Food Quality and Preference 142 (2026) 105914

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Assessing spontaneous responses to insect-based foods using BIAT and manikin task

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A R T I C L E I N F O

Keywords:
Implicit association test
Spontaneous reactions
Insect-based food
Manikin task
Sustainable food choices
Behavioral intentions
Approach-avoidance tasks

A B S T R A C T

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.

1. 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 (Olivadese & 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 et al. (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, 2021; Mancini et al., 2019; Ribeiro et al., 2023; 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.,

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https://doi.org/10.1016/j.foodqual.2026.105914
Received 10 November 2025; Received in revised form 27 February 2026; Accepted 13 March 2026
Available online 14 March 2026

2009). For example, Fürtjes et al. (2020) demonstrated that self-control influences eating behavior mainly indirectly, through habit modulation, while automatic processes have a significant direct impact on outcomes. In their comprehensive review, Fernqvist et al. (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 et al., 2012).

1.1. 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 et al. (2022) demonstrated that implicit and explicit safety evaluations vary across food processing stages, while Piqueras-Fiszman et al. (2014) showed that hunger modulates approach-avoidance tendencies. Furthermore, Zogmaister, Brignoli, et al. (2023) and Zogmaister, Vezzoli, et al. (2023) highlighted that social modelling (observing others approach or avoid certain foods) shifts participants' spontaneous evaluations. A recent comprehensive review by Gallucci et al. (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, Greenwald et al., 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 et al. (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 et al. (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 et al. (2024) used verbal phrases (e.g., "larvae cookies") to identify a spontaneous preference for traditional foods. Brunner et al. (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., 2011). Research indicates that pictorial food cues elicit more consistent rapid hedonic responses than abstract words (Avery et al., 2025; Freijy et al., 2014; Lee et al., 2022; Luo et al., 2022). For example, Ostende et al. (2024) 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 et al. (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.

2. 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.

2.1. 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.

2.2. 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 et al. (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.

2.3. 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.

2.4. 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.

3. Study 1

3.1. 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 Fig. 1).

An a priori sensitivity analysis with G*Power (Faul et al., 2007) indicated that 100 participants provided sufficient power ($1\text{-}\beta = 0.95$, $\alpha = 0.05$, 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.

3.2. 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.

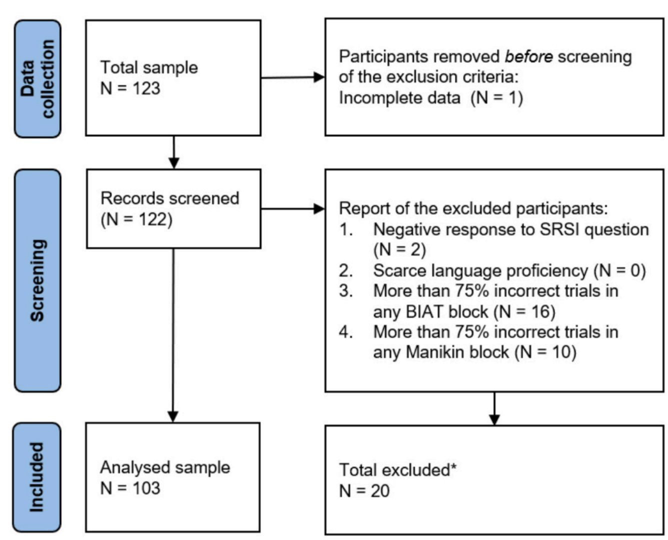

Fig. 1. Study 1: Data cleaning and exclusion criteria. Note: Exclusion criteria were not mutually exclusive, and some participants were excluded for multiple reasons.

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 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/asvoidance 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 response 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).

3.3. 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 min to complete.

3.4. 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.

3.5. Results

3.5.1. 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 ω alongside Cronbach's α, as ω 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.

3.5.2. 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 0.70 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.

Table 1
Descriptive Statistics and Internal Consistency.

Measure		M	SD	Cronbach's α	McDonald's ω
Study 1					
InsectoBite Attitude BIAT		−0.03	0.44	0.66	0.69
ClassicGrill Attitude BIAT		0.29	0.49	0.73	0.80
ClassicGrill Preference BIAT		0.32	0.65	0.72	0.81
InsectoBite Manikin Task		66.04	242.44	0.68	0.73
ClassicGrill Manikin Task		75.11	294.03	0.81	0.88
Manikin Task Differential		9.07	502.90	0.89	0.90
EAQ Disgust		2.99	1.11	0.92	0.93
EAQ Interest		3.00	1.29	0.92	0.92
Study 2					
InsectoBite Attitude BIAT		−0.04	0.42	0.77	0.78
	Standard subsample	*−0.11*	*0.41*	*0.75*	*0.80*
	Familiarization subsample	*0.04*	*0.42*	*0.79*	*0.86*
ClassicGrill Attitude BIAT		0.21	0.42	0.79	0.81
	Standard subsample	*0.21*	*0.46*	*0.82*	*0.88*
	Familiarization subsample	*0.21*	*0.38*	*0.75*	*0.78*
ClassicGrill Preference BIAT		0.25	0.68	0.85	0.88
	Standard subsample	*0.32*	*0.72*	*0.86*	*0.90*
	Familiarization subsample	*0.17*	*0.63*	*0.85*	*0.87*
InsectoBite Manikin Task		73.27	170.93	0.69	0.82
	Standard subsample	*95.61*	*193.16*	*0.70*	*0.83*
	Familiarization subsample	*48.86*	*140.21*	*0.66*	*0.81*
ClassicGrill Manikin Task		35.86	175.85	0.68	0.78
	Standard subsample	*14.42*	*191.53*	*0.62*	*0.76*
	Familiarization subsample	*59.28*	*155.06*	*0.76*	*0.85*
DifferentialManikin Task		−37.41	298.44	0.80	0.88
	Standard subsample	*−81.19*	*318.44*	*0.76*	*0.87*
	Familiarization subsample	*10.42*	*269.27*	*0.84*	*0.91*
Behavioral Intentions to InsectoBite		2.87	1.19	0.97	0.98
Semantic Differential (Affective)		3.94	1.20	0.95	0.96
Semantic Differential (Cognitive)		4.85	1.28	0.97	0.98
Semantic Differential (Aggregate)		4.41	1.17	0.97	0.95
Intention to Taste Insect-Based Foods		4.26	3.08	0.87	0.92

Two psychometric observations are noteworthy. First, McDonald's ω was consistently higher than Cronbach's α, 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 advantage. Self-report measures showed high reliability across both α and ω.

3.5.3. *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 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.

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

Table 2
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	- 0.01 [−0.20, 0.18]	–						
3. BIAT Preference for ClassicGrill	−0.68*** [−0.77, −0.56]	0.74*** [0.64, 0.82]	–					
4. Manikin InsectoBite	−0.05 [−0.24, 0.15]	−0.00 [−0.20, 0.19]	0.03 [−0.17, 0.22]	–				
5. Manikin ClassicGrill	−0.01 [−0.20, 0.18]	−0.02 [−0.21, 0.17]	−0.01 [−0.20, 0.19]	−0.76*** [−0.83, −0.66]	–			
6. Manikin Preference for ClassicGrill	0.02 [−0.18, 0.21]	−0.01 [−0.20, 0.18]	−0.02 [−0.21, 0.18]	−0.92*** [−0.95, −0.89]	0.95*** [0.93, 0.97]	–		
7. EAQ disgust	−0.18* [−0.36, 0.01]	0.16 [−0.03, 0.35]	0.24* [0.05, 0.42]	−0.11 [−0.30, 0.08]	0.08 [−0.12, 0.27]	−0.10 [−0.09, 0.29]	–	
8. EAQ interest	0.10 [−0.10, 0.29]	−0.12 [−0.31, 0.07]	−0.16 [−0.34, 0.04]	0.10 [−0.10, 0.29]	−0.09 [−0.28, 0.10]	−0.10 [−0.29, 0.09]	−0.85** [−0.90, −0.79]	–

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

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.

3.6. 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 (α: 0.66–0.89; ω: 0.69–0.90) is in line with previous findings (Bar-Anan & Nosek, 2014; Krieglmeyer & 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.

4. 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.

4.1. Participants and design

A total of 145 participants were recruited via Prolific (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 Fig. 2). The target sample size was determined a priori using G*Power (Faul et al., 2007). With $\alpha = 0.01$ (one-tailed) and power $(1-\beta) = 0.90$, a minimum of 135 participants was required to detect medium-sized correlations ($\rho \geq 0.30$).

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.

4.2. Materials

All materials were identical to 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

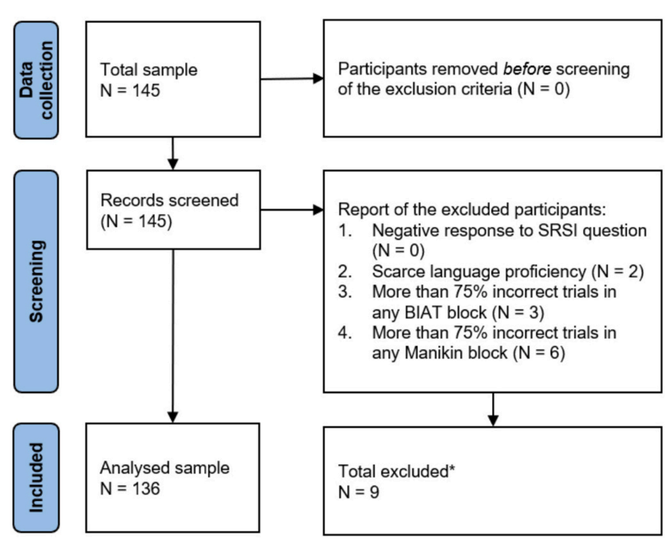

Fig. 2. Study 2: Data cleaning and exclusion criteria. *Note.* Exclusion criteria were not mutually exclusive, and some participants were excluded for multiple reasons.

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-s 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 = 3736 ms, SD = 1140 ms; median = 3592 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.

4.3. 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.

4.4. 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) 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.

4.4.1. Internal consistency

Cronbach's alpha (α) and McDonald's omega (ω) 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.

4.4.2. Hypothesis testing

As Affective and Cognitive Semantic Differentials were highly correlated ($r = 0.83$, $p < .001$), the 10 items were averaged into one composite score. Following preregistration, significance was evaluated at $\alpha = 0.01$ (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 ($r = 0.23$, $p = .053$ for the Affective Semantic Differential and $r = 0.24$, $p = .04$ 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 Maniking 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.

4.4.3. 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). 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.

4.5. 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 ($r \leq 0.15$). Despite designing the situational measures 'Willingness to Eat in Real Life' and 'Intention to Taste' to

Table 3
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	−0.31** [−0.45, −0.15]	–								
3. BIAT Preference ClassicGrill	−0.81*** [−0.86, −0.74]	0.81*** [0.74, 0.86]	–							
4. Manikin InsectoBite	−0.02 [−0.19, 0.15]	−0.10 [−0.26, 0.07]	−0.05 [−0.22, 0.12]	–						
5. Manikin ClassicGrill	0.08 [−0.09, 0.24]	0.08 [−0.09, 0.24]	−0.00 [−0.17, 0.17]	−0.48*** [−0.60, −0.34]	–					
6. Manikin Preference	0.06 [−0.11, 0.22]	0.10 [−0.07, 0.27]	0.03 [−0.14, 0.20]	−0.86*** [−0.90, −0.80]	0.86*** [0.81, 0.90]	–				
7. Semantic Differential	0.13 [−0.04, 0.29]	−0.02 [−0.19, 0.15]	−0.09 [−0.26, 0.08]	0.09 [−0.08, 0.26]	0.09 [−0.08, 0.25]	−0.00 [−0.17, 0.17]	–			
8. Behavioral Intentions	0.15* [−0.02, 0.31]	−0.06 [−0.23, 0.11]	−0.13 [−0.29, 0.04]	0.04 [−0.13, 0.21]	0.11 [−0.06, 0.28]	0.04 [−0.13, 0.21]	0.70*** [0.61, 0.78]	–		
9. Willingness to Eat	0.08 [−0.09, 0.25]	−0.05 [−0.22, 0.12]	−0.08 [−0.25, 0.09]	0.02 [−0.15, 0.19]	0.01 [−0.16, 0.18]	−0.00 [−0.17, 0.16]	0.47*** [0.33, 0.59]	0.45** [0.31, 0.58]	–	
10. Intention to Taste	0.08 [−0.09, 0.24]	−0.04 [−0.20, 0.13]	−0.07 [−0.24, 0.10]	−0.00 [−0.17, 0.17]	0.05 [−0.12, 0.21]	0.03 [−0.14, 0.20]	0.59*** [0.47, 0.69]	0.75*** [0.67, 0.82]	0.34** [0.19, 0.49]	–
Standard version subsample										
1. BIAT InsectoBite	–									
2. BIAT ClassicGrill	−0.35** [−0.54, −0.13]	–								
3. BIAT Preference ClassicGrill	−0.80*** [−0.87, −0.69]	0.85*** [0.77, 0.90]	–							
4. Manikin InsectoBite	0.04 [−0.20, 0.27]	−0.12 [−0.34, 0.12]	−0.10 [−0.32, 0.14]	–						
5. Manikin ClassicGrill	−0.04 [−0.27, 0.20]	0.09 [−0.14, 0.32]	0.08 [−0.15, 0.31]	−0.37*** [−0.56, −0.15]	–					
6. Manikin Preference ClassicGrill	−0.05 [−0.28, 0.19]	0.13 [−0.11, 0.35]	0.11 [−0.13, 0.33]	−0.83*** [−0.89, −0.74]	0.83*** [0.73, 0.89]	–				
7. Semantic Differential	0.25* [0.02, 0.45]	−0.08 [−0.31, 0.15]	−0.19 [−0.41, 0.04]	0.01 [−0.23, 0.24]	0.16 [−0.08, 0.38]	0.09 [−0.14, 0.32]	–			
8. Behavioral Intentions	0.27* [0.03, 0.47]	−0.17 [−0.39, 0.07]	−0.26* [−0.46, −0.03]	0.02 [−0.22, 0.25]	0.12 [−0.12, 0.34]	0.06 [−0.18, 0.29]	0.70*** [0.61, 0.78]	–		
9. Willingness to Eat	0.14 [−0.10, 0.36]	−0.22 [−0.43, 0.01]	−0.22 [−0.43, 0.01]	−0.03 [−0.26, 0.20]	0.00 [−0.23, 0.24]	−0.02 [−0.21, 0.25]	0.47** [0.33, 0.59]	0.45*** [0.31, 0.58]	–	
10. Intention to Taste	0.15 [−0.08, 0.37]	−0.05 [−0.28, 0.19]	−0.12 [−0.34, 0.12]	−0.02 [−0.26, 0.21]	−0.01 [−0.24, 0.23]	−0.01 [−0.22, 0.24]	0.59*** [0.47, 0.69]	0.75*** [0.67, 0.82]	0.34*** [0.19, 0.49]	–
Familiarization version subsample										
1. BIAT InsectoBite	–									
2. BIAT ClassicGrill	−0.27* [−0.49, −0.03]	–								
3. BIAT Preference ClassicGrill	−0.82*** [−0.89, −0.72]	0.77*** [0.65, 0.86]	–							
4. Manikin InsectoBite	−0.05 [−0.29, 0.20]	−0.06 [−0.30, 0.19]	−0.00 [−0.25, 0.24]	–						
5. Manikin ClassicGrill	0.18 [−0.07, 0.41]	0.04 [−0.20, 0.29]	−0.09 [−0.33, 0.16]	−0.66*** [−0.78, −0.50]	–					
6. Manikin Preference	0.13 [−0.12, 0.36]	0.05 [−0.19, 0.30]	−0.05 [−0.29, 0.20]	−0.90*** [−0.94, −0.84]	−0.92*** [0.87, 0.95]	–				

(*continued on next page*)

Table 3 (*continued*)

	1	2	3	4	5	6	7	8	9	10
7. Semantic Differential	0.00 [−0.24, 0.25]	0.07 [−0.18, 0.31]	0.04 [−0.21, 0.28]	0.24* [−0.01, 0.46]	−0.02 [−0.26, 0.23]	−0.13 [−0.37, 0.11]	–			
8. Behavioral Intentions	0.05 [−0.20, 0.29]	0.09 [−0.16, 0.33]	0.02 [−0.22, 0.27]	0.07 [−0.18, 0.31]	0.12 [−0.13, 0.35]	0.03 [−0.22, 0.28]	0.70*** [0.61, 0.78]	–		
9. Willingness to Eat	−0.06 [−0.30, 0.19]	0.22 [−0.02, 0.45]	0.17 [−0.07, 0.40]	0.18 [−0.07, 0.41]	−0.04 [−0.28, 0.21]	−0.12 [−0.35, 0.13]	0.47*** [0.33, 0.59]	−0.45** [0.31, 0.58]	–	
10. Intention to Taste	0.00 [−0.24, 0.25]	−0.02 [−0.27, 0.22]	−0.02 [−0.26, 0.23]	0.03 [−0.22, 0.27]	0.13 [−0.12, 0.36]	0.06 [−0.19, 0.30]	0.59*** [0.47, 0.69]	0.75*** [0.67, 0.82]	0.34** [0.19, 0.49]	–

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

bridge the gap toward situational behavior (Vizcaíno & 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.

5. 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 (La Barbera et al., 2018; Verneau et al., 2016) 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 min). 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 entirely new ones. 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. High negative correlations between the 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 (Bar-Anan & Nosek, 2014; Bosson et al., 2000). 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 and Lozo, 2015), evaluation 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 et al. (2016) 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 (Hajhamidiasl 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, Dalmaijer, Hodges, et al., 2021). 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.

Open science practices and ethical statement

This study 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), 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.

CRediT authorship contribution statement

Cristina Zogmaister: Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Francesco Fedeli:** Writing – review & editing, Writing – original draft, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Davide Albertoni:** Writing – review & editing, Investigation. **Francesca Romana Alparone:** Writing – review & editing, Investigation, Funding acquisition. **Antonio Aquino:** Writing – review & editing, Investigation. **Cosimo Talò:** Writing – review & editing, Investigation. **Silvia Mari:** Writing – review & editing, Investigation.

Funding statement

This work was supported by the European Union – Next Generation EU, within the project “A BUG In the Food is Yummy (BUGIFY): Strategic Approaches for Changing Eating Behaviours” (grant no. 2022-NAZ-0687/ZOGMAISTER, CUP H53D23009810001), funded under the Italian MUR program Missione 4, Componente 2, Investimento 1.1 – Avviso 1409/2022.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Cristina Zogmaister reports financial support was provided by European Union. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2026.105914.

Data availability

Data are openly available. Link to the data is provided in the manuscript

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