

## ORIGINAL ARTICLE

# Development of a consumer-led emotion lexicon for meat and plant-based burger patties using digitally recreated eating contexts

Rebekah E. Orr<sup>1</sup> | Caroline Giezenaar<sup>1</sup> | A. Jonathan R. Godfrey<sup>2</sup> | Joanne Hort<sup>1,3</sup> 

<sup>1</sup>Food Experience and Sensory Testing (Feast) Lab, Massey University, Palmerston North, New Zealand

<sup>2</sup>Statistics Group, School of Mathematical and Computational Sciences, Massey University, Palmerston North, New Zealand

<sup>3</sup>Riddet Institute, Massey University, Palmerston North, New Zealand

**Correspondence**

Joanne Hort, Food Experience and Sensory Testing (Feast) Lab, School of Food and Advanced Technology (SF&AT) PN 452, Massey University, Private Bag 11222, Palmerston North 4410, New Zealand.  
Email: [j.hort@massey.ac.nz](mailto:j.hort@massey.ac.nz)

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**Abstract**

The decision to consume novel foods such as plant-based meat alternatives is often determined by emotional response. Generic food emotion lexicons are available for measuring emotional response, however, such lexicons may not capture the nuanced emotions associated with novel products. Here, an emotion lexicon specific to meat and plant-based burger patties was developed. Discussion groups, where participants were digitally immersed in two typical burger eating environments, were used to generate relevant emotion terms toward different patties. A range of consumers contributed to the lexicon including users and nonusers of meat alternatives, two age groups, and three dietary groups. Subsequently, an on-line sorting task followed by hierarchical clustering was used to reduce the size of the lexicon. The final lexicon contained 24 emotion categories. The lexicon shared terms with generic lexicons but notably contained other emotions associated with food neophobia, uncertainty, and deception.

**Practical Applications:** The results of this study provide an emotion lexicon specific to burger patties of meat and plant-based origins. Currently no emotion lexicon has been developed for plant-based patties, or plant-based meat alternatives in general. It provides an important tool for further research concerning links between sensory and emotional drivers of plant-based patty consumption across different types of patty consumers and has potential to be adopted for a wider product set.

## 1 | INTRODUCTION

### 1.1 | Plant-based meat alternatives

Consumers are becoming more aware of the health, animal welfare, and environmental consequences associated with meat consumption prompting them to replace animal-based foods in their diets with plant-based foods (Aschemann-Witzel, Gantriis, Fraga, & Perez-Cueto, 2021; Euromonitor International, 2020). While vegans (4%)

and vegetarians (6.4%) only make up a small percentage of global consumers, flexitarians, or those who restrict certain animal products but do not eliminate them from their diet entirely, account for 42% of consumers globally (Euromonitor International, 2020). A global shift to a primarily plant-based diet is supported by public health experts, with a summary report of the EAT-Lancet Commission identifying that the consumption of plant-based foods including fruits, vegetables, legumes, and nuts needed to more than double, while the consumption of red meat needs to more than halve in order to meet Scientific

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Targets for Healthy Diets and Sustainable Food Production by 2050 (Willett & Rockström, 2019).

Substituting meat with plant-based meat alternatives is one approach consumers can take to reduce their meat consumption. In recent years there has been a rapid expansion of the plant-based foods market, with the global market for meat alternatives expected to grow from USD 5.37 billion in 2021 to USD 10.80 billion by 2028 (Fortune Business Insights, 2021). Many plant-based meat alternatives incorporate purified plant-proteins (e.g., soy or wheat) into processed products that mimic the sensory properties (taste, texture, aroma, appearance) of conventional meat products for example, patties, sausages, meatballs (Tso, Lim, & Forde, 2020). These products are commonly known as meat analogues. Other plant-based meat alternatives aim to replace meat in a meal but do not intend to mimic the sensory properties of meat and are typically less processed. The present research focused on plant-based meat alternatives, specifically burger patties, including patty products that do and do not aim to mimic meat.

## 1.2 | Barriers to consumption of plant-based meat alternatives

Despite growing interest in meat alternatives, acceptance is not universal, and these products are still niche in most Western countries (Giacalone, Clausen, & Jaeger, 2022). Sensory characteristics are consistently rated as the most important motivation underlying acceptance (Martins & Pliner, 2005), however, the primary barriers to the consumption of meat alternatives have been identified as lower sensory appeal compared to meat, and unfamiliarity (Michel, Hartmann, & Siegrist, 2021). Meat-alternatives are often marketed with explicit reference to their meat counterparts for which consumers hold specific sensory expectations (Giacalone et al., 2022), however, recreating the unique texture, mouthfeel, and juiciness of traditional meat poses an ongoing challenge (Fiorentini, Kinchla, & Nolden, 2020).

