ***Food Choice Questionnaire (Steptoe, 1995)***

We assessed the self-reported importance of sensory characteristics in food using the sensory appeal subscale of the Food Choice Questionnaire. This subscale consists of four items asking participants to rate how much they value foods that smell good, look attractive, have a pleasing texture, and taste enjoyable. Participants responded using a 4-point Likert scale, ranging from 1 (*Not important at all*) to 4 (*Very important*).

### ***Demographic questions***

Participants provided basic demographic information, including their age (in full years, open response) and gender, with response options of *Man*, *Woman*, *Non-binary*, or *Other/Prefer not to answer*. Dietary preferences were assessed with the question, "Does your

diet include meat (e.g., steaks, cold cuts) and/or foods that contain meat?” (response options: *Yes* or *No*).

### ***Data quality questions***

To assess potential influences on response validity, participants completed two measures. First, the Adaptation to Demand (Orne, 2009) asked, “People sometimes adjust their responses based on what they think the researcher expects. In this study, to what extent did you adjust your responses to fit our expectations?” with response options *Not at all*, *A little*, *Unsure*, *Fairly*, and *Very much*. Second, the Self-Reported Single Item (SRSI; Meade & Craig, 2012) asked, “Honestly, do you think we should use your data for this study?” with response options coded as 1 = *Yes* and 0 = *No*.

### **Procedure**

The study was administered online. Participants were first provided with details about the study and then given their informed consent. After this, they were introduced to the two brands of burgers: *ClassicGrill* and *InsectoBite*. They viewed labeled product images along with a brief description indicating that the two brands were not available in Italy, and the information that *ClassicGrill* produces meat burgers, whereas *InsectoBite* produces burgers containing insect flour. To ensure understanding, participants answered two comprehension questions identifying which type of burgers each brand produced. Incorrect responses triggered a repetition of the information until both answers were correct; all participants answered correctly on the first attempt. Next, participants completed the BIAT, the swipeAAT, the EAQ, and the Food Choice Questionnaire, in that order. Finally, participants answered questions

regarding their demographics and data quality. The entire study took approximately 15 minutes to complete.

## **Hypotheses**

This study does not propose specific directional hypotheses. Instead, the primary goal is to explore the psychometric properties of the swipeAAT, alongside a smartphone application-based BIAT. Given that this is the first implementation of these measures, we intentionally refrained from formulating formal hypotheses, allowing the study to remain exploratory. The investigation focuses on a first examination of the reliability of these tools and their associations with self-reported measures and other relevant variables within the present research context.

## **Computation of indices**

### ***Spontaneous evaluation - BIAT***

Attitudes measured with the BIAT were calculated separately for the two brands following the BIAT-specific recommended improved scoring procedure (Nosek et al., 2014). The resulting D score represents a measure of the spontaneous evaluation of the brand, which is thought to reflect participants' attitude toward it.

The following steps were applied during data processing. Trials with response times exceeding 10,000 milliseconds were removed. The first four trials of each response block were excluded to account for practice effects. Error trials were retained, and response times shorter than 400 milliseconds were recoded to 400 ms, while those longer than 2,000 milliseconds were recoded to 2,000 ms. Participants with more than 10% of responses faster than 300 milliseconds were excluded. Separately for each brand, the BIAT score was calculated by subtracting the mean response latency in the block where the brand and positive words were

focal from that in the block where the same brand and negative words were focal. This difference was then divided by the pooled standard deviation of latencies across the two blocks. Higher scores reflected a more positive spontaneous evaluation of the brand.

Moreover, a differential BIAT preference score for ClassicGrill was then obtained by subtracting the InsectoBite score from the ClassicGrill score.

### ***Spontaneous approach/avoidance tendencies - SwipeAAT***

For the swipeAAT, spontaneous behavioral tendencies toward each brand were computed as the difference between the mean latency in trials where the brand had to be avoided and those where the brand had to be approached. Responses faster than 250 ms were removed because they likely did not allow sufficient time for stimulus processing, whereas latencies exceeding 10,000 ms were excluded as clear indicators of distraction or inattention. A differential score was then computed as the approach tendency toward ClassicGrill minus the approach tendency toward InsectoBite, with higher values reflecting a stronger relative tendency to approach ClassicGrill compared to InsectoBite.

Moreover, for exploratory purposes, we computed a D score to compare these with the more traditional scores described above, by dividing the swipeAAT score (procedure described above) by the standard deviation for all the latencies involved in such difference.

### ***Self-reported measures***

Self-reported measures were scored as follows: a disgust score toward eating insect-containing foods was computed as the mean of all five items of the Disgust subscale (EAQ-D), and an interest score as the mean of the three items of the Interest subscale (EAQ-I). Sensory

appeal was calculated as the mean of the four items of the sensory appeal subscale of the Food Choice Questionnaire.

## Results

### *Reliability analyses*

Descriptive statistics and internal consistency estimates for all primary measures are presented in Table 4. Cronbach's alpha indicated good to optimal internal consistency across the measures.

Consistent with the preregistration, internal reliability was assessed for the BIAT and swipe-AAT by calculating Cronbach's alpha for each brand-specific score, as well as for the Disgust (EAQ-D) and Interest (EAQ-I) subscales, and for the sensory appeal subscale of the Food Choice Questionnaire. Moreover, we also report the reliability of the differential measures (BIAT swipeAAT preference).

Moreover, we also computed McDonald's  $\omega$  as an additional measure of internal consistency (not preregistered). McDonald's  $\omega$  is based on a factor-analytic approach, in contrast to Cronbach's  $\alpha$ , which is primarily based on the correlations between items. Omega has been shown to be more robust than alpha, particularly when items contribute unequally to the underlying construct, as is often the case for indirect measures, where factors such as fatigue can influence item response latencies.

**Table 4.** P2. Study 1. Descriptive statistics and internal consistency

Measure	N	M	SD	Cronbach's $\alpha$	McDonald's $\omega$
BIAT InsectoBite	102	-0.02	0.45	.74	.77
BIAT ClassicGrill	102	0.29	0.46	.75	.77
BIAT Differential	102	0.31	0.57	.70	.76
SwipeAAT InsectoBite	102	103.74	456.74	.79	.82
SwipeAAT ClassicGrill	102	59.34	430.42	.66	.76
SwipeAAT Differential	102	-44.39	802.65	.88	.93
EAQ Disgust	102	2.68	1.00	.92	.94
EAQ Interest	102	3.33	1.12	.92	.92
Sensory appeal	102	3.46	0.42	.58	.66

Both the smartphone-based BIAT and the swipeAAT demonstrated satisfactory internal consistency, aligning with previous findings obtained using computer-based versions (e.g., Nosek et al., 2014; Krieglmeier & Deutsch, 2010). This suggests that adapting these paradigms for mobile devices does not necessarily compromise their psychometric quality (see also, Zech et al., 2020; 2023). In particular, the BIAT demonstrated good reliability across both target categories, with  $\alpha$  and  $\omega$  coefficients exceeding the threshold of 0.70. Similarly, the swipeAAT achieved good to excellent internal consistency, particularly for the differential score, which yielded the highest reliability estimates. This finding suggests that the relative measure (i.e., the difference between approach tendencies toward ClassicGrill and InsectoBite) captures stable individual differences more effectively than the single-category scores. Finally, recent methodological work suggests that bootstrapped split-half reliability provides a more suitable estimate for tasks such as the AAT (Kahveci et al., 2025). Therefore, although not preregistered, we additionally computed swipeAAT bootstrapped split-half reliability using the *aat\_splithalf* function of the R package *AATtools* (version 0.0.3; Kahveci, 2025), performing 6,000 random

splits. The full-length Spearman–Brown corrected reliability estimate was  $r = 0.84$  (uncorrected  $r = 0.73$ ).

The self-report measures, in contrast, displayed a mixed reliability pattern. The EAQ subscales (Disgust and Interest) showed excellent internal consistency, replicating the psychometric performance reported by La Barbera et al. (2020). The sensory appeal subscale showed generally low reliability, which was still evident when compared with the original study in which the scale was introduced (Cronbach’s  $\alpha = 0.70$ ).

### *Association with other variables*

As preregistered, Pearson correlations were computed between all indices to examine their interrelationships. This analysis aimed to quantify the strength and direction of associations among the various measures.

Table 5 reports all the relevant correlations. Differential scores were included to capture relative preferences and comparative behavioral tendencies. All analyses applied a two-tailed significance threshold of  $p < .05$ . Exploratory D-scores were computed but are not reported here.

**Table 5.** P2. Study 1. Correlations among BIAT scores, swipeAAT scores, and self-reported measures

Measure	1	2	3	4	5	6	7	8	9	10
1. BIAT InsectoBite	—									
2. BIAT ClassicGrill	.22*	—								
3. BIAT Differential	-.61***	.64***	—							
4. SwipeAAT InsectoBite	-.01	.03	.04	—						
5. SwipeAAT ClassicGrill	-.05	-.18	-.10	-.64***	—					
6. Swipe AAT Differential	-.02	-.11	-.08	-.91***	.90***	—				
7. EAQ Disgust	-.26**	-.02	.19	-.03	-.11	-.04	—			
8. EAQ Interest	.25*	.02	-.18	-.02	.10	.06	-.87***	—		
9. Sensory appeal	.04	-.03	-.06	-.05	.04	.05	.13	-.04	.10	—

Note. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

No significant correlation emerged between BIAT and swipeAAT scores. As for the association with self-reported measures, the BIAT showed modest yet significant correlations with the Disgust and Interest subscales of the EAQ, such that participants who reported stronger disgust or lower interest in insect-based foods also tended to display less positive spontaneous evaluations of the *InsectoBite* brand. The Disgust and the Interest subscales were highly correlated ( $r = -.87, p < .001$ ), indicating that they may either capture a single underlying construct or represent two theoretically distinct but empirically overlapping dimensions. Given this strong association, the creation of a single composite index would be justifiable. Notably, the aggregated score also shows a significant correlation with the BIAT score ( $r = -0.26, p = 0.008$ ). Moreover, the BIAT scores for the *ClassicGrill* brand were not correlated to the self-reported measures of disgust and interest in insect-based foods, as expected, given that they refer to a different product category.

No significant correlations emerged for the swipeAAT, neither with the spontaneous tendency scores toward each individual brand nor with the differential preference score.

## Discussion

Overall, the results of Study 1 provide a promising foundation for investigating spontaneous reactions toward both conventional foods and those containing insect-derived ingredients, using smartphone-based measures.

As for the self-reported measures, the EAQ subscales (Disgust and Interest) demonstrated excellent internal consistency, replicating previous findings (La Barbera et al., 2020). Conversely, the sensory appeal subscale displayed lower reliability, which suggests that

it might have a formative nature (Edwards & Bagozzi, 2000), where distinct sensory attributes, such as taste, smell, and texture, jointly define the construct rather than reflecting a single latent factor.

Both indirect tasks also showed satisfactory internal consistency. For the swipeAAT, reliability was higher for the differential index (e.g., preference for ClassicGrill over InsectoBite), suggesting that relative measures may better capture stable individual differences in behavioral approach tendencies.

Correlational analyses confirmed that the BIAT and the swipeAAT were uncorrelated, consistent with prior evidence showing that different indirect paradigms often capture distinct components of automatic evaluation (Bosson et al., 2000; Bar-Anan & Nosek, 2014). The BIAT, however, correlated modestly but significantly with Disgust and Interest in the expected direction: participants reporting higher disgust or lower interest in insect-based foods also showed less positive implicit evaluations of the insect-based brand. These associations were specific to insect-related stimuli, suggesting targeted rather than generalized evaluative processes. No significant associations emerged for the swipeAAT, possibly because it reflects relative approach–avoidance dynamics rather than absolute positive or negative evaluations related to the stimulus itself. Although the present findings support the feasibility and psychometric soundness of mobile-based indirect measures, there is room to further improve their reliability.

Building on these insights, Study 2 was designed to enhance the reliability of both the BIAT and the swipeAAT through methodological refinements, including an increased number of trials. Moreover, a possible reason for the relatively modest reliability of some indices may lie in participants' limited familiarity with insect-based foods, which could lead to less stable or less elaborated evaluative representations. To reduce the potential noise associated with

unfamiliarity, we focused on legume-based foods, which represent more familiar products. This shift allows us to test whether the improved procedures generalize to another food category characterized by presumably more established evaluations. Finally, to better align the direct and indirect measures, Study 2 introduced time-constrained self-reported evaluations, procedurally closer to the speeded nature of the indirect tasks. Because indirect measures require rapid categorization, while self-reports are typically completed without time pressure, this adjustment would allow us to explore whether imposing procedural constraints increases the correspondence between direct and indirect indices of spontaneous reactions.

## Study 2

### Method

#### Participants and design

As in Study 1, Study 2 employed a single-group correlational design. A total of 185 participants were recruited through the Prolific platform. Participants were 18 to 45 years old and were sampled from the Italian population. Only participants with a high approval rate (ranging from 95% to 100%) on previous Prolific studies were selected. Participants received the recommended compensation on Prolific, corresponding to 9£/12\$ per hour.

We applied the following preregistered exclusion criteria. Participants were excluded if they provided a negative response to the SRSI item, exhibited an error rate exceeding 25% in one or more blocks of the BIAT or of the Swipe Approach–Avoidance Task, or showed obvious response patterns indicative of inattention or disengagement (e.g., straight-lining). In addition, we excluded participants who interrupted the task, operationalized as having at least one trial with an unusually long response time (i.e., > 60 seconds). The final sample consisted of 176

participants (118 women, 55 men, 2 non-binary, 1 participant preferred not to answer,  $M_{age} = 29.12$  years,  $SD_{age} = 5.22$ ).

The sample size was determined through an a priori power analysis conducted with G\*Power. We planned to examine a set of correlations among the study variables: (i) BIAT and Swipe-AAT, (ii) BIAT and consumption frequency, (iii) Swipe-AAT and consumption frequency, (iv) BIAT and consumption experience, (v) Swipe-AAT and consumption experience, (vi) BIAT and attitude thermometer, (vii) Swipe-AAT and attitude thermometer, (viii) BIAT and behavioral intention under time constraints, and (ix) Swipe-AAT and behavioral intention under time constraints. To control for Type I error due to multiple parallel correlation tests, the significance level was set to  $\alpha = .01$ . Based on a desired statistical power of .95, an expected medium effect size of  $|\rho| = .30$ , and  $\alpha = .01$  (one-tailed), the required sample size was  $N = 163$  participants. To ensure the study was powered to detect a practically relevant relationship, we established a Smallest Effect Size of Interest (SESOI) of  $|\rho| = .30$ . While literature often reports lower correlations between implicit and explicit measures, a coefficient of .30 implies approximately 9% shared variance. Correlations substantially higher than this would suggest redundancy, undermining the incremental validity of using both measures jointly in predicting consumer outcomes. Effects smaller than this magnitude would suggest a negligible overlap between the constructs.

## Materials

Unless otherwise specified, the materials were identical to those used in Study 1, as were the implementation of the measures, the counterbalancings, and the instructions provided to participants.

### ***Stimuli***

In Study 2, the stimuli consisted of two food categories: legume-based and meat-based products. Five images were used for each category. Legume stimuli depicted peas, chickpeas, beans, mixed legume soup, and hummus, representing both cooked and prepared forms of these foods. Meat stimuli followed the same logic, including images of cooked items such as pork steaks, hamburgers, beef slices, and chicken fillets, as well as one uncooked item, sliced ham. All stimuli were created specifically for this study. We photographed the foods ourselves using a high-resolution camera on a white background to ensure uniformity and clarity across the images.

### ***BIAT***

The number of trials was increased by 50%, from 32 to 48, to enhance the reliability of the measure. Each test block, therefore, consisted of 48 trials. Images and words were presented in random order. As in Study 1, the critical blocks were preceded by 20 practice trials to familiarize participants with the task.

### ***SwipeAAT***

As for the BIAT, the number of trials was increased by 50%, that is, from 40 to 60, to improve the internal consistency of the measure. An 8-trial practice block preceded each block, and all other task characteristics remained unchanged.

### ***Attitude thermometer***

Participants rated their general attitude toward meat and legume-based foods using two separate thermometer scales (Alwin, 1997), ranging from 0 = *Very unfavorable* to 100 = *Very favorable*. Higher scores indicated more positive evaluations of each food category.

### ***Legume Experience & General Usage Measurement Evaluation (LEGUME Scale, ad-hoc developed).***

We developed a new self-report scale to assess participants' attitudes and experiences related to legume consumption, aiming to capture a broad and multidimensional evaluation of this food category. The LEGUME scale includes five dimensions: Sensory Aspects (e.g., "I find legume-based dishes tasty to eat"), Health Aspects (e.g., "I believe that eating legumes contributes to improving my overall health"), Digestive Aspects (e.g., "Consuming legumes causes me digestion problems"), Environmental Aspects (e.g., "I feel satisfied knowing that eating legumes is a sustainable choice"), and Practical Aspects (e.g., "I find that legumes are easy to prepare in everyday meals"). Responses were collected on a 5-point Likert scale ranging from 1 = *Strongly disagree* to 5 = *Strongly agree*. As this scale was used for the first time in the present research, we employed the current sample to perform an initial psychometric evaluation, including exploratory factor analysis and reliability assessment. Detailed item information, factor loadings, and reliability indices are reported in the Supplementary Materials, as the validation of the scale was not the primary focus of the present study.

### ***Legume consumption frequency***

Participants were asked: "How often do you consume a serving of legumes (1 serving = 100 grams cooked, half a can, or 2–3 tablespoons of dried or roasted legumes)?" Response

options were: *Never*, *One serving per month*, *2–3 servings per month*, *One serving per week*, *Multiple servings per week*, and *One or more servings per day*.

### ***Behavioral intentions assessed under time constraints***

Participants' intentions to choose legume-based foods were measured using six items (e.g., "If I saw a legume-based dish on a menu, I would probably order it"). Responses were provided on a 5-point Likert scale ranging from 1 = *Strongly disagree* to 5 = *Strongly agree*. Higher scores indicated stronger behavioral intentions to select legume-based foods. A 6-second countdown was displayed for each item; however, responses were recorded even if participants responded after the timer expired. The time limit was set based on pilot testing and estimated reading speed. Across 1232 trials, only 11 responses (less than 0.01%) exceeded the time limit ( $M = 3.887$  ms,  $SD = 1.299$  ms; median = 3.692 ms). All the items are openly available in the supplementary materials.

### **Procedure**

The details of the procedure were identical to those described in Study 1.

### **Hypotheses**

Results from Study 1 indicated that the smartphone-based BIAT and the swipeAAT were reliable. Hence, unlike in Study 1, we preregistered the following hypotheses to test whether associations exist between the two indirect measures and between these indirect measures and self-reported variables.

- H1: We expected positive correlations between the indirect measures, specifically between BIAT scores and swipeAAT scores, with a more precise prediction that the BIAT score of

attitude toward legumes would positively correlate with the swipeAAT score of preference to approach legumes.

- H2: We expected positive correlations between BIAT scores of attitudes toward legumes and self-reported measures, including (a) the attitudes thermometer score toward legumes, (b) the overall score on the legume consumption experience scale, (c) self-reported consumption intentions under time constraints, and (d) self-reported legume consumption frequency.
- H3 (Specificity Hypothesis): We expected no correlation between BIAT scores of attitudes toward meat and self-reported attitudes or intentions toward legumes.
- H4: We expected positive correlations between swipeAAT scores of preference to approach legumes and self-reported measures, including (a) the attitudes thermometer score toward legumes, (b) the overall score on the legume consumption experience scale, (c) self-reported legume consumption frequency, and (d) self-reported consumption intentions under time constraints.
- H5 (Specificity Hypothesis): We expected no correlation between swipeAAT scores of attitudes toward meat and self-reported attitudes or intentions toward legumes.

## **Computation of indices**

### ***Spontaneous evaluation - BIAT***

For the latency screening, we decided to adopt a more stringent criterium (preregistered) as compared to Study 1, excluding anticipations (<250ms) and late responses (>3,000ms), instead of only removing trials exceeding 10,000 milliseconds. The remaining steps for computing the BIAT indices followed the standard procedure described in Study 1.

### ***Self-reported measures***

Self-reported measures were scored as follows: for the legume-based foods scale, an overall score was computed by averaging all items. Similarly, for the behavioral intentions under time constraints, an overall intentions score was calculated by averaging responses across all items. All items were phrased in the same direction, so that higher scores on the overall legume-based foods scale reflected a more positive experience with legumes, and higher scores on the overall behavioral intentions scale reflected stronger intentions to choose legume-based foods under time constraints.

## **Results**

### **Reliability analyses**

Descriptive statistics and internal consistency estimates for all primary measures are presented in Table 6. Cronbach's alpha indicated good to optimal internal consistency across the measures.

As preregistered, internal reliability was assessed for the BIAT and swipe-AAT by calculating Cronbach's alpha and McDonald's  $\omega$  for each food category, as well as for the self-reported measures.

**Table 6.** P2. Study 2. Descriptive statistics and internal consistency

<b>Measure</b>	<b>N</b>	<b>M</b>	<b>SD</b>	<b>Cronbach's <math>\alpha</math></b>	<b>McDonald's <math>\omega</math></b>
BIAT Legume	176	0.16	0.34	.74	.81
BIAT Meat	176	0.07	0.35	.74	.79
BIAT Differential	176	-0.09	0.49	.70	.76
SwipeAAT Legume	176	105.50	280.27	.65	.77
SwipeAAT Meat	176	60.76	211.53	.59	.74
Swipe AAT Differential	176	-44.74	407.56	.75	.84
LEGUME scale	176	4.10	0.55	.79	.92
Intention (time constraints)	176	3.82	0.73	.86	.89

The smartphone-based BIAT demonstrated acceptable reliability across both target categories, with Cronbach's  $\alpha$  and McDonald's  $\omega$  exceeding the conventional threshold of 0.70. In contrast, the swipeAAT, when considered separately for each food category, did not achieve acceptable internal consistency, as indicated by Cronbach's alpha indices. Nevertheless, the differential score of the swipeAAT performed somewhat better, revealing that, consistent with the findings of Study 1, the swipeAAT is better suited as a relative measure of preference for one target category over another rather than for assessing spontaneous behavioral tendencies toward a single target. This pattern suggests that difference scores more effectively capture stable individual differences in approach tendencies than single-category scores. Finally, as in Study 1, even though it was not preregistered, we computed swipeAAT bootstrapped split-half reliability. The full-length Spearman–Brown corrected reliability estimate was  $r = 0.76$  (uncorrected,  $r = 0.61$ ).

Taken together, both the smartphone-based BIAT and the swipeAAT demonstrated satisfactory internal consistency, aligning with previous findings.

The self-report measures displayed good internal consistency. Both the LEGUME scale and the intentions under time constraints scale yielded  $\alpha$  and  $\omega$  coefficients of around 0.80 or higher, indicating a good level of reliability and suggesting that all items consistently contributed to their respective constructs. These results suggest that the employed scales were clearly interpretable, providing reliable indices of positive experiences with legumes and intentions to consume them under time constraints.

### Hypothesis testing

As preregistered, Pearson correlations were computed between the main variables to test the formulated hypotheses, and are reported in Table 7. All analyses used a significance criterion of  $p < .01$ , one-tailed.

**Table 7.** P2. Study 2. Correlations among BIAT scores, swipeAAT scores, and self-reported measures

Measure	1	2	3	4	5	6	7	8	9	10	11
1. BIAT legume	—										
2. BIAT meat	.01	—									
3. BIAT Differential	-.70**	.72**	—								
4. SwipeAAT legume	-.06	-.10	-.03	—							
5. SwipeAAT meat	.06	.08	.02	-.36***	—						
6. Swipe AAT Differential	.07	.11	.03	-.88***	.77***	—					
7. Legume thermometer	.12	-.14	-.18*	-.06	-.01	.04	—				
8. Meat thermometer	-.29**	.32***	.42***	.01	-.11	-.07	-.23**	—			
9. LEGUME scale	.22**	-.29**	-.36**	-.07	.05	.08	.64***	-.47***	—		
10. Intention (time constraints)	.22*	-.27**	-.35**	.04	-.01	-.04	.65***	-.50***	.81***	—	
11. Legume consumption frequency	.06	-.19*	-.18*	-.13	-.03	.07	.57***	-.35***	.62***	.61***	—

Note. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

The results did not support H1, as no significant correlation emerged between the BIAT score of attitude toward legumes and the swipeAAT score of preference for approaching legumes.

H2 was partially supported. Specifically, consistent with H2c, we found a positive correlation between BIAT scores of attitudes toward legumes and self-reported consumption intentions under time constraints. However, although this association reached the conventional significance level ( $p < .05$ ), it did not meet the more conservative threshold ( $\alpha = .01$ ) set in the preregistered power analysis. Therefore, this result should be interpreted with caution.

Contrary to H3, the BIAT score of attitudes toward meat was significantly correlated with the self-reported measures related to legumes, namely, the legume experience scale, the intentions assessed under time constraints, and the legume consumption frequency. However, these correlations were negative, indicating that more positive implicit attitudes toward meat were associated with less positive self-reported evaluations and intentions toward legumes. Moreover, an inspection of the correlation matrix revealed that the BIAT score of attitudes toward meat was positively associated with the meat attitude thermometer, indicating that participants who showed more positive spontaneous evaluations toward meat also rated meat more positively on the thermometer. A similar pattern was observed for the differential BIAT score (calculated as the difference between the BIAT for meat and the BIAT for legumes), as all significant correlations for the meat BIAT score were also significant, and in the same direction, for the differential score.

No evidence emerged in favour of H4, as no positive correlations were found between the swipeAAT scores of preference to approach legumes and the related self-reported measures.

Finally, H5 was fully confirmed as no significant correlations were observed between swipeAAT scores of attitudes toward meat and self-reported attitudes or intentions toward legumes.

In sum, Study 2 broadly replicated the pattern observed in Study 1 using a different set of stimuli. The swipeAAT showed satisfactory internal consistency and, consistent with Study 1, showed no meaningful associations with the other measures. Similarly, the mobile BIAT confirmed its reliability and maintained theoretically coherent correlations with the self-report measures, mirroring the findings from Study 1.

## General discussion

The present research aimed to develop and test smartphone-based indirect measures for assessing spontaneous reactions toward foods, with a focus on both conventional and alternative products. Across two studies, we implemented a mobile BIAT and swipeAAT, examining their psychometric properties, associations with self-reported measures, and generalizability across different food categories. Overall, the findings provide promising evidence for the feasibility of administering indirect measures via mobile devices and for their utility in capturing spontaneous evaluative and behavioral tendencies. Both studies demonstrated that the BIAT and swipeAAT can achieve satisfactory internal consistency when adapted for smartphone use.

Consistent with prior research (Fazio & Olson, 2003; Köllner & Schultheiss, 2014), BIAT and swipeAAT scores were uncorrelated in both studies, suggesting that the two paradigms assess different facets of spontaneous reactions. The BIAT primarily reflected evaluative associations, while the swipeAAT captured approach–avoidance tendencies, indicating that each task provides a unique contribution.

Correlations with self-reported measures were generally low or absent. The BIAT showed significant correlations with explicit measures of disgust and interest (Study 1) and

with legume-related consumption experience and behavioral intentions (Study 2). These associations were stimulus-specific. Indeed, in Study 1, the BIAT scores for meat did not correlate with measures of attitudes toward insect-based foods. In contrast, in Study 2, the BIAT for meat was negatively correlated with measures related to legumes. This pattern suggests that, although the BIAT can be used to capture category-specific attitudes, the concurrent administration of the swipeAAT, which encourages participants to relate the two categories, might have influenced evaluations of meat and legumes, leading participants to position them at opposite ends of a continuum. An alternative explanation could be that attitudes toward legumes and meat are negatively related; however, the absence of a correlation between the two BIAT scores does not support this account. Unlike the BIAT, the swipeAAT did not show any association with self-reported measures of disgust or interest in either study. This pattern may reflect a fundamental difference in what the two tasks capture: the BIAT, like self-report measures, primarily assesses evaluative responses toward the foods, whereas the swipeAAT is based on approach/avoidance tasks, thus reflecting spontaneous behavioral tendencies. For this reason, correlations between swipeAAT scores and other outcome measures may be absent, as the tasks measure distinct constructs. This difference is also consistent with theoretical models that conceptualize approach and avoidance as fundamental motivational systems underlying behavior (Gray, 1990). Within this perspective, tasks that require participants to execute approach or avoidance actions may capture motivational action tendencies distinct from the evaluations typically assessed by self-report measures or categorization-based tasks. For example, individuals may show similar evaluative evaluations while differing in their behavioral readiness to approach or avoid a stimulus. Moreover, inspection of the correlation matrix raises the question of why the swipeAAT did not correlate with behavioral intentions, despite both measures reflecting approach–avoidance tendencies in

some form. In contrast, the BIAT did show such correlations. One plausible explanation is that the BIAT and self-report measures share a verbal nature, as both involve processing and responding to words, which may make them more directly related. In contrast, the swipe-AAT is a visuo-motor task, measuring spontaneous approach-avoidance behaviors in response to images, thereby capturing tendencies not mediated by language and reflecting a different facet of participants' reactions that may not align directly with verbally reported intentions.

Finally, aligning self-report measures with the procedural characteristics of indirect tasks (e.g., through time constraints) may reduce structural task differences, improving convergence between explicit and implicit indices (Payne, Burkely, & Stokes, 2008; Gawronski & De Houwer, 2014).

### **Limitations and future directions**

The present study has several limitations. First, the sample consisted entirely of Italian participants, which may limit the generalizability of the findings, and only a limited set of food categories was included, thereby restricting the scope of inference. Furthermore, since participants used their own devices, this introduces potential variability in characteristics such as screen size, touch sensitivity, and touch sampling latency, which could have added noise to the measurements; as already noted by Zech (2020), future research could track device type to better account for such variability. Similarly, differences in the contexts in which participants completed the study, such as at home versus in a café, may also have influenced responses. Despite these differences, the swipeAAT showed acceptable reliability in both studies (bootstrapped split-half SB-corrected: 0.84 in Study 1 and 0.76 in Study 2). Future validation studies could consider modeling environmental effects on task performance. Moreover, both studies employed cross-sectional designs, highlighting the need for test-retest assessments to

establish temporal stability, which is particularly important for indirect measures, as they often exhibit low reliability over time (Gawronski et al, 2020). Notably, significant correlations with other indirect and self-report measures were absent. This pattern may indicate that the swipeAAT captures constructs distinct from self-report or BIAT measures. At the same time, this leaves the construct validity of the swipeAAT an open empirical question. The absence of correlations with other measures may reflect the fact that the task captures partially distinct components of evaluative responding, but it may also indicate limitations in the extent to which the task measures the intended construct. Future research should therefore further examine the convergent validity of the swipeAAT with other meaningful outcomes measures. Finally, given the potential relevance of predictive validity, future studies could include behavioral outcomes to examine whether approach–avoidance tendencies, as measured by the swipeAAT, predict real-world food choices or consumption.

## **Conclusions**

Studies 1 and 2 demonstrate that smartphone-based indirect measures, such as the swipeAAT and BIAT, can reliably measure spontaneous food-related evaluations and behavioral tendencies, highlighting the multidimensional nature of these reactions. The swipeAAT indexes a relative, preference-based approach–avoidance tendency, whereas the BIAT primarily reflects target-specific evaluative associations. Practically, these paradigms enable the mobile, large-scale assessment of consumer attitudes and behavioral tendencies toward sustainable and alternative foods. Overall, the present work represents the first application of the swipe-based Approach–Avoidance Task (swipeAAT) to assess spontaneous behavioral tendencies toward food stimuli. Unlike previous touchscreen-based AATs, which have typically been employed as experimental manipulations or administered in controlled

laboratory settings (Meule et al., 2019; Wang et al., 2022; Rinck et al., 2021; Kahveci et al., 2021; Van Alebeek et al., 2023), the swipeAAT was implemented here as a measurement tool in a fully mobile format. While some prior smartphone-based measures share the mobile format (e.g., Zech et al, 2020), they rely on physical device movements that users do not typically perform when interacting with their phones. In contrast, the swipeAAT utilizes swipe gestures, actions deeply ingrained in everyday smartphone use, as an intuitive response modality that naturally aligns with the device's affordances. Importantly, this is the first time such a measure has been applied to evaluate spontaneous approach–avoidance tendencies toward meat, legumes, and insect-based foods, offering a novel and practical tool for studying food-related behavioral tendencies in real-world contexts. However, while the present work focused on testing the internal consistency of the swipeAAT, its predictive validity for actual food choices or consumption remains untested. Arguably, the most valuable contribution of such measures may lie in their potential to predict real-world food-related choices, particularly those made quickly. Future research should investigate whether behavioral tendencies measured with the swipeAAT indeed translate into actual food-related behavior, providing crucial evidence for the task's predictive validity.

## Chapter conclusion

The two projects described in this chapter have systematically investigated the psychometric properties of both traditional and smartphone-based direct and indirect measures for assessing evaluative responses toward foods, with a focus on insect-based products.

Project 1 employed traditional computer-based paradigms: the Brief Implicit Association Test (BIAT) and the Manikin Task. These tasks are designed to capture evaluative responses that may not be fully accessible through self-report. Across these studies, both paradigms demonstrated acceptable to good internal consistency. The BIAT was particularly effective at isolating evaluations toward individual food targets, while the Manikin Task excelled at capturing differential preferences between paired options. Importantly, the distinct patterns of associations with self-reported measures underlie the importance of multi-method assessment in studying food evaluations.

Project 2 adapted the same indirect paradigms for mobile administration, implementing the BIAT and introducing a new swipe-based Approach–Avoidance Task (swipeAAT). These studies demonstrated that indirect measures can be reliably administered on smartphones, broadening the possibilities for large-scale and ecologically valid data collection. Reliability estimates for the BIAT were at the lower bound of acceptability, whereas the swipeAAT, particularly its differential score, exhibited good internal consistency. Methodological refinements, such as increasing the number of trials, improved reliability.

Across the studies presented in this chapter, several consistent patterns emerged regarding the psychometric properties and characteristics of indirect measures of food evaluations. First, both the BIAT and approach–avoidance paradigms demonstrated acceptable

to good reliability, which could be further enhanced through methodological refinements, such as increasing the number of trials or carefully selecting the scoring procedure to reflect the theoretical assumptions and characteristics of each task. The BIAT appeared particularly sensitive to evaluations of single, target-specific food items, whereas approach–avoidance measures like the swipeAAT or Manikin Task better performed with relative, preference-based tendencies. Second, these indirect measures were largely uncorrelated with each other, consistent with the idea that differences in how the measures are implemented, or the conditions under which they are administered, can lead to different outcomes. Third, associations with self-reported measures were generally weak or absent, yet these indirect measures provide unique contributions, supporting the idea that including both types of measures in the assessment of evaluations can offer a more informative and comprehensive perspective. Moreover, some evidence suggested that aligning procedural features, such as introducing time constraints in self-report measures, can increase convergence, supporting the principle of correspondence between measurement conditions and the to-be-predicted outcomes (Gawronski, 2019). Collectively, these findings highlight the importance of employing multiple distinct measures to gain a more comprehensive and nuanced understanding of consumer evaluations.



## Chapter 3. Changing pre-existing evaluations

### Introduction

Understanding how pre-existing negative evaluations can be modified is increasingly important for addressing societal challenges, such as those that require shifts toward more sustainable and health-promoting behaviors. However, as discussed in Chapter 1, a substantial portion of the literature on learning and vicarious learning has relied on paradigms involving neutral CS or, alternatively, negative evaluations that are themselves experimentally induced. Studies employing counterconditioning typically begin by establishing negative evaluations through repeated pairings and then attempt to reverse or attenuate them. In such paradigms, evaluative responses emerge within the laboratory and are therefore recent, experimenter-created, and likely weakly embedded in participants' broader belief systems. Although these designs provide high experimental control, they leave open the question of whether the same interventions can successfully modify pre-existing, long-standing attitudes acquired through cultural learning and reinforced over years or decades.

The present chapter offers a contribution to this issue by examining interventions targeting insect-based foods, a category that, for Western consumers, elicits deeply ingrained negative evaluations (Looy et al., 2014) and disgust (Castro & Chambers, 2019; Kröger et al., 2022). Unlike laboratory-conditioned stimuli, these attitudes are neither recently formed nor the result of experimental contingencies, and may be more difficult to modify. Rather, they are part of the attitudinal structures shaped by prolonged exposure to cultural narratives and normative expectations regarding what is considered edible, appropriate, and desirable within

a given food culture (Looy et al., 2014). For this reason, insect-based foods provide a stringent and theoretically informative test of whether well-established learning paradigms such as EC and vicarious learning can influence evaluations that are entrenched rather than experimentally constructed. Moreover, from an applied perspective, interventions that target evaluations of these foods respond to pressing societal needs. Increasing acceptance of sustainable protein alternatives may have direct implications for environmental impact, food security, and public health; yet, informational campaigns and persuasive messages often fail to produce stable improvements in attitudes or willingness to consume such foods (Gassler et al, 2024). Identifying strategies capable of shifting evaluations of these negatively perceived products therefore holds substantial practical relevance.

## **Outline of the present chapter**

This chapter brings together a set of studies that examine three different intervention strategies: vicarious approach–avoidance (VAA), observational evaluative conditioning (OEC), and the shared features principle (SFP) integrated with the goal-directed perspective (GDP). Each empirical program applies one of these strategies to insect-based foods, thereby offering distinct yet converging insights into how deeply rooted negative evaluations may be modified. The first research project investigates VAA, testing whether knowing that a model has approached or avoided insect-based products can shape individuals' evaluations. The second project examines OEC, which refers to a change in liking as a function of observing contingencies between a stimulus and a model's evaluative reactions. The third project applies the SFP, in combination with the GDP, to examine whether highlighting similarities between insect-based foods and food categories that are known to serve specific goals (e.g., health or a pleasant taste experience) increases the extent to which insect-based products are perceived as

capable of serving those same goals. Together, these three paradigms provide an initial demonstration of how pre-existing negative attitudes toward insect-based foods may be influenced by different interventions.

Following the presentation of these empirical programs, the chapter includes a summary section that brings together the findings across studies to offer an overarching view of the various interventions. This synthesis aims to provide conceptual clarity regarding the range of strategies examined, while taking into account the methodological and measurement differences that prevent strict cross-study comparability. Rather than evaluating the relative superiority of one intervention over another, the discussion focuses on identifying common patterns, divergences, and broader insights that emerge across the set of studies. The overarching aim is thus not to draw definitive comparisons, but to highlight recurring themes and potential influencing factors that may inform future research on how different learning processes influence longstanding, culturally acquired attitudes toward insect-based foods.

## **Project 3: I'll take the same! Vicarious effects of approach/avoidance behaviors toward insect-based foods<sup>3</sup>**

### **Abstract**

In response to the rising need for sustainable food options, insect-based foods present a promising alternative to conventional protein sources. However, many Western consumers often show an aversion toward insect-based food consumption.

This work explores a novel application of vicarious learning, that is, the Vicarious Approach-Avoidance (VAA) procedure, to influence attitudes toward insect-based foods. Across two studies, we investigate the VAA effect, in which participants learn about a model's behavior toward insect-containing cookies. Study 1 tested the VAA effect on direct and indirect evaluations of cookie brands by comparing vicarious approach versus avoidance behavior, with participants exposed either to conventional or insect-based cookies. The approached brand, as compared to the avoided, was associated with more positive evaluations, especially for insect-based products. Study 2 will extend these findings by examining whether vicarious approach or avoidance can modify evaluations of insect-based cookies relative to a conventional alternative, thereby assessing whether the VAA procedure can alter the preference for insect-based products in an inter-category comparison. Results from our work could offer valuable

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<sup>3</sup> Project 3 is based on the Registered Report "Fedeli, F., Boddez, Y., Perugini, M., Vezzoli, M., De Houwer, J., Bading, K., Steca, P., Zogmaister, C. I'll take the same! Vicarious effects of approach/avoidance behaviors toward insect-based foods" submitted to Collabra. Study 1 data were collected prior to submission, and the design of Study 2 was included in the report. The manuscript is currently under review and we have received a revise-and-resubmit decision.

insights for designing interventions to increase consumers' openness to insect-containing foods through vicarious learning.

## **Introduction**

### **Insect-containing foods, a promising alternative**

As the global population burgeons, the strain on traditional food sources intensifies, necessitating a paradigm shift in our approach to nutrition and sustainability. New consumption alternatives are emerging, and novel foods are among the most promising. The European Commission defines Novel Foods as “food that had not been consumed to a significant degree by humans in the EU before 15 May 1997, when the first Regulation on novel food came into force” (European Commission, n.d.). Examples of such foods are chia seeds, algae-based foods, baobab fruit, cultured meat, and insect-containing food.

Insect farming offers numerous environmental advantages; emissions of greenhouse gases and water, and land use are considerably lower than for typical livestock (Van Huis & Oonincx, 2017). Species like crickets have feed-to-protein conversion rates that are two and twelve times higher than those of poultry and cattle, respectively, indicating greater efficiency in converting feed into edible protein (FAO, 2021). In addition, insects are naturally rich in protein and vitamins while being low in fat, making them a nutritionally dense food source (Kouřimská & Adámková, 2016).

However, the successful integration of novel foods into mainstream diets hinges not only on their nutritional profile and ecological footprint but also on people's attitudes and emotional reactions toward these foods. Consumers from Western countries generally show an aversion to insects as food (Castro & Chambers, 2019; La Barbera et al., 2018). Insects can

evoke negative emotions such as disgust, and their consumption is considered a primitive behavior (Huis, 2013).

### **Direct and indirect measures of evaluation**

To gain a comprehensive understanding of attitudes toward a given target, it would be beneficial to include measures administered under diverse conditions, encompassing both self-report scales and task-based assessments. Indeed, evaluations of stimuli can result from controlled, aware, resource-intensive, and slow processes (Moors, 2013). These evaluations are typically investigated through direct measures, which often involve questionnaires where respondents express their evaluations on predefined scales (e.g., Likert-type items). Participants usually complete these measures at their own pace, with the opportunity to reflect carefully before answering. Direct measures of attitudes are widely regarded as both valid and reliable instruments for assessing evaluative responses (Ajzen et al., 2018; Albarracín & Shavitt, 2018; Lin & Roberts, 2020). While valuable, direct measures often fall short in fully revealing the complexities of an individual's psychological and behavioral patterns (Gawronski & De Houwer, 2014).

Evaluations of stimuli can also result from uncontrolled, unaware, efficient, or fast processes (Gawronski & Bodenhausen, 2011; Moors & De Houwer, 2006; Moors, 2013). In this sense, we refer to indirect measures as measures that capture the automatic influence of attitudes and cognitions on behavior (De Houwer, 2006). Contrary to direct measures, indirect measures are characterized by the fact that participants are not asked to self-assess the extent to which they hold a certain attitude or cognition toward the focal target. Instead, the attitude or cognition is inferred from an indirect measurement by examining its effect on other

behaviors (De Houwer, 2006). Among the most adopted indirect measures are those based on reaction time tasks, such as the Implicit Association Test (Greenwald et al., 1998), in which participants are asked to categorize stimuli presented in various combinations. Such measures, which rely on performing tasks under time constraints, may be more informative in contexts that require rapid decisions (De Houwer, 2006).

Because of these differences, each type of measure may provide unique predictive value. Indeed, the ability of a measure to predict a certain outcome may depend on how closely the processing conditions of the measure match those of the outcome being predicted (Gawronski, 2019). Since the conditions under which individuals express evaluations may vary (e.g., fast vs slow judgments), an approach that incorporates both direct and indirect measures can offer a more comprehensive view.

### **Strategies to shape consumers' attitudes**

Several strategies have been used to ameliorate psychological and behavioral reactions toward foods containing insects. Some studies focused on specific marketing interventions related to the product packaging (i.e., removing the image of the insects or making it less realistic) (Pozharliev et al., 2023), while others tested the effectiveness of educational sessions (Szczepanski et al., 2022), seminars and tasting sessions (Sogari et al., 2017), persuasive messages (Verneau et al., 2016), writing short essays (Stone et al., 2023), information boosts and social norm nudges (Bao & Song, 2022).

However, since insect-based foods were introduced by the European Union in 2021, little has changed. Attitudes toward and willingness to try insect-based foods remain poor (Modlinska et al., 2021; Onwezen et al., 2021; Gassler et al., 2024). As addressed by the

European Union during the event “How to make sustainable diets the norm?” one reason lies in the inadequacy of policies solely focused on providing people with food information about health and sustainability. Moreover, studies investigating the impact of information regarding the advantages of entomophagy have revealed conflicting findings. While some studies proved the effectiveness of this approach (e.g., Ardoin & Prinyawiwatkul, 2020; Naranjo-Guevara et al., 2021), others did not. For instance, Arena et al. (2020) found that consumers' perceptions about insect-based foods were not altered by receiving information about these products.

Additionally, while educational sessions, seminars, and writing essays can be effective methods, their scalability is inherently limited. These interventions require significant time and individualized attention, making it challenging to reach broader audiences. Given the state of the art, finding and testing new strategies to address the possible consumers' reluctance toward novel foods can be a turning point.

### **Vicarious learning pathway for insect-based food consumption**

In his influential works on social learning, Bandura stated that learning phenomena resulting from direct experiences can also occur through observation of other people's behavior and its consequences for them (Bandura et al., 1963; Bandura, 1969; Bandura, 1977). In the same vein, emotional responses can arise from observing others' affective reactions (Bandura et al., 1963). Research on fear reduction showed that observing others' positive interactions with a stimulus can attenuate fear responses (e.g., Kelly et al., 2010; Newall et al., 2015; Krause & Askew, 2022). Beyond fear, vicarious learning has also been shown to shape attitudes and preferences in other domains, including attitudes toward social institutions and health-related behaviors (e.g., Rosenbaum et al., 2005; Buckley & Malouff, 2005). Finally, results from a

review about eating habits (Suwalska & Bogdański, 2021) also confirm the robustness of vicarious learning.

A procedure that relies on vicarious learning is the Vicarious Approach Avoidance (VAA; Zogmaister et al., 2023a, 2023b). With a series of experiments, Zogmaister and colleagues investigated the approach/avoidance behaviors from a vicarious perspective (i.e., when participants know that a model enacted an approach/avoidance behavior toward a target). In their procedure, through the reading of vignettes, participants were informed about the behavior of a model who either approached or avoided a target. After that, the authors observed that participants formed a preference for the approached target over the avoided one. This VAA effect proved robust, as providing information that the models were not operating according to their preferences was insufficient to disrupt it.

Nevertheless, applying the VAA procedure with insect-based food is a step that requires careful reflection. In the studies by Zogmaister et al. (2023a, 2023b), the target objects had a neutral or, at most, mildly positive valence (i.e., brands of biscuits and fruit juices), while the same may not hold for insect-based foods. Research by Centerbar and Clore (2006) on the impact of enacting approach/avoidance behaviors may be informative to this end. They showed that when negative-evaluated stimuli were involved, participants developed a more positive attitude when they were avoided and a more negative attitude when they were approached. They interpreted these findings to suggest that approach-avoidance behaviors have context-dependent meanings, with evaluations being influenced by the compatibility between the valence of the actions and the valence of the stimuli. Based on this evidence, engaging in approach behavior towards disgust-inducing foods (e.g., foods containing insects) might not always result in a more positive attitude. Instead, it could lead participants to develop an even more negative attitude towards them. Conversely, the same foods may be evaluated less

negatively if associated with avoidance behavior. Notably, the study by Centerbar and Clore (2006) used a direct approach/avoidance procedure. It is an empirical question whether similar reverse effects of approach/avoidance behaviors with negative stimuli will also occur in the case of a vicarious paradigm.

Nevertheless, a vicarious approach intervention is likely to elicit lower psychological reactance than a direct approach requirement (Sittenthaler et al., 2015). In the context of insect-based foods, a classical AAT would require individuals to approach a potentially aversive target, a demand that could heighten reactance and, in some cases, even produce boomerang effects (e.g., Centerbar & Clore, 2006). A vicarious procedure, by contrast, introduces an intermediate step: participants observe or learn about a model's behavior rather than enacting it themselves. This indirectness could attenuate the feeling of being compelled to engage with an unwanted stimulus. Moreover, vicarious exposure may be more likely to convey social-normative information (Rubenstein et al., 2022). Knowing that a model has approached a food offers a descriptive norm about what others do and, to some extent, an injunctive cue about what is appropriate to do. Given that insect-based foods constitute a novel and normatively ambiguous category, such cues may be particularly influential. A further practical advantage concerns scalability: whereas a classical AAT requires each participant to repeatedly perform the training, making it effortful and less suitable for large-scale or ecologically valid interventions, a vicarious paradigm can be embedded in formats that are easy to disseminate, such as short narratives or advertising materials.

Regarding a theoretical account of VAA, in line with Van Dessel and colleagues (2019; also see Van Dessel & Boddez, 2025), we believe that vicarious approach-avoidance effects can be explained by inferential processes. Specifically, observers may generate inferences based on the model's behavior and its implications. Learning that a model approached an object

can elicit propositions such as (1) “The person has approached the object,” combined with the general idea that (2) “People approach things they like,” ultimately yielding the inference (3) “The object is positive.” The same logic applies to avoidance (“People avoid things they dislike”), leading to the complementary inference that objects avoided are negative (see also Zogmaister et al., 2023b, for a discussion on the theoretical account of the VAA effect).

Here, we will investigate whether the VAA procedure can be used to improve evaluative reactions toward products containing insects. Knowing that other individuals (i.e., models) engaged in an approach rather than an avoidance behavior toward some foods could shape individuals' perception and acceptance of such products. The importance of this research is both theoretical and practical. We will enrich the literature on the vicarious effect of the approach/avoidance procedure, shedding light on its effectiveness with stimuli that could elicit disgust or rejection feelings. From a pragmatic perspective, the research will test whether and to what extent VAA can represent a pathway to increase willingness to purchase and consume insect-based foods.

## **The research**

The main aim of the present work is to test whether the VAA procedure is effective in improving attitudes and willingness to try insect-based foods. As we employ different vignettes than Zogmaister and colleagues (2023a, 2023b), and given that stimuli that tend to elicit adverse reactions are involved, the first experiment tested the effectiveness of our new vignettes in an experiment similar to those conducted by Zogmaister and colleagues. The only differences lie in the content of the vignettes and the nature of the target stimuli. Indeed, in

Study 1, which was completed before the submission of this Registered Report for IPA, we employed more realistic vignettes than the original studies, where the vignettes described a virtual reality game. Moreover, our targets were both regular and insect-containing cookies. Hence, Study 1 tested whether our VAA procedure influenced preferences between two foods of the same type, namely two fictitious cookie brands, both containing (or not) insect powder. Including the type of cookies (i.e., whether they contained insect powder or not) as a between-condition served another purpose apart from testing the effectiveness of the new vignettes. Conducting the study simultaneously with both traditional and insect-containing cookies offered insights into potential variations in the efficacy of the procedure, contingent upon the type of product. Otherwise, in the absence of observed effects, it would remain unclear whether the lack of response is due to the presence of insect-containing foods or due to the vignette itself.

Having established in Study 1 that the VAA procedure is effective when applied to insect-based foods, Study 2 is designed to extend and refine these findings by addressing a more applied and theoretically informative question. Specifically, Study 2 examines whether vicarious approach and avoidance behaviors toward insect-based cookies shape evaluations of these products relative to a conventional alternative, rather than merely producing preferences within a single product category. To this end, Study 2 will adopt a between-participants design including a baseline condition and two vicarious learning conditions -approach and avoidance-directed at insect-based cookies. Importantly, all participants are also exposed to regular cookies, but the model does not enact any behavior to such foods, thereby providing a consistent comparator across conditions. This design allows us to isolate the specific contribution of each behavioral cue and to test whether vicarious approach improves, and vicarious avoidance worsens, the relative evaluation of insect-based foods compared to a

familiar conventional product. By moving beyond intra-category contrasts and implementing a controlled inter-category comparison, Study 2 allows for a more precise assessment of the effects of the VAA procedure in a context that more closely approximates real consumer choices. In doing so, it provides a stronger test of the robustness and practical relevance of VAA for improving evaluations of insect-based foods.

In both studies, we investigate direct and indirect evaluations, demographic characteristics, and employ items to check the goodness of the data. Unless otherwise specified, the measurement procedures, the characteristics of the measures (i.e., number of trials, response options), the stimuli, the scoring of the indices, and the exclusion criteria of Study 2 will follow the description of Study 1.

### **Practices of open science and reproducibility**

All measures, manipulations, and exclusion criteria in the studies are disclosed, as well as the method used to determine the final sample size. We did not collect new data after data analysis. All the studies were preregistered. All the data, the materials, and the power analysis protocol are openly available at: <https://osf.io/6pcnk>.

All the analyses of studies were preregistered, and the analyses for all studies are described in sufficient detail for reproducibility. Preregistration of Study 1 is available at <https://osf.io/5zhs6>. Study 2 will be preregistered after this registered report successfully completes Stage 1.

## Study 1

### Method

#### Hypotheses and hypothesis testing

We expect that participants will show a preference for the brand associated with approach behavior compared to the brand associated with avoidance behavior (H1). We further expect that this preference will be moderated by cookie type (H2), with a stronger preference for approach-associated brands in the regular cookie condition compared to cookies containing insect flour. Both H1 and H2 will be tested using a mixed ANOVA, where a significant main effect of the type of behavior would provide evidence for H1, and a significant interaction with cookie type would provide evidence for H2. Finally, we expect that the preference for the brand associated with approach behavior will emerge when examined separately for regular cookies (H3a) and insect-derivates cookies (H3b), with these effects tested using paired t-tests within each group.

#### Participants and design

One hundred fifty-three participants volunteered to take part in the study. Data from four participants were excluded because they terminated the experiment before providing sociodemographic information and completing the data-quality checks. The final sample therefore consisted of 149 participants (122 women, 23 men, 2 non-binary, 2 “prefer not to say”;  $M_{age} = 26.16$  years,  $SD_{age} = 9.21$ ), and their data were not included. The initial phase of data collection ( $N = 30$ ) was conducted in the department's laboratory. Subsequently, due to the conclusion of the university semester, we shifted to inviting participants to complete the study online to facilitate recruitment. In both settings, the procedure remained identical. Although this dual recruitment modality can represent a potential source of error, several

literature studies have shown that online collection does not compromise the quality of data (e.g., Germine et al., 2012).

Recruitment was held through the Departmental Subject Management Pool and word of mouth. Participants joining through the Subject Management Pool received course credits. No additional incentives were provided. We conducted a power analysis with G\*Power 3 (Faul et al., 2007), with  $\alpha = .017$  (Bonferroni criterion for three DVs), power  $(1-\beta) = .90$ , for the test of H1 and H2 with a mixed model ANOVA (2x2). Considering a pessimistic scenario with little correlation between the repeated measures, we set  $r = 0$ . This analysis indicated a required total sample size of  $N = 112$ . For both hypotheses, the power analysis indicated that this is the minimum sample size to detect a small to medium effect size  $f = 0.25$ . Concerning the test of H3 and H4, this sample size would provide a sensitivity of  $d = 0.46$  with two repeated measures t-tests, with  $\alpha = .017$  and power = .90. This sensitivity is conservative relative to prior VAA findings ( $d \approx 0.63$ ; Zogmaister et al., 2023a), and was deemed appropriate for the present study.

Due to the nature of our online data collection, we ended up with a slightly larger sample size.

The study had a mixed design 2 (cookies: regular vs. insect cookies; manipulated between participants) x 2 (behavior: approach vs. avoidance; manipulated within participants). 74 participants were randomly assigned to the regular condition and 75 to the insect cookies condition.

## **Materials**

### ***Target products***

The target products were two different cookie brands not sold in Italy. One of them was an existing commercial brand not sold in Italy, whereas the other was a fictitious brand

created to closely match the existing one. They were the same stimuli employed in the studies from Zogmaister and colleagues (2023a, b).

### *Vignettes*

Each participant read two text vignettes in a counterbalanced order between participants. In each of them, a story about a model named Sofia (an Italian female name; the same name was used for all the vignettes) was presented, who visits a culinary fair and meets a promoter who offers her a voucher to taste cookies. Each vignette described Sofia enacting a behavior toward one of the two brands. In one of the two vignettes, Sofia receives a voucher for one of the two brands and uses it to take the biscuits (approach behavior), while in the other vignette, she receives a voucher for the other brand and throws it away (avoidance behavior). No additional information about Sofia's behavior or its consequences was provided. We counterbalanced the presentation of the two brands between participants to determine which was associated with approach or avoidance behavior, as well as the order in which participants read the approach and avoidance vignettes. Depending on the experimental condition, they were informed that the cookies from both brands contained insect flour, or no further specification was provided. Below is reported the wording of the vignettes.

Sofia is attending a culinary fair, the Arena del Gusto.  
At this fair, visitors can find new products that are not yet available on the Italian market.  
While walking through the stands, she meets a promoter who is distributing vouchers to taste *some cookies / some cookies made with insect flour*.

The promoter has two different types of vouchers: some allow visitors to taste products from the *Brand 1/2* brand, and others are for the *Brand 2/1* brand. The promoter hands Sofia a voucher drawn at random from the booklet.

The voucher Sofia receives entitles her to obtain a free package of *cookies / cookies made with insect flour* from the *Brand 1 / 2* brand.

The vignette then ended with the model displaying one of the two different behaviors. In the approach version, participants were told that “Shortly afterwards, Sofia goes to the cookie stand and takes the *Brand 1 / Brand 2* cookies.”, while in the avoidance condition, the model avoided the cookies, “Shortly afterwards, Sofia throws the voucher into a trash bin, avoiding taking the *Brand 1 / Brand 2* cookies.”.

The original Italian version of the vignettes is available at: <https://osf.io/6pcnk/>.

### ***Manipulation check***

After each vignette was provided, the participants were asked two separate questions: For which brand was the voucher? For this question, participants provided an answer by indicating one of the four options: Brand 1, Brand 2, “The brand was not specified”, or “I do not remember”. The second question was: What did Sofia do with the voucher? Possible answers were: “She used it to get the cookies”, “She threw it away”, “It was not specified”, or “I do not remember”.

### ***BIAT***

Our implementation of the BIAT adhered to the established format outlined in the original work (Experiments 1 and 2, Sriram & Greenwald, 2009). The two cookie brands served as target categories, with five images representing each brand as target stimuli. Positive and Negative were the attribute categories, encompassing taste-related adjectives. Positive attributes included the Italian equivalents of tasty, good, appetizing, enticing, and appealing, while negative attributes comprised disgusting, nasty, nauseating, repulsive, and retching. Participants completed two consecutive BIATs, one for each brand. Each BIAT consisted of

two training blocks (1 and 3) with 8 trials each, followed by critical blocks (2 and 4) containing 32 trials each. Stimuli were presented in odd-even order (see Sriram & Greenwald, 2009, for the specifics about the stimulus presentation) for all participants, and the order of the BIATs was counterbalanced between participants. The BIAT featured a built-in penalty, requiring participants to provide the correct answer in case of an error, with the latency recorded upon the occurrence of the correct response.

### *Semantic differentials*

Self-reported attitudes were investigated using two separate semantic differentials, each tailored to assess participants' attitudes toward the respective brands. The same adjectives were used as in the BIAT and were paired as follows: Tasty-Disgusting, Good-Nasty, Appetizing-Nauseating, Enticing-Repulsive, and Appealing-Retching. Participants were instructed to express their opinions on a 7-point graduated scale, spanning between the two opposing attributes.

### *Intention scale*

To align the task with more realistic scenarios, participants were asked to imagine that the cookies from the two brands would be available in their country starting from next month. Then, they reported how likely they would be to purchase and consume the cookies through the completion of an ad hoc scale consisting of the following four items:

1. If they are available in the shops I usually visit, I will probably buy them.
2. I am going to buy them no matter where they are sold.
3. As soon as I can, I am going to eat them.
4. If they are offered to me, I will probably taste them.

Participants responded on a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree).

### ***Knowledge of brands***

We assessed participants' prior knowledge of the two cookie brands by prompting them to indicate whether they were familiar with the brands. In case of an affirmative response, participants were asked to provide a brief explanation of what the brand entails.

### ***Disgust and interest scale***

Disgust and interest toward consuming insects were measured using eight items from the Entomophagy Attitude Questionnaire (EAQ; La Barbera et al., 2020). Participants were provided with the Disgust and Interest subscale of the EAQ, and they expressed their responses on a 5-point Likert scale ranging from 1 (Not at all) to 5 (Very much). We then computed two different scores for disgust and interest toward eating insect-containing foods. The disgust score was computed as the mean of all 5 items from the Disgust sub-scale (EAQ-D, La Barbera et al., 2020). The interest score was calculated as the mean of all 3 items from the Interest subscale (EAQ-I, La Barbera et al., 2020).

### ***Self-Reported Single-Item “Use Me” question (Meade & Craig, 2012)***

This asked participants whether we should use their data in our analyses (response options were Yes and No) to detect careless responding.

### ***Demographic questions***

We asked questions on age, gender, degree of knowledge of the Italian language, type of diet, and whether the respondent was a student.

### **Procedure**

The experiment was programmed using Inquisit 6.6.0. We conducted the study online through Inquisit Web by Millisecond software. Following the provision of informed consent, participants were informed that they would be presented with short vignettes related to two brands of cookies. Counterbalanced between participants, each participant read the vignette of one brand associated with the approach behavior and the vignette of the other brand associated with the avoidance behavior. After each vignette, participants underwent the manipulation check. If participants failed to answer both questions correctly, the vignettes were presented again until correct responses were provided, with a maximum of four attempts. Subsequently, the self-reported measures (i.e., the semantic differentials and intention to buy and eat scales, in this order) and the BIAT were administered in a counterbalanced order. Following this, we assessed participants' prior knowledge of the brands, as well as their disgust and interest toward consuming insects. Finally, participants were asked the SRSI "Use Me" question, followed by demographic questions.

### **Hypotheses**

We expected that participants would show a preference for the brand associated with approach behavior compared to the brand associated with avoidance behavior (H1). We further expected that this preference would be moderated by cookie type (H2), with a stronger

preference for approach-associated brands in the regular cookie condition compared to cookies containing insect flour. Both H1 and H2 were tested using a mixed ANOVA, where a significant main effect of the type of behavior provided evidence for H1, and a significant interaction with cookie type provided evidence for H2. Finally, we expected that the preference for the brand associated with approach behavior would also emerge when examined separately for regular cookies (H3a) and insect-derivates cookies (H3b), with these effects tested using paired t-tests within each group.

## Results

### Exclusion criteria and data cleaning

Data exclusion followed these preregistered criteria: a “No” response to the SRSI-use me question, participants who are vegetarian or vegan (i.e., do not eat meat), fewer than 75% correct responses in either of the two BIATs, incorrect responses to the manipulation check that persist even after reading the vignettes three times, or participants who are familiar with either of the two biscuit brands. Outlier detection was performed using the 3-MAD rule, along with a visual inspection of the data, before proceeding with any step of the hypothesis testing. Missing data were handled through pairwise deletion.

One participant answered ‘No’ to the SRSI question and was excluded from the analysis. An additional 12 participants were vegetarians, and five were vegans. In addition, three participants gave less than 75% correct responses in any of the two BIATs, six participants answered incorrectly to the manipulation check even after three repetitions of the vignettes, and 1 participant reported knowledge of one of the two brands of cookies. Following the preregistration, data from these 28 participants were excluded from the analysis.

The 3-MAD rule was used to detect potential outliers, followed by a visual inspection of these potential outliers. No outlier was detected. Our final sample consisted of 121 participants, 61 in the regular cookies and 60 in the insect-containing cookies condition. Due to a programming mistake, the semantic differential responses of 13 participants were not registered. For this reason, the final sample for the analysis concerning semantic differentials consisted of 108 participants, 55 in the regular cookies and 53 in the insect-containing cookies condition.

For each participant, we computed a BIAT D score separately for the approached brand and for the avoided brand. Because the assignment of brands to approach or avoidance was counterbalanced across participants (i.e., half saw Brand 1 as approached and Brand 2 as avoided, while the other half saw the opposite), each participant had one BIAT score for the brand they approached and one for the brand they avoided. The recommended scoring procedure from Nosek and colleagues (2014) was employed to compute the D measures. Specifically, higher values indicate a more positive attitude toward the brand.

We computed the mean of the responses for the items from the semantic differentials, separately for the brand associated with the approach and the brand associated with the avoidance behavior. Higher values indicate a more positive self-reported evaluation of the product. We computed the mean response to the four items of the intention scale separately for the brand associated with the approach and for the brand associated with the avoidance behavior. Higher values indicate a stronger intention to buy and eat the product. Moreover, we computed the mean response for the EAQ items, separately considering the five items in the disgust and the three items in the interest subscale. Higher values respectively indicate a higher disgust and interest toward consuming insect-containing foods. The main descriptive statistics and correlations between measures are reported in Table 8.

**Table 8.** P3. Main statistics and correlations (Pearson's  $r$ ) between measures, separately for the two types of cookies

<i>Regular cookies</i>													
	Cronbach's $\alpha$	Mean	SD	Min	Max	1	2	3	4	5	6	7	8
1.BIAT <sub>Approach</sub>	.80	.16	.46	-.83	1.07	-							
2.BIAT <sub>Avoidance</sub>	.63	.14	.45	-1.21	1.27	-.10 [-.35, .15]	-						
3.SEM. DIF. <sub>Approach</sub>	.97	4.72	1.15	1.00	7.00	.10 [-.17, .36]	-.17 [-.42, .10]	-					
4.SEM. DIF. <sub>Avoidance</sub>	.96	4.23	1.22	1.00	7.00	-.03 [-.29, .24]	.08 [-.19, .34]	-.53*** [-.70, -.31]	-				
5.INTENTION <sub>Approach</sub>	.67	3.33	.59	1.75	4.25	.05 [-.21, .30]	-.00 [-.26, .25]	.56*** [.35, .72]	-.45*** [-.64, -.21]	-			
6.INTENTION <sub>Avoidance</sub>	.76	3.14	.66	1.75	4.50	-.03 [-.28, .22]	-.03 [-.28, .22]	.02 [-.25, .28]	.24 [-.03, .48]	.36** [.12, .56]	-		
7.DISGUST	.95	3.15	1.27	1.00	5.00	-.01 [-.26, .24]	-.02 [-.27, .23]	.23 [-.03, .47]	-.26 [-.49, .00]	.25* [.00, .47]	-.18 [-.42, .07]	-	
8.INTEREST	.93	2.78	1.28	1.00	5.00	-.11 [-.15, .35]	-.03 [-.28, .22]	-.23* [-.46, .04]	.25 [-.01, .49]	-.29* [-.50, -.04]	.18 [-.07, .42]	-.87*** [-.92, -.80]	-
<i>Insect-containing cookies</i>													
	Cronbach's $\alpha$	Mean	SD	Min	Max	1	2	3	4	5	6	7	8

1.BIAT <sub>Approach</sub>	.63	.18	.40	-.86	.93	-							
2.BIAT <sub>Avoidance</sub>	.72	-.03	.44	-1.07	.80	.24 [-.02, .46]	-						
3.SEM. DIF. <sub>Approach</sub>	.95	4.05	1.35	1.00	7.00	.02 [-.25, .29]	.14 [-.13, .40]	-					
4.SEM. DIF. <sub>Avoidance</sub>	.95	3.48	1.29	1.00	7.00	-.35* [-.56, -.08]	.02 [-.26, .28]	.51*** [.28, .69]	-				
5.INTENTION <sub>Approach</sub>	.90	2.73	0.92	1.00	4.50	-.01 [-.26, .24]	-.04 [-.29, .21]	.73*** [.57, .84]	.51*** [.27, .68]	-			
6.INTENTION <sub>Avoidance</sub>	.88	2.52	0.95	1.00	4.50	-.21 [-.44, .04]	-.06 [-.31, .20]	.48*** [.24, .66]	.71*** [.54, .82]	.78*** [.65, .86]	-		
7.DISGUST	.94	3.11	1.19	1.00	5.00	.25** [-.00, .48]	.18 [-.08, .41]	-.50*** [-.68, -.27]	-.59*** [-.74, -.38]	-.65*** [-.77, -.47]	-.65*** [-.78, -.48]	-	
8.INTEREST	.90	2.86	1.23	1.00	5.00	-.22 [-.45, .03]	-.06 [-.31, .20]	.55*** [.33, .71]	.57*** [.35, .73]	.65*** [.48, .78]	.65*** [.48, .78]	-.86*** [-.91, -.77]	-

Notes: VariableName<sub>Approach</sub> and VariableName<sub>Avoidance</sub> refer respectively to the brand associated with the approach and the avoidance behavior. Values in square brackets represent 95% confidence intervals. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

The internal consistency of the measures ranged from good to very good, with the exception of the BIAT score for the avoided brand in the regular cookies condition and the BIAT score for the approached brand in the insect-based cookies condition. In the regular cookies condition, correlations between direct and indirect measures and the disgust and interest subscales were negligible. By contrast, in the insect-containing cookies condition, semantic differentials and intentions showed meaningful correlations with both the disgust and interest subscales, as did the BIAT scores for the approached brand with disgust. Correlations between direct and indirect measures were largely absent, consistent with previous research that has generally found weak associations between these types of measures (e.g., Bosson et al., 2000; Bar-Anan & Nosek, 2014). This pattern likely reflects differences in the characteristics of the measures and variability in their reliability.

### **Test of the hypotheses**

To test Hypotheses H1 and H2, namely that participants would show a preference for the brand associated with the approach behavior (H1) and the preference for the brand associated with the approach behavior would be stronger for regular cookies (H2), we used a mixed model ANOVA with factors - type of cookies (2 levels between participants: regular and with insect flour) – and type of behavior (2 levels within participants: approach and avoidance); semantic differential, behavioral intention, and BIAT scores are the dependent variables.

For the semantic differentials score, a significant main effect of the type of behavior,

$F(1, 106) = 10.06, p = .002, \eta^2_p = .09, 95\% \text{ CI } [0.02, 1.00]$ , indicated that H1 was supported. Participants' self-reported evaluations were higher for cookies associated with the approach than those associated with the avoidance behavior ( $M = 4.39, SD = 1.31$ , and  $M = 3.86, SD = 1.31$ , respectively). The main effect of the type of cookie was significant,  $F(1, 106) = 17.00, p < .001, \eta^2_p = .14, 95\% \text{ CI } [0.05, 1.00]$ , with a more positive evaluation of regular cookies ( $M = 4.48, SD = 0.58$ ) compared to insect-based cookies ( $M = 3.76, SD = 1.15$ ). H2 was not supported as no significant interaction effect was found,  $F(1, 106) = 0.05, p = .822, \eta^2_p < .001, 95\% \text{ CI } [0.00, 1.00]$ , showing that the VAA effect on semantic differential scores was not significantly different for regular and insect cookies. Hypotheses H3 and H4 that the VAA effect would be present for regular and insect-containing cookies were tested through two paired  $t$ -tests. Results showed that the effect of the type of behavior was significant in the insect condition,  $t(52) = 3.17, p = .001$ , Cohen's  $d = 0.43, 95\% \text{ CI } [0.19, \text{Inf}]$ , with the higher score associated with the approached ( $M = 4.05, SD = 1.35$ ) than the avoided ( $M = 3.48, SD = 1.29$ ) brand, supporting H4. H3 was not supported, as no significant effect was detected in the normal cookies conditions,  $t(54) = 1.76, p = .041$ , Cohen's  $d = 0.41, 95\% \text{ CI } [0.01, \text{Inf}]$ .

Because Levene's tests indicated violations of homogeneity of variance, intention scores were analyzed using a linear mixed-effects model with type of cookies (between-subjects) and behavior type (within-subjects) as fixed effects and a random intercept for participants. With regular cookies associated with avoidance behavior as the reference category, the intercept indicated that the estimated intention score in this condition was 3.14,  $95\% \text{ CI } [2.94, 3.34], SE = 0.10$ . Relative to this reference, insect-based cookies were associated with a substantial decrease in intention scores ( $\beta = -0.62, 95\% \text{ CI } [-0.90, -0.33], SE = 0.14, t(167.83) = -4.28, p < .001$ ), indicating a preference for regular over insect-based cookies. In addition, observing approach behavior increased intention scores relative to avoidance for

regular cookies ( $\beta = 0.18$ , 95% CI [0.02, 0.35],  $SE = 0.09$ ,  $t(119) = 2.16$ ,  $p = .033$ ). The interaction between cookie type and behavior type was not significant ( $\beta = 0.02$ , 95% CI [-0.22, 0.26],  $SE = 0.12$ ,  $t(119) = 0.16$ ,  $p = .871$ ), indicating that the effect of approach versus avoidance did not reliably differ between regular and insect-based cookies.

We then conducted paired *t*-tests to account for H3 and H4. Paired *t*-tests results only supported H4, showing that the effect of type of behavior was significant in the insect cookies condition,  $t(59) = 2.54$ ,  $p = .006$ , Cohen's  $d = 0.22$ , 95% CI [0.07, 1.00], with higher scores for the approach ( $M = 2.73$ ,  $SD = 0.92$ ) as compared to the avoidance ( $M = 2.52$ ,  $SD = 0.95$ ). No significant effect emerged in the regular cookies conditions, given the set significance level  $\alpha = .017$ ,  $t(60) = 2.03$ ,  $p = .023$ , Cohen's  $d = 0.29$ , 95% CI [0.05, 1.00], indicating that H3 was not supported. However, the scores were in the expected directions ( $M = 3.33$ ,  $SD = 0.59$  for the approach and  $M = 3.14$ ,  $SD = 0.66$  for the avoidance).

For the BIAT scores, the effect of the type of behavior was not significant given the set significance level  $\alpha = .017$ ,  $F(1, 119) = 4.38$ ,  $p = .038$ ,  $\eta^2_p = .04$ , 95% CI [0.00, 1.00], therefore H1 was not supported ( $M_{Approach} = 0.17$ ,  $SD_{Approach} = 0.43$ ;  $M_{Avoidance} = 0.06$ ,  $SD_{Avoidance} = 0.45$ ). In addition, the main effect of the type of cookies was not significant,  $F(1, 119) = 1.54$ ,  $p = .216$ ,  $\eta^2_p = .01$ , 95% CI [0.00, 1.00], indicating that the overall automatic reactions of participants to the brands were not significantly influenced by the presence of insect powder ( $M_{Insects} = 0.08$ ,  $SD_{Insects} = 0.33$ ;  $M_{Regular} = 0.15$ ,  $SD_{Regular} = 0.30$ ). H2 was not supported, as the interaction effect between type of behavior and condition was not significant,  $F(1, 119) = 2.77$ ,  $p = .098$ ,  $\eta^2_p = .02$ , 95% CI [0.00, 1.00], revealing that the effect of the behavior type on BIAT scores was not significantly different for regular and insect cookies. H3 and H4 hypothesized that the vicarious approach-avoidance effect would manifest both for regular cookies and those containing insects. In line with the preregistration, we conducted paired *t*-tests, separately for

the regular and the insect-containing cookies conditions. Consistent with the results observed in the previous analysis, also for the BIAT results supported H4, showing that the effect of the behavior type was significant in the insect condition,  $t(59) = 3.07, p = .002$ , Cohen's  $d = 0.48$ , 95% CI [0.21, Inf], with the higher BIAT score associated with the approached brand ( $M = 0.18, SD = 0.40$ ) than the avoided ( $M = -0.03, SD = 0.44$ ). No significant effect was detected in the normal cookies conditions,  $t(60) = 0.27, p = .394$ , Cohen's  $d = 0.05$ , 95% CI [-0.26, Inf], indicating that H3 was not supported ( $M_{Approach} = 0.16, SD_{Approach} = 0.46; M_{Avoidance} = 0.14, SD_{Avoidance} = 0.45$ ).

### Ancillary analyses

We also investigated, for exploratory purposes, whether disgust and interest of participants toward food-containing insects were related to the effect of the VAA procedure. First, we compared mean levels of disgust and interest toward insect-based foods between the experimental groups to verify that these variables did not differ at baseline. No significant differences emerged between groups for either disgust or interest. We then computed Pearson's correlation between the three dependent variables and disgust and interest scores. No correlation between either disgust or interest and the size of the VAA toward insect-containing foods emerged.

Moreover, the shift from laboratory to online data collection may have introduced contextual differences that could, in principle, moderate the effects under investigation. To assess this possibility, we included data-collection mode (lab vs. online) as a moderator in all primary ANOVAs. Across all models, data collection mode did not interact with our experimental manipulations, nor did it exert main effects on the dependent measures. Indeed,

the largest observed effect was small and non-significant ( $F = 1.542, p = .217, \eta^2 = 0.01, 95\%$  CI [0.00, 1.00], for a three-way interaction type of cookies\*type of behavior\*data collection mode). These ancillary analyses (not pre-registered) are reported in the supplementary materials section.

## Discussion

Study 1 primarily aimed to test the efficacy of the manipulation with insect-based foods, which represents an unknown and theoretically informative context. Establishing whether vicarious approach–avoidance cues operate reliably with potentially aversive novel foods was a necessary first step. The results of this first study are promising. We found significant main effects in the two self-reported measures, indicating that the VAA procedure was effective in eliciting a self-reported preference (measured with semantic differentials and behavioral intention items) for the brand associated with the approach behavior as compared to the avoidance. Although the interaction effect did not reach statistical significance, more specific analyses revealed that the manipulation effect was significant only in the insect-containing cookies condition. Inspection of the means for the semantic differentials and intentions in comparisons that were not significant indicates that they were nevertheless in the predicted direction and not far from the significance level (set at .017). Additional studies will be needed to establish the reliability of these effects. For the indirect measure, neither the main effect of the type of behavior nor the main effect of the type of cookie reached statistical significance, and the interaction between the two was also non-significant. Intra-category *t*-tests revealed a significant VAA effect for insect-based cookies, with preference scores for the approached brand significantly higher than those for the avoided brand. Conversely, no such effect was

found for regular cookies on the indirect measure. However, interpretation of the results from the indirect measures should be cautious, given the variability in the indices' reliability. At first sight, VAA effects seem more robust for insect-based cookies. One possible explanation is that the unfamiliar and potentially aversive nature of insect-based foods may have amplified the impact of avoidance information. Because our dependent measure reflects the difference between approach and avoidance evaluations, stronger avoidance responses for these unfamiliar foods could have increased the differential score, producing a larger observed effect.

Overall, we replicated the findings of Zogmaister and colleagues (2023a, b), and demonstrated that a VAA procedure, as adapted from Zogmaister and colleagues, can generate preferences between two brands of the same category, even when both products contain insect ingredients. Focusing on an intra-category comparison, Study 1 tested whether a VAA procedure in which a model approaches one brand and avoids another can generate preferences for the approached option over the avoided one. This step was necessary, as it allowed us to establish the basic efficacy of the vignette-based manipulation. Importantly, we tested the procedure with both regular and insect-based cookies, thereby assessing whether it remains effective even when the target is plausibly negative. Demonstrating such efficacy was a substantive empirical question in its own right, particularly given previous findings that classical AAT training can be ineffective or even counterproductive when applied to negatively valenced targets (e.g., Centerbar & Clore, 2006). In Study 1, a VAA effect emerged for approached versus avoided products. Relying on an inferential account of VAA (Van Dessel et al., 2019), participants may have reasoned that people generally approach things they evaluate positively, which, in turn, supported a more favorable evaluation of the approached product. Moreover, VAA may have conveyed social-normative information by depicting

another person's behavior, thereby signaling what others do (i.e., descriptive norms) and, potentially, what is considered appropriate (i.e., injunctive norms). In addition, compared to a classical AAT, which requires participants to enact responses themselves, VAA is more likely to afford socially meaningful cues because it involves observing another individual's choices. In addition, VAA may reduce psychological reactance, as participants are not required to perform approach behaviors toward the target but merely observe another person doing so, a feature that may be particularly relevant when the target is potentially aversive, such as insect-based foods. In Study 1, we did not directly investigate the mechanisms underlying the observed effects. However, establishing the presence of a VAA effect is valuable in itself. Demonstrating that a VAA intervention can shift evaluations contributes to the literature on evaluative learning, even before the specific mediating mechanisms are fully identified. This approach is consistent with the functional–cognitive framework (De Houwer et al., 2017; Hughes & De Houwer, 2016), which emphasizes that research on behavioral effects can be meaningfully conducted without an immediate focus on the underlying mechanisms, while still allowing for their systematic investigation at a later stage. Building on this perspective, Study 2 will include exploratory post-experimental questions to shed light on the processes underlying the VAA effect.

Finally, as an initial step, Study 1 necessarily entails two defining features. First, because evaluations were computed as intra-category differential scores, the study does not allow us to disentangle the specific contribution of approach and avoidance behaviors. Second, by focusing on intra-category comparisons, Study 1 provides a controlled test of whether vicarious approach or avoidance can shift evaluations within a culturally negative product category, independent of comparisons with conventional alternatives. To build on this

foundation, Study 2 will examine whether a vicarious approach or avoidance of an insect-based product alters its evaluation relative to a conventional alternative, while also isolating the effects of approach and avoidance through a between-participants design.

## Study 2

Study 2 will build on the findings of Study 1, which showed that VAA can shape relative preferences within a food category, including for insect-based products. After providing an essential first demonstration of the procedure's effectiveness with potentially aversive novel foods, with Study 2 we aim to determine the independent contribution of approach and avoidance and assess how these cues affect evaluations of insect-based foods relative to conventional products. Therefore, Study 2 will employ a between-participants design with three behavioral conditions: a baseline condition in which no systematic behavior toward insect-based food is observed, an approach condition in which participants will be exposed to approach-oriented behavior directed at insect-based food, and an avoidance condition in which participants will be exposed to avoidance-oriented behavior directed at insect-based food. This design will allow us to isolate the specific impact of each behavioral cue. In addition, all participants will be exposed to regular cookies, involving no approach or avoidance behavior, which enables a controlled inter-category comparison that was not possible in Study 1. This design will permit the examination of whether approach behavior alone increases the relative positivity of insect-based foods compared to a neutral baseline, and whether avoidance correspondingly reduces it. In Study 2, each participant will be presented with two vignettes: one describing regular cookies and the other describing insect-based

cookies. The vignette involving regular cookies will be identical across all conditions and will serve as a neutral baseline: the cookies will be briefly introduced, but the model will not engage in either approach or avoidance behavior. In contrast, the vignette involving insect-based cookies will vary depending on the experimental condition. In the baseline condition, the model will encounter the insect-based cookies but neither approaches nor avoids them. In the approach condition, the model will approach the insect-based cookies, whereas in the avoidance condition, the model will explicitly avoid them. Because all participants will also view the neutral vignette involving regular cookies, we will compute a measure of relative preference between insect-based and regular cookies within each condition. This structure will allow us to compare these preferences across groups and, therefore, to test the effects of the VAA on the evaluation of insect-based foods. Moreover, in place of the BIAT used in Study 1, Study 2 will employ an Implicit Association Test (IAT).

Moreover, Study 2 will examine whether the effects of our manipulation generalize beyond cookies. Indeed, interventions aimed at changing evaluations of a focal attitude object may produce changes in evaluations of related attitude objects (i.e., Lateral Attitude Change, Glaser et al., 2014). For this reason, testing whether VAA will also influence evaluations of other insect-based foods is important for assessing the scope of the procedure. We will therefore include additional self-report measures of attitudes and intentions toward other insect-based products (e.g., burgers, pasta) to evaluate whether the effects observed for cookies extend to these other food categories. Finally, we will also add some explorative questions to investigate the role of the model's perceived agency, inferred social norm, and perceived taste and safety on the VAA effect.

## Method

### Hypotheses and hypothesis testing

The main hypothesis is that participants in the approach condition will show a higher preference for insect-based cookies (computed as the difference between insect-based and regular cookies) as compared to the baseline (H1). A second, theoretically informed hypothesis is that participants in the avoidance condition will show a lower preference for insect-based cookies (again computed as the difference between insect-based and regular cookies) as compared to the baseline (H2). Both H1 and H2 are directional hypotheses and will be tested using two parallel ANOVAs and then applying Dunnett-adjusted contrasts comparing the approach and avoidance conditions to the baseline, using the R package *DescTools*. The main dependent variables will be the semantic differential and intention scores, with the experimental condition as the independent variable.

### Participants and design

Data collection will be conducted online via a platform (e.g., Prolific or Qualtrics). The target sample size is 330 participants. We will attempt to recruit up to 360 participants, assuming that some will be excluded due to the exclusion criteria.

To ensure a culturally and experientially consistent sample, we included only Italian participants. Participants were also required to be between 18 and 45 years of age, as younger adults are generally more open to insect-based foods (Alhujaili et al, 2023). Moreover, only omnivores were included, as participants who do not eat animal products would introduce a confounding factor. Finally, we aimed for a balanced gender distribution.

The required sample size for Study 2 was determined by adopting a safeguard power analysis (Perugini et al., 2014). The main dependent variables in Study 2 will be the semantic differential and the intention scale toward insect-based cookies. In Study 1, the main effect of behavior type on the self-report measures was  $\eta^2_p = .09$  for the semantic differential and  $\eta^2_p = .08$  for behavioral intentions. However, the intention scale showed unexpectedly low internal consistency for a self-report measure of this kind (Cronbach's  $\alpha \approx .67$  and  $.76$  for the approached and avoided brands, respectively, in the regular-cookies condition). Item-level reliability analyses indicated that one item was problematic; removing it increased internal consistency substantially ( $\alpha = .83$  for approach and  $.84$  for avoidance). Although in other studies this scale showed acceptable levels of reliability, here we will slightly revise this item to improve it, and expect a more reliable intention measure. Nonetheless, we based the power analysis on the more stable semantic differential outcome and used a conservative estimate. Specifically, we used the lower bound of the 80% confidence interval for the semantic differential main effect from Study 1, which corresponds to  $\eta^2_p = .048$  (i.e.,  $f = 0.22$ ). Because Study 2 will employ two dependent variables, we applied a Bonferroni correction and set  $\alpha = .025$  for each (two-sided), with target power = .90. A priori power analysis with the *pwr* package in R for a one-way ANOVA with three groups (behavior type: baseline, approach, avoidance),  $f = 0.22$ ,  $\alpha = .025$ , and power = .90 yield a total sample size of  $N = 297$  (99 participants per condition). The code and output of this analysis are provided in the supplementary materials and linked OSF files. This estimate represents a minimum safeguard sample size. To adopt a further conservative safeguard, we decided to recruit 330 participants, adding approximately 10% more than the initial estimate. A sensitivity analysis for a one-way ANOVA with three groups, with a sample size of  $n = 330$ ,  $\alpha = .025$ , and power = .90, indicated

a minimum detectable effect size of  $\eta^2_p = .043$ . Given the approach we adopted, we consider this effect size both reasonable and realistic.

Study 2 will have a full between-participants design with a single factor, behavior type, comprising three levels: baseline, approach, and avoidance.

### **Exclusion criteria and data cleaning**

Data exclusion will follow the preregistered criteria: a “No” response to the SRSI-use me question, participants who are vegetarian or vegan (i.e., do not eat meat), fewer than 75% correct responses in either of the two IATs, and incorrect responses to the manipulation check that persist even after reading the vignettes three times.

Outlier detection will be performed using the 3-MAD rule, along with a visual inspection of the data, before proceeding with any step of the hypothesis testing. Missing data were handled through pairwise deletion. In addition, the main analysis will be performed with and without participants who will show high scores in the demand characteristics questions (i.e., a score greater than 3 on a 4-point scale). If data from these participants substantially alter results, we will discard them from the analyses.

### **Materials**

#### ***Vignettes***

Each participant will read two text vignettes. The first vignette will be identical across the three experimental conditions, and will depict a model called Sofia exploring a culinary fair and encountering a stand promoting regular cookies. The vignette will be phrased as follows (English translation):

Sofia is visiting a culinary fair, the Arena del Gusto. As she walks through the stands, she notices a booth presenting new cookie products from the brand Flimber. The promoter briefly describes these regular cookies, explaining that they are part of a new product line being introduced at the fair.

The second vignette will be different for each experimental condition and will depict the same model continuing to explore the fair and meeting another stand, which this time presents insect-based cookies. In the baseline condition, the vignette will be phrased as follows:

As she continues through the fair, Sofia comes across another booth presenting cookie products from the brand Phoenix. The cookies are placed on a tray and look similar to the regular ones she has seen earlier, with the only difference being that they are made with insect flour. The promoter briefly describes these insect-based cookies, noting that they are also part of the new products being showcased at the fair.

Vignettes in the approach and avoidance conditions will resemble the baseline vignette, except that the model will be additionally described as either approaching or avoiding the insect-based cookies at the stand. Specifically, in the approach condition, the following sentence will be added: “Sofia takes one of the samples and tastes the Phoenix cookies.” In the avoidance condition, the vignette will instead conclude with “Sofia moves away, avoiding tasting the Phoenix cookies.” All vignettes will be available in the supplementary materials, both in their original Italian and in English translation.

We conducted a pilot test to confirm the plausibility and comprehension of the materials. The vignettes were pretested for perceived credibility and for their interpretative meaning in terms of approach versus avoidance behavior. The pretest was conducted on a sample of 20 participants drawn from the same population as the main study. Overall, the vignettes were evaluated as sufficiently credible, with a median credibility rating of 6 on a 7-point scale. Importantly, the three vignettes were clearly differentiated in terms of perceived approach and avoidance, as shown by robust test results. Full details of the pretest procedure

and materials are provided in the online supplementary materials, along with the raw data and analysis scripts.

### ***Manipulation check***

After viewing the vignettes, participants will complete a series of manipulation-check questions to ensure that they correctly encoded the key elements of the scenario. All participants will answer two questions assessing recognition of the products presented in the story: (1) “What kind of cookies are Phoenix?” with response options “Regular cookies”, “Cookies made with insect flour”, “The story did not specify it”, and “I don’t remember”; and (2) “What kind of cookies are Flimber?” with the same response options. Two additional questions will be administered only to participants in the approach and avoidance conditions, assessing their recollection of Sofia’s behavior: (3) “What did Sofia do when she encountered the Phoenix cookies?” and (4) “What did Sofia do when she encountered the Flimber cookies?”, with response options “She tasted them”, “She avoided tasting them”, “It was not specified”, “I don’t remember”. If a participant provides an incorrect answer, the vignettes will be presented again until the correct response is given.

### ***Semantic differentials toward insect-based food category***

To assess participants’ evaluations of insect-based foods as a general category, we will use the same semantic differential scale employed in Study 1, adapting the referent from a specific cookie product to the broader category of insect-based foods. The wording of the items will remain identical (e.g., tasty–untasty, appealing–unappealing), while the instructions will be modified to ask participants to report their general impressions of insect-based foods rather than their evaluations of the particular cookie brand. Since participants may not be fully aware

of which other foods can be made with insect flour, we will include a brief introductory paragraph before the semantic differential. The paragraph will read: “Beyond cookies, insect-powder ingredients are used in many other products, for example, pasta, burgers, snacks, and protein bars. In the next section, we ask you to indicate your general impression of this broader category of food made with insect powder.”

### *Intention scale*

Consumption intentions for both the cookie products and insect-based foods more generally will be separately assessed using an intention scale. Compared to Study 1, we will revise the scale by replacing one item that had shown a relatively low association with the other items. Specifically, the item “If they are offered to me, I will probably taste them” may have performed poorly because participants could not ascertain the context, source, or safety of the offered product, potentially leading to heterogeneous interpretations and inconsistent responses. We will therefore replace this item with the following formulation, which more directly targets willingness to consume the product: “When I have the chance, I am willing to try insect-based foods.” Reliability analysis and correlation among items will be reported in the supplementary materials (see accompanying R scripts). The intention scale will be presented together with the same cover story employed in Study 1.

### *IAT*

We will assess relative preferences between the two brands using the Implicit Association Test (IAT; Greenwald et al., 1998). In the task, the two biscuit brands will serve as the target categories, and the same taste-related adjectives used in Study 1 will be employed as attribute categories. Five pairs of new image stimuli will be created for each brand. The

procedure will follow the seven-block IAT structure, and D2 scores are computed using the built-in error-penalty algorithm described by Greenwald, Nosek, and Banaji (2003).

Positive scores indicate a preference for the insect-based brand, whereas negative scores indicate a preference for the regular brand; larger absolute values reflect a stronger preference.

### *Exploratory questions*

After the primary outcome measures, participants will complete exploratory questions designed to probe the inferences elicited by the VAA manipulation. Specifically, we will focus on the perceived agency of the model, inferred social norms, and perceived taste and safety of the cookies. Perceived agency of the model will be assessed with one item, “To what extent did Sofia’s behavior reflect her personal choice (rather than external factors)?”, rated on a 7-point scale ranging from 1 (not at all) to 7 (very much). Perceived descriptive norm will be investigated with the question “Out of 100 people at a food fair like this, how many do you think would taste the insect-based cookies?”, answered using a 0–100 slider. To assess perceived injunctive norm, we will ask participants, “To what extent do you think Sofia behaved as she did because she felt she ‘should’ (i.e., because it was what other people considered appropriate)?”. Perceived taste and safety of the insect-based cookies will be assessed with two items: “How tasty do you think the Phoenix cookies are?” and “How safe do you think the Phoenix cookies are to eat?”, both rated on 7-point scales ranging from 1 (not at all) to 7 (very much).

### ***Demand characteristics question***

To assess demand characteristics, we will ask participants whether and to what extent they adjusted their responses to align with the experiment's hypotheses. Specifically, we will ask them, "In this research, how much have you adapted your answers to fit our expectations?". Response options will be on a four-point scale, ranging from "Not at all", "A little", "Quite a bit", to "Very much".

### **Procedure**

Study 2 will be conducted online. First, participants will be presented with the two cookie brands used in the study, Flimber (regular cookies) and Phoenix (insect-based cookies), and they will view the vignette corresponding to their assigned experimental condition. After the vignette, participants will complete manipulation-check questions to verify their understanding. If the manipulation check is answered incorrectly, the vignette will be shown again until the participant provides a correct response. Once the manipulation checks are passed, participants will complete the measures specific to the cookie products. These will include one indirect measure (the IAT) and two direct measures (semantic differentials and the intention scale), which will be administered in a counterbalanced order. Next, participants will complete the measures assessing their evaluations of insect-based foods as a general category. They will then respond to the disgust and interest scales, followed by the exploratory questions about agency, social norms, and perceived taste and safety, the demographic questions, and items assessing data quality.

### **Exploratory analyses**

For exploratory purposes, we will examine the effect of the manipulations on the IAT scores for insect cookies and whether the effect generalizes to the broader category of insect-based foods. These analyses will follow the same analytical approach used to test H1 and H2. In addition, we will test whether disgust and interest toward insect-based foods moderate the effect of the manipulation by including their interactions with the experimental condition in the analysis. Finally, we will also explore whether perceived agency, inferred social norms, and perceived taste and safety influence the effect of the experimental condition on the dependent variables (i.e., semantic differential, intention scale).



## Project 4: Observing Others Influences Attitudes Toward Insect-Based Foods<sup>4</sup>

### Abstract

Insect-based foods represent a sustainable and ethical alternative protein, but their adoption in Western societies faces cultural resistance due to disgust and unfamiliarity. We examined the effectiveness of two social learning strategies, Observational Evaluative Conditioning (observing others' emotional reactions) and Vicarious Consumption (observing others eating), for shaping attitudes and behavioral intentions toward insect-based biscuits. Experiment 1 ( $N = 131$ ) tested only Observational Evaluative Conditioning, and it influenced spontaneous preferences and intentions for both insect-based and regular biscuits. Experiment 2 ( $N = 293$ ) examined Observational Evaluative Conditioning and Vicarious Consumption. Both strategies improved attitudes toward insect-based foods compared to baseline, with no significant difference between them. These findings suggest that observing others' consumption and emotional reactions can reduce aversion to insect-based products. Observational Evaluative Conditioning and Vicarious Consumption offer promising, scalable approaches to promote acceptance of novel, eco-friendly foods, potentially facilitating sustainable dietary shifts without requiring direct exposure or taste experience.

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<sup>4</sup> Project 4 is based on: Zogmaister, C., Fedeli, F., Bading, K.C., Vezzoli, M., De Houwer, J., Mari, S., Rinaldi, M.A., Perugini, M. (2026). Observing Others Eat Influences Attitudes Toward Insect-Based Foods. Zenodo. <https://doi.org/10.5281/zenodo.18155956>. The manuscript is currently under review at *Personality and Social Psychology Bulletin*.

## Introduction

As the global population grows, the resulting strain on agricultural systems has intensified the search for sustainable protein sources. Insects have emerged as a promising solution, offering a nutritionally rich alternative that is high in essential nutrients (Van Huis et al., 2013; Van Huis, 2022). Insect farming is also environmentally advantageous, producing lower greenhouse gas emissions and requiring less land than conventional livestock production (Oonincx & de Boer, 2012; Van Huis & Rumpold, 2023). Ethically, insects may represent a preferable option, as their simpler nervous systems suggest a much lower capacity for suffering compared to vertebrates (Adamo, 2016; Burrell, 2017; Delvendahl et al., 2022; Gibbons et al., 2022). Thus, encouraging even a partial substitution of meat with insect-based foods could reduce overall animal suffering, particularly as welfare-oriented rearing and slaughter protocols continue to evolve. Despite these nutritional, environmental, and ethical advantages, Western societies remain resistant to consuming insects. Unlike foods that are disliked, such as certain vegetables, or those that are culturally specific, like black pudding, the resistance to insects is rooted in a fundamental perception: Insects are not seen as food at all, but rather are associated with dirt or contamination (Deroy, Reade, & Spence, 2015; Fasanelli et al., 2020; Kröger et al., 2022). This deeply ingrained perception creates a significant barrier to acceptance.

On the other hand, in many non-Western societies, insects are commonly consumed as part of the diet, and archaeological evidence suggests that they were a significant food source for early humans (Van Huis et al., 2022; Van Huis & Rumpold, 2023). This contrast highlights the role of cultural influences in shaping dietary preferences (Jeong & Lee, 2021) and suggests that Western aversion to insect-based food is learned rather than universal. Accordingly, social

learning interventions may offer a promising route to changing evaluations and increasing willingness to consume insect-based foods. Most previous interventions aimed at improving Western consumers' reactions to insect food have relied on information-based approaches, such as emphasizing the health and environmental benefits of insect-based foods (Laureati et al., 2024; van Huis & Rumphold, 2023). Although these strategies can raise awareness, they seldom alter persistent disgust or perceptions that insects are not food. By contrast, interventions that highlight similarities between insect-based food and familiar foods (Fedeli et al., 2025) or that employ social learning strategies (Fedeli et al., 2024) appear promising for reducing avoidance. While information alone does not disrupt underlying disgust and neophobic reactions (i.e., fear of new foods), cognitive techniques that engage mental representations of insect-food, encourage comparisons, or utilize observational learning may more effectively address the sources of rejection. Therefore, when designing interventions to promote acceptance of novel foods, cognitive strategies should be prioritized over simple information delivery, as the latter often fails to challenge deeply held rejection schemas and food norms. Here, we will focus specifically on social learning strategies.

### **Using social learning strategies to overcome negative reactions to food with insect derivatives**

In Western cultures, people rarely observe others (i.e., social models) eating insect-based foods, which may contribute to the persistence of negative attitudes toward such foods. By contrast, observing others' eating behavior has a powerful effect on individuals' eating choices with traditional foods (Cruwys et al., 2015). In social modeling of food choices, two aspects of the model's behavior can be distinguished: the act of consuming the food and the emotional response displayed by the model.

### ***Vicarious consumption***

Observing another person (the model) consume a food can shape one's evaluation. Reviews by Cruwys and colleagues (2015) and Suwalska and Bogdański (2021) show that social modeling reliably affects choices and behaviors, particularly for highly palatable, high-calorie foods such as snacks, chocolate, and ice cream. When, more rarely, less appealing foods, such as carrots or cucumbers, are examined, effects tend to be smaller and may require repeated exposure. Thus, although social modeling is a robust mechanism, its impact appears reduced for foods that are initially unattractive. This limitation may be even more pronounced for insect-based foods. Nonetheless, research using a vicarious approach paradigm indicates that merely learning that someone has approached rather than avoided an insect-based food can create a preference (Fedeli et al., 2024), suggesting that observing consumption alone may be sufficient to nudge attitudes even toward culturally resisted foods.

From a theoretical perspective, witnessing a model consume a target food can foster positive attitudes, a vicarious consumption (VC) effect, for multiple reasons. First, the act of eating is itself evaluated positively (Zogmaister, Brignoli, et al., 2023). Therefore, observing someone eat can produce evaluative conditioning (Moran et al., 2023), with the food as the conditioned stimulus and eating as a positive unconditioned stimulus. Second, from a propositional perspective (De Houwer, 2018), observers may infer that, if someone eats a food, they like it, and therefore the food must be good (see Zogmaister, Brignoli, et al., 2023, for a related discussion).

### ***Observational evaluative conditioning***

Models can go beyond merely demonstrating consumption by also conveying their appreciation or dislike of a food. Adding this evaluative information may strengthen social

modeling effects and thus represent a particularly effective strategy for improving reactions to insect-based foods.

Various studies have examined the effects of models' positive or negative emotional expressions during food consumption (Baeyens et al., 1996, 2001; Barthomeuf et al., 2012; Cruwys et al., 2015; Suwalska et al., 2021). Most research has focused on appetitive or neutral foods and shows that observing a model consume a food and express an appreciation typically increases subsequent liking for that food (e.g., Kasran et al., 2022, 2023). This effect is known as Observational Evaluative Conditioning (OEC; Baeyens et al., 1996; Mineka et al., 1984). Evidence for OEC with commonly unappealing foods, such as Brussels sprouts or black pudding, is more limited and mixed: Negative expressions reliably reduce liking, whereas positive expressions sometimes fail to increase it (Barthomeuf et al., 2009; Edwards et al., 2022, 2024; Soussignan et al., 2015).

Within an associative theoretical framework (Conditioning Hypothesis, Baeyens et al., 2001), the model's emotional reaction functions as an unconditioned stimulus that elicits a corresponding evaluative response in the observer. When the food (conditioned stimulus) is paired with this reaction, associations form between their mental representations, allowing the food to elicit a similar response later on. By contrast, the inferential account suggests that observers derive the evaluative qualities of a stimulus by interpreting the model's reaction (De Houwer et al., 2021), for instance inferring that a food is good because the model appears to like it.

### **The present research**

We examined the effects of Observational Evaluative Conditioning (OEC) and Vicarious Consumption (VC) on attitudes toward insect-based foods across two experiments.

We began with OEC because, of the two social learning strategies, it was expected to be the most effective. OEC combines the observation of consumption with the model's affective reaction, whereas VC involves observing consumption without emotional cues.

Experiment 1 focused on OEC. Participants were randomly assigned to one of two between-participant conditions: regular biscuits, to validate the paradigm with conventional stimuli, or insect-based biscuits, to test whether OEC generalizes to culturally resisted foods. In both conditions, the model consumed two brands and expressed a positive reaction to one and a negative reaction to the other.

After establishing the efficacy of this full social learning signal, Experiment 2 tested whether observation of consumption alone (VC) would also influence preferences and evaluations. This experiment included three between-participant levels: baseline, VC, and OEC. To align with the goal of improving attitudes, the OEC condition included only a positive model reaction (OEC+). Experiment 2 also shifted from an intra-category to an inter-category comparison, examining whether VC and OEC+ could alter preferences between biscuits with and without insect ingredients. This design enabled us to test whether social modeling can enhance evaluations of insect-based foods compared to non-insect alternatives and whether affective reactions are necessary for such effects.

Overall, this research addresses a largely neglected domain by examining OEC and VC with foods that are typically perceived as unappealing or culturally resisted. Prior research on VC and OEC focused mainly on palatable or neutral foods (Baeyens et al., 1996, 2001; Barthomeuf et al., 2012; Cruwys et al., 2015; Kasran et al., 2022, 2023; Suwalska & Bogdański, 2021), with studies on disliked foods showing weaker or inconsistent effects (Barthomeuf et al., 2009; Edwards et al., 2022, 2024; Soussignan et al., 2015). By examining insect-based foods, the present studies offer valuable information on the effectiveness of these strategies

with this type of stimuli. Moreover, it sheds light on the role of positive affective reactions as a means for changing attitudes by directly comparing within the same experiment the effects of procedures with and without those reactions. Practically, the findings from this research could have implications beyond those for communication strategies regarding insect-based foods and approaches to persuade consumers. If proven effective with insect-containing foods, the OEC or VC strategy could also be applied to interventions aimed at encouraging people to adopt other potentially beneficial dietary behaviors.

In addition to standard direct measures, we employed indirect measures to assess spontaneous and automatic reactions toward insect-based foods. Such approaches are rare in research on novel food interventions (e.g., Fedeli et al., 2024, 2025; Verneau et al., 2016), but are crucial because, as highlighted by Brunner and colleagues (2025), indirect assessment techniques can capture aspects of consumer attitudes that self-report measures might miss, offering a more complete picture of intervention effectiveness.

### *Open science practices*

Both experiments were preregistered (Experiment 1, <https://osf.io/exb82>; Experiment 2, <https://osf.io/gzh5a>) prior to data collection, with any deviations from preregistrations clearly indicated. The materials, data, and analysis syntax are openly available and can be accessed at the following links: <https://osf.io/7j8vf> (Experiment 1) and <https://osf.io/erpkm/> (Experiment 2).

We clearly differentiate between preregistered and exploratory analyses.

## Experiment 1

Following Kasran and colleagues (2023), participants watched short video clips depicting a model tasting two brands of sweet biscuits. After sampling one brand, the model displayed a facial expression of appreciation; after the other, the model expressed disgust. We then measured participants' spontaneous evaluative reactions and behavioral intentions toward each brand. Half of the participants observed the model consuming insect-based biscuits, and the other half viewed the model eating traditional biscuits. This design enables testing the effectiveness of OEC with insect-based foods while confirming that the strategy operates as expected in our setting using conventional biscuits, establishing a baseline to distinguish effects of the target food from characteristics of the materials or procedure.

### Method

#### Participants and design

The experiment employed a mixed 2 x 2 design: biscuit type (regular vs. insect biscuits; between participants) x reaction (appreciation vs. disgust; within participants). A total of 163 participants (97 women, 60 men, six non-binary;  $M_{age} = 24.93$  years,  $SD = 6.06$ ) volunteered for the study. Participants were recruited via the Departmental Subject Management Pool, where they received study information and registered to participate, and through word of mouth. Those recruited from the Management Pool earned CFUs proportional to their time commitment; no additional compensation was provided. A power analysis using G\*Power 3 (Faul et al., 2007), with  $\alpha = .017$  (Bonferroni criterion for three dependent variables), power  $(1 - \beta) = .90$ , and an effect size of  $f = 0.25$ , to test H1 and H2 (described below) using a 2 x 2 mixed model ANOVA indicated a required total sample size of  $N = 112$ . Anticipating a low or

null correlation between within-participant measures, we conservatively set  $r = 0$ . Due to online data collection, recruitment could not be stopped precisely at this target.

After applying preregistered exclusion criteria (see below), data from 132 participants were analyzed, with 68 in the regular biscuit condition and 64 in the insect biscuits condition. For each brand, we measured three dependent variables: spontaneous affective reactions, self-reported attitudes, and behavioral intentions.

## **Materials**

### ***Target products***

We used two biscuit brands: an existing, relatively uncommon commercial brand, which we refer to as Darivo in this article to protect the interest of the brand; and Medeva, a mock brand created for the study. The mock brand was designed to resemble the existing brand in length, Italian-sounding character, and three-syllable structure. The identity of the commercial brand corresponding to Darivo is available upon request for exact replication. For each brand, we produced five images showing the brand, its packaging, or both. The image sets were carefully matched: For every image of one brand, a corresponding image of the other brand was created with the same general characteristics (e.g., if one image showed two packages, the parallel image depicted two packages of the other brand).

### ***Videos***

The two biscuit brands served as conditioned stimuli. Each brand was presented in a 15-second video, beginning with a three-second display of the biscuit package. The brand name was clearly visible, and in the insect condition, the presence of insect powder was explicitly indicated. A male model then took a biscuit from the package, tasted it, and displayed either appreciation or disgust, accompanied by a sound consistent with the emotional reaction. The specific emotion displayed for each brand was counterbalanced between participants. The

model, a young Caucasian man, stood in front of an Italian theme park, with a the park's name visible in the background to indicate the scene was filmed in Italy.

### ***Manipulation check***

After viewing the videos, participants answered two questions regarding the model's reactions to each biscuit brand: "What expression did the boy show after tasting the biscuit?" Response options were: Satisfied, Disgusted, No particular expression, or I do not remember. If participants answered incorrectly or indicated they did not remember, the videos were shown again.

### ***Brief Implicit Association Tests (BIAT)***

The task was implemented following Sriram and Greenwald (2009; Experiments 1 and 2) and run in Qualtrics using the procedure described by Maimon (2020). The two biscuit brands were target categories, with five images per brand. Positive and negative taste-related adjectives served as attribute categories: tasty, good, appetizing, enticing, and appealing for Positive; disgusting, nasty, nauseating, repulsive, and vomiting for Negative. Attribute assignment was counterbalanced, with half of the participants first categorizing the brand with positive adjectives, while the other half categorized it first with negative ones. Participants completed two consecutive BIATs, one per brand, each comprising two training blocks (1 and 3) of 8 trials and two critical blocks (2 and 4) of 32 trials. Stimuli were presented in random order, with images on odd trials and adjectives on even trials. BIAT order was counterbalanced across participants. The BIAT had a built-in penalty: incorrect responses required participants to provide the correct answer before continuing, with response latencies recorded on the correct response.

### ***Self-reported attitudes***

Participants completed two semantic differentials, one per brand, using the same adjectives as in the BIAT paired as follows: Tasty–Disgusting, Good–Nasty, Appetizing–Nauseating, Enticing–Repulsive, and Appealing–Retching. Ratings were on a 7-point scale. Due to a programming error, data from the semantic differential scales were not successfully recorded and are unavailable for analysis.

### ***Intentions***

Four items assessed the intention to purchase and consume insect-based foods:

1. If they are available in the shops I usually visit, I will probably buy them.
2. I am going to buy them no matter where they are sold.
3. As soon as I can, I am going to eat them.
4. If they are offered to me, I will probably taste them.

Participants responded on a 5-point Likert scale: 1 = *strongly disagree*, 2 = *disagree*, 3 = *neither agree nor disagree*, 4 = *agree*, 5 = *strongly agree*.

### ***Knowledge of brands***

Prior knowledge of the biscuit brands was assessed with the question: “Have you ever heard of this brand before this experiment?” Response options were: “No, I have never heard of it,” “Yes, I have heard of it, but I do not know what it is,” and an open-ended option “Yes, I know it, and I am familiar with what it is (please specify).”

### ***Disgust and interest toward eating insects***

These were measured using eight items from the Entomophagy Attitude Questionnaire (EAQ; La Barbera et al., 2020), comprising the Disgust and Interest subscales. Participants rated each item on a 5-point Likert scale: 1 = *not at all*, 2 = *a little*, 3 = *moderately*, 4 = *a lot*, 5 = *very much*.

### ***Self-Reported Single-Item “Use Me” question (SRSI; Meade & Craig, 2012)***

Participants indicated whether their data should be included in our analyses (No/Yes).

### ***Demographic questions***

Participants reported age, gender, Italian proficiency, dietary type (omnivorous, vegetarian, vegan, or other), and student status.

### **Procedure**

The experiment was programmed in Inquisit 6.6.1 and administered online via Inquisit Web (Millisecond Software). After providing informed consent, participants were informed they would watch short videos about two biscuit brands. Following Kasran and colleagues (2022, Experiment 1), each participant viewed the two videos – one per brand – three times each, in a random sequence. Brand-valence pairings were counterbalanced across participants: one brand was paired with the positive reaction, and the other with the negative reaction. After viewing the videos, participants completed the manipulation check. If responses were incorrect for either brand, the videos were replayed until correct, with a maximum of four attempts. Participants then completed the BIAT, the semantic differential, and the intention-to-buy-and-eat scales. Semantic differentials always preceded intention questions and the order of BIATs and self-reports was counterbalanced between participants. Measures of prior brand knowledge, disgust, and interest in eating insect followed. Participants then completed the SRSI “Use Me” item to identify careless responding and provided demographic information.

### **Primary hypotheses**

Building on research on Observational Evaluative Conditioning and Vicarious Consumption, and considering that prior studies report stronger conditioning effects for neutral

or positively valenced foods than for initially disliked foods (Barthomeuf et al., 2009; Edwards et al., 2022, 2024; Soussignan et al., 2015; Moran et al., 2025), we formulated the following hypotheses:

H1) Participants will prefer the brand associated with appreciation over the brand associated with disgust across all three measures (BIAT, semantic differential, intention).

H2) This preference will be stronger for regular biscuits than for insect-based biscuits.

### **Secondary hypotheses**

Although H2 hypothesized an attenuated effect for insect-based biscuits, we expected the OEC effect to remain detectable within each food category, yielding the following hypotheses:

H3) Participants viewing videos featuring regular biscuits will prefer the brand associated with appreciation over the brand associated with disgust, replicating Kasran et al. (2023).

H4) Participants viewing videos featuring insect-based biscuits will also prefer the brand associated with appreciation over the brand associated with disgust, extending those findings.

## **Results**

Due to a programming error, semantic differential responses were not recorded. Consequently, all hypothesis tests rely on indirect measures of attitudes and self-reported behavioral intentions. Statistical analyses were performed in R (R Core Team, 2023). Using the following packages: readr (Wickham, Hester & Bryan, 2024), dplyr (Wickham et al., 2023), tidyr (Wickham, Vaughan & Girlich, 2024), reshape2 (Wickham, 2007), ez (Lawrence, 2016), effectsize (Ben-Shachar, Lüdtke & Makowski, 2020), psych (Revelle, 2025), car (Fox &

Weisberg, 2019), apaTables (Stanley, 2021), purrr (Wickham & Henry, 2025), and MBESS (Kelley, 2025).

### **Preliminary analyses**

Data from participants who answered ‘No’ to the SRSI question ( $n = 5$ ), were vegetarians ( $n = 7$ ) or vegans ( $n = 3$ ), scored below 75% correct responses on either BIAT ( $n = 16$ ), or reported prior knowledge of the Darivo brand ( $n = 0$ ) were excluded, following preregistration. The final sample comprised 132 participants (regular biscuits:  $n = 68$ ; insect-containing biscuits:  $n = 64$ ). Potential outliers were screened using the 3-MAD rule and visual inspection; no outliers were detected.

BIAT scores for each brand were computed separately using the D measure (Greenwald, Nosek, & Banaji, 2003). This computation was based on the difference between the mean penalized latency in blocks pairing the brand with negative words and the mean for blocks pairing it with positive words (see Zogmaister et al., 2025, for a similar approach). Higher scores indicate a more positive attitude. Reliability was Cronbach’s  $\alpha = .79$  (Darivo) and  $\alpha = .83$  (Medeva) in the regular biscuit conditions, Cronbach’s  $\alpha = .76$  (Darivo) and  $\alpha = .82$  (Medeva) in the insect-based biscuit conditions. Scores were recoded to reflect the brand paired with the positive reaction versus the brand paired with the negative reaction, irrespective of the specific brand, so that the focus was on the effect of emotional reaction rather than brand identity.

Mean responses on the four-item intention scale were computed separately for Darivo ( $\alpha = .82$  for the regular biscuit condition;  $\alpha = .91$  for the insect-based biscuit condition) and Medeva ( $\alpha = .86$  for regular biscuits;  $\alpha = .87$  for insect-based biscuits). Higher values indicate stronger intentions to buy and eat the product. For analysis, we computed the difference

between the mean score for the brand paired with the model's positive reaction and the mean score for the brand paired with the negative reaction. Consequently, positive values reflect a preference for the brand associated with the positive reaction, whereas negative values indicate a preference for the brand associated with the negative reaction.

Mean scores were computed for the EAQ subscales: disgust (five items,  $\alpha = .92$ ) and interest (three items,  $\alpha = .91$ ). Higher scores indicate greater disgust or interest toward consuming insect-containing foods. Descriptive statistics and inter-measure correlations are reported in Table 9.

**Table 9.** P4. Experiment 1: Descriptive statistics and correlations among measures

	M	SD	Min	Max	Correlations				
					1.	2.	3.	4.	5.
<i>Regular Biscuits</i>									
<b>1. Appreciation-paired brand BIAT</b>	0.22	0.56	-0.98	1.25					
<b>2. Disgust-paired brand BIAT</b>	-0.15	0.55	-1.46	0.92	-.12 [-				
<b>3. Appreciation-paired brand intentions</b>	3.51	0.70	1	5	.07 [-	-.10 [-			
<b>4. Disgust-paired brand intentions</b>	2.55	0.91	1	5	-.13 [-	-.01 [-	.22 <sup>†</sup> [-		
<b>5. Disgust EAQ score</b>	3.05	1.20	1	5	.09 [-	.13 [-	-.26***	-.08 [-	
					.16,	.11,	[-.47, -	.31, .16]	
					.32]	.36]	.02]		

<b>6. Interest EAQ score</b>	2.79	1.20	1	5	-.04 [-	-.06 [-	.35**	.17 [-	-.70***
					.28,	.29,	[.11, .54]	.07, .39]	[-.80, -
					.20]	.19]			.55]
<i>Biscuits with insect powder</i>									
<b>1. Appreciation-paired brand BIAT</b>	0.31	0.48	-0.90	1.49					
<b>2. Disgust-paired brand BIAT</b>									
<b>3. Appreciation-paired brand intentions</b>									
<b>4. Disgust-paired brand intentions</b>									
<b>5. Disgust EAQ score</b>									
<b>6. Interest EAQ score</b>	2.98	1.20	1	5	.03 [-	.05 [-	.48***	.41***	-.74***
					.22,	.19,	[.26, .65]	[.18,	[-.84, -
					.27]	.30]		.59]	.61]

Note. Values in brackets represent 95% confidence intervals. † p < .10, \* p < .05, \*\* p < .01, \*\*\* p < .001

### Test of the hypotheses

To test Hypotheses H1 and H2, we conducted two mixed-model ANOVAs with biscuit type (regular vs. insect-containing, between participants) and emotional reaction (appreciation-paired vs. disgust-paired, within participants) as factors, using BIAT and intention scores as dependent variables. To test H3 and H4, we next conducted paired sample t-tests for each biscuit type.

For BIAT scores, the mixed-model ANOVA revealed a significant main effect of emotional reaction,  $F(1,130) = 36.82, p < .001, \eta^2_p = .221, 95\% \text{ CI } [.123, 1.000]$ , with higher scores for the brand paired with appreciation ( $M = 0.26, SD = 0.52$ ) than for the brand paired with disgust ( $M = -0.15, SD = 0.55$ ), supporting H1. The main effect of biscuit type was not significant,  $F(1,130) = 0.53, p = .466, \eta^2_p = .004, 95\% \text{ CI } [.000, 1.000]$ , suggesting that insect ingredients did not influence automatic reactions. The reaction X biscuit type interaction was also non-significant,  $F(1,130) = 0.65, p = .421, \eta^2_p = .005, 95\% \text{ CI } [.000, 1.000]$ , indicating that emotional reaction effect on BIAT scores was similar for regular and insect-containing biscuits, contrary to H2.

Despite the non-significant interaction, preregistered paired-sample t-tests were conducted for each biscuit type to test hypotheses H3 and H4. BIAT scores were higher for the brand paired with appreciation than for the brand paired with disgust for both regular (H3) and insect-containing biscuits (H4). Table 2 reports the means, standard deviations, and t-test results by biscuit type and reaction.

For intention scores, the mixed-model ANOVA revealed a significant main effect of emotional reaction,  $F(1,130) = 99.35, p < .001, \eta^2_p = .433, 95\% \text{ CI } [.333, 1.000]$ , confirming H1. Participants reported greater intention to buy and consume biscuits paired with appreciation ( $M = 3.35, SD = 0.90$ ) than with disgust ( $M = 2.46, SD = 0.92$ ). Although the overall intention scores (calculated as the difference between positive- and negative-paired biscuits) were higher for regular biscuits ( $M = 0.96, SD = 1.02$ ) than for insect-containing biscuits ( $M = 0.81, SD = 1.02$ ), the main effect of biscuit type did not reach the preregistered significance level of  $p < .025$ ;  $F(1,130) = 4.15, p = .044, \eta^2_p = .031, 95\% \text{ CI } [.000, 1.000]$ . The interaction between reaction and biscuit type was not significant,  $F(1, 130) = 0.80, p = .373,$

$\eta^2p = .006$ , 95% CI [.000, 1.000], indicating that the OEC effect did not differ between biscuit types, and H2 was not supported.

Following preregistration, we tested H3 and H4 using paired-sample t-tests for each biscuit type. Consistent with prediction, the emotional reaction significantly influenced both conditions, with higher intention score for the brand paired with appreciation than with disgust. Table 10 presents the means, standard deviations, and t-test results by biscuit type and reaction.

**Table 10.** P4. Mean BIAT and intention scores (SDs in parentheses) by biscuit type and model's emotional reaction

	Positive reaction	Negative reaction	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
<i>Regular biscuits (n = 68)</i>					
BIAT	0.21 (0.56)	-0.15 (0.55)	3.52	< .001	0.43 [0.18, .067]
Intentions	3.52 (0.70)	2.55 (0.91)	7.77	<.001	0.94 [0.65, 1.23]
<i>Biscuits with insects (n = 64)</i>					
BIAT	0.31 (0.47)	-0.15 (0.56)	5.24	< .001	0.65 [0.38, 0.92]
Intentions	3.17 (1.04)	2.37 (0.93)	6.34	< .001	0.79 [0.51, 1.07]

*Note.* Values in brackets represent 95% confidence intervals.

### Ancillary analyses

Significant correlations emerged between disgust and interest toward insect-based food, and self-reported intention to buy and eat it. Because these correlations were observed for both the regular and insect-containing food conditions, we compared them across scenarios using z-tests for independent correlations. The correlation between disgust and intention to buy the appreciated food (Table 1) differed significantly between conditions,  $Z = 2.34, p = .019$ , as did the correlation between disgust toward insect food and intention to buy the food associated with a disgusted reaction,  $Z = 2.67, p = .008$ . In contrast, correlations involving interest – both with intention to buy the appreciated food and the food associated with disgust – did not differ between conditions,  $Z = 0.88, p = .377$  and  $Z = 1.48, p = .138$ , respectively.

Next, we examined whether participants' disgust and interest were related to the OEC effect. Differential BIAT and intention scores were computed as the difference between the positively and negatively paired biscuits, with higher values indicating a stronger OEC effect. These differential scores were uncorrelated with disgust and interest ratings (Table 11), suggesting that general disgust or interest toward insect-containing foods did not influence the OEC effect.

**Table 11.** P4. Experiment 1. Pearson's correlations between the OEC effect and disgust/interest ratings

	Differential BIAT	Differential intention
<i>Regular biscuits</i>		
Disgust	-.03 [-.27, .21]	-.11 [-.34, .13]
Interest	-.01 [-.23, .25]	.09 [-.16, .32]
<i>Insect-containing biscuits</i>		

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Disgust	-05 [-.13, .22]	-0.22 <sup>†</sup> [-.38, -.05]
Interest	.03 [-.20, .15]	.12 [-.06, .28]

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*Note.* Values in brackets represent 95% confidence intervals. <sup>†</sup>p < .10, \* p < .05, \*\* p < .01, \*\*\* p < .001

## Discussion

Study 1 demonstrated that the OEC manipulation effectively shaped both attitudes (BIAT) and intentions toward biscuits. Participants consistently preferred the brand paired with appreciation over the brand paired with disgust, for both traditional biscuits (replicating Kasran et al., 2023) and novel insect-containing biscuits (extending prior findings). The effect was robust across food types and was independent of participants' general disgust or interest in insect-based foods.

Participants reporting stronger disgust toward insect ingredients showed lower purchase intentions to insect-containing biscuits, regardless of the model's reaction. Conversely, participants with higher interest in insect-based foods exhibited higher purchase intentions across both model pairings. These patterns align with the view that disgust functions as an aversive motivational signal promoting avoidance, whereas interest reflects approach motivation and curiosity toward novel foods (Piqueras-Fiszman et al., 2014; Stone et al., 2022). Importantly, differential OEC scores – reflecting the relative influence of the model's affective reaction – were uncorrelated with participants' self-reported disgust or interest, suggesting that general attitudes toward insect foods do not determine the magnitude of the social learning effect.

Participants' disgust toward insect-based foods, as measured by the EAQ, was negatively associated with their purchase intention even for regular biscuits. Although the EAQ

specifically assesses reactions to insect-based foods, these can be related to a broader, trait-level disgust propensity: Individuals high in this propensity are generally more sensitive to potential contamination, more prone to food neophobia and selective eating (Brown et al., 2022; Egolf et al., 2018). Notably, the regular biscuit brands in this experiment were unfamiliar to participants, potentially eliciting cautious responses from individuals high in disgust sensitivity. This association supports prior findings that higher food-disgust sensitivity predicts selective eating, lower variety seeking, and avoidance of unfamiliar foods (Brown et al., 2022). Notably, the effect was stronger for insect-based biscuits, indicating that negative reactions were particularly relevant when insect ingredients were present. Crucially, neither disgust nor interest predicted the magnitude of the OEC effect, suggesting that social learning operated independently of preexisting disgust. The disgust measure was collected at the end of the experiment to avoid interfering with the manipulation; results should therefore be interpreted with caution.

## Experiment 2

Experiment 2 examined whether OEC+ (observing a model eating the biscuit followed by a positive reaction) and VC (merely observing a model eating the biscuit) can shift preferences when the brands belong to separate categories that are evaluated differently. Specifically, we always compared attitudes towards an insect-based biscuit brand with attitudes towards a traditional biscuit (an inter-category comparison). For the traditional biscuit, the video merely showed a model holding the product. For the insect-based biscuit, we varied between participants whether the video showed the model holding the product (baseline), holding the product and eating the biscuit (VC), or holding the product, eating the biscuit and

showing a positive reaction (OEC+). This allowed us to assess whether VC and OEC+ improved the attitude toward the insect-based biscuit relative to the attitude toward traditional biscuit.

This design represents a critical modification to Experiment 1, where the two brands belonged to the same category (either traditional biscuits, or biscuits with insects, manipulated between participants). Unlike the intra-category comparison of Experiment 1, where no prior preference existed between the two unknown brands, the current experiment requires the manipulation to act against a pre-existing cultural aversion to insect-based food. Modifying an existing negative reaction is inherently more challenging than merely creating a new preference (Albarracin & Shaiyvit, 2018).

## Method

### Participants and design

Three hundred sixteen participants (122 women, 190 men, three non-binary individuals, and one who preferred not to answer;  $M_{age} = 30.43$  years,  $SD = 7.45$ ) took part in the study. They were recruited via Prolific (<https://www.prolific.com/>) with the following inclusion criteria: age 18-45 and native Italian speakers, with a Prolific approval rate of at least 95%. These criteria were based on evidence that both age and cultural background influence acceptance of novel foods, including insect-based products (Laureati et al., 2024). This is particularly relevant in the present study, as we are comparing preferences across different food categories, unlike Experiment 1, which compared brands within the same category. Participants were compensated at the standard Prolific rate (£9 / \$12 per hour).

The number of participants was determined based on resource constraints, with a target sample of approximately 288 participants, as indicated by a sensitivity power analysis

described below. To account for expected exclusions (see Results), we slightly increased the sample size to  $N = 310$ . Sensitivity power analyses were conducted using G\*Power (Faul et al., 2007). With a significance level of  $\alpha = .025$  (adjusted via Bonferroni correction for the two main dependent variables), a sample of 288 provides power  $(1-\beta) = .90$  to detect an effect size of  $f = 0.23$  and power  $(1-\beta) = .95$  to detect an effect size of  $f = 0.25$  in a between-participants ANOVA with one factor with three levels. For post hoc comparisons among the three conditions, considering Bonferroni correction ( $\alpha = .05/6 = .008$ ) and directional hypotheses, this sample yields a sensitivity of Cohen's  $d = 0.54$  with power  $(1-\beta) = .90$  and Cohen's  $d = 0.59$  with provides power  $(1-\beta) = .95$ , indicating sufficient power to detect medium-to-large effects. We considered this level of sensitivity appropriate for the study's objectives.

The experiment employed a between-subjects, single-factor design with three conditions: baseline, VC, and OEC+). Participants were randomly assigned to each condition (111 baseline, 98 VC, 107 OEC+). Attitudes toward insect-based versus regular food were measured using two dependent variables: a semantic differential scale and an IAT score.

## **Materials**

### ***Target products***

The target products were the same biscuit brands as those in Experiment 1. In this study, Darivo was presented as an insect-based brand, and Medeva as a traditional biscuit brand.

### ***Videos***

The videos used in Experiment 1 were adapted for Experiment 2. For Medeva, the video showed the product packaging and the model presenting the biscuit, without any mention of insect ingredients. For Darivo, the video showed the packaging indicating the presence of insect

derivatives and included the same initial part where the model showed the product. In the baseline condition, the video ended after the model displayed the package; in the VC condition, it ended after the model tasted the biscuit; in the OEC+ condition, the whole video was shown, as in Experiment 1.

### ***Implicit Association Test***

We assessed automatic reactions using the Implicit Association Test (IAT; Greenwald et al., 1998), to capture relative preferences between the two brands. We used the *iatgen* implementation in Qualtrics (Carpenter et al., 2019). The two biscuit brands served as target categories, with the same images and taste-related adjectives used in Experiment 1. IAT D scores were computed using the built-in penalty procedure, following Greenwald, Nosek, and Banaji (2003). Positive scores indicate a preference for the insect-based brand, while negative scores indicate a preference for the regular brand; larger absolute values reflect a stronger preference. The reliability was good (Cronbach's  $\alpha = .87$ ).

### ***Semantic differentials***

We assessed self-reported attitudes as in Experiment 1. Scores were computed as the difference between the average ratings for the insect-based and regular biscuit brands, so that, analogous to the IAT scores, positive values indicated a preference for the insect-based brand and negative values indicated a preference for the regular brand. The reliability was excellent (Cronbach's  $\alpha = .94$ ).

### ***Disgust and interest toward eating insects***

They were measured as in Experiment 1. As the correlation between the Interest and Disgust subscales was strongly negative,  $r = -.83$ ,  $p < .001$ , indicating that higher disgust was associated with lower interest scores, following the preregistration, we computed an aggregated measure by averaging all the items, after reverse-coding interest items. Therefore, high values

indicate a high level of disgust and a low level of interest toward food with insects. This aggregated measure demonstrated excellent reliability (Cronbach's  $\alpha = .95$ ).

### ***Manipulation check***

Participants assigned to the VC condition were asked what the model did with the Darivo biscuits by selecting one of three options: “I don’t know”, “He did not do anything”, or “He ate them”. In the OEC+ condition they were asked what the model did after eating the Darivo biscuits by selecting one of four options: “Satisfied”, “Disgusted”, “None”, “I don’t remember”. No manipulation check questions were asked to participants in the baseline condition.

### ***Knowledge of brands and SRSI***

These were measured using the same procedures as in Experiment 1.

### ***Compliance with demand characteristics***

Participants indicated the extent to which they adapted their responses to meet our expectations on a scale from 1 (*Not at all*) to 5 (*A lot*).

### ***Demographic questions***

Participants reported their age, gender, proficiency in Italian, prior experience with insect-based food, and meat consumption. Meat consumption was assessed with the question “Do your eating habits include meat (e.g., steaks, cold cuts) and/or foods that contain meat (e.g., pasta with bolognese sauce)?” with response options “Yes” or “No”.

### ***Food Choice Questionnaire – sensory appeal subscale (FCQ; Steptoe et al., 1995)***

For exploratory purposes, participants completed the four-item Sensory Appeal subscale, which assesses the importance of smell, taste, texture, and appearance in food. Responses were rated on a 5-point scale from 1 (*Not at all important*) to 5 (*Very important*). Correlations among the items were low (.09 to .33), and the scale overall reliability was poor

( $\alpha = .39$ ), so it was excluded from further analysis. Importantly, no preregistered analyses involved this scale.

## **Procedure**

After providing informed consent, participants completed the Disgust and Interest and Sensory Appeal scales. They were then shown a photo of the two biscuit brands, Medeva and Darivo, with text noting that the ingredients were nearly identical except that Darivo contained insect derivatives.

Participants then viewed two videos, each repeated three times for a total of six presentations, with order randomized between participants. The Medeva video was identical for all participants, showing only the model presenting the brand. The Darivo video varied between participants according to condition (baseline, VC, OEC+), as described above. Following the videos, participants in the VC and OEC+ conditions completed the manipulation check, with incorrect responses triggering a replay up to 2 times.

Finally, participants completed the IAT and semantic differentials in counterbalanced order, followed by questions on brand knowledge, demographics, compliance with demand characteristics, and the SRSI.

## **Hypotheses**

We formulated three directional hypotheses:

H1: OEC+ would enhance preference for insect-containing food compared to baseline.

H2: VC would enhance preference for insect-containing food compared to baseline.

H3: OEC+ would produce a stronger effect than VC, resulting in more positive attitudes towards insect-based foods.

## Results

All statistical analyses were performed in R. In addition to the packages used in the first study, the following R packages were employed: readxl (Wickham & Bryan, 2025), openxlsx (Schauberger & Walker, 2025), lme4 (Bates et al., 2015), rstatix (Kassambara, 2023), Hmisc (Harrell Jr, 2024), and insight (Lüdtke, Waggoner & Makowski, 2019).

### Preliminary analyses

Following the preregistration, participants were excluded for the following reasons: negative response to the SRSI “use me” question ( $n = 2$ ), excessive number of incorrect responses in the IAT task ( $>25\%$ ;  $n = 16$ ), not eating meat ( $n = 5$ ), or prior knowledge of Darivo ( $n = 2$ ). The final sample consisted of 90 participants in the baseline group, 101 in the VC group, and 100 in the OEC+ group. The main descriptive statistics and Pearson’s correlations between the variables are reported in Table 12. As shown in Table 13, semantic differential scores vary across conditions, whereas IAT scores are near zero and similar across all conditions.

**Table 12.** P4. Experiment 2: descriptive statistics and correlations among measures

	M	SD	Min	Max	Correlations		
					1.	2.	3.
<b>1. IAT</b>	-0.08	0.48	-1.15	1.11			
	-0.62	1.11	-4.00	4.00	.33***		
					[.23,		
<b>2. Semantic Differential</b>					.43]		
	2.87	1.03	1.00	5.00	-.31***	-	
					[-.41, -	.57***	
<b>3. Disgust-interest composite</b>					.20]	[-.64, -	.49]

Note. Values in brackets represent 95% confidence intervals. †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 13.** P4. Experiment 2: mean IAT and semantic differential scores (SDs in parentheses) by experimental condition

	IAT	Semantic Differential
Baseline	-0.10 (0.48)	-0.92 (1.16)
VC	-0.07 (0.48)	-0.47 (0.83)
OEC+	-0.08 (0.47)	-0.42 (1.21)

### Preregistered analyses

Two parallel ANCOVAs were conducted on IAT and Semantic Differential scores, with experimental condition as the independent variable and the disgust-interest score as a covariate.

The ANCOVA on the Semantic Differential showed a significant effect of condition,  $F(2,289) = 8.948, p < .001, \eta^2_p = .059, 95\% \text{ CI } [.020, 1.000]$ , with a significant effect of the covariate,  $F(1,287) = 138.890, p < .001, \eta^2_p = .326, 95\% \text{ CI } [.256, 1.000]$ . Inspection of the regression coefficients indicated that higher disgust-interest scores were associated with lower preference for the insect-containing biscuits,  $\beta = -0.605, p < .001$ , consistent with the expected direction of the covariate. Consistent with preregistered hypotheses, one-tailed t-tests for independent samples indicated that both OEC+ (H1) and VC (H2) increased preference for the insect-containing biscuits relative to baseline and both strategies led to a substantial reduction of the preference for the regular biscuit brand compared to the baseline, diminishing it by almost half a standard deviation (see Table 14). However, OEC+ did not outperform VC (H3), as the difference between the two strategies was negligible and non-significant.

**Table 14.** P4. Experiment 2: One-tailed independent sample t-tests comparing semantic differential scores across experimental conditions

	<i>t</i>	<i>df</i>	<i>p</i>	<i>Cohen's d</i>
Baseline	3.110	181.17	.001	0.447
vs. VC				[0.161, 0.731]
Baseline	2.867	199	.002	0.404
vs. OEC+				[0.125, 0.683]
VC vs.	0.191	188	.424	0.028 [-
OEC+				0.257, 0.313]

*Note.* For the Baseline vs. VC comparison, the Welch test was computed due to heteroskedasticity. Values in brackets represent 95% confidence intervals.

For the IAT, the ANCOVA revealed no significant effect of condition,  $F(2,287) = 0.154$ ,  $p = .858$ ,  $\eta^2_p < .001$ , 95% CI [.000, 1.000], while the disgust-interest covariate was significant,  $F(1,287) = 29.842$ ,  $p < .001$ ,  $\eta^2_p = .094$ , 95% CI [.047, 1.000]. The direction of the relationship between the covariate and the preference for insect food was negative, as expected,  $\beta = -0.143$ ,  $p < .001$ . Following the preregistration of specific hypotheses, one-sided t-tests were conducted to examine differences between conditions in the IAT. The results indicate that none of our hypotheses were supported, for all t-tests  $|t| < 0.51$ ,  $p > .30$ .

### Ancillary analyses

Two ancillary ANCOVAs were conducted to test whether disgust-interest moderated the effect of the experimental manipulation on both implicit (IAT) and explicit (Semantic Differential) evaluations of the insect-based biscuits. In the analysis of IAT scores, neither the main effect of condition,  $F(2,285) = 0.154$ ,  $p = .857$ ,  $\eta^2_p = .001$ , 95% CI [.000, 1.000] nor the

condition  $\times$  disgust-interest interaction,  $F(2,285) = 1.112$ ,  $p = .330$ ,  $\eta^2_p = .008$ , 95% CI [.000, 1.000], was statistically significant. The main effect of the covariate remained significant,  $F(1,285) = 29.865$ ,  $p < .001$ ,  $\eta^2_p = .095$ , 95% CI [.048, 1.000].

The ANCOVA on Semantic Differential ratings replicated the significant main effects of both the conditions,  $F(2,285) = 9.069$ ,  $p < .001$ ,  $\eta^2_p = .060$ , 95% CI [.020, 1.000], and disgust-interest,  $F(1,285) = 140.766$ ,  $p < .001$ ,  $\eta^2_p = .331$ , 95% CI [.260, 1.000]. The condition  $\times$  disgust-interest interaction did not reach statistical significance,  $F(2,285) = 2.940$ ,  $p = .054$ ,  $\eta^2_p = .020$ , 95% CI [.000, 1.000].

### Discussion

The OEC and VC procedures influenced self-reported preferences, even when the two target foods belonged to categories that differed substantially in their consumers' acceptance. Exposure to the social-learning videos substantially reduced the magnitude of the preference for the traditional food, although it did not eliminate it. The effect was comparable for OEC and VC, indicating that adding further positive emotive reactions did not enhance the impact of witnessing food consumption. In contrast, no significant changes emerged for spontaneous preferences. Consistent with Experiment 1, disgust toward insect food was negatively associated with preferences for insect-containing foods across both outcome measures. Higher disgust predicted lower preferences on both the IAT and the semantic differential, and, as before, it did not significantly moderate the effect of the social learning manipulation.

### General Discussion

This research investigated whether two social learning procedures, OEC and VC, could be effective for promoting acceptance of insect-based foods, a category that often elicits cultural aversion among Western consumers. We found that these learning procedures

influenced participants' reactions not only to regular foods, but also to those containing insect derivatives, particularly with respect to self-report measures.

### **Differences between experiments and implications for interpretation**

In Experiment 1, effects were observed both in direct (self-report) and indirect measures, whereas in Experiment 2, effects were limited to direct measures. A theoretically relevant distinction between the two experiments concerns the type of social learning manipulation. In Experiment 1, participants observed both positive (appreciation) and negative (disgust) reactions to the foods, whereas in Experiment 2, the strategies focused only on improving attitudes by showing positive or neutral reactions. Observing negative reactions may exert a stronger influence than observing positive reactions, consistent with the negativity bias (Baumeister et al., 2001; van den Bosch et al., 2015), which may explain why the effects in Experiment 1 were more robust and detectable across measures. Another potentially relevant difference between the two experiments is that the manipulation in Experiment 1 may have created a much more pronounced contrast between the two brands: One brand was paired with a clearly positive social signal, the other with a clearly negative one. In Experiment 2, by contrast, one brand was accompanied with the positive social signal and the other with a neutral presentation. The contrast context of Experiment 1 may have amplified the impact of the manipulation (Bar-Anan & Dahan, 2013).

Finally, the learning contexts differed. In Experiment 1, participants formed preferences between two novel brands within the same product category, creating a context conducive to attitude formation, as there were no strong preexisting preferences. In Experiment 2, participants compared a novel insect-containing brand with a novel non-insect brand. Although both brands were unfamiliar, the difference in ingredients likely activated preexisting

attitudes toward insect-based foods, placing participants in a context of attitude change. Because existing attitudes are more resistant to change (Albarracin & Shaivitt, 2018; Moran et al., 2025), this difference in context may be part of the explanation of why the effects observed in Experiment 1 were more robust and evident across both measures, whereas in Experiment 2 they emerged only in self-reports.

### **Interpreting the lack of differences between OEC+ and VC**

Unexpectedly, in Experiment 2 we found no differences between the effects of OEC+ and VC. This result suggests that merely observing a model consume the food may already convey positive information, rendering additional positive signals redundant. From the propositional perspective, the model's eating signals that the food is safe, palatable, or socially acceptable, so that the model's additional positive reaction adds little new information. Similarly, from an associative perspective, both OEC+ and VC procedures paired the insect-containing food with the eating behavior, which is evaluated positively (Zogmaister, Brignoli, et al., 2023) and, therefore, serves as a positive unconditioned stimulus; in this context, any additional emotional reaction by the model may provide little extra reinforcement. However, a single study is not sufficient to rule out the possibility of differences between OEC+ and VC. The key takeaway from this study is that both procedures are effective in producing improvements in attitudes toward the target food.

### **No impact of disgust toward insect food on the size of attitude change**

Across both studies, self-reported disgust toward insect-containing foods consistently predicted more negative evaluations of these products, confirming the robustness of this association. At the same time, disgust was not significantly associated with the effect of the social learning manipulations in either study. This effect, together with the absence of

interactions between the manipulation and the type of food in Experiment 1, indicates that the observed attitude change operated relatively independently of pre-existing affective dispositions. Nevertheless, the absence of a significant interaction should be interpreted cautiously. Failing to detect an effect does not constitute evidence of its absence. Future studies, perhaps with a more fine-grained assessment of disgust (e.g., a scale measuring specifically disgust for foods containing insect derivatives), may help clarify whether and under what conditions disgust attenuates or amplifies the impact of social learning on attitudes toward insect-based foods.

Interestingly, this absence of moderation by disgust contrasts with evidence that appetitive motivational states such as hunger and thirst can amplify the effects of approach–avoidance training on implicit preferences: Zogmaister and colleagues (2016) have found that deprivation-related states strengthen the formation of implicit preferences following repeated approach/avoidance behaviors, whereas moderation was weaker or absent for explicit evaluations. The present findings suggest that different motivational and affective states may play qualitatively distinct roles in shaping evaluative learning. Whereas homeostatic drives such as hunger directly enhance approach-related learning, disgust—despite being robustly associated with negative evaluations—does not appear to attenuate the impact of observational social information. It is, however, important to notice the presence of important differences between learning driven by one’s own actions, as in Zogmaister et al.’s (2016) studies, and learning from observing others’ behavior, as in the present research. Accordingly, our results suggest new research directions that explore both the distinction between first-person and vicarious experiences and the influence of different types of motivational states on social learning.

## **Practical implications**

The present findings offer several practical insights beyond the general conclusion that OEC+ and VC increase acceptance of insect-based foods. First, the observed social learning effects were elicited through very brief video stimuli (approximately 15 seconds), highlighting the scalability of this approach. Such short-format content is particularly well-suited for dissemination via social media, online advertising, or public awareness campaigns, enabling a broad reach at a relatively low cost. Its brevity also facilitates repeated exposure and seamless integration into everyday media consumption, potentially enhancing cumulative impact.

Second, the applicability of these strategies is not limited to insect-based products. The underlying mechanism of observational social learning can be plausibly extended to a wide range of novel, unfamiliar, or culturally stigmatized foods, including under-consumed vegetables and emerging protein alternatives, such as plant-based or cultured meat products. From both a public health and a sustainability perspective, this suggests a flexible, low-cost approach for promoting more diverse and environmentally sustainable dietary patterns.

Recent findings by Kasran and colleagues (2022, 2023; see also Zogmaister, Vezzoli, et al., 2023) highlight that the effectiveness of observational learning depends on the perceived authenticity of the model's reaction. To ensure observers draw the intended inferences (e.g., that the food is safe, palatable, or socially acceptable), the model must be perceived as credible and sincere. Campaigns should therefore prioritize socially relevant and trustworthy models, and design scenarios that actively engage viewers' attention and inferential processing rather than relying on passive exposure.

Finally, observational strategies can be integrated into educational and training contexts, such as schools or community-based programs that promote healthy eating. Showing not only factual information but also the act of consumption and, when appropriate, the associated emotional response, may foster more positive and informed attitudes toward unfamiliar or initially aversive foods.

### **Limitations and emerging questions**

All participants were Italian, a population with strong culinary traditions and low baseline acceptance of insect-based foods (Arena et al., 2020; Verneau et al., 2016; 2020). While this may have influenced initial attitudes, it also underscores the robustness of the observed social learning effects: Even in a culturally resistant context, both OEC+ and VC increased acceptance of the target foods. The focus on insect-based foods also limits generalizability, since Western consumers' aversion often reflects cultural unfamiliarity rather than sensory properties. Similar initial aversions are observed for other novel or culturally uncommon foods, such as organ meats or emerging protein sources, including cultured meat (Laureati et al., 2024). Further research in different populations and with different foods is needed to confirm the scope and boundary conditions of these social learning strategies. Additionally, this research investigated taste-related aspects of the food evaluations, and future studies could examine whether these interventions also influence other product perceptions, such as perceived healthiness, usefulness, or sustainability. Future lines of research should also investigate the impact of these procedures on open behavior (e.g., actual consumption of these foods) beyond attitudinal or intention measures.

Another limitation concerns the absence of implicit effects in Study 2. Although the manipulation was strong enough to create explicit preferences between two insect-based

brands, a single modeling episode may have been insufficient to influence automatic reactions. Future studies could examine whether repeated, temporally spaced exposures strengthen the impact of the manipulations, potentially revealing effects on more spontaneous behavioral responses.

Overall, while a single contribution cannot answer all questions about the effectiveness and boundary conditions of observational social learning, the present work provides evidence for these mechanisms in a challenging context and highlights multiple promising directions for future research. Far from being a limitation, the open questions uncovered here represent a strength, pointing to rich avenues for extending our understanding of how social learning shapes attitudes toward novel or culturally unfamiliar foods.



## Project 5: A Goal-Directed Approach to Promoting Insect-Based Foods through Shared Features<sup>5</sup>

### Abstract

Consumers often evaluate unfamiliar foods based on their similarity to familiar products. Drawing on the Shared Features Principle and the Goal-Directed Perspective, we tested whether sharing a perceptual feature with a familiar food can transfer goal-relevant attributes (taste or health) to an unfamiliar target food, thereby influencing its perceived utility for consumption.

Across two preregistered within-subject experiments (total  $N = 341$ ), participants completed a learning task in which two target foods shared a coloured frame with either a tasty or a healthy source food. Experiment 1 employed unfamiliar, neutral food items, whereas Experiment 2 used insect-based foods. Following the learning phase, participants' evaluations were assessed using goal-specific semantic differentials, behavioural intention scales, and a Brief Implicit Association Test (BIAT). In both experiments, participants attributed greater expected utility (assessed via direct and indirect measures) to target foods paired with goal-relevant sources. These findings suggest that interventions combining SFP and GDP can alter the perceived utility of foods in serving taste- or health-related goals, even for products that may elicit negative reactions. By integrating SFP with GDP, this research provides a novel framework for promoting sustainable eating through scalable and non-invasive interventions.

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## Introduction

Low consumer acceptance of insect-based foods (Modlinska et al., 2021; Kröger et al., 2022; Pacholek et al., 2025) underscores the need to identify novel, theoretically informed approaches to facilitate their integration into mainstream diets. One promising direction is to leverage mechanisms that shape how individuals evaluate and respond to unfamiliar foods.

The Shared Features Principle (SFP; Hughes, De Houwer, Mattavelli, & Hussey, 2020), posits that when individuals learn that two stimuli share one attribute, they assume that the stimuli also share other attributes. For instance, when encountering a new fruit that resembles a familiar one in shape or color, an individual might infer that it also has a similar taste. So, when encountering new stimuli, individuals may rely on their knowledge of other known stimuli with similar features to generate inferences. While the SFP explains how individuals make inferences about unfamiliar stimuli through feature transfer, it does not elucidate how such inferences translate into behavior. To address this gap, we draw on the Goal-Directed Perspective (GDP; Moors et al., 2017), which accounts for how behavior is guided by the perceived utility of achieving specific goals. Together, these perspectives help elucidate how feature-based inferences may influence goal-relevant behavior.

Building on this theoretical foundation, this work introduces an intervention grounded in the SFP and the GDP and empirically tests its effectiveness. Specifically, we present two experiments that use shared features to transfer goal-relevant features (e.g., taste, health) to both conventional and insect-based foods, with the aim of increasing their perceived utility for consumption, shaping evaluations, and influencing purchasing and consumption intentions.

### **Insect-based food, a promising alternative**

A high-quality diet plays a crucial role in reducing premature death and disability worldwide. Higher consumption of whole grains, vegetables, fruits, nuts, and fish has been consistently associated with a lower risk of all-cause mortality (Schwingshackl et al., 2017). In contrast, extensive research from large U.S. (Pan et al., 2012) and European (Rohrmann et al., 2013) cohort studies demonstrates a positive association between the intake of red and processed meats and an increased risk of all-cause mortality. Beyond health-related concerns, food production is a major driver of global environmental change (Serra-Majem et al., 2020). Livestock farming alone contributes 18% of GHG emissions (CO<sub>2</sub>-equivalent), a higher share than the transport sector (FAO, 2013), and accounts for a large proportion of land and water use (Aleksandrowicz et al., 2016).

In this context, identifying dietary alternatives that are both health-promoting and environmentally sustainable has become a key research and policy priority. One healthy and sustainable alternative to traditional meat is insect-based food (Mancini et al., 2019; Batat et al., 2020). Indeed, insect-based foods hold high nutritional value and provide a viable alternative source of protein, vitamins, and essential micronutrients (Batat et al., 2020; Oonincx & Finke, 2021). Notably, insect farming also offers several environmental benefits, such as drastically lower greenhouse gas emissions and reduced water and land usage compared to conventional livestock farming (“Looking at Edible Insects from a Food Safety Perspective,” 2021). Despite these advantages, the successful integration of insect-based foods into mainstream diets hinges on people’s attitudes and reactions toward them. Insect-based foods often evoke negative emotions such as disgust (Alhujaili et al., 2013; Kroger et al, 2022), and consumers from Western countries generally show aversion to insects as food (Castro & Chambers, 2019; Ribeiro et al., 2024).

Different approaches have been tested to improve responses to insect-based foods, including modifications to packaging such as reducing realistic insect imagery or adding nutritional claims (Pozharliev et al., 2023; Pascucci & Magistris, 2013), celebrity endorsements (Park et al., 2022), and educational or experiential interventions such as information sessions and tastings (Sogari et al., 2017; Szczepanski et al., 2022), persuasive messaging (Verneau et al., 2016), writing exercises (Stone et al., 2023), and social norm or positive information cues (Suzuki & Park, 2018; Bao & Song, 2022).

Taken together, existing interventions highlight both the potential and the limitations of current approaches to promoting insect-based foods. Crucially, strategies that rely primarily on providing positive information have not always proven effective (Arena et al., 2020). Moreover, many of these interventions are not easily scalable to broader audiences, as they require considerable time investment and sustained attention from individuals to achieve meaningful effects (for example, in the case of seminars or in-person tasting sessions). On the other hand, interventions that operate through visual or contextual cues seem promising (Puteri et al., 2023). These considerations point to the value of exploring alternative strategies that do not depend exclusively on explicit persuasion or extended cognitive engagement. Instead, it may be possible to influence food-related evaluations through more minimal and readily scalable interventions that operate via contextual cues. The Shared Features Principle offers a theoretical framework for such an approach.

### **The Shared Feature effect**

Hughes et al. (2020) propose that a variety of well-documented phenomena across psychology fields (the minimal group effect, Tajfel, Billig, Bundy, & Flament, 1971; the mere

proximity effect, Hebl & Mannix, 2003; the halo effect, Gräf & Unkelbach, 2016; the false memories, Roediger & McDermott, 1995) are instances of the SFP, as are certain learning effects.

One such learning effect is Evaluative Conditioning, defined as a change in the liking of a stimulus (conditioned stimulus, CS) that results from pairing it with another stimulus (unconditioned stimulus, US; De Houwer et al., 2001). Evaluative conditioning has been extensively applied across various domains to influence individuals' evaluations of attitudinal objects (De Houwer et al., 2001; Moran et al., 2023). Besides valence, stimulus pairings have been shown to influence attributes of stimuli (i.e., attribute conditioning, Förderer & Unkelbach, 2011). Within the SFP framework, evaluative and attribute conditioning effects can be understood as arising from CSs and USs sharing a special set of features, namely, their spatial and temporal contiguity. This spatiotemporal contiguity may lead individuals to infer that the CS and US are similar in other respects as well, such as valence (evaluative conditioning) or attributes (attribute conditioning). In other words, the spatiotemporal contiguity typical of evaluative and attribute conditioning procedures would be one possible way to elicit a shared features (SF) effect.

For example, a plant-based meat alternative that closely resembles a conventional beef burger in shape, colour, texture, and packaging style may elicit a SF effect. As a result, consumers may infer that the plant-based product shares additional characteristics with the conventional burger beyond its observable features. These inferences may encompass expected taste, satiety, nutritional properties (e.g., protein content), or suitability for similar consumption occasions. In this way, perceptual shared features may serve as a basis for broader attribute transfer, also shaping behavioral intention accordingly. Importantly, research on insect-based foods suggests that product format plays a critical role in consumer acceptance. Products that

resemble familiar food formats (e.g., processed or incorporated forms rather than whole visible insects) tend to be evaluated more positively in Western contexts (e.g., Kröger et al., 2022; Pozharliev et al., 2023; Puteri et al., 2023). Although these findings have not been interpreted within a Shared Features framework before, they are consistent with the idea that perceptual similarity to familiar foods may influence inferred attributes and acceptance.

Shared features need not be limited to intrinsic product characteristics. According to the SFP, spatiotemporal proximity itself may function as a shared feature. For example, an unfamiliar food product placed on the same supermarket shelf as established “healthy” products may be inferred to share health-related properties, simply by virtue of its co-location. In such cases, spatial proximity operates as a shared contextual feature that can guide inferences about less directly observable attributes. Consistent with this idea, the literature on insect-based food has highlighted the importance of product placement, suggesting that insect-based burgers be positioned in vegetarian or meat-alternative aisles rather than in separate sections (House, 2016).

### **Driving goals via Shared Features**

According to the GDP (Moors et al., 2017), individuals select the behavior they perceive as most effective for achieving a specific goal. This selection is based on the behavior’s expected utility, that is, the behavior’s perceived effectiveness in reducing the gap between their current condition (e.g., what they are doing or experiencing now) and their desired end state (e.g., the outcome they aim to reach). For example, if a person’s goal is to follow a diet with low environmental impact, eating a salad may be associated with higher expected utility than eating a hamburger, as it is perceived to better support the environmental

goal. Once the behavior with the highest expected utility is identified, an associated action tendency is triggered. This tendency may ultimately lead to the enactment of the behavior itself.

Hence, the GDP emphasizes that actions towards stimuli are evaluated in terms of their appropriateness for goal attainment. To influence food-related behavior, it may therefore be necessary to shape perceptions of how well a given product serves particular goals. Among different possible food-related goals, we built on the work of Sobal & Bisogni (2009) and decided to focus on taste and health as central drivers of eating behavior, also due to their relevance among different influential studies (see Glanz et al., 1998; Eertmans et al., 2001; Lusk et al., 2009). Therefore, the present work examines whether the SFP can be used to modify such goal-relevant evaluations. Specifically, we test whether associating food stimuli with taste- or health-related features via shared visual cues alters their perceived tastiness and healthfulness, and consequently their expected utility for consumption.

### **The present research**

We propose a learning paradigm based on the SFP and informed by the GDP, in which we use tasty and healthy foods as source stimuli to modify the features associated with novel foods. We theorized that a novel food would be perceived as healthy when it shares a feature with a familiar healthy food and as tasty when it shares a feature with a familiar tasty food.

To test this, we present two experimental studies that share the same design but differ in the type of target foods employed: Experiment 1 uses neutral, nondescript foods, while Experiment 2 focuses on insect-based foods. This two-step approach serves a specific purpose. In Experiment 1, we test whether the SF principle can effectively influence the perceived utility of food items by associating them with goal-relevant attributes (tastiness or healthiness). Using

neutral foods allows us to establish a baseline and isolate the effect of the SF intervention without the interference of strong pre-existing evaluations. After validating the mechanism in this more controlled context, we move to Experiment 2, where we apply the same strategy to insect-based foods, a category often met with resistance or ambivalence.

This research extends previous studies on the SF effect by exploring its impact on the perceived utility of food, a domain with significant implications for consumer behavior and public health. While prior studies have investigated the SF effect using word stimuli and in the context of person perception, its role in shaping food-related evaluations remains unexplored. Understanding whether shared features influence the perceived healthiness and tastiness of novel foods is crucial, as these perceptions can drive consumer acceptance and dietary choices. Additionally, this work is the first to examine the SF effect employing potentially disliked stimuli, that is, insect-based foods. Previous research has primarily used neutral targets, leaving open the question of whether the SF effect can reshape assumptions about foods that may be initially perceived as unappealing. By incorporating both traditional and insect-based foods, this research offers practical applications for promoting healthier and more sustainable food alternatives.

The manipulation we used involved presenting two source foods: a cereal bar described as “very healthy but not too tasty” and an ice cream described as “very tasty but not too healthy,” representing high expected utility for health or taste goals, respectively. Two novel target foods were then consistently related to the source foods by means of a shared perceptual feature, a colored frame, following the procedure of Hughes et al. (2020). Specifically, one target food shared its frame color with the healthy source, and the other with the tasty source. Subsequently, we assessed the expected utility of the target stimuli using both self-report and

indirect measures. We expected that, following this procedure, foods would be perceived as more palatable or appealing, and that individuals would be more willing to choose them to pursue relevant goals (e.g., eating something healthy or tasty); such outcomes would reflect an increase in their expected utility.

Given the high similarity between the two studies, unless otherwise specified, the measurement procedures, characteristics of the measures (i.e., number of trials and response options), stimuli, scoring of the indices, and exclusion criteria in Experiment 2 will follow the description outlined in Experiment 1.

### ***Practices of open science and reproducibility***

All measures, manipulations, and exclusion criteria in the studies are disclosed, as well as the rationale for determining the final sample size. We did not collect new data after the data analysis. We preregistered both studies. All the analyses were preregistered and described in sufficient detail for reproducibility.

Data, materials, power analysis protocols, and analyses are openly available at <https://osf.io/eznb6/>.

### ***Ethical approval and informed consent***

All procedures performed in these experiments were in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Ghent University (approval number 2023-137). All participants were informed about the aims of the research, the voluntary nature of their participation, any potential risks, and how their data would be stored and used. Participants' confidentiality was ensured, and informed consent was obtained prior to the participation to the study.

## Experiment 1: Testing the SF principle with neutral Foods

### Hypotheses

We preregistered the following hypotheses on OSF

([https://osf.io/vpxku/overview?view\\_only=00043bcd66f845c6a6a1f5996534a7db](https://osf.io/vpxku/overview?view_only=00043bcd66f845c6a6a1f5996534a7db)):

H1) Participants would attribute a higher expected utility in serving the taste goal to the target stimulus that shares features with the tasty source stimulus, compared to the target stimulus that shares features with the healthy source stimulus. This effect was expected in each of the three measures (BIAT, semantic differential, behavioral intention scale).

H2) Participants would attribute a higher expected utility in serving the health goal to the target stimulus that shares features with the healthy source stimulus, compared to the target stimulus that shares features with the tasty source stimulus. This effect was expected in each of the three measures (BIAT, semantic differential, behavioral intention scale).

### Method

#### Participants and design

A total of 172 participants (96 women, 72 men, four non-binary,  $M_{age} = 32.11$  years,  $SD_{age} = 7.33$ ) took part in the experiment and provided complete data. Participants were recruited through the Prolific platform (<https://www.prolific.com/>). Participants were 18 to 45 years old and were sampled from the UK population. Only participants with a high approval rate (ranging from 95% to 100%) were selected. Participants received the recommended compensation on Prolific, corresponding to 9£/12\$ per hour.

For determining the sample size, we conducted a power analysis with G\*Power3 (Faul et al., 2007), with  $\alpha = .017$  (Bonferroni criterion for three DVs), power  $(1-\beta) = 0.80$ , and a small to medium effect size  $d = 0.25$  for the test of hypotheses with paired t-tests. This analysis indicated a required total sample size of  $N = 143$ .

The experiment had a simple within-subjects design with 1 factor (type of source food) consisting of 2 levels (tasty and healthy).

## **Materials**

### ***Source stimuli (tasty and healthy foods)***

Participants were shown source stimuli (a cereal bar and an ice cream from two different brands) via images drawn from a pre-evaluated stimulus set, rated in advance for tastiness and healthiness (taken from Köster et al., 2023). Each image was accompanied by a description providing information about the food's high expected utility for the associated goal. Specifically, the cereal bar was described as a healthy option, while the ice cream was highlighted as a tasty option. Additionally, both the cereal bar and the ice cream were presented as having moderate expected utility for the non-focal goal (i.e., being moderately tasty and healthy, respectively).

The cereal bar was described as follows: “[...] *CEREALVIBES* bars are crafted to provide a nutritious snack option, packed with essential vitamins and minerals. However, despite their health benefits, consumer feedback highlights that they lack the desired flavor profile, failing to fully satisfy taste preferences. Because of this, it can be concluded that *CEREALVIBES* bars are healthy, while their taste is not particularly good”.

The ice cream was described as “[...] *FROSTYTREATS* ice creams offer a delightful treat for the taste buds. However, despite their outstanding taste, it is essential to exercise moderation in indulging in these ice creams, as they are not the healthiest choice for daily consumption. Because of this, it can be concluded that *FROSTYTREATS* ice creams are tasty, while they are not particularly healthy”. The complete instructions are available in the supplementary materials section on OSF.

### ***Target stimuli (made-up foods)***

Target foods were two different made-up food products, namely *Phoenix* and *Flimber*. These stimuli were developed ad hoc for the present experiment. The packages of the two foods were shown to the participants as in Figure 4.



**Figure 4.** P5. Study1: Visual representations of the target stimuli

Apart from the name and image of the products, no additional information was provided to the participants.

### ***Manipulation check for the source stimuli***

After the presentation of the source foods, participants were asked one question separately for each of them: What are the characteristics of this food? Participants responded by indicating one of the following three options: "Healthy but average in terms of taste", "Tasty but average in terms of health", or "I do not know".

### ***Learning task***

Before starting the learning procedure, participants were given the following instructions (taken from the original work of Hughes and colleagues, 2020): “In the next part of the study, you will encounter two new products: *Flimber* and *Phoenix*. You have probably never seen these products before. These products will appear on the screen together with two other products. The new products (*Flimber* or *Phoenix*) and the others (*Cerealvibes* and *Frostytreats*) will initially appear without any colored frame. Subsequently, colored frames will appear. Please pay close attention to the colored frames and the related products. You will be asked some questions about this later in the study”. The learning procedure consisted of twelve trials. At the beginning of each trial, three stimuli were simultaneously displayed on the screen: one target stimulus (either *Flimber* or *Phoenix*) together with the tasty and healthy source stimuli (i.e., the ice cream and the cereal bar). The target food was presented centrally on the left side of the screen. The two source foods were displayed on the right side, positioned one above the other, following the general layout used by Hughes et al. (2020). The vertical order of the source foods was counterbalanced across participants. The three stimuli were presented together for the duration of 3000ms. After this period, colored frames appeared surrounding each of the three stimuli so that the target stimulus shared the same colored frame with one source stimulus, and the remaining source stimulus had a different frame from the other two stimuli. Across trials, one target stimulus consistently shared the same colored frame with the same source stimuli, while the other target food did the same with the other source

stimuli (e.g., depending on the condition, Flimber was paired with the ice cream and Phoenix with the cereal bar).

### ***BIAT***

Responses toward the target foods were evaluated using the Brief Implicit Association Test (BIAT, Sriram & Greenwald, 2009). The implementation adhered to the original format (Experiments 1 and 2, Sriram & Greenwald, 2009), with the exception that, to achieve greater reliability, our version of the BIAT consisted of 40 trials in the critical blocks, unlike the original study, which included 32 trials.

Two different BIATs were administered to measure the spontaneous reactions to the target foods in relation to the two goals. For each goal, the Phoenix and Flimber products served as target categories, each represented by five package images (available at [https://osf.io/eznb6/overview?view\\_only=087e00260d77456c95c3a242325fe5e0](https://osf.io/eznb6/overview?view_only=087e00260d77456c95c3a242325fe5e0)). In the taste BIAT, attribute words described tastiness (tasty, appetizing, delicious, mouthwatering, palatable) and distastefulness (gross, disgusting, bland, repulsive, nauseating). In the health BIAT, attributes pertained to healthiness (healthy, beneficial, nutritious, natural, vital) and unhealthiness (unhealthy, harmful, junk, artificial, ill).

Participants completed both BIATs for each target food, resulting in a total of four different BIATs. Each BIAT consisted of two training blocks (1 and 3) with eight trials each, followed by critical blocks (2 and 4) containing 40 trials each. The stimuli were presented in an odd-even order (see Sriram & Greenwald, 2009, for details on the stimulus presentation), and the order of the BIATs was counterbalanced across participants. The BIATs included a built-in penalty that required participants to correct their errors, with the response latency recorded upon providing the correct answer.

### ***Semantic differentials***

Semantic differentials were employed to assess participants' evaluations of the target foods regarding the two goals. We administered two different versions of the measure, one for each goal. We employed the same adjectives used in the BIAT, paired as follows: Disgusting-Tasty, Repulsive-Appetizing, Gross-Delicious, Nauseating-Mouthwatering, and Bland-Palatable for the taste version and Unhealthy-Healthy, Junk-Nutritious, Harmful-Beneficial, Artificial-Natural, and Ill-Vital for the health version. Participants were instructed to evaluate each target food on a 7-point scale, ranging between the two opposing attributes.

### ***Behavioral intentions scale***

To measure goal-specific intentions, we created two versions of the behavioral intention scale: one focused on taste and one on health. In each version, participants were first asked to imagine that each of the target foods would soon be available in their country and were then prompted with a goal-related instruction, for example, "Now imagine that you want to eat something tasty. With this in mind, please answer the questions below. Remember that you are looking to eat something tasty while answering." The health version followed the same structure, replacing "tasty" with "healthy."

Participants' intention to purchase and consume the target foods was then assessed using four items: (i) "If they are available in the shops I usually visit, it is likely that I will buy them"; (ii) "If I see them on a shelf at the supermarket, I will buy them"; (iii) "As soon as I can, I am going to try them"; and (iv) "If they are offered to me, it is probable that I will taste them." Responses were provided on a 5-point Likert scale ranging from "Strongly disagree" to "Strongly agree."

### ***Demographic questions***

We asked participants about their age in years and gender.

### ***Memory check questions***

At the end of the experiment, two exploratory questions were asked: “Did Flimber always have the same color as...” and “Did Phoenix always have the same color as...” Participants responded with one of the following options: “Ice cream”, “Cereal bar”, or “I do not know”.

### ***Demand characteristics***

We examined whether and to what extent participants adjusted their responses to align with the researchers’ hypotheses by asking, "In this research, how much have you adapted your answers to fit our expectations?". Response options were on a five-point scale, ranging from "Not at all" to "Very much".

### ***Self-Reported Single Item (SRSI, Meade & Craig, 2012)***

We included a question aimed at detecting careless respondings: "In your honest opinion, should we use your data?". Response options were "Yes" and "No".

## **Procedure**

The experiment was implemented using Inquisit 6.6.0. The experiment was conducted online via Inquisit Web, developed by Millisecond Software. After participants had provided informed consent, they were presented with pictures and descriptions of the source stimuli, as described above. Subsequently, they answered the manipulation check for the source stimuli. If participants provided incorrect responses, the information on the source products was presented again until correct responses were given, with a maximum of four attempts.

Thereafter, participants went through the learning task, with half of them seeing Phoenix associated with the healthy source food and Flimber with the tasty source food, while

the other half saw Phoenix associated with the tasty source food and Flimber with the healthy one.

After the learning task, the BIAT, the semantic differential, and the behavioral intention scale were administered, separately for each target stimulus, to assess the target stimuli's expected utility in serving the goals. All measures were completed for one target stimulus before moving to the other.

A reminder learning procedure preceded the administration of each measure. These reminder learning procedures were identical to the main one, except that they consisted of eight trials instead of twelve. Finally, we administered demographic questions, the memory check questions, the demand characteristic item, and the SRSI, in this order.

### **Counterbalancing**

We implemented counterbalancing for the source-target pairings. For half of the participants, the target food Phoenix was paired with the tasty source food, and the target food Flimber with the healthy source food. For the other half, the pairings were reversed, with Phoenix sharing features with the healthy source food and Flimber with the tasty one. Concerning the BIATs, the counterbalancing was as follows: the order in which the two target foods were displayed (*Flimber-Phoenix* or *Phoenix-Flimber*); the order in which each target food was categorized with either a taste or a health-related attribute (*Flimber* + Taste and *Phoenix* + Health, or *Flimber* + Health and *Phoenix* + Taste); and the order in which each target food was categorized with either a positive or negative taste/health-related attribute (*Flimber* + Positive and *Phoenix* + Negative, or *Flimber* + Negative and *Phoenix* + Positive).

Furthermore, we counterbalanced the order of presentation of the BIAT and the explicit measures (i.e., semantic differentials and behavioral intention items).

## Results

### Data cleaning

Data cleaning was conducted in adherence to the preregistered exclusion criteria, ensuring consistency and transparency in the handling of the dataset. Data exclusion followed the preregistered criteria: participants were excluded if they answered “No” to the SRSI question or had less than 75% accuracy on either BIAT. No participants responded ‘No’ to the SRSI question, but one did not meet the BIAT accuracy threshold and was excluded from the analysis.

Moreover, twelve participants indicated a high level of demand characteristics (i.e., a score greater than 4 on a 5-point scale). As preregistered, we conducted analyses both with and without these participants. Since their exclusion did not meaningfully affect the results, they were included in the final analyses. After exclusions, the final sample included 170 participants.

We computed the BIAT scores for both target foods using the improved D score (Greenwald et al., 2003). The BIAT-specific recommended scoring procedure from Nosek and colleagues (2014) was employed. Higher D scores indicate a more favorable evaluation of the target foods for taste and health goals, respectively. In line with the recommendations by Nosek et al. (2014), we excluded one participant who gave fast responses (< 300 ms) on more than 10% of trials. For explicit evaluations, we calculated two separate scores for each target food. A taste score was computed as the mean of the five semantic differentials related to taste, while

a health score was computed as the mean of the five semantic differentials related to health. Higher values in these scores reflect more positive explicit evaluations of the target foods.

For behavioral intentions, we computed two separate scores for each target food: a taste-related and a health-related intention score. Each score was calculated as the mean of the four behavioral intention items, completed when participants were prompted to imagine pursuing either the taste or the health goal, respectively. Thus, each target food was evaluated twice, once in a taste-related context and once in a health-related context, resulting in two separate intention scores per product.

Higher scores on these scales indicate stronger intentions to purchase and consume the food based on taste or health goals.

Cronbach's  $\alpha$  was computed as an index of internal consistency of the self-report measures, separately for the two target foods. A split-half procedure was used to assess the internal consistency of the BIATs, following guidelines from Nosek and colleagues (2014).

The internal consistency was good to excellent for all the measures. In particular, the average reliability of the BIATs was  $\alpha = .77$ , for the semantic differentials average  $\alpha = .98$ , for the intention scores average  $\alpha = .93$ , with no substantial variations depending on the specific task. More detailed information is reported in the supplementary materials (Table S1).

### **Deviation from the preregistration**

In addition to frequentist t-tests, we conducted Bayesian t-tests using the BayesFactor package (Morey & Rouder, 2023) in R to assess the strength of evidence for the alternative hypothesis relative to the null hypothesis. Results are reported in terms of the Bayes factor ( $BF_{10}$ ), which expresses how much more likely the observed data are under the alternative

hypothesis than under the null. According to widely used conventions (Lee & Wagenmakers, 2014),  $BF_{10}$  values between 1 and 3 are interpreted as anecdotal evidence, values between 3 and 10 as substantial evidence, values between 10 and 30 as strong evidence, values between 30 and 100 as very strong, and values above 100 as extreme evidence for the alternative hypothesis.

To assess the robustness of the Bayesian analyses, we repeated all tests using different prior widths for the effect size under the alternative hypothesis. Specifically, in addition to the default Cauchy prior centered at zero with a scale parameter of 0.707, we conducted the tests using wider (scale = 1) and ultrawide (scale = 1.414) priors. The pattern of results remained consistent across all prior specifications, suggesting that the conclusions are robust to reasonable variations in prior assumptions.

### **Test of the hypotheses**

We tested hypotheses H1 and H2 using a series of frequentist and Bayesian directional paired t-tests. Since these are within-subject comparisons, we report Cohen's  $d_z$  for all the frequentist analyses.

H1 predicted that participants would evaluate the target paired with the tasty source as more effective for achieving the taste goal than the one paired with the healthy source. H1 was fully supported, as a significant SF effect was observed in both self-reported and indirect measures of taste value. Specifically, significant differences in taste-related ratings were found between the two target stimuli on semantic differentials, with higher ratings for the stimulus associated with the tasty source ( $M = 5.33$ ,  $SD = 1.57$ ) compared to the healthy source stimulus ( $M = 3.49$ ,  $SD = 1.20$ ),  $t(169) = 10.45$ ,  $p < .001$ ,  $d_z = 0.80$ ,  $BF_{10} > 10^{16}$ , indicating extreme

evidence in favor of the alternative hypothesis. Similarly, for behavioral intentions, a significant difference emerged in the taste-related intentions, with higher scores for the target stimulus that had been associated with the tasty source ( $M = 3.74$ ,  $SD = 0.92$ ), compared to the one associated with the healthy source ( $M = 2.58$ ,  $SD = 0.99$ ),  $t(169) = 10.24$ ,  $p < .001$ ,  $d_x = 0.79$ ,  $BF_{10} > 10^{16}$ , also indicating extreme evidence. Lastly, for BIAT scores, we found a significant difference between the two stimuli, with higher scores associated with the tasty stimulus ( $M = 0.20$ ,  $SD = 0.46$ ) compared to the healthy stimulus ( $M = 0.03$ ,  $SD = 0.44$ ),  $t(169) = 3.13$ ,  $p < .001$ ,  $dz = 0.24$ ,  $BF_{10} = 9.34$ , suggesting substantial evidence for the alternative hypothesis.

H2 predicted that participants would evaluate the target paired with the healthy source as more effective for achieving the health goal than the one paired with the tasty source. Similarly to H1, H2 was fully supported, as a significant SF effect emerged for all the dependent variables. Specifically, significant differences in health-related ratings were found between the two target stimuli on semantic differentials, with higher ratings for the stimulus associated with the healthy source ( $M = 5.53$ ,  $SD = 1.28$ ) compared to the tasty source stimulus ( $M = 2.69$ ,  $SD = 1.20$ ),  $t(169) = 17.63$ ,  $p < .001$ ,  $dz = 1.35$ ,  $BF_{10} > 10^{36}$ , providing extreme evidence in support of the alternative hypothesis. Similarly, for behavioral intentions, a significant difference emerged, with higher ratings for the healthy-related target stimulus ( $M = 3.62$ ,  $SD = 0.87$ ) compared to the tasty one ( $M = 2.51$ ,  $SD = 0.89$ ),  $t(169) = 10.62$ ,  $p < .001$ ,  $dz = 0.81$ ,  $BF_{10} > 10^{17}$ , also reflecting extreme evidence. Lastly, for BIAT scores, we found a significant difference between the two stimuli, with higher scores associated with the healthy stimulus ( $M = 0.20$ ,  $SD = 0.43$ ) compared to the tasty stimulus ( $M = 0.06$ ,  $SD = 0.42$ ),  $t(169) = 2.89$ ,  $p = .005$ ,  $dz = 0.22$ ,  $BF_{10} > 10^{17}$ , indicating substantial evidence.

### **Ancillary analysis**

Fourteen participants provided incorrect responses to the memory check questions. We also conducted the analysis by excluding these participants, and the results did not differ substantially. Full details of these additional analyses are provided in the supplementary materials

section

([https://osf.io/eznb6/overview?view\\_only=087e00260d77456c95c3a242325fe5e0](https://osf.io/eznb6/overview?view_only=087e00260d77456c95c3a242325fe5e0)).

### **Discussion**

This first experiment extends previous research on the SF effect by exploring its impact on the expected utility of food. Findings from Experiment 1 demonstrate that the sharing of features between nondescript food and either a tasty or healthy source stimulus significantly influenced participants' implicit and explicit evaluations, as well as behavioral intentions. As predicted, participants attributed greater taste-related utility to the food sharing features with the tasty source, and greater health-related utility to the food sharing features with the healthy source, as reflected across self-reported and indirect measures.

### **Experiment 2: applying the SF principle to insect-based foods**

Having established the effectiveness of the shared features principle in shaping utility judgments for neutral foods, Experiment 2 examined whether this approach could be applied to foods that can be perceived as unfamiliar or elicit disgust reactions. In particular, we tested whether feature sharing with tasty or healthy source stimuli could enhance the perceived utility of insect-based products. This second experiment therefore extends the previous findings to a more challenging domain, as insect-based foods can evoke pre-existing attitudes such as

disgust or skepticism, which may influence evaluation. At the same time, the methodological structure remains unaltered, allowing a comparison with the effects observed for neutral foods.

## Hypotheses

We preregistered the following hypotheses on OSF

([https://osf.io/fm368/overview?view\\_only=a9dc0cd106e0418b8f4aab9a4b83e7f1](https://osf.io/fm368/overview?view_only=a9dc0cd106e0418b8f4aab9a4b83e7f1)):

H1) Participants would evaluate the insect-containing target food that shared features with the tasty source food as having a higher expected utility in serving the taste goal than the insect-containing target food that shared features with the healthy food, in each of the three measures (BIAT, semantic differential, behavioral intention scale).

H2) Participants would evaluate the insect-containing target food that shared features with the healthy source food as having a higher expected utility in serving the health goal than the insect-containing target food that shared features with the tasty food, in each of the three measures (BIAT, semantic differential, behavioral intention scale).

## Method

### Participants and design

A total of 169 participants (82 women, 85 men, one non-binary, one answered “Other/prefer not to answer”  $M_{age} = 34.14$  years,  $SD_{age} = 6.46$ ) took part in the experiment and submitted complete data. As in Experiment 1, participants were recruited through the Prolific platform by applying the same criteria.

The sample size was determined by conducting a power analysis with G\*Power3, with  $\alpha = .017$  (Bonferroni criterion for three DVs), power  $(1-\beta) = 0.80$ , and a small to medium effect

size  $d = 0.25$  for the test of hypotheses with paired t-tests. Based on this analysis, the required total sample size was  $N = 143$ .

Experiment 2 has the same design as Experiment 1, consisting of a within-subjects design with 1 factor (type of source food), consisting of 2 levels (tasty and healthy).

## Materials

### *Target foods*

The target food stimuli were similar to those of Experiment 1. A stylized insect icon and the phrase “made with insect powder” were added to the packaging to highlight the presence of insect-derived ingredients. Furthermore, the package images were accompanied by a description informing participants that the products contained insect powder. The packages of the two insect-containing foods are shown in Figure 5.



Figure 5. P5. Study 2: Visual representations of the target stimuli.

### *Manipulation check*

At the end of the study, participants were asked the same exploratory questions as in Study 1. Additionally, we included one new question to verify whether participants remembered the information regarding the target foods: “Which was the characteristic of Flimber and Phoenix brands?”, options were “They were normal food brands”, “They were insect-based food brands”, “I do not know”.

### ***Disgust and interest***

Disgust and interest toward consuming insect-based foods were assessed using eight items from the Entomophagy Attitude Questionnaire (EAQ; La Barbera et al., 2020). Participants completed the Disgust and Interest subscales of the EAQ, responding on a 5-point Likert scale, where 1 represented “Not at all” and 5 represented “Very much.”

### ***Dietary habits***

Dietary habits were assessed using two self-report questions. First, participants were asked whether their diet included meat or meat-containing foods: “Does your diet include meat (e.g., steaks, cold cuts) and/or foods that contain meat?” with response options Yes or No. Second, participants reported their willingness to consume insects or insect-based foods in real life: “Would you be willing to eat insects or try insect-based foods in real life?”. Response options included: “Yes, I am willing to eat insects,” “No, because I am a vegetarian,” “No, because I am a vegan,” and “No, because of personal disgust or aversion,” with an additional open-ended option “No, for other reasons, please specify”.

### ***Manipulation awareness***

To evaluate participants' awareness of the manipulation, two exploratory questions were included: "Looking back at the task, is there anything in particular that you believe influenced your assessment of the products Phoenix and Flimber?", participants provided open-ended responses; and "Do you think that your assessment of the products Phoenix and Flimber was influenced by the prior presentation of these products with and in the same colored frames as the tasty Frostytreats ice-cream and the healthy Cerealvibes bars?", response options were "Yes, I think my assessment was influenced by this", "No, I do not think my assessment was influenced by this", "I don't know".

### **Procedure**

Study 2 was conducted following the same procedure as Study 1. The only differences concerned the final block, where we included measures of disgust and interest, the manipulation check, and two exploratory questions to assess participants' awareness of the manipulation.

## **Results**

### **Data cleaning**

As in the first study, data were cleaned according to the preregistered exclusion criteria. One participant answered 'No' to the SRSI question, and seven participants achieved less than 75% correct responses in at least one of the two BIATs. In line with the preregistration, data from these eight participants were excluded from the analyses.

Additionally, nine participants reported a high level of demand characteristics. Since data from these participants did not substantially alter the results, they were retained in the final analyses. After exclusions, the final sample included 161 participants.

All measures demonstrated good to excellent internal consistency. Specifically, the BIATs showed average reliability of  $\alpha = .81$ , the semantic differential scales reached an average of  $\alpha = .97$ , and the intention measures had an average of  $\alpha = .95$ . The aggregated disgust and interest scale reached an internal consistency of  $\alpha = .97$ .

These values remained consistent across the different tasks. Full details are provided in the supplementary materials ([https://osf.io/eznb6/overview?view\\_only=087e00260d77456c95c3a242325fe5e0](https://osf.io/eznb6/overview?view_only=087e00260d77456c95c3a242325fe5e0)).

### Test of the hypotheses

For H1, we found a significant SF effect for the self-reported measures but not for the indirect measures. Specifically, significant differences emerged on semantic differentials in taste-related ratings, with higher ratings for the stimulus associated with the tasty source ( $M = 4.51$ ,  $SD = 1.78$ ) compared to the healthy source stimulus ( $M = 3.28$ ,  $SD = 1.38$ ),  $t(160) = 7.71$ ,  $p < .001$ ,  $dz = 0.61$ ,  $BF_{10} > 10^{10}$ , indicating extreme evidence for the alternative hypothesis. Similarly, a significant difference for behavioral intentions, with higher ratings for the tasty-related target stimulus ( $M = 3.06$ ,  $SD = 1.24$ ) compared to the healthy one ( $M = 2.38$ ,  $SD = 1.10$ ),  $t(160) = 6.09$ ,  $p < .001$ ,  $dz = 0.48$ ,  $BF_{10} > 10^6$ , also indicating extreme evidence. Regarding the BIAT, ratings for the stimulus associated with the tasty source ( $M = 0.16$ ,  $SD = 0.44$ ) were higher than those for the healthy source ( $M = 0.08$ ,  $SD = 0.46$ ). However, this difference did not reach statistical significance,  $t(160) = 1.51$ ,  $p = .067$ ,  $dz = 0.12$ ,  $BF_{10} = 0.50$ ,

providing only anecdotal evidence in favor of the null hypothesis. Regarding the BIAT, the difference between the stimulus associated with the tasty source ( $M = 0.16$ ,  $SD = 0.44$ ) and the healthy source ( $M = 0.08$ ,  $SD = 0.46$ ) did not reach statistical significance,  $t(160) = 1.51$ ,  $p = .067$ ,  $dz = 0.12$ ,  $BF_{10} = 0.50$ .

H2 was fully supported, as a significant SF effect emerged for both self-reported and indirect measures. Specifically, significant differences in health-related ratings were found on semantic differentials, with higher ratings for the stimulus associated with the healthy source ( $M = 5.09$ ,  $SD = 1.60$ ) compared to the tasty source stimulus ( $M = 3.12$ ,  $SD = 1.46$ ),  $t(160) = 10.56$ ,  $p < .001$ ,  $dz = 0.83$ ,  $BF_{10} > 10^{17}$ , showing extreme evidence in favor of the alternative hypothesis. Likewise, for behavioral intentions, a significant difference was found, with higher ratings for the healthy-related target stimulus ( $M = 3.09$ ,  $SD = 1.21$ ) compared to the tasty one ( $M = 2.39$ ,  $SD = 1.05$ ),  $t(160) = 7.01$ ,  $p < .001$ ,  $dz = 0.55$ ,  $BF_{10} > 10^8$ , also indicating extreme evidence. Finally, also for BIAT scores, a significant difference emerged, with higher scores associated with the healthy stimulus ( $M = 0.18$ ,  $SD = 0.44$ ) compared to the tasty stimulus ( $M = 0.06$ ,  $SD = 0.47$ ),  $t(160) = 2.20$ ,  $p = .014$ ,  $dz = 0.17$ ,  $BF_{10} = 1.82$ , suggesting anecdotal evidence for the alternative hypothesis.

### **Ancillary analyses**

As in Experiment 1, we checked the correctness of the answers to the final manipulation check questions. Nineteen participants provided wrong answers and were excluded from the main analysis, as preregistered. To assess the robustness of the findings, we also ran the analysis including these participants, and the results did not differ substantially.

Moreover, we examined whether the level of disgust and interest was related to the effectiveness of the manipulation. A strong inverse relationship between the Interest score

(average of responses to the interest subscale) and Disgust score (average of responses to the disgust subscale),  $r(159) = -0.79, p < .001$  justified the creation of an overall score, where higher values indicate greater disgust and lower interest toward insect foods. Next, we calculated a manipulation effectiveness score for each dependent variable. These scores were obtained by subtracting, for each goal (taste and health), the ratings of the stimulus not associated with that goal from the ratings of the stimulus associated with it, resulting in a differential score of manipulation effectiveness. Finally, we correlated the composite disgust-interest score with the differential effectiveness scores for each dependent variable. No significant correlations emerged across the six variables, indicating that individual differences in disgust/interest levels were not associated with the effectiveness of the manipulation.

We also examined whether participants' awareness of the manipulation (coded as "Yes" vs. "No/I don't know") was related to its effectiveness. Independent-sample t-tests revealed that participants who reported being aware of the manipulation scored significantly higher on the taste-related intention scale and on both semantic differential measures, compared to those who were unaware of the manipulation. When restricting the analysis to participants who were unaware of the manipulation, the manipulation remained effective across most outcome measures, with the exception of the health BIAT health. These findings suggest that, although the manipulation was more effective among participants who were aware of it, SF effects did not depend entirely on participants' awareness. Regarding dietary habits, most participants reported consuming meat ( $n = 141$ ), whereas a smaller subset reported not consuming meat ( $n = 20$ ). Re-running the hypothesis tests while restricting the sample to meat eaters yielded the same pattern of results. Full details for all the analyses are reported in the supplementary materials section.

## Discussion

Experiment 2 extended the effects observed in Experiment 1 with neutral foods to the domain of insect foods. However, here the SF effect emerged for self-reported measures (semantic differentials and behavioral intentions) and for the indirect measure (BIAT) concerning the health goal. For taste-related BIAT scores, the expected pattern of results emerged but the results were not statistically significant. Moreover, the magnitude of the effects was smaller compared to Experiment 1.

## General discussion

The present research tested the SFP within a novel paradigm informed by the GDP, investigating whether feature sharing can influence utility-based evaluations of both conventional and insect-based novel foods. Across two experiments, we found that shared features can effectively transfer goal-relevant attributes, specifically healthiness and tastiness, from familiar source foods to novel target foods, thereby shaping the expected utility of the linked consumption behavior. This effect emerged consistently across multiple self-report measures and, to a lesser extent, on an indirect measure, the BIAT.

In Experiment 1, where neutral foods were employed as targets, we found consistent and substantial effects across all dependent variables. The SF manipulation significantly increased both direct and indirect evaluations of the target foods in line with the goal-relevant attribute (taste or health) of the associated source. In Experiment 2, we extended the paradigm to a more challenging domain: insect-based foods. Findings from Experiment 2 demonstrate that the Shared Features effect successfully generalizes to insect-based foods, extending its

applicability beyond neutral target stimuli. This represents a significant advancement, as it suggests a pragmatic approach to increasing consumer acceptance of sustainable food alternatives by making them relevant to specific consumption goals such as pursuing taste or health objectives. However, the effects observed in Experiment 2 were notably smaller in magnitude and emerged primarily through explicit rather than implicit measures.

One possible explanation for the differing effects observed between Experiment 1 and Experiment 2 is that two distinct psychological processes may have influenced participants' evaluations of expected utility: forming new evaluations versus modifying pre-existing ones. Specifically, Experiment 1 focused on the expected utility of consuming entirely unknown foods, items that participants had never encountered before and toward which they had no prior evaluative expectations. Following the manipulation involving the shared features, participants were able to form favorable evaluations of these foods, perceiving them as tastier or healthier. In contrast, Experiment 2 involved foods that, although also new, contained insect-based ingredients, an element likely to activate pre-existing beliefs or prejudices. Such evaluations tend to be stable and deeply rooted, and changing them is generally more effortful and less successful than forming new ones (Fazio & Olson, 2003; Petty & Cacioppo, 1986). Forming expected utility judgments related to consuming unfamiliar, neutral stimuli might involve minimal resistance, allowing manipulations to operate effectively. By contrast, modifying expected utility for behaviors that are already associated with prior evaluations might be considerably more difficult, making the manipulation less effective.

The limited effectiveness of the intervention in Experiment 2 can also be understood from a GDP perspective in terms of competing goals. Consuming insect-based foods may activate multiple, potentially conflicting goals, such as maintaining health and safety, and

adhering to social norms related to eating unusual foods. Existing beliefs about these foods connect them to this broader set of goals, whereas the intervention targeted only a subset of goal-relevant attributes (e.g., taste or health). As a result, the manipulation may have been less effective because it addressed only part of the utility assessment landscape, leaving other goal-driven evaluations unaltered.

One consistent finding across both studies is that the effects of the SF manipulation were consistently stronger on self-reported measures than on the BIAT. This result may be attributed to several factors. Firstly, the BIATs exhibited lower reliability, which can potentially reduce observed effect sizes (Nunnally & Bernstein, 1994). Moreover, self-report measures are generally considered more susceptible to demand characteristics than implicit measures (e.g., Fazio & Olson, 2003): Therefore, it is possible that the stronger effects observed in direct measures simply reflect participants' responses to these cues. Although this possibility cannot be entirely ruled out, it should be noted that participants in both studies were asked to report the extent to which they adjusted their responses to the demand characteristics, and the pattern of results, including the stronger impact of the manipulations on self-report measures, remains stable even after excluding participants who reported adapting to demand characteristics.

Secondly, the observed difference between the impact of the manipulation on the two types of measures may also reflect theoretical considerations. Specifically, this pattern aligns well with early dual-attitude models (e.g., Wilson, Lindsey, and Schooler, 2000), which posited that implicit reactions change more slowly and require more prolonged or intensive exposure to manipulations. However, subsequent research shows that implicit evaluations can shift rapidly, challenging this assumption (Gawronski & Bodenhausen, 2011) and suggesting that

different types of learning situations may differentially influence the cognitions captured by indirect versus direct measures (Gawronski & Bodenhausen, 2006). Accordingly, the stronger effects observed on self-report measures, as compared to indirect measures, suggest that the manipulation primarily engages propositional reasoning, targeting conscious reflections on food features.

Finally, since we relied on a single indirect measure, the BIAT, we cannot exclude that the pattern we observed is partially due to the characteristics of this instrument. Specifically, the BIAT may be optimized to capture evaluative associations such as positive or negative valence (Sriram & Greenwald, 2009), whereas expected utility represents a more complex construct that integrates beliefs about goal attainment and outcomes within a hierarchical goal system. The limited correspondence between the construct and the measure may reduce the sensitivity to small shifts in utility-related associations, particularly when stimuli are complex or when participants hold strong pre-existing associations. Alternative indirect measures that capture more explicitly propositional content, such as the Implicit Relational Assessment Procedure (Barnes-Holmes et al., 2004), may be better suited to detect goal-relevant inferences about utility. More broadly, Moors & Köster (2022) suggest that, in order to predict behavior, indirect measures may need to target the value of behavior itself rather than attitudes toward the target of the behavior.

Taken together, these considerations indicate that there are several potential explanations for the difference we observed between explicit and implicit SF effects. We, therefore, believe that this is an interesting result that deserves further investigation in future research.

A central novelty of the present research lies in the type of features targeted through the SF paradigm. Previous studies (e.g., Hughes et al., 2024) manipulated perceptual features unrelated to participants' goals, such as height, which were not linked to behaviorally relevant outcomes. In contrast, the current work focuses on features directly tied to personally meaningful, goal-relevant outcomes, specifically the expected utility of actions such as consuming a food item.

The GDP and SFP offer complementary insights, providing a comprehensive framework for understanding expected utility modification of goal-directed behaviors. In food consumption contexts, GDP is particularly useful for identifying which attributes are relevant for achieving current goals, such as taste or health. Experimental findings further show that SF interventions can successfully transfer these goal-relevant attributes from source to target foods, thereby modifying the perceived utility of consuming them. Taken together, this demonstrates how GDP can inform interventions, while SF provides a tool to shape expectations in line with goal-directed evaluations. By integrating SF and GDP, this framework links cognitive inferences about stimulus features to the expected utility of the associated behavior, thus providing a proof of concept for a systematic method to experimentally manipulate expected utilities in a controlled setting.

Limitations of the present research should be acknowledged. The external validity of the experimental paradigm employed in this research remains to be established. The current research follows a modelling approach, meaning that one phenomenon is studied in order to gain insights into another phenomenon (Boddez et al., 2023). In this case, behavior in the laboratory procedure (including the stimuli, measurements, and sample under investigation) is used to gain information about everyday behaviors such as purchasing and consuming specific

food products. At present, we do not know whether these laboratory findings generalize to the target phenomenon. To validate a laboratory procedure, one can examine whether variables that affect outcomes in the laboratory also affect outcomes in the target phenomenon (e.g., actually buying and eating food products). The underlying idea is that the more variables show parallel effects across the laboratory procedure and the target phenomenon, the more likely it is that the effect of a new variable studied in the lab will translate to the real-world context, even when there are substantial surface differences between the model and the target phenomenon (Boddez et al., 2023). Although we did not explicitly adopt this validation approach, the difference observed between Experiment 1 and Experiment 2 may be of interest here. The nature of the stimuli (non-insect-based foods vs. insect-based foods) appears to influence behavior both in the laboratory procedure and in real life. Indeed, in real-world contexts, people are generally less willing to buy and consume insect-based foods compared to conventional alternatives (e.g., Hartmann & Siegrist, 2017). This convergence suggests that the laboratory procedure may capture at least some relevant aspects of the target phenomenon. Nevertheless, this is only a first step, and further validation studies are clearly warranted.

Future research could further clarify the mechanisms and boundary conditions of GDP-SF interventions. One avenue is to examine whether the magnitude of the effects depends on the contextual salience of the targeted goal dimension, for example, whether effects are stronger when specific goal considerations are already prioritized. Individual differences, such as personality traits or openness to novel foods, may also moderate the intervention's impact. Additionally, it would be valuable to compare changes in expected utility induced by the integrated GDP-SF with traditional attitude-change interventions to assess their relative influence on behavior. Importantly, investigating whether expected utility modifications

translate into actual food choices or consumption patterns, potentially through longitudinal designs, could provide insights into the persistence and real-world applicability of the GDP-SF interventions.



## **Chapter discussion**

This chapter brings together three empirical projects that investigate how manipulations can shape evaluations of insect-based foods. Although each study adopts a different intervention paradigm, all three contribute to a more comprehensive understanding of the mechanisms through which evaluative change can occur when the target is characterized by pre-existing negativity, as is the present case. The evidence collectively illustrates that such attitudes are not immutable and that learning and social learning interventions can produce measurable shifts in evaluations, assessed both with direct and indirect measures.

### **Comparative evaluation of the intervention paradigms**

To provide an overarching view of the findings, Table 15 summarises, for each study, the intervention employed, the specific insect-based target food, the dependent variables assessed, the contrasts tested, and the corresponding effect sizes.

**Table 15.** Summary of interventions and outcomes across studies

Study	Contrast (insect-related target)	Dependent variable	Test statistic	Effect size 95%CI
VAA	Approached vs avoided brand, insect cookies	BIAT	$t(59) = 3.07, p = .002$	$d = 0.48 [0.21, Inf]$
		Semantic differential	$t(52) = 3.17, p = .001$	$d = 0.43 [0.19, Inf]$
		Behavioral intentions	$t(59) = 2.54, p = .006$	$d = 0.22 [0.07, Inf]$
OEC – Exp. 1	Appreciation-paired vs disgust-paired brand	BIAT	$t(63) = 5.24, p < .001$	$d = 0.65 [0.38, 0.92]$
		Behavioral intentions	$t(63) = 6.34, p < .001$	$d = 0.79 [0.51, 1.07]$
OEC – Exp. 2	Condition effect (ANCOVA)	IAT	$F(2, 287) = 0.15, p = .858$	$\eta^2 p < .001 [0.00, 1.00]$
	OEC+ vs baseline		$t(199) = 2.87, p = .002$	$d = 0.40 [0.13, 0.68]$
	VC vs baseline	Semantic differential	$t(181.17) = 3.11, p = .001$	$d = 0.45 [0.16, 0.73]$
	OEC+ vs VC		$t(188) = 0.19, p = .424$	$d = 0.03 [-0.26, 0.31]$
SFP-GDP – Exp. 2	“Tasty” vs “healthy” target stimulus	BIAT – taste	$t(160) = 1.51, p = .067$	$dz = 0.12 [-0.01, Inf]$
		Semantic differential – taste	$t(160) = 7.71, p < .001$	$dz = 0.61 [0.47, Inf]$
		Behavioral intentions – taste	$t(160) = 6.09, p < .001$	$dz = 0.48 [0.34, Inf]$
		BIAT – health	$t(160) = 2.20, p = .014$	$dz = 0.17 [0.04, Inf]$
		Semantic differential – health	$t(160) = 10.56, p < .001$	$dz = 0.83 [0.68, Inf]$
		Behavioral intentions – health	$t(160) = 7.01, p < .001$	$dz = 0.55 [0.41, Inf]$

The interpretation of the pattern of results across studies is constrained by several methodological and conceptual differences that limit direct comparability. Indeed, some interventions relied on difference scores that were computed using heterogeneous contrasts. For instance, in some cases dependent variables reflected approach–avoidance difference scores, whereas in others they were derived from comparisons with baseline conditions (e.g., mere exposure). Self-report measures also slightly varied in wording and indirect measures, when not entirely different in type, still differed in their procedural details (e.g., the number of

trials). The studies further employed heterogeneous designs, some within-subjects, others between-subjects, and while most experiments were conducted with Italian participants, the SFP–GDP project involved a UK sample. Taken together, however, the studies remain informative: despite their differences, they collectively map a set of complementary strategies through which evaluative change can occur when insect-based foods are involved.

Overall, the pattern of standardized effects indicates that all three families of intervention strategies produced meaningful changes in evaluations, particularly at the level of self-reported measures, whereas changes on indirect measures emerged more selectively. In the VAA study, the effects of the manipulation were consistently in the expected direction. Observing a model approach rather than avoid the target brand produced small-to-medium improvements in self-reported evaluations and intentions, and a comparable effect on indirect evaluative responses as indexed by the BIAT. The first OEC experiment yielded similar results. Specifically, observing a model tasting two insect-based cookies and expressing either appreciation or disgust led participants to show a preference for the brand paired with appreciation over the one paired with disgust. The effect emerged both on direct and indirect measures. The second OEC study compared two social learning strategies, OEC and vicarious consumption, against a baseline condition (i.e., mere exposure of the products). Both strategies produced small-to-medium effects in relative preference for the insect-based brand when compared to the baseline, whereas no significant difference emerged between the two strategies. These results indicate that simply observing a model eat the insect-based product can be as effective as observing explicit affective reactions, at least in terms of self-reported attitudes. By contrast, no reliable effects emerged on the IAT, where condition differences were absent. The SFP–GDP study complements these findings by using a different type of

manipulation. Rather than relying on social models, this intervention aimed to alter the perceived utility of insect-based products in serving salient goals (i.e., taste and health). Here, the strongest effects were observed on self-reported measures. When the insect-based target food was associated with a tasty source, taste-related semantic differentials and intentions showed medium effects, whereas health-related outcomes showed even larger effects when the product was linked to a healthy source. Effects on BIAT scores were small overall, with only the health-related BIAT showing a statistically significant shift. Taken together, these results indicate that SFP-GDP-framing interventions can substantially shape direct evaluations of insect-based foods and can extend to indirect measures, although effects on the latter are generally small and not consistently observed. Importantly, unlike the others interventions that primarily assessed global evaluative valence (e.g., good–bad), the present SFP-GDP focused on more specific evaluative dimensions. Both the semantic differential measures and the BIAT were constructed to assess perceptions of healthiness and taste rather than overall positivity or negativity. As a result, the observed effects reflect differences in these attribute-specific evaluations, suggesting that the SFP–GDP framing intervention can act upon how insect-based foods are construed along concrete, goal-relevant dimensions, rather than merely shifting their general evaluative valence.

### **Disgust and evaluative responses to insect-based foods**

To assess the role of disgust as an individual-difference factor, we conducted a series of ancillary analyses examining the association between self-reported disgust toward insect-based foods and the evaluative measures employed across the experimental programs. This analysis was motivated by a substantial body of literature showing that disgust is a central determinant of Western consumers' reactions to insect-based foods, consistently predicting

negative evaluations, lower acceptance, and reduced willingness to consume such products (Castro & Chambers, 2019; Kröger et al., 2022; Wendin & Nyberg, 2021; Laureati et al., 2024).

Table 16 reports the correlations between evaluations of insect-based foods and disgust across the experimental programs. The table also includes a column indicating whether each correlation was consistent with theoretical expectations. In line with prior literature, correlations were considered expected when higher levels of disgust were associated with more negative evaluations or lower behavioral intentions.

**Table 16.** Correlations between disgust and evaluations of insect-based foods

Study	Variable	Association with disgust (Pearson's <i>r</i> )	Expected direction
VAA	BIAT - approached brand	.25*	×
	BIAT - avoided brand	.14	×
	Semantic differential - approached brand	-.54***	✓
	Semantic differential - avoided brand	-.60***	✓
	Behavioral intentions - approached brand	-.67***	✓
	Behavioral intentions - avoided brand	-.68***	✓
OEC – Exp. 1	BIAT - appreciation-paired brand	.01	×
	BIAT - disgust-paired brand	-.05	✓
	Behavioral intentions - appreciation-paired brand	-.61***	✓
	Behavioral intentions - disgust-paired brand	-.47***	✓
OEC – Exp. 2	IAT - mere-exposure-paired brand	-.43***	✓
	IAT - consumption-paired brand	-.21*	✓
	IAT - consumption + positive feedback brand	-.27**	✓
	Semantic differential - mere-exposure-paired brand	-.50***	✓
	Semantic differential - consumption-paired brand	-.66***	✓
	Semantic differential - consumption + positive feedback brand	-.54***	✓
SFP–GDP – Exp. 2	BIAT (taste) - brand 1	.06	×
	BIAT (taste) - brand 2	-.04	✓
	Semantic differential (taste) - brand 1	-.17*	✓
	Semantic differential (taste) - brand 2	-.22*	✓
	Behavioral intentions (taste) -brand 1	-.25***	✓
	Behavioral intentions (taste) - brand 2	-.24***	✓
	BIAT (health) - brand 1	.09	×
	BIAT (health) - brand 1	-.07	✓
	Semantic differential (health) - brand 1	-.17*	✓
	Semantic differential (health) - brand 2	-.06	✓
	Behavioral intentions (health) -brand 1	-.22***	✓
	Behavioral intentions (health) - brand 2	-.16*	✓

Note. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

Overall, higher levels of disgust were consistently associated with more negative semantic differential ratings and lower willingness to consume insect-based foods, regardless

of the specific intervention paradigm. Associations with indirect evaluative measures (BIAT/IAT) were weaker and less consistent. The pattern of results confirms that disgust constitutes a stable background factor related to evaluative responses to insect-based foods, replicating prior findings across multiple paradigms and outcome measures.

We next explored whether disgust was also related to the effectiveness of the experimental manipulations. Whereas Table 16 reported the associations between disgust and absolute evaluative responses toward the insect products (i.e., evaluations of the approached and the avoided brands considered separately), Table 17 focuses on the magnitude of the evaluative change induced by the interventions (i.e., the difference between the approached and the avoided brand). Across experiments, these associations were consistently non-significant and uniformly close to zero. This pattern held across VAA, OEC, and SFP–GDP interventions, and across both direct and indirect outcome measures. These findings provide initial evidence that, in our studies, while disgust constitutes a powerful background determinant of how insect-based foods are evaluated, it does not necessarily constrain or undermine the impact of interventions designed to modify those evaluations.

**Table 17.** Magnitude of the effects across experiments

Study	Dependent variable	Association with disgust
VAA	BIAT - approach	$r = .08$ ( $p = .56$ )
	Semantic differential -approach	$r = .04$ ( $p = .76$ )
	Behavioral intentions - approach	$r = .03$ ( $p = .82$ )
OEC – Exp. 1	BIAT	$r = .04$ ( $p = .74$ )
	Behavioral intentions	$r = -.19$ ( $p = .13$ )
OEC – Exp. 2	IAT	$\eta^2 p < .001$ ( $p = .33$ )
	Semantic differential	$\eta^2 p = 0.02$ ( $p = .06$ )
SFP-GDP – Exp. 2	BIAT – taste	$r = -.02$ ( $p = .81$ )
	Semantic differential – taste	$r = -.03$ ( $p = .91$ )
	Behavioral intentions – taste	$r = -.03$ ( $p = .71$ )
	BIAT – health	$r = .01$ ( $p = .28$ )
	Semantic differential – health	$r = -.09$ ( $p = .69$ )
	Behavioral intentions – health	$r = -.07$ ( $p = .38$ )

*Note.* Values indicate the strength of the association between disgust and the manipulation outcome. Zero-order associations are reported as Pearson's  $r$ , whereas effect sizes from ANCOVA models are reported as partial eta squared ( $\eta^2 p$ ).

## Conclusions

Across the studies presented in this chapter, we examined whether different intervention strategies, VAA, OEC, vicarious consumption, and SFP-GDP could modify attitudes toward insect-based foods. Taken together, the findings demonstrate that attitudes toward this food category can, to some extent, be manipulated. Indeed, interventions produced consistent shifts in self-report evaluations and, in some cases, changes in time-reaction measures and affecting not only overall evaluative responses but also more specific evaluative dimensions, such as perceived healthiness and taste.

Returning to the broader premise that attitudes and their modification play a crucial role in addressing social issues, such as those related to sustainability, a critical question nevertheless remains unaddressed: how changes in attitudes and intentions translate into actual

behavior. The next chapter situates the empirical findings of the present work within a broader theoretical landscape by reviewing classic and contemporary models of behavior generation. These frameworks offer complementary perspectives on how evaluative change may or may not translate into action, thereby suggesting how interventions aimed at attitude and intention change may acquire behavioral relevance.



## Chapter 4. From evaluations to action: models of behavior and the role of goals

### Introduction

Across domains, attitudes and intentions have been widely regarded as key components in models designed to predict behavior<sup>6</sup>. Nevertheless, a substantial body of evidence suggests that changes in attitudes and intentions may not translate into corresponding changes in behavior. This dissociation can be attributed to several factors, including contextual constraints and the presence of competing and hierarchically organized goals (Moors et al., 2017). Moreover, attitude and intention changes may remain behaviorally ineffective when they are not integrated within individuals' broader belief systems or when they fail to support the prediction that a given behavior will actually be enacted in relevant contexts. Research on the attitude– and intention–behavior gaps, particularly within environmental psychology, provides some of the most salient and well-documented evidence of this dissociation (Kollmuss & Agyeman, 2002). Within this domain, individuals often endorse pro-environmental values, report positive attitudes toward sustainable practices, and even express strong intentions to act accordingly, while continuing to engage in behaviors that contradict these evaluations (Morwitz et al., 2007; Claudy et al., 2013; Park et al., 2020; Zhuo et al., 2022). For example, Longo and colleagues (2019) qualitatively documented how, even among individuals strongly committed to sustainability, actual decision-making remains complex and does not consistently align with these commitments. Specifically, they showed how sustainability knowledge can

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<sup>6</sup> Some theoretical perspectives consider self-reports themselves as forms of behavior (e.g., verbal or self-report behavior). In the present thesis, however, the term *behavior* is used more narrowly to refer to overt actions directed toward the target object (e.g., choice or consumption).

hinder the enactment of the relevant behavior by increasing confusion, distress, and a sense of burden linked to the perceived complexity of sustainable choices. Farjam and colleagues (2019) tested the attitude–behavior gap using an incentivised experiment with real money. The gap manifested in that environmental concern predicted pro-environmental behavior only in low-cost conditions, whereas in high-cost situations, attitudes no longer influenced behavior, despite strong pro-environmental beliefs. Hoffmann and colleagues (2019) further show how hunger systematically reduced sustainable food choices despite stable pro-sustainability attitudes and explicit evaluations.

This body of evidence suggests that attitudes and intentions, while influential, do not operate in isolation through a linear pathway that culminates in overt behavior. Rather, behavior can be understood as occurring in a context in which one or multiple goals are activated (e.g., eating sustainably while also prioritizing taste), and situational constraints on the behavioral options are present (e.g., in a restaurant where sustainable options are absent or substantially more expensive). Under such conditions, changes in attitudes or intentions may be necessary but insufficient for behavior change. Understanding when, how, and why evaluative shifts are translated into action, therefore, requires more integrative models that account for contextual influences, broader goal systems and their contextual activation, and individuals' prior belief structures.

The present chapter builds on this premise. After reviewing some influential models, including attitude- and intention-based models and dual-process frameworks, that have informed much of the intervention literature on behavior change, it will be argued that, despite their explanatory value, many of these approaches would benefit from a more integrated perspective. Together, these considerations motivate the introduction of the Goal-Directed Predictive Processing (GDPP) framework, grounded in predictive processing and goal-directed

theories, which conceptualizes behavior as the outcome of dynamic inference rather than as the terminal point of a linear causal chain.

The theoretical model proposed in this chapter was developed after the empirical studies presented in the previous chapter and should therefore not be understood as the framework that originally guided the design of those interventions. Rather, the GDPP model is proposed as a complementary and forward-looking theoretical contribution. Its aim is to offer a more integrated account of how interventions may influence actual behavior selection, moving beyond a view of attitudes and intentions as relatively static predictors of behavior toward a broader perspective based on goal-directed inferences and compatibility with the individual's belief system.

## **Classical models of behavior**

Several theoretical models have been developed to explain how behavior originates, often by introducing constructs such as attitudes, intentions, or by appealing to dual-system explanations that distinguish between reflective and automatic processes.

Fishbein and Ajzen's work provides one of the most influential frameworks for predicting behavior. The Theory of Reasoned Action (TRA; Fishbein & Ajzen, 1975) posits that behavior is directly determined by behavioral intentions, which in turn are shaped by two components: attitudes toward the behavior and subjective norms. Attitudes reflect evaluations of performing the behavior, whereas subjective norms capture perceived social pressure to perform or not perform the behavior. A core assumption of TRA is that, when individuals have full control over their actions, intentions constitute a sufficient and proximal predictor of behavior. A subsequent extension of the Theory of Reasoned Action is the Theory of Planned Behavior (TPB; Ajzen, 1991). TPB retains the central role of intention but introduces perceived

behavioral control, which represents beliefs about one's capacity to perform the behavior. By explicitly accounting for non-volitional influences on action, TPB substantially broadened the scope of TRA and demonstrated strong empirical support across a wide range of behavioral domains. Building on TPB, the Reasoned Action Approach (Fishbein & Ajzen, 2010) further refines the model while preserving its core assumptions. Like TRA and TPB, this framework retains intentions as the proximal determinant of behavior, while emphasizing the role of underlying behavioral, normative, and control beliefs in shaping attitudes, perceived norms, and perceived behavioral control. A key contribution of the Reasoned Action Approach is its explicit attention to background variables, such as personality, culture, and past behavior, which are assumed to influence behavior indirectly through their effects on beliefs. Building on the TPB, Perugini and Bagozzi (2001) proposed the Model of Goal-Directed Behavior (MGB), which retains the main predictors of TPB, but embeds them within a more explicitly motivational architecture. In the MGB, intentions are complemented by desires, defined as motivational states reflecting how much individuals want to perform a behavior given its anticipated outcomes. Desires are shaped not only by attitudes, norms, and perceived control, but also by anticipated emotions, that is, affective reactions expected to follow successful or unsuccessful goal attainment. By introducing desires as a core motivational construct, the MGB aimed to extend the TPB by providing a more explicit account of the motivational basis of action.

The Motivation and Opportunity as Determinants (MODE; Fazio, 1990) model proposes that attitudes can influence judgments and behavior through both spontaneous and deliberative processes, with motivation and opportunity determining which pathway is likely to operate. When motivation or opportunity for deliberation is low, attitudes may be automatically activated upon encountering the attitude object and directly guide perception,

judgment, and behavior without conscious reflection. By contrast, when individuals are sufficiently motivated and have the cognitive resources and time to deliberate, attitudes can influence behavior through effortful, reflective processes involving the evaluation of behavioral alternatives and their consequences. The model further allows for mixed sequences in which automatic and controlled components interact, emphasizing that any controlled correction of automatically activated attitudes requires both motivation and opportunity to engage in deliberate processing.

According to the Reflective–Impulsive Model (RIM; Strack & Deutsch, 2004), behavior is determined by the joint operation of two qualitatively distinct systems: a reflective system and an impulsive system. The reflective system operates through propositional reasoning, is capacity-limited, and relies on conscious deliberation. It generates behavioral decisions based on evaluations, norms, and expectancies. The impulsive system, by contrast, operates automatically through associative links, activating behavioral tendencies in response to situational cues and affective states. Within the RIM, behavior results from the joint activation of behavioral schemata by the reflective and impulsive systems. When both systems converge on the activation of the same behavioral schemata, action execution is facilitated, requiring fewer cognitive resources. In contrast, when the two systems activate incompatible schemata, reflective control can prevail only if sufficient cognitive resources are available; otherwise, impulsive processes are more likely to dominate behavior.

## **Toward more integrative accounts of behavior**

Taken together, the models reviewed above have substantially advanced the understanding of how evaluations and beliefs relate to behavior, particularly by clarifying the

role of intentions as proximal predictors of action, while also taking into account the role of automatic processes. At the same time, more recent goal-directed models (Moors et al, 2017) and predictive processing accounts (Friston, 2010; Clark, 2016) offer broader process-oriented perspectives that can extend these frameworks. With respect to models such as the TRA and the TPB, complementary frameworks allow for a more explicit consideration of how behavior is shaped by the hierarchical organization of goals, as well as contextual goal activation. From this perspective, behavior is not simply the downstream expression of attitudes and intentions, but reflects the resolution of trade-offs among multiple, competing goals and the selection among alternative behavioral options through which these goals may be pursued.

Beyond these considerations, broader approaches also enrich dual-process accounts of behavior. While models distinguishing between reflective and automatic pathways (e.g., MODE, RIM) posit that deliberative processing operates primarily when sufficient cognitive resources and motivation are available, recent perspectives emphasize that complex information (e.g., about multiple action-outcome links) integration can be possible also under time constraints (Moors et al., 2017; Van Dessel et al., 2024). For example, Moors and colleagues (2017) noted how empirical evidence indicates that individuals can integrate values and expected outcomes rapidly and without explicit awareness, as demonstrated by findings showing advantageous decision-making in the absence of articulated knowledge of underlying outcome utilities (Bechara et al., 1997; Hassin, 2013; Mudrik et al., 2014). Moreover, such approaches place less emphasis on the impulsive-reflective distinction, instead allowing for the possibility that even fast and efficient actions remain sensitive to goal-relevant information. Finally, by treating attitudes, intentions, and related constructs as dynamically updated, these perspectives offer a more flexible account of behavioral variability across situations, highlighting how behavior can adapt to changing contexts through continuous belief updating.

## **Predictive processing and behavior generation**

Predictive processing provides a unifying framework for understanding perception, cognition, and action as components of a single, unified inferential architecture. This approach conceptualizes the cognitive system as a hierarchical prediction engine that continuously generates expectations about sensory input and updates these expectations in light of prediction errors, that is, mismatches between expected and actual states of the world (Friston, 2010; Clark, 2016). Although predictive processing is often introduced as a theory of perception, its implications for behavior are central. Within this framework, behavior emerges through active inference: organisms act to bring the world into line with their predictions, thereby minimizing expected prediction error over time (Friston et al., 2016). From this perspective, behavior is itself a form of prediction fulfillment. Rather than assuming that attitudes or intentions causally precede behavior, predictive processing treats behavior as the enactment of the system's best current hypothesis about what it will do in a given context. These hypotheses are shaped by prior experience, contextual cues, and higher-order expectations about the self and the environment. A key advantage of predictive processing is its intrinsic sensitivity to context, with predictions and error minimization dynamically shaped by goals, tasks, and environmental constraints (Pezzulo et al., 2018; Butz et al., 2025).

## **A Goal-Directed Perspective on behavior**

While predictive processing provides a general computational architecture for action, it does not, by itself, specify how goals structure behavior. Goal-directed theories, such as the Goal Directed Perspective (GDP, Moors et al., 2017) introduced in the previous chapter, clarify how actions are selected in light of desired outcomes. According to GDP, behavior is guided

by the evaluation of available action options in terms of their expected utility in serving desired outcomes, and by the value assigned to these outcomes (Moors et al., 2017). A central claim of GDP is that goal-directed processes are not exceptional or resource-intensive mechanisms reserved for deliberative control. Instead, they are proposed to be the default drivers of behavior, operating even under conditions of limited time or attention (Moors et al., 2017). What differs across situations is not whether behavior is goal-directed, but which goals are active and how behavior–outcome expectancies are weighted. This position challenges standard dual-process models, which assume that stimulus-driven or impulsive processes dominate behavior by default. Importantly, goal-directed theories highlight the role of goal competition. Individuals typically pursue multiple, hierarchically organized goals, which may be simultaneously activated and mutually incompatible. Behavior emerges from the resolution of this competition, favoring actions that are expected to satisfy higher-priority or more salient goals in a given context.

Integrating the goal-directed perspective with predictive processing yields a powerful framework for understanding behavior change. Indeed, goals can be conceptualized as higher-level priors that shape behavioral predictions, while action–outcome beliefs determine which predictions are most likely to minimize expected prediction error. From this integrated standpoint, behavior change does not solely require altering attitudes or strengthening intentions. Instead, it requires restructuring the inferential pathways through which goals, beliefs, and contextual information give rise to behavioral predictions. This insight sets the stage for the integrative framework introduced in the following section, in which behavior is modeled as the outcome of goal-directed inference chains rather than as the terminal point of a linear causal sequence.

## **Project 6: From Goal-Directed Inference Chains to Action: An Integrative Framework for Promoting Sustainable Behavior<sup>7</sup>**

### **Abstract**

Addressing climate change requires behavior change - not just in daily actions, but also in how people develop and adopt broader solutions. However, existing interventions often fail to leverage insights from cognitive science on how individuals adopt and maintain pro-environmental behaviors. The EFPA opinion paper calls for integrative, evidence-based approaches that bridge individual cognition with collective transformation (Kalwak et al., 2024). In response, this paper introduces the Goal-Directed Predictive Processing (GDPP) framework, which models behavior as emerging from dynamic inference chains linking goals, beliefs, and behavioral predictions. We demonstrate the framework's utility through applications to a range of climate-relevant behaviors and provide a structured intervention pathway, illustrated with a case analysis of insect-based food consumption. This approach offers a scalable, mechanistic basis for fostering sustainable behavior change.

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<sup>7</sup>Project 6 is based on Van Dessel, P., Fedeli, F., Zogmaister, C., & Boddez, Y. (2025). From Goal-Directed Inference Chains to Action: An Integrative Framework for Promoting Sustainable Behavior. The manuscript is currently under revision at *European Psychologist*.

## Introduction

Amid the growing scientific consensus on the urgency of climate change and its far-reaching ecological and societal impacts (IPCC, 2023), it is increasingly understood that the implementation of effective solutions crucially depends on human behavior. Whether in the development and adoption of low-carbon technologies, the design and acceptance of environmental policies, or the transformation of consumption patterns and lifestyle choices, behavioral factors are central across all levels of climate action (Gifford, 2011; Stern, 2000). As such, psychology plays a pivotal role in understanding and influencing how individuals and communities engage with both systemic and personal dimensions of sustainability.

Over the past two decades, psychological research on climate change has evolved rapidly, encompassing a wide array of topics including risk perception (van der Linden, 2015), motivational barriers (Gifford, 2011), social norms (Nolan et al., 2008), identity processes (Fielding & Hornsey, 2016), and emotional responses such as eco-anxiety (Clayton et al., 2014; Pihkala, 2020). Despite this broadening scope, many interventions still rely on linear, information-based models, which often overlook the dynamic interplay between goals, beliefs, inferences, and contextual cues that shape behavior (Weber, 2013).

The EFPA opinion paper on the psychology of climate change (Kalwak et al., 2024) echoes a growing call for integrative frameworks that connect individual cognition to collective transformation. We respond by advancing a framework grounded in predictive processing (Clark, 2016; Friston, 2010) and goal-directed theories (Kruglanski et al., 2002; Moors, 2022). This model explains both overt actions (e.g., transport, consumption) and covert responses (e.g., eco-anxiety, disengagement) as outcomes of inference chains - automated, largely unconscious processes where individuals predict their own context-appropriate actions based

on active goals and associated beliefs. It provides a framework for intervention by identifying the cognitive components most amenable to change and the conditions under which these can be aligned to foster pro-environmental action.

This paper first introduces the new model, integrating insights from predictive processing, goal-directed theories, and belief updating to explain sustainable behavior. It then outlines how goal-directed inference chains can account for both overt and covert responses to climate change and discusses a multi-level intervention framework grounded in this model, covering individual, community, and policy contexts. Finally, it illustrates the model's practical utility through a targeted case study on insect-based food consumption.

## **Goal-Directed Predictive Processing and the architecture of inference chains**

Designing effective interventions for climate-related behavior requires an empirically grounded theory of action generation in context. A first foundational insight in behavioral science is that behavior emerges from the activation of beliefs (Ajzen, 1991; Fazio, 1990). These beliefs are embedded in broader networks of compatibility - for example, beliefs about climate change and the need to counteract it are often accepted or rejected based on their coherence with political identity or cultural values. A second key insight is that among the beliefs influencing behavior, those concerning the value and attainability of goals are critical (Locke & Latham, 2006; Moors, 2022). When individuals believe a goal (e.g., “reducing emissions”) is worthwhile and achievable, they are more likely to pursue it.

While foundational, these hypotheses require further specification to inform effective interventions - understanding how beliefs are selected, enacted, or translated into real-time behavior in specific contexts is key. Recent work in cognitive psychology and neuroscience

suggests that behavior emerges through predictive inferences - dynamic processes whereby individuals use prior experiences, activated beliefs, and motivational states to predict the most appropriate actions in a given situation (Friston et al., 2016; Clark, 2016; Pezzulo et al., 2018). These processes form what we term inference chains: context-sensitive sequences of activated beliefs through which contextual cues shape behavior.

### **Predictive processing and goal-directed theories**

Predictive processing theories conceptualize the brain as a hierarchical prediction engine. It continuously generates probabilistic models of the environment to minimize prediction error - the discrepancy between expected and actual input (Friston, 2010). While originally developed to explain sensory perception, this framework extends to action: Organisms act to bring sensory input in line with their predictions. This process, known as active inference, suggests that behavior is a means of minimizing prediction error by aligning external states with internal predictions (Clark, 2016; Parr et al., 2022).

Imagine a consumer in a grocery store, committed to sustainable consumption. If they expect an "organic" product to be sustainably packaged, finding it wrapped in single-use plastic generates a prediction error. To resolve this, the individual may update their beliefs - revising what they associate with "sustainable" in light of the new information – or engage in behavior such as scanning for alternatives that align with their expectations, or seeking additional sustainability cues, like eco-labels.

Complementary to these insights, goal-directed theories posit that behavior is organised around hierarchically structured goals (Kruglanski et al., 2002). A recent theory by Agnes Moors (2022) explains behavior through a goal-directed cycle where behavior emerges from comparisons between current and desired states (i.e., goals). When a discrepancy is detected,

the cognitive system can engage in several types of regulation: reinterpretation of the current state to make it consistent with the goal, revision of the goal, or initiation of behavior aimed at resolving the discrepancy. Revisiting the grocery store example, a person committed to sustainable consumption who encounters an organic product in plastic may initially experience dissonance. To reduce this discrepancy, they might rationalize that the packaging is recyclable or industry standards are changing (state reinterpretation), lower the priority of their packaging-related standards (goal revision), or choose a different product (behavioral strategy).

Both predictive processing and goal-directed theories converge on the view that behavior is driven by dynamic, context-sensitive strategies for restoring alignment between internal states and external circumstances. Yet they offer distinct focuses: Predictive processing focuses on predictive inferences and minimizing prediction error through model updating, while goal-directed theories describe how organisms select strategies based on their expected utility – how effectively these are anticipated to reduce the discrepancy between current and desired states.

### **Integrating theories: the Goal-Directed Predictive Processing (GDPP) framework**

To connect these theoretical perspectives, the Goal-Directed Predictive Processing (GDPP) framework integrates predictive processing with goal-directed processes (Van Dessel & Boddez, 2025). It models behavior as emerging from dynamic inference chains structured around three central types of inference (Figure 5).

(1) Goal-Activation Inference (I1). In every situation, the cognitive system constructs a model of the self and the environment. When sensory input deviates from expectations, the resulting prediction error is assessed for its compatibility with prior beliefs. This assessment

activates beliefs about what a person values and about their desired states (i.e., goals). For example, seeing single-use plastic on an organic product may violate expectations, prompting the system to evaluate the implications of this discrepancy and activate goals and values related to environmental protection.

(2) Action-Outcome Inference (I2). Once a goal is activated, the system infers which beliefs in the mental model can be updated to achieve this goal. This may involve beliefs about actions one may take, hence evaluating which candidate behaviors they might engage in to fulfil the activated goal. In our example, the system may consider updating the belief that the person will purchase the plastic-wrapped product and instead predict that seeking an alternative product with recyclable packaging will better reduce the discrepancy.

(3) Behavioral Prediction (I3). In the final step, the system forms a prediction about whether a particular behavior will actually be carried out. This prediction arises when the cognitive system comes to the conclusion that performing that behavior is the most effective strategy to reduce incompatibility with prior beliefs - a process often described in predictive processing as the minimization of expected surprise or entropy (Van Dessel & Boddez, 2025). In the grocery example, the system may consider several behavioral options - such as ignoring the packaging, seeking more information, or selecting an alternative product - and predict which of these best accords with prior beliefs (e.g., “I am someone who makes thoughtful choices”). If walking to a different aisle and choosing another product is predicted to reduce incompatibility most effectively, this belief is enacted, resulting in the behavior.

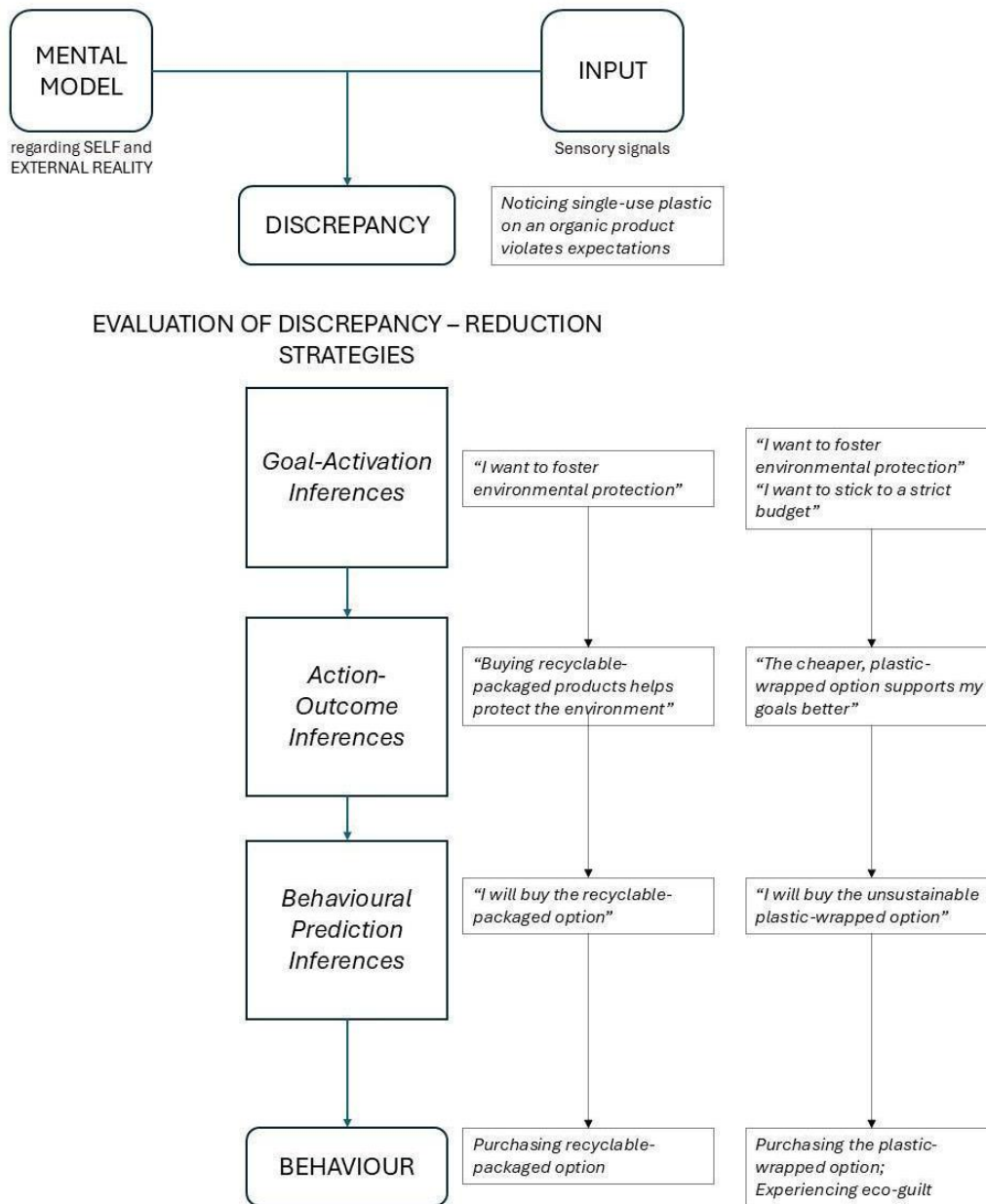


Figure 5. P6. Structure of inference chains in the GDPP model, illustrated with a scenario with divergent behaviors

Central to this framework is the idea that behavior results from behavioral predictions (I3): individuals act not merely when they believe a behavior is good or effective, but when they predict they will engage in it. These predictions are shaped by contextual cues and compatibility with prior beliefs, and most particularly self-concept beliefs - beliefs about what a person values and what behaviors one tends to perform (e.g., “I’m someone who avoids

plastic waste”). These beliefs are often resistant to change and deeply generative in shaping action patterns (Bandura, 1977; Rosenberg, 1979).

### **Inference chains in climate-related behavior**

In this section, we apply the model to explain when and why sustainable behaviors are enacted. We first focus on overt behavior and then explore how repeated inference patterns can lead to habitual behaviors, before turning to covert psychological responses such as eco-anxiety and disengagement.

#### **How overt pro-environmental behavior emerges: a process of self-prediction**

According to the GDPP framework, pro-environmental behavior results from dynamically constructed inference chains. For example, to explain why an individual decides to bike or drive to work, traditional models might refer to static constructs such as attitudes (e.g., “biking is fun”), intentions (e.g., “I intend to bicycle more”), or values (e.g., “biking is important for me”). Instead, the GDPP framework models this decision as an inferential process of self-prediction. A person valuing sustainability may still drive to work if the goal of efficiency is more salient in that moment, leading them to predict that acting on this belief minimizes incompatibility with other beliefs.

This dynamic can explain well-documented inconsistencies between values and behavior, often referred to as the “value-action gap” (Kollmuss & Agyeman, 2002), interpreted by the GDPP framework as a natural outcome of competing, context-dependent inference chains. Sustainable behavior occurs when the chain favouring pro-environmental action outcompetes alternatives in terms of predicted utility. Conversely, inaction or unsustainable action does not necessarily reflect a lack of knowledge or concern, but may instead result from

the momentary dominance of alternative predictions when sustainability-related goals are not activated or do not integrate well with other beliefs in that context.

### **Habitual behavior and goal inertia**

While behaviors are constructed dynamically, predictive processing mechanisms may favour the emergence of repeated patterns of behavior or habits. In the GDPP framework, this occurs when particular goal-action-outcome pathways are repeatedly enacted – such as when environmental cues reliably activate the same goals and behavioral predictions (for related work see Buabang et al., 2023; Van Dessel et al., 2024). Over time, these reinforced pathways become high-probability priors in the system’s generative model, making certain behaviors more readily predicted and enacted.

For example, using disposable packaging for convenience may initially be a pragmatic choice. But if repeatedly enacted in contexts where the efficiency goal is prioritized, the inference that “I will buy pre-packaged food” becomes a dominant behavioral prediction. Even when new sustainability goals are introduced (I1) - such as reducing waste - these may fail to shift behavior unless the downstream inference chain (I2–I3) is restructured.

This perspective helps explain why information-based interventions often fall short (Weber, 2013): They may not sufficiently alter the inferential architecture through which behavior is generated. To change habitual patterns, interventions must target the cues, priors, or prediction structures that make sustainable options not only cognitively available but also predictable as enacted behavior.

### **Covert psychological responses: from eco-anxiety to disengagement**

The GDPP framework argues that the same inferential processes underlie both overt actions and covert experiences such as thoughts and feelings. Specifically, conscious

experiences are also understood as resulting from predictions of enacting (covert) behavior (i.e., having the conscious experience) that emerge when this prediction best fits activated beliefs (Van Dessel & Boddez, 2025). This perspective may account for covert psychological responses to climate change, such as emotional distress, denial, or disengagement.

A prominent example is eco-anxiety. An individual may perceive environmental harm, activating a high-level goal of safeguarding planetary protection (I1). Yet if no effective action is inferred (I2), the system cannot predict that any behavior will reduce the discrepancy (I3), and instead may infer that emotional distress (e.g., anxiety, helplessness, or frustration) is the most likely response. In this way, the emotion is not a failure of prediction, but the result of the system's attempt to resolve an important discrepancy through a plausible experiential prediction (Van de Cruys & Van Dessel, 2021; Pihkala, 2020).

Alternatively, some individuals may reduce such discrepancy through updating beliefs about the current state of affairs (e.g., denying climate change) or about the value or feasibility of climate-related goals. This may manifest as denial or disengagement, which, from the GDPP perspective, are not irrational responses but strategic inference resolutions when actionable behavioral predictions are not available.

## **Designing inference-based interventions**

The Goal-Directed Predictive Processing (GDPP) framework offers a conceptually integrated approach to designing behavioral interventions. Rather than opposing traditional models that emphasize values, intentions, or information deficits, GDPP formalizes the inferential processes by which these factors translate - or fail to translate - into action. At its core, GDPP provides a structure for understanding how context-sensitive prediction chains link activated goals to behavioral outcomes via beliefs and expectations.

## **Core principles of inference-based intervention design**

Intervening in behavior, from this perspective, means reshaping the cognitive architecture that generates behavior: the inference chain that connects a goal (I1), to the belief that a specific behavior will serve that goal (I2), and finally to the prediction of actually carrying out the behavior (I3). This final prediction is critical: behavior occurs when predicted to be enacted, because doing so reduces incompatibility with other beliefs more effectively than other available updates.

Designing effective interventions, therefore, involves two interdependent tasks. The first step is to diagnose the structure of inference chains as they typically unfold in the target population within relevant behavioral contexts. This involves identifying the beliefs that guide goal activation (I1), action-outcome inferences (I2), and behavioral predictions (I3). Specifically, one can assess which goals activate in specific settings, how individuals connect these to potential behaviors, and which behaviors they tend to predict themselves performing. Mapping this structure includes examining contextual cues, prior experiences, and self-concept beliefs that influence whether certain actions are expected to minimize incompatibility with other beliefs. For example, in the context of sustainable food choices, individuals may hold pro-environmental values but act on the belief that meat-based meals are easier to prepare or more socially acceptable. Diagnosing this pattern reveals which parts of the inference chain may require strengthening or restructuring.

The second step is to design interventions that promote inference chains in which the desired behavior becomes the most predictively coherent and uncertainty-reducing option. This requires understanding how to shift the beliefs and contextual cues that influence inference construction. Interventions must foster environments where individuals not only activate relevant goals, but also infer that a specific action will effectively serve those goals and,

crucially, predict that they will enact the behavior. This can be achieved by either shaping environments that foster new inference patterns that generalize across contexts or adapting choice environments to cue inferences that align with existing beliefs and goals (Van Dessel et al., 2022).

A key consideration here is the zone of proximal development (Vygotsky, 1978): Interventions should aim for belief shifts and behavioral predictions that are plausible within the individual's current model. For example, encouraging a recreational biker to commute by bike may require a belief update that is feasible and might be reliably enacted by cuing sustainability or health goals. In contrast, for someone with no biking experience, public transportation may be a more predictable and actionable alternative. Similarly, linking behaviors to goals that already structure self-concept beliefs - such as health, responsibility, or identity - can enhance the predictive coherence of the behavior, making it more likely to be enacted.

### **Designing effective inference-based interventions in practice**

Building on the core principles outlined above, this section illustrates how the GDPP framework can be translated into actionable intervention strategies. By modelling behavior as the outcome of inference chains, it allows practitioners to target the specific points where behavior is most likely to falter. We discuss how this approach applies across individual, community, and policy contexts, highlighting techniques that align with the structure of inference chains and support effective behavior change.

#### **Individual-level interventions**

Effective interventions may require a clear diagnosis of how inference chains typically operate in context (Van Dessel & Boddez, 2025). Individuals may readily activate pro-

environmental goals (I1) but fail to engage in corresponding actions if they infer that these behaviors are inconvenient or ineffective (a breakdown at I2), and/or they may not predict themselves enacting them (I3) (Weber, 2013; Kollmuss & Agyeman, 2002). In such cases, belief updating can target the specific inferences that falter by selecting suitable techniques. For instance, goal framing can recontextualize sustainable behavior as aligning with convenience or personal relevance (van der Werff et al., 2013); implementation intentions can increase the likelihood that individuals predict themselves following through on sustainable actions by anchoring them to concrete cues (Gollwitzer, 1999); and social norm interventions can increase perceived efficacy by showing that others are acting successfully (Goldstein et al., 2008).

The GDPP model emphasizes the importance of aligning interventions with individuals' existing belief systems in the zone of proximal development. This means targeting beliefs that are close enough to current models to be realistically updated. Encouraging someone who already cycles recreationally to commute by bike is more feasible than promoting a complete shift from car use. Similarly, it may be more effective to relate desired behavior to goals other than sustainability - such as health or responsibility - depending on the audience (e.g., among individuals with more conservative political orientations; Steg et al., 2014; Bolderdijk et al., 2013).

This logic also extends to emotional responses. Emotions such as eco-anxiety can be understood as outcomes of unresolved prediction error (Van de Cruys & Van Dessel, 2021; Boddez et al., 2022), and interventions can help redirect this affective state by supporting feasible and meaningful actions. Enhancing self-efficacy and promoting identity-congruent behaviors increases the likelihood that individuals generate positive behavioral predictions, thereby transforming distress into motivated engagement (Clayton et al., 2014; Pihkala, 2020).

This resonates with the principles of cognitive-behavioral therapy (CBT; Beck, 2011), which may teach individuals to regulate emotions through the development and application of adaptive beliefs - a strategy that accords with the belief updating mechanisms described in the GDPP framework.

### **Community and organizational-level interventions**

While the GDPP model focuses on individual inferential processes, it naturally extends to collective behavior through shared beliefs and environmental cues. Inference chains are influenced by environmental regularities that signal which beliefs and behaviors are effective, appropriate, or expected. Designing environments that promote the formation and reinforcement of context-specific inference chains enables interventions to scale across social and institutional levels. This involves creating settings where groups of individuals learn to predict that sustainable actions are appropriate, effective, and personally enactable.

For instance, consistent exposure to visible sustainability practices, decision architectures that foreground green choices, and leadership modelling sustainable behavior can serve as learning contexts where individuals infer which behaviors align with their identity and the social setting. Similarly, norm-based interventions (e.g., public pledges, energy use feedback, visible sustainability commitments: Yamin et al., 2019) may support inferences like, "In this setting, people like me act sustainably" which can be effective if they foster inferences that align with self-concept beliefs. By targeting how groups of people predict their own behavior in social contexts, interventions can foster consistent, context-sensitive pathways for sustainable action.

### **Policy-level interventions**

At the policy level, inference-based design involves shaping the broader environment in which individuals form predictions about sustainable behavior. Effective policies facilitate the construction of inference chains by activating widely shared goals (e.g., safety, fairness), clarifying the causal links between behaviors and desirable outcomes, and fostering confident behavioral predictions. Crucially, policies should address the entire inference chain in ways that are compatible with widely shared beliefs and values.

Several interventions can be considered. On the one hand, environments can cue relevant beliefs such as by consistently linking sustainable behavior to positively valued outcomes. For instance, public messaging that frames climate policy in terms of fairness or national resilience may activate goals already endorsed across diverse audiences. Public commitments by institutions, visible sustainability investments, and default policy settings (e.g., opt-out green energy programs) serve as inferential cues that help individuals predict sustainable behavior as appropriate, endorsed, and expected.

On the other hand, policies can foster belief change by altering contingencies - shaping the regularities through which people learn which beliefs and behaviors are viable. This includes incentives, infrastructure, and institutional practices that reinforce the outcomes of sustainable action. Over time, these structured environments help individuals develop new belief models, particularly when aligned with widely shared goals such as autonomy, competence, and relatedness (Deci & Ryan, 2012). Ultimately, the goal is to create policy environments in which sustainable action becomes the most self-evident, predictable, and psychologically coherent course of behavior.

## **Applying the GDPP framework to insect-based food consumption**

To illustrate how the GDPP framework can guide both the analysis and design of behavioral interventions, we apply it to a concrete and timely case: insect-based food (IBF) consumption. This area offers a rich testbed for the framework due to the well-documented gaps between pro-environmental values and actual behavior, strong social and cultural influences, and a growing body of empirical interventions.

Insect-based foods (IBFs) have emerged as a promising substitute for conventional animal protein due to their high nutritional value and lower environmental impact, requiring fewer resources and producing fewer greenhouse gas emissions (FAO, 2021; Lisboa et al., 2024). Despite these advantages, widespread adoption in Western markets has proven challenging (Castro & Chambers, 2019; Kröger et al., 2022). Moreover, even when people explicitly recognize IBF consumption as desirable, this evaluation rarely translates into consumption behavior (Willeke et al., 2025). Designing effective interventions requires understanding the inference chains that underlie food choices and identifying where they can be shifted to support IBF consumption.

In terms of diagnosing the inference chains that may underlie resistance to IBF, studies highlight how inferences related to food neophobia or associations with disgust can inhibit adoption (e.g., Tan et al., 2016; Tuccillo et al., 2020). Interventions do not typically target these inferences explicitly. Instead, they vary considerably in focus. Some aim to enhance the salience of specific goals such as sustainability or health, others seek to alter expectations regarding outcomes like taste or safety, while others focus on increasing alignment with self-concept beliefs. Using the GDPP framework, we categorize these interventions based on the

inference they may impact: goal activation (I1), action-outcome inference (I2), or behavioral prediction (I3).

### **Targeting goal-activation inferences**

The first key element of an effective intervention is to target goal-activation inferences relevant to the consumption of IBFs. Accordingly, understanding which goals effectively drive food choices is paramount. Research consistently shows that goals play a central role in shaping food choices. The key goals consistently ranked as the most influential in guiding food-related behavior are those related to taste, price, safety, nutritional value, environmental impact, convenience, and social relationships (Connors et al., 2001; Eertmans et al., 2001; Lusk et al., 2009; Sobal & Bisogni, 2009). In the case of IBFs, the novelty of insect-based foods in many Western cultures also attracts consumers who desire new experiences and sensations, with several studies identifying curiosity as a goal driving consumption (Tan et al., 2016; Tuccillo et al., 2020; Penedo et al., 2022; Andric et al., 2023).

Once relevant goals are identified, they can be strategically activated through internal cues - such as prompting reflection on dietary habits - or external ones, like political campaigns promoting certain values (Leonard et al., 2008). Priming techniques, such as videos on environmental protection (Bimonte et al., 2020) or presenting foods in environmentally themed settings (Friis et al., 2017) may also increase goal salience. By shaping the context in these ways, interventions can promote goal-activation inferences for IBF consumption.

### **Targeting action-outcome inferences**

Once a relevant goal is activated, the next key element of effective intervention involves inducing the prediction that a specific action, in this case, consuming IBF, is likely to help attain that goal. In this context, this means inferring that eating IBF will lead to desirable

outcomes such as environmental sustainability, health benefits, or social approval. A substantial amount of research has focused on interventions aimed at modifying this inference.

One of the most widely adopted strategies involves providing consumers with comprehensive information about the benefits of IBF consumption (Ros-Baró et al., 2022; Zugravu et al., 2023). Numerous studies have investigated the use of informational campaigns and targeted messaging to emphasize the environmental consequences, such as lower greenhouse gas emissions and reduced land and water usage associated with insect farming (Mancini et al., 2019; Wendin et al., 2021; Michel et al., 2023). Other interventions focused on the nutritional benefits by highlighting their high protein content and optimal nutritional values (Gassler et al., 2024). By providing this information, these interventions may promote the inference that choosing IBF will lead to desirable outcomes for both their health and the environment. However, evidence suggests that while such information can improve attitudes and intentions, its impact on actual behavior tends to be limited (Hoek et al., 2011) - according to GDPP theory because parts of the inference chain or contextual barriers remain unaddressed.

The format in which insect-based foods are presented may also influence consumers' outcome inferences (Puteri et al., 2023). Research suggests that processed insects, where the original appearance is less visible, are generally more accepted by consumers than whole, unprocessed insects (Kulma et al., 2023). Ros-Baró and colleagues (2022) found that respondents preferred IBF in the form of familiar products (also Halonen et al., 2022), with insect flour being the most favoured format. Tan et al. (2016) similarly found greater willingness to eat insects when they were incorporated into a burger rather than served on their own. By embedding IBF in familiar formats, interventions may reduce prediction error, aligning the product more closely with food appearance predictions, while also fostering positive taste inferences.

Interventions can also leverage social goals by highlighting that insect consumption is becoming increasingly common, thereby framing the act of eating insects as a way to conform to social norms. Research by Jensen and Lieberoth (2019) demonstrates that individuals' subjective beliefs about insect-eating norms significantly predict their tasting behavior, and the importance of social norms has been further supported by recent findings (Merlino et al., 2024). Relatedly, social learning may shape action-outcome inferences. For instance, observing peers affects pre-trial expectations and taste evaluations of products such as mealworm-based nutrient bars (Berger et al., 2019). Similarly, when peers express positive views on food safety and palatability, participants tend to report higher willingness to taste IBF (Sidali et al., 2019). Recent studies also provide evidence that learning about others' acceptance or rejection of IBF significantly influences participants' attitudes and intentions toward these products (Fedeli et al., under review) and that showing videos in which people eat IBFs, or pairing these foods with emotional reactions, is an effective strategy to improve IBF evaluations (Zogmaister et al., in preparation).

### **Interventions targeting behavioral prediction inferences**

The final step for IBF consumption, according to the GDPP model, involves predicting to engage in the action of IBF consumption based on an assessment that this aligns best with the individual's broader belief system and self-concept. Even if a goal is activated and a behavior inferred to support that goal, the action is unlikely unless it is also predicted as personally enactable.

Interventions targeting this inference aim to strengthen the self-prediction that the individual will engage in IBF consumption. Encouraging consumers to make a commitment to try IBFs may target the prediction that they will indeed engage in this behavior. This can

involve simple pledges or more formal commitments to consume IBF. Furthermore, forming implementation intentions specifying when, where, and how the behavior will be enacted has been shown to be effective in supporting a sustainable consumption shift (Loy et al., 2016).

Previous self-guided consumption experiences with IBF can also reinforce strong priors that one has engaged in IBF consumption before, making such experiences more likely to be considered on future occasions. Relatedly, tasting sessions have proven effective in shifting both sensory-liking and perceived food appropriateness, with a significant increase in sensory-liking observed after tasting burgers labelled as containing mealworms (Tan et al., 2016).

Importantly, behavioral predictions are shaped by broader self-concept beliefs. The GDPP framework proposes that behaviors are more likely to be enacted when consistent with an individual's broader system of beliefs and self-related concepts. For example, a person identifying as vegetarian will likely predict - and enact - vegetarian behavior in a given context, because this aligns with their self-concept. The same principle applies to IBF: individuals are more likely to consume IBF when the behavior coheres with self-beliefs, such as identifying as someone who values sustainability, health, or novelty.

Interventions are therefore most effective when they do not merely make a behavior seem possible, but make it feel like a natural extension of who the person already is - or could plausibly become. By reinforcing consistency between the action and the self-model, they increase the likelihood that the belief "I will do this" is inferred and enacted. Importantly, this does not mean only one narrative can be effective. Rather, diverse entry points can be emphasized to resonate with different self-concepts (e.g., linking IBF consumption to environmental protection, curiosity and adventure, cultural identity, or non-conformity with mainstream culture). In this way, interventions can flexibly scaffold the inference chain in alignment with multiple belief systems.

### **Interventions integrating all 3 inferences**

The diverse strategies reviewed above suggest that many behavior change efforts can be understood as targeting different components of the inference chain. Still, the numerous intervention strategies, ranging from informational campaigns to experiential tastings, have typically produced mixed and often inconsistent results (Arena et al., 2020; Lensvelt & Steenbekkers, 2014). This variability suggests that they may fall short by addressing only isolated elements - such as goal salience or outcome expectations - without aligning the full inferential sequence required for action. The GDPP framework offers a dynamic solution to this impasse by reconceptualizing behavior (change) as the outcome of three interdependent inferences driven by specific prediction-updating mechanisms.

Specifically, in the case of IBF consumption, this means interventions must work in concert to ensure that (1) relevant goals such as environmental responsibility or health consciousness are activated (goal-activation inference); (2) the action of consuming IBFs is perceived as an effective means to achieve those goals (action–outcome inference); and (3) individuals can plausibly predict themselves engaging in that action (behavioral prediction inference). When the full inference chain is supported, behavior becomes the most contextually coherent response - making it more likely to be enacted and repeated. This structured, prediction-oriented approach offers a theoretically grounded and empirically actionable model for designing more effective interventions, not only for IBFs but for a wide range of sustainable behaviors.

### **Conclusion**

As the urgency of the climate crisis intensifies, the demand for behaviorally informed, psychologically grounded interventions continues to grow. Yet many existing models remain

constrained by static constructs such as values, knowledge, or intentions, failing to account for the context-sensitive, inferential nature of behavior. In this paper, we discussed the Goal-Directed Predictive Processing (GDPP) framework - an integrative model that explains sustainable and unsustainable behaviors as the output of dynamically generated inference chains.

We demonstrated how this framework can guide intervention design across individual, community, and policy levels. By diagnosing inference chains and identifying beliefs within the zone of proximal development, interventions can be tailored to shift predictions in realistic, identity-congruent ways. This was illustrated through a detailed analysis of insect-based food consumption, showing how each step of an inference chain – goal activation, action-outcome inference, and behavioral prediction - can be strategically targeted to support sustainable behavior change.

In sum, the GDPP framework provides both theoretical clarity and practical utility. It reorients the study of climate behavior from static traits to dynamic prediction mechanisms. By viewing behavior as an emergent property of inferential processes, the framework equips interventionists with a powerful toolkit for creating conditions in which sustainable actions become not only probable but natural and self-reinforcing responses to the challenges of our time. Future research should empirically map these structures, refine intervention techniques, and explore how belief updating unfolds across cultural and institutional contexts.



## Chapter conclusion

This chapter has traced a progression from classical attitude–intention models to more recent process-oriented accounts of behavior, culminating in the introduction of the Goal-Directed Predictive Processing (GDPP) framework. By integrating predictive processing with goal-directed theories, GDPP provides a principled account of how attitudes, goals, beliefs, and contextual cues jointly shape behavior through dynamic inference chains, rather than through linear causal pathways. The embedded manuscript formalizes this perspective and discusses its relevance for understanding and promoting sustainable behavior. Building on this theoretical synthesis, the final chapter of the thesis returns to the overarching research questions and empirical findings, drawing general conclusions, outlining implications for the study and measurement of behavior change, and critically reflecting on the strengths and limitations of the present work.



## Chapter 5. General discussion

### Overview of the thesis and main results

This thesis examined how attitudes toward pre-existing negative stimuli can be measured and modified, and offered a theoretical reflection on the conditions under which such changes may acquire behavioral relevance. Using insect-based foods as a theoretically stringent and pragmatically relevant case, the thesis combined a learning-based perspective on attitude change, a systematic analysis of measurement issues, a set of empirical intervention studies, and their integration with theoretical models of behavior prediction.

Chapter 1 positioned the thesis within the literature on evaluative conditioning (EC) and vicarious learning, two well-established procedures through which evaluations can be acquired and modified. While extensive evidence demonstrates that both procedures reliably influence evaluations of neutral stimuli, the chapter identified a key gap: comparatively little is known about their effectiveness when negative, pre-existing evaluations are held toward the target stimulus. Indeed, much of the work that does address negatively valenced stimuli relies on paradigms in which such evaluative responses are first established in the laboratory and subsequently reversed through counterconditioning or related procedures. As a consequence, these evaluations are experimentally created, relatively recent, and unlikely to be integrated into participants' broader belief systems, at least not to the same extent as long-standing evaluations formed through real-world experience and cultural influences. Against this background, the thesis aimed to investigate whether OEC and vicarious learning can also influence such pre-existing, long-standing negative evaluations. Insect-based foods were introduced as an ideal test case, as they are associated with negative evaluations in Western

contexts, yet are of growing practical importance due to their nutritional and sustainability-related benefits.

Chapter 2 then focuses on the development and testing of appropriate measurement tools as a prerequisite before implementing interventions. This step was essential to avoid drawing premature conclusions about the effectiveness of the intervention and to ensure that subsequent empirical findings could be interpreted meaningfully. Across different correlational studies that employed measures administered both via computer and smartphones, the implemented measures showed acceptable to high reliability. Associations among direct and indirect measures were largely absent. This was not interpreted as noise but as informative of how evaluative responses may manifest under different conditions. This perspective is particularly relevant when considering the specific outcome being targeted (for example, decisions made under low time pressure versus rapid choices made under constraint). To this end, including multiple types of evaluative measures may provide a more comprehensive and informative basis for assessing the effects of interventions.

Chapter 3 represents the core of the present thesis and presented a series of experimental studies examining whether learning-based intervention strategies can modify evaluations and behavioral intentions toward insect-based foods. Three approaches were investigated: vicarious approach–avoidance (VAA), observational evaluative conditioning (OEC), vicarious consumption (VC), and an intervention based on the shared features principle integrated with a goal-directed perspective (SFP-GDP). Across projects, both direct and indirect measures developed and validated in Chapter 2 were employed. The findings showed that attitudes toward insect-based foods are not immutable: all three strategies produced reliable changes in self-reported evaluations and intentions. Effects on indirect measures were generally smaller and more variable than those observed for direct measures.

Chapter 4 introduces a variety of theoretical frameworks, from classic models (e.g., TRA, TBP) to more recent predictive processing and goal-directed accounts, with particular emphasis on the goal-directed perspective (GDP, Moors et al., 2017) and the goal-directed predictive processing (GDPP, Van Dessel et al., 2025). These models are introduced because they provide a framework for interpreting and predicting behavioral relevance. The GDP conceptualizes behavior as emerging from the pursuit of goals. Once a discrepancy between the current state and the desired state is detected, individuals form the goal to reduce this discrepancy and select from their behavioral repertoire the action with the highest expected utility (i.e., the greatest likelihood of reducing the discrepancy). The GDPP also takes into account the role of behavioral prediction. People emit (overt or covert) behavior if they believe that emitting the behavior is compatible with their other beliefs.

## **Learning-based interventions and attitude change**

The experimental studies reported in Chapter 3 demonstrate that learning and social-learning interventions can significantly alter long-standing negative evaluations. These changes concern not only the general evaluative valence associated with insect-based foods, but also more specific attributes that are central to food choice, such as healthiness and taste. Much of the existing work on insect-based foods has relied on informational interventions, with mixed evidence. Some studies lead to improvements in attitudes or willingness to consume (Kroger et al., 2022), but often yield weak or null results (Gassler et al., 2024). Moreover, these strategies typically involve extended messages that require sustained attention and cognitive effort and may therefore be difficult to scale in real-world contexts. In contrast, the interventions tested here rely on brief narratives, short videos, or simple visual cues,

requiring relatively little effort from participants and lending themselves more readily to scalable applications, such as advertising materials or in-store marketing communication.

Beyond these considerations, the main strength of the present work is the focus on developing and testing a variety of interventions that, with the acknowledged limitations, effectively improved evaluative responses and behavioral intentions. Moreover, this contribution is not limited to attitude and intention change per se. As discussed in Chapter 1, much of the pertinent literature has focused on the modifications of evaluations that were recent and/or experimentally created in the laboratory through conditioning-like procedures. In contrast, by using insect-based food as a case study, this work brings evidence of the effectiveness of learning and social learning interventions in modifying long-standing negative attitudes. From this perspective, the thesis extends the existing literature in two ways. First, by replicating previous findings from VAA and OEC, paradigms that had been shown to be effective with novel neutral or slightly positive stimuli (e.g., regular cookies). Second, by introducing and testing novel strategies, such as the manipulation based on the SFP-GDP, thereby providing new interventions for modifying evaluations.

As discussed in Chapter 4, attitudes and intentions are widely recognized as key psychological outcomes and occupy a central role in many influential models of behavior (e.g., TPB, MGB), being considered as proximal predictors of action. Accordingly, the presented studies focused on these constructs as primary dependent variables, examining whether the proposed interventions could reliably modify evaluations and intentions toward insect-based foods. At the same time, the absence of direct behavioral measures necessarily limits the conclusions that can be drawn, also given the extensive evidence documenting attitude and intention-behavior gaps. Thereby, whether the observed changes in attitudes and intentions

translate into actual purchasing or consumption behavior of insect-based foods remains an open question that future research should address.

## **Enhancing the behavioral relevance of the interventions**

Although the present work is primarily focused on strategies for shaping attitudes and intentions, it is also valuable to consider how such strategies may be made more behaviorally relevant. In this sense, the theoretical models discussed in Chapter 4 point to the relevance of additional cognitive contents that were not directly examined in our studies and could be fruitfully investigated in future research. One of these concerns social norms, which have been shown to predict attitudes, intentions, and behavior across various domains, including food choice and sustainability-related practices (Pristl et al., 2021; Salmivaara et al., 2021; Cialdini & Jacobson, 2021). Indeed, both descriptive norms (beliefs about what others do) and injunctive norms (beliefs about what is appropriate to do) can shape behavior by signalling what is acceptable, typical, or socially rewarded in a given context. Other models primarily emphasize goal-directed accounts of behavior. For example, within the GDP, one preliminary step is the detection of a discrepancy between the current and the desired state; if no such discrepancy is perceived, the goal-directed cycle is not activated, even if the goal itself is endorsed. For instance, an individual may value healthy eating yet fail to change their eating behavior if they do not perceive their current diet as deviating from this goal. In the present work, however, goal-related variables such as goal activation and discrepancy detection were not directly assessed. Future research could examine whether and to what extent learning-based interventions can acquire behavioral relevance when they explicitly engage relevant goals and make discrepancies salient, for example, by framing (insect-based) food consumption as

serving valued goals and highlighting the mismatches between these goals and current food choices. Moreover, even when individuals detect a discrepancy and value a goal, behavior may still not occur if suitable actions are not present in their behavioral repertoire. This can happen when people are unaware of available actions or hold inaccurate beliefs about their effectiveness or costs, highlighting the importance of interventions that not only activate goals but also clarify feasible actions and their consequences. Finally, interventions may be further improved by considering a hierarchical and competitive structure of goals. According to GDP, individuals typically pursue multiple goals simultaneously, some of which operate at higher, more abstract levels (e.g., have healthy eating habits), while others are more immediate and concrete (e.g., staying within the grocery budget). In addition, goals may be experienced as comparable or competitive, with behavior being influenced by how such goals are prioritized or resolved in a given situation. Further studies may explore interventions that explicitly consider this hierarchical organization of goals in their design.

Another relevant construct that was not directly assessed in the present work is perceived behavioral control (Ajzen, 1991), which refers to the individuals' beliefs about their ability to perform a given behavior. Meta-analytic evidence has shown that perceived behavioral control reliably predicts both intentions and behavior (Armitage & Conner, 2001). Notably, perceived behavioral control is distinct from actual behavioral control, and for some individuals, the two may diverge substantially in a way that some may perceive a behavior as unfeasible even when objective constraints are minimal. From this perspective, future research could benefit from integrating measures of perceived control and testing whether new intervention strategies effectively shape control beliefs, in addition to attitudes and intentions. This is also aligned with some implications from the GDPP. According to GDPP, for an action to acquire behavioral relevance, it has to be compatible with one's prior belief system, such

that individuals can predict themselves enacting it. Interventions aimed at behavior change may build on this and investigate whether combining learning-based interventions with strategies that encourage individuals to self-predict their engagement in the behavior, for instance, by highlighting situational cues, past experiences, or identities that support such a prediction.

## **Limitations and future directions**

Several limitations of the present work should be acknowledged, which also point to directions for future research. First, the experimental paradigms differed across studies, particularly with respect to task structure and outcome measures, which limited the extent to which direct comparisons between interventions could be drawn. Second, the samples were predominantly drawn from the Italian population, which raises questions about the generalisability of the findings to cultural contexts in which insect-based foods may be evaluated differently. Moreover, all studies were conducted as online surveys. Future research would benefit from applying the same intervention strategies in more ecologically valid settings, for instance, by implementing social-learning paradigms involving real models in naturalistic environments, such as food choice contexts or retail settings. Third, the presented studies focused on insect-based foods, in which insects or their parts were not visible. This was done because products in which insects are not visually present are more acceptable to consumers (Schäufele et al., 2019; Modlinska et al., 2020; Kroger et al., 2022; Lee et al, 2025) and therefore represent a suitable starting point for studying attitude change. Moreover, the stimuli used represent a sub-category of insect-based foods that is currently more likely to be advertised and encountered in Western markets. For similar reasons, in our experiments, we used cookies with insect flour or non-specific insect-based foods. At the same time, this focus

may represent a limitation in generalizability, since evaluative responses to these products may vary across specific products and formats (Kroger et al., 2022; Pozharliev et al., 2023; Puteri et al., 2023). Future studies could therefore examine the generalizability of interventions, for example, by manipulating the visibility of the insect ingredient or the product format. Importantly, the present studies did not assess the temporal stability of the evaluative change, as they relied on cross-sectional designs. This leaves open the question of whether the interventions created experiences that are subsequently sampled and integrated into future inference processes. Longitudinal research is therefore needed to answer the question of whether observed effects persist over time and examine how repeated exposure can shape evaluative responses and behavioral predictions.

## **Broader relevance of the findings**

This thesis addressed the challenge of changing attitudes toward insect-based foods, a class of stimuli characterised by long-standing and negative evaluations. Although this focus, the approach and insights developed here may also inform research on other behaviors that share similar characteristics. Within the food domain, this includes the consumption of disliked foods such as certain vegetables or legumes, as well as the acceptance of novel or unfamiliar food products. Beyond food, similar inferential dynamics may operate in other sustainability-related behaviors that involve resistance or avoidance, such as the use of public transportation or the purchase of second-hand clothing.

Taken together, the approach adopted speaks to a broader class of societal challenges that extend well beyond the specific case of insect-based foods. Many contemporary problems, ranging from environmental sustainability to public health and social cohesion, require large-

scale behavioral change, yet are characterized by prior beliefs, emotional resistance, and mismatches between intentions and actions. Addressing such challenges requires approaches that move beyond isolated attitude change and instead consider how behavior emerges from the interaction between goals, prior beliefs, emotions, and contextual cues.

## Conclusion

The present thesis integrates empirical and theoretical contributions to the study of food-related attitudes and intentions, using insect-based foods as a theoretically and practically relevant test case. From an applied perspective, these products have been proposed as nutritionally viable and environmentally sustainable protein sources, with the potential to reduce emissions and the overexploitation of natural resources. From a theoretical perspective, they pose a critical challenge for psychological research that is whether, and under what conditions, long-standing negative evaluations can be experimentally modified. Across the studies presented, multiple interventions were developed and tested, drawing on learning-based and vicarious learning mechanisms, as well as on the role of consumption-related goals. Overall, these interventions proved effective in shifting attitudes and behavioral intentions toward insect-based foods. Crucially, the manipulations relied on brief vignettes or short video exposures, making them easily implementable and highly scalable. Such formats can be readily embedded in media content, marketing materials, and physical or digital choice environments, without requiring prolonged engagement or extensive cognitive efforts. As such, this work illustrates how psychologically grounded interventions can be designed to support meaningful changes in attitude and intention, thereby providing an initial foundation for applied efforts aimed at fostering adaptive and sustainable behavior on a large scale.





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