It is also not clear whether consumers want meat alternatives that mimic the sensory properties of meat or not, with previous research reporting conflicting results. (Michel et al., 2021) found both omnivores and flexitarians indicated a preference for meat alternatives to be on the meat-like side, while Collier et al. (2021) found products that mimicked the sensory characteristics of meat were perceived as “strange” and “dishonest” by some meat-eaters, and nonmeat-eaters alike. Given the important role meat alternatives can play in aiding consumers to transition to a more sustainable diet, a better understanding is needed of what product characteristics are driving consumer acceptance.

## 1.3 | Consumer emotional response

Traditionally, in consumer research, acceptance is measured through hedonic liking alone (Fiorentini et al., 2020). However, it is not always possible to differentiate products based on degree of liking (Mora,

Urdaneta, & Chaya, 2018), and liking is rarely a strong predictor of product success (Jaeger & Giacalone, 2021; Thomson & Coates, 2021). Emotions play a key role in food choice decision-making through both the anticipated emotional consequences associated with purchasing and consuming specific products, and emotions experienced immediately after purchasing or consuming the product (Loewenstein & Lerner, 2003).

Recognizing that factors such as nutritional value, ease of preparation, and safety are influential, Jiang, King, and Prinyawiwatkul (2014) indicated that the decision to buy novel foods may be dominated by emotional connotations of the food. Onwezen, Verain, and Dagevos (2022) found the experience of positive emotions in relation to alternative sources of protein was highly relevant to understanding their acceptance.

Collection of emotional measurements in consumer testing can deepen understanding of consumer product experiences and food choices (Jaeger et al., 2020). Measuring emotional response provides additional information beyond overall acceptance that often distinguishes products that are equally liked (Meiselman, 2017; Ng, Chaya, & Hort, 2013), and improves food choice prediction compared to overall liking alone (Dalenberg et al., 2014; Gutjar et al., 2015; Schouteten, Verwaeren, Lagast, Gellynck, & De Steur, 2018). Furthermore, a product's emotional profile has been found to rely on its specific sensory properties suggesting a product's sensory profile may be modified in order to increase-specific positive emotions or to decrease negative emotions (Spinelli & Jaeger, 2019).

Verbal self-report measures are commonly used to measure food evoked emotions due to ease of use, cost effectiveness, and discriminative power (Dorado, Chaya, Tarrega, & Hort, 2016). Consumers are provided with a list of emotion terms (lexicon) and asked to check or rate the emotion(s) evoked by a product (Dalenberg et al., 2014). Emotion lexicons can be either general for all foods, for example, the EsSense Profile (King & Meiselman, 2010) and the valence  $\times$  arousal circumplex-inspired emotion questionnaire (CEQ) (Jaeger et al., 2020), or product category specific where the vocabulary is developed by consumers or by research personnel themselves (Dorado et al., 2016). The main advantage to using a general emotion lexicon is that such lexicons can be applied to any group of products without the labor-intensive process of developing a product category specific lexicon (Chaya et al., 2015; Spinelli, Masi, Dinnella, Zoboli, & Monteleone, 2014). Developing a product-specific lexicon has the advantage of better capturing emotions specific to the product category thereby increasing its discrimination ability (Ng et al., 2013). A product-specific lexicon can also provide deeper information on emotions underlining the consumption experience (Bhumiratana, Adhikari, & Chambers, 2014). Several product category specific lexicons have been developed including blackcurrant squashes (Ng et al., 2013); coffee (Bhumiratana et al., 2014); beer (Chaya et al., 2015; Mora, Giussani, Pagliarini, & Chaya, 2019); wine (Ferrari et al., 2010; Mora, Dupas de Matos, Fernández-Ruiz, Briz, & Chaya, 2020); and milkshakes (Maheeka Weerawarna, 2021). To date, no emotion lexicon specific to plant-based meat-alternative products has been published.

Jaeger, Spinelli, Ares, and Monteleone (2018) and Prescott (2017) recommend product-specific emotion lexicon should strive for a more complete coverage of the different segments of the Circumplex Model of Core Affect (Russell, 1980; Yik, Russell, & Steiger, 2011). Circumplex segments combine the two dimensions of valence (pleasure vs. displeasure, or positive vs. negative) and arousal (activation vs. deactivation). Together, valence and arousal comprise what is known as “core affect” (Feldman Barrett, 2017; Jaeger et al., 2020; Russell, 1980).

#### 1.4 | Effect of digitally recreated eating contexts on emotional response

Consumption context can affect emotional response (Piqueras-Fiszman & Jaeger, 2014). By testing in context, responses that more closely match the emotional responses consumers feel in real-life eating situations may be captured (Piqueras-Fiszman & Jaeger, 2014). Digital immersive techniques are increasingly used in the field of consumer science to increase the ecological validity of an evaluation while still allowing experimental control (Galiñanes Plaza, Delarue, & Saulais, 2019; Giezenaar & Hort, 2021). Low, Lin, Jun Yeon, and Hort (2021) found that emotional response to tea-break snacks was similar between a recreated café using mixed-reality and the real café but response in sensory booths was different highlighting the importance of including context in emotional response data collection. Digital immersion during term generation for lexicon development provides the opportunity to evoke more relevant terms for intended product consumption scenarios.

It is unknown if generic lexicons encompass all emotions associated with consumption of meat alternatives. The primary objective of the present study was to develop a consumer-led emotion lexicon specific to meat and plant-based patties using digital immersive eating contexts to evoke emotions across different relevant eating scenarios.

## 2 | MATERIALS AND METHODS

Emotion lexicon development took place over three stages. In stage one, 12 discussion groups generated emotion terms in response to five patty samples varying in sensory characteristics in relevant recreated digital contexts. Stage two, involved reducing the list of terms by removing irrelevant and nonemotion terms. Stage three encompassed further term reduction via an online task where consumers sorted the remaining emotion terms into categories based on similar meaning. The study was evaluated via the Massey Human Ethics Committee and was judged to be low risk (000024400). Written informed consent was obtained from all participants. Participants who took part in the discussion groups and online activity were offered a NZD40 shopping voucher as compensation for their time. Participants who took part in the online activity only were offered a NZD15 shopping voucher.

**TABLE 1** Participant demographics for discussion groups.

Meat consumption group	n	Age group	n	Gender	n
Meat excluders	12	Millennials	7	Male	1
				Female	6
		Generation X	5	Male	0
				Female	5
Meat reducers	16	Millennials	9	Male	2
				Female	7
		Generation X	7	Male	1
				Female	6
Meat eaters	16	Millennials	8	Male	2
				Female	6
		Generation X	8	Male	3
				Female	5

#### 2.1 | Stage one: Emotion term generation discussion groups

##### 2.1.1 | Participants

Forty-four participants were recruited from the Food Experience and Sensory Testing (Feast) Lab consumer database, Massey University internal emails, and flyer distribution around Palmerston North, New Zealand. To ensure a range of users and nonusers of plant-based meat alternatives contributed to the lexicon, participants (Table 1) from two age groups (Millennials: born 1980–1996; and Generation X: 1965–born 1981) and three meat consumption groups (meat eater, meat reducer, meat excluder) were recruited. Participants were required to be able to communicate effectively in English, and be a regular patty consumer (at least once a month). Participants included both users (fortnightly or more, 43%) and nonusers of meat alternatives (once a month or less, 57%), and all participants were willing to try meat alternatives as part of the study.

Participants were split into 12 discussion groups (up to 5 participants per group) and attended one discussion group (~75 min) with participants from the same meat consumption and age group. Participants were grouped in this way so as not to discourage participants from sharing their true emotions based on the assumption that different consumer groups (e.g., vegetarians and meat eaters) may experience contrasting emotions toward the samples.

##### 2.1.2 | Samples

Five patties were evaluated (Table 2). Four were plant-based, and one was animal-based (beef). The plant-based patties were selected to represent variation across the New Zealand plant-based patty market in terms of sensory characteristics, and main protein source. Two of the plant-based patties were selected to resemble meat that is, meat analogues, the other two patties were selected not to resemble meat

**TABLE 2** Description of the patty samples used in the discussion groups.

Sample	Type of patty	Key ingredients
1	Vegetable based	Hemp, green peas, spinach, kale, chickpeas
2	Vegetable based	Tomatoes, cauliflower, onion, carrots, peanuts, potato flakes
3	Meat analogue	Textured soy protein concentrate, vital wheat gluten, soy protein isolate
4	Meat analogue	Pea protein
5	Animal protein	Beef

<sup>a</sup>Life Health Foods NZ Ltd., Auckland, New Zealand.

<sup>b</sup>Olive and Ash Ltd., Whangarei, New Zealand.

<sup>c</sup>Conagra Brands Inc., Chicago, IL, USA.

<sup>d</sup>Beyond Meats Inc., El Segundo, CA, USA.

<sup>e</sup>First Light Foods Ltd., Havelock North, New Zealand.

that is, vegetable based. The animal-based sample was a high-end beef patty selected to represent a good quality meat patty. The beef patty was included so that the lexicon was representative of meat products in addition to plant-based products and the lexicon could be used for studies that include meat products in addition to plant-based products if required. Four samples were commercially available in New Zealand. Sample 2 was formed from a commercially available vegetable “mince” mix specifically aimed at being made into patties.

Samples were cooked in a frying pan (Daily Cook Frypan, Tefal, France) in one tablespoon of olive oil per patty (100% Pure Olive Oil, Pams, New Zealand). All commercial samples were prepared according to the manufacturer's instructions on the packaging. Sample 2 came as a dehydrated mix and was rehydrated with boiling water using instructions provided by the manufacturer, then formed into similar sized patties. Once cooked, each patty was cut into six pieces (14–19 g) and individual pieces were wrapped in aluminium foil (Catering Foil, Rota, New Zealand). Samples were held in a food warmer (E84 Food Warmer, Bakbar, New Zealand) heated to  $45 \pm 5^\circ\text{C}$  until served (20–60 min). Samples were served blind (labeled with three-digit random codes) directly from the food warmer. The plant-based samples were served in a fixed order within a discussion group so that participants could assess and discuss the same sample. Between the different discussion groups, the presentation order was based on a balanced Williams Latin square design (Wakeling & MacFie, 1995). The beef-patty sample was excluded from the design and always served in the fifth position, as it was not assessed by nonmeat-eating participants. Participants were not required to consume the whole sample, but enough to assess how it made them feel. Unsalted water crackers (Water crackers original, Arnott's, Australia) and filtered water were provided as palate cleansers.

### 2.1.3 | Test environments

Two digitally recreated eating contexts were used for emotion term generation discussion groups to elicit terms that were relevant to real life consumption, not to compare the emotions generated between

the two digital eating contexts. The contexts used were a meal at home and a meal out at a gastropub. To create the immersive eating contexts, 360° images (purchased from Shutterstock; <https://www.shutterstock.com/>) of the kitchen and living area of a home (Figure 1) and the inside of a gastropub (Figure 2) were projected on the walls of the evaluation room using Igloo immersive technology (Igloo Vision Ltd., Australia). In the home context, audio of an evening current events TV show was played as background noise (recording created by the researcher). In the bar context, audio of bar ambiance including chatter and jazz music was played as background noise. Participants were spread out and seated at their own tables to adhere to social distancing requirements due to the COVID-19 pandemic.

In addition to image projection and audio, a brief written scenario (Table 3) was read to participants to provide clarity on how to interpret the images. The written scenarios were broad as making them too specific may have prevented participants from imagining themselves in the specific scenario. For the home context it was considered that emotional response to a meal may differ depending on who has prepared it. It could also differ depending on who is being cooked for, for example, family or visitors. The written scenario also enabled clarification that the patties were purchased from the supermarket and cooked at home not purchased from a takeaway which would result in different expectations.

For the gastropub, it was important to clarify that the participants were out for a casual meal with friends. As they were paying for the meal expectations would be higher than at home and it was expected that this would stimulate a different range of emotions.

### 2.1.4 | Discussion group procedure

All discussion groups were led by the same moderator who used a discussion guide to facilitate the discussion and ensure all groups followed the same pattern of discussion.

Each session started with an ice breaker activity where participants introduced themselves and spoke about their favorite burger. This was followed by an explanation of the purpose of the session: to

**FIGURE 1** Digitally recreated home eating context.



**FIGURE 2** Digitally recreated gastropub eating context.



come up with a list of emotion terms in response to how you feel when eating different burger patties, and a short explanation of what was meant by an emotion term and how this differs from other affective feelings such as mood. This was based on the definition of an emotion as being in response to a specific event, rapid, intense, and short lasting (Ferrarini et al., 2010; Meiselman, 2015), and a mood not being in response to a specific event, building up more gradually and lasting longer (Beedie, Terry, Lane, & Devonport, 2011). Participants were instructed that “We are interested to discuss how these patties make

you feel in the moment you are eating them (emotional response). We are not interested in how you are generally feeling today. These longer-term feelings are your mood and are not in response to the burger patty”.

Two warm-up activities verified participants understood what the moderator meant by an emotion term and stimulated emotion elicitation. The first required participants to choose from a selection of images and describe how the image made them feel following Ng et al. (2013). For the second warm-up activity, participants focused on

**TABLE 3** Written scenarios provided to participants during discussion groups.

Eating context	Written scenario	Subsequent samples
Home	I want you to imagine you are at home with your family and/or flatmates and you are having burgers for dinner. You have purchased burger patties from the supermarket and cooked them for dinner. This is the patty you have prepared (referring to sample in front of participant).	I want you to keep imagining you are at home with your family and/or flatmates having burgers for dinner. But now this is the patty you have prepared.
Gastropub	I want you to imagine you are at the pub with friends having dinner and a few drinks. You have ordered a burger for dinner. This is the patty that arrives in your burger (referring to sample in front of participant).	I want you to keep imagining you are at the pub with friends having dinner and a few drinks. But now this is the patty that arrives in your burger.

emotions specific to burger eating. They were asked to think of positive and negative emotion terms to describe how eating their favorite burger, and a less preferred burger, would make them feel. These terms were not included in the formation of the lexicon.

Following the warm-up activities, emotion term generation commenced. All five (four for nonmeat-eating groups) samples were first assessed in the digital home context.

Participants received the samples one at a time and were instructed to assess the sample by looking at it, eating it, then writing down how the samples made them feel. Participants assessed the samples individually, and after every two samples shared and discussed their terms. Each new emotion term was recorded by the moderator in a table projected onto the wall so participants could see an overview of terms already suggested. The table was split into three categories: positive, negative, or neither positive nor negative (unclassified). Participants were asked to specify in which category the emotion term belonged if it was unclear to the moderator. After all samples were assessed in the home context, the process was repeated in the gastropub context but with samples presented in a different order.

After participants had generated their terms, they were presented with the emotion terms from the EsSense Profile (King & Meiselman, 2010) and asked to consider if any of those also explained how they felt toward any of the samples in either of the contexts. This step was included to check that terms often used for assessing food and beverage had not been able articulated/missed. Participants completed this activity individually, then shared and discussed as a group.

Relevant new terms from the EsSense Profile were added to the table for the home context, gastropub context, or both.

Finally, participants were presented with all the emotion terms their group had generated and were asked to reconsider if all the emotion terms were relevant to burger eating and were terms they would use in their everyday lives. If most participants within a discussion group agreed a term was irrelevant, the emotion term was removed.

## 2.2 | Stage two: Filtering of terms

Emotion terms from all the discussion groups (not including terms from the warm-up activities) were compiled into an initial list which was further refined by the researcher by removing nonemotion terms (e.g., *Unhealthy*, *Opinionated*), or emotions that did not relate to how the patty samples made the participants feel (e.g., feeling “offended” being served a less preferred sample in the digital immersive gastropub).

To verify the terms were generally regarded as emotions, the list was checked following van Zyl and Meiselman (2015). Each term was compared with published lists of emotions by Clore, Ortony, and Foss (1987) and Laros and Steenkamp (2005), containing 564 and 50 terms, respectively. If a term was not included on one of the lists or in the EsSense Profile, it was removed. In instances where a term was not included in published lists, but a synonym was and the word had been suggested by more than one discussion group, the term was not removed as it was regarded as a more common or relatable way for consumers to express that emotion. Finally, for consistency, all terms were formulated to be an adjective (if not already) to fit into the sentence “I feel....”

## 2.3 | Stage three: Online sorting task

An online sorting task was used to group the refined emotion list from stage two into emotion categories based on similar meaning. The purpose of this stage was to use a consumer-led approach to reduce the overall number of terms to remove overrepresented emotion categories and synonyms and make the final lexicon more efficient to use. The approach used was adapted from the rapid-method for grouping of terms into emotional categories used by Mora et al. (2020).

### 2.3.1 | Participants

Participants ( $n = 115$ ) were recruited from the Feast Lab consumer database, Massey University internal emails, advertisements on community social media pages and flyer distribution around Palmerston North, New Zealand. Of the 115 participants, 42 had also attended a discussion group. Participants were balanced across the same age groups and meat consumption groups as the discussion groups

**TABLE 4** Participant demographics sorting task.

Meat consumption group	n	Age group	n
Meat excluders	36	Millennials	19
		Generation X	17
Meat reducers	42	Millennials	24
		Generation X	18
Meat eaters	37	Millennials	19
		Generation X	18

(Table 4). Participants were not screened for gender. Additionally, participants were required to be able to communicate effectively in English. All new participants to the study (i.e., did not attend a discussion group) provided informed consent within the online activity.

### 2.3.2 | Online sorting-task procedure

A sorting task activity was created in Compusense Cloud (Compusense Inc., Guelph, ON, Canada). Participants were invited to complete the sorting task activity in their own time using their own laptop or desktop computer using a link sent by email. Participants were instructed to organize emotion terms into categories they thought shared a similar meaning and to choose one emotion term from each category to be the title term (i.e., the term that best represented all the other terms in the category). Participants were informed that the emotion terms had been generated in response to meat and plant-based patties.

Participants could propose as many categories as they considered necessary and did not have to categorize all the terms. However, to set expectations, they were informed that typically 10–20 categories would be made (based on pilot study).

A pilot study was completed by five researchers from the Feast laboratory who completed the activity on their own devices in their own time as per the study protocol. All emotion terms were presented in a randomized order (i.e., positive, negative, and neutral terms randomized), but feedback indicated it was difficult to complete the activity with >100 terms randomized. It was suggested terms should be grouped in positive, negative, and neutral subgroups so participants would generally only have to look through a proportion of the terms each time they created a category. Therefore, in the actual study, emotion terms were presented in a fixed order of positive, negative, then unclassified emotions, in alphabetical order within each subgroup. This classification of each emotion term was determined based on the most frequently indicated classification by participants during the discussion groups.

## 2.4 | Data analysis

Statistical analyses were performed using R version 4.1.3 (R Core Team, 2022) through R Studio software version 1.4.1717 (R Studio

Team, 2021). Package factoextra (Kassambara & Mundt, 2020) was used for data manipulation.

### 2.4.1 | Identifying frequently mentioned emotion terms from discussion groups

Across the 12 discussion groups, there were 24 opportunities for an emotion term to be recorded as, although each term was only recorded once, it could be recorded for each context. The frequency with which each emotion term was mentioned across the 12 discussion groups was determined.

### 2.4.2 | Clustering of emotion terms to determine emotion categories

The sorting-task data were arranged in a dissimilarity matrix, where each of the emotions was listed along the first row and top column. Each cell recorded the frequency at which each pair of emotions was not co-sorted into the same category. Hierarchical cluster analysis was then performed on the dissimilarity matrix using the R package factoextra (Kassambara & Mundt, 2020) to group similar emotions into categories. Emotions were grouped using Euclidean distance and the Complete Linkage criterion. The appropriate number of clusters was determined using the elbow method, which determines the optimal number of clusters for a relatively low within-cluster sum of square.

#### *Identification of inconsistently understood emotion terms*

To ensure the final lexicon was familiar and easily interpreted by end users regardless of consumer group, the grouping of emotion terms for each of the consumer groups was compared to the groupings of the total sample.

To achieve this, a *standardized* dissimilarity matrix was created to present the level of agreement of grouping of emotional terms between consumer groups. In the *standardized* dissimilarity matrix, the frequency at which each pair of emotions was not co-sorted in the original dissimilarity matrix was divided by square root of total variance (standard deviation [SD]). Here, variance presented the difference between the proportion of each consumer group and the proportion of the total consumer group that did not co-sort a pair of emotions into the same category. The total variance for each of the emotions pairs was calculated by summing the variance of each of the six consumer groups. Pairs of emotions with a low total variance indicated consistency in understanding of the similarity of emotions *a* and *b* between the six consumer groups. Hierarchical clustering was performed on the *standardized* dissimilarity matrix in the same manner as the *original* dissimilarity matrix.

The clustering solution for the *original* dissimilarity matrix was compared to the clustering solutions for the *standardized* dissimilarity matrix. Emotion terms that shifted clusters between the *original* and *standardized* matrix (indicating that these terms were understood differently between consumer groups) were identified and classified as

inconsistently understood emotion terms. These emotion terms were subsequently excluded from the emotion categories and hence the final lexicon.

### 2.4.3 | Title terms for emotion categories for final lexicon

The frequency each emotion term was denoted as a title term during the sorting-task stage was determined. The emotion within a category most frequently selected as a title term was assigned as the category title term.

## 3 | RESULTS

### 3.1 | Emotion term generation

Twelve group discussions generated an initial list of 158 different terms (Table 5) to describe how a range of plant-based and meat patties made them feel when consumed across two different eating contexts.

At stage 2, the initial list of terms was reduced to 119 by removal of 31 nonemotion terms and eight irrelevant emotion terms. Included in this refined list were 10 terms not present on published lists by Clore et al. (1987) and Laros and Steenkamp (2005), but were suggested by more than one discussion group, and were retained as synonyms to existing emotion terms, for example, intrigued, underwhelmed, and deceived were kept as another way to express interested, disappointed, and cheated, respectively.

Similar numbers of positive and negative emotions were experienced. Of the 119 emotion terms, 64 were classified as positive terms, 58 as negative terms, and 22 as unclassified. In some instances, a term was classified by the participants as more than one category for example, accepting, curious, and surprised were classified as positive, negative, and unclassified.

Emotions could be recorded a maximum of 24 times (numbers in parentheses indicate citation frequency across groups/context). Positive emotions happy (20), interested (20), pleased (19), satisfied (19), relaxed (18), and curious (17) were experienced most frequently across the discussion groups as well as negative emotions disappointed (23), dissatisfied (17), annoyed (14), and disgusted (14). For unclassified emotions terms, curious (12), neutral (11), and mild (9) were mentioned most frequently.

In the home context, 109 emotion terms were articulated and 101 were generated in the gastropub context. Eighteen were only generated in the home context while 10 terms were only generated in the gastropub context (Table 6).

### 3.2 | Emotion categories

Consumers grouped the 119 emotion terms into a mean of 15 ( $SD = 7$ ) categories, and a mean of 102 ( $SD = 27$ ) emotion terms

were used in the categories, that is, some terms were left as single term categories.

In the cluster analysis, beyond 25 clusters there was minimal drop in the within-cluster sum of square and so additional clusters did not model the data much better. Also, from a practical point of view, it was important to capture the key emotion categories but also keep the lexicon concise for ease of use and to avoid redundant emotion categories.

The 25 cluster solution using the original dissimilarity matrix (Table 7) and the standardized dissimilarity matrix (Table 8) were compared. Terms consistently clustered together in both clustering solutions were adopted in the final emotion categories (Table 9). Twenty-nine emotion terms with inconsistent cluster membership between solutions were identified. These were removed from the clustering solutions because their interpretation in relation to the other terms was apparently different between consumers. However, as an exception, the terms “Satisfied” and “Disgusted” were not removed and assigned their own categories as they have been repeatedly reported as important emotions in previous research. Disgust is the negative emotion most often studied in emotion research related to food and consumer products (Meiselman, Jaeger, Carr, & Churchill, 2022), and “Satisfied” features in a number of lexicon for other product categories (Bhumiratana et al., 2014; King & Meiselman, 2010; Mora et al., 2020; Ng et al., 2013). “Satisfied” and “Disgusted” were also among the most frequently mentioned emotion terms during the discussion groups.

A key difference between the two clustering solutions was that when the *original* dissimilarity matrix was used for clustering, the terms *Afraid*, *Anxious*, *Apprehensive*, *Avoidant*, *Cautious*, *Concerned*, *Fearful*, *Insecure*, *Nervous*, *Scared*, and *Worried* were one cluster. However, when the standardized matrix was used this cluster split into three clusters: *Afraid*, *Cautious*, and *Concerned* (joined with *Uncomfortable* and *Uneasy*); *Anxious*, *Apprehensive*, and *Nervous*; *Avoidant*, *Insecure*, and *Worried* (joined with *Skeptical* and *Suspicious*). Bolded terms are those that would be assigned as the title term for that category. It was decided to keep the three separate clusters as *Afraid* and *Anxious* are not viewed as interchangeable terms (National Alliance on Mental Illness, 2021).

Another key difference was that in the clustering solution for the *original* dissimilarity matrix the terms *Active*, *Alert*, *Eager*, *Energetic*, *Enthusiastic*, *Excited*, *Keen*, and *Lively* were one cluster, and *Adventurous*, *Brave*, *Confident*, *Courageous*, and *Daring* were another cluster. However, in the *standardized* matrix these two clusters were joined as one. It was decided to keep these as two separate emotion categories as the two clusters represented distinct meanings. *Adventurous* indicates someone willing to try new or difficult things (Cambridge University Press, 2022a) which is highly relevant to the consumption of new and novel foods, while *Energetic* means having or involving a lot of energy (Cambridge University Press, 2022c) or wanting very much to do or have something (Eager) (Cambridge University Press, 2022b).

The frequency of each emotion term selected as a title term during the sorting-task is listed in Table 9. The term within a category most frequently selected as a title term was assigned as the title term

**TABLE 5** Complete list of terms generated during discussion groups including classification of positive, negative, or unclassified (neither positive nor negative) as determined by discussion group participants.

**Terms generated during discussion groups**

Acceptance (+ - /)	Fearful (-)	Scared (-)	Removed terms:
Active (+)	Friendly (+)	Skeptical <sup>c</sup> (- /)	Compulsive <sup>a</sup> (-)
Adventurous (+)	Frustrated (-)	Secure (+ /)	Conflicted <sup>a</sup> (/)
Affectionate (+)	Fulfilled (+)	Surprised (+ - /)	Confrontational <sup>a</sup> (-)
Afraid (-)	Glad (+)	Suspicious (- /)	Dubious <sup>a</sup> (-)
Agitated (-)	Glum (-)	Tame (- /)	Diet/restricted <sup>a</sup> (-)
Alert (+)	Good (+)	Tender (+)	Familiar <sup>a</sup> (+)
Amazed (+)	Grateful (+)	Thoughtful (+)	Flat <sup>a</sup> (-)
Ambivalent (/)	Greedy (+)	Tired (- /)	Full <sup>a</sup> (+)
Angry (-)	Grumpy (-)	Uncertain (-)	Healthy <sup>a</sup> (+)
Annoyed (-)	Guilty (-)	Uncomfortable (-)	Heavy <sup>a</sup> (-)
Anticipation (+)	Happy (+)	Underwhelmed <sup>c</sup> (-)	Invigorated <sup>a</sup> (+)
Anxious (-)	Hopeful (+ /)	Uneasy (-)	Indecisive <sup>a</sup> (-)
Apprehensive (-)	Hungry (+ -)	Unfulfilled (-)	Insatiable <sup>a</sup> (+)
At-ease (+)	Impatient (+ -)	Unhappy (-)	Judgemental <sup>a</sup> (-)
Attracted (+)	Impressed (+)	Unimpressed <sup>c</sup> (-)	Let-down <sup>a</sup> (-)
Avoidant (-)	Indifference (/)	Uninspired (-)	Opinionated <sup>a</sup> (-)
Bliss (+)	Insecure (-)	Uninterested (- /)	Repulsed <sup>a</sup> (-)
Bored (- /)	Inspired (+)	Unsure <sup>c</sup> (-)	Reserved <sup>a</sup> (-)
Brave (+ /)	Interested (+ /)	Upset (-)	Resistant <sup>a</sup> (-)
Calm (+)	Intrigued <sup>c</sup> (+ -)	Wanting more (Want) (+)	Rewarded <sup>a</sup> (+)
Cared-for <sup>c</sup> (+)	Irritated (-)	Warm (+)	Satiated <sup>a</sup> (+)
Cautious (-)	Joyful (+)	Whole (+)	Social <sup>a</sup> (+)
Cheated (-)	Keen <sup>c</sup> (+)	Wonder (+)	Spoilt <sup>a</sup> (+)
Cheerful (+)	Lively (+)	Worried (-)	Strange <sup>a</sup> (-)
Comfortable (+)	Loving (+)		Stressed <sup>a</sup> (-)
Concerned (-)	Mad (-)		Tempted <sup>a</sup> (+)
Confident (+)	Merry (+)		Trapped <sup>a</sup> (-)
Confused (- /)	Mild (/)		Tricked <sup>a</sup> (-)
Content (+)	Nauseous (-)		Unhealthy <sup>a</sup> (-)
Courageous (+)	Nervous (-)		Unenthusiastic <sup>a</sup> (-)
Critical (-)	Neutral <sup>c</sup> (/)		Wasteful <sup>a</sup> (-)
Curious (+ - /)	Nostalgic (+)		Appreciative <sup>b</sup> (+)
Daring (+)	Overwhelmed (-)		Awful <sup>b</sup> (-)
Deceived <sup>c</sup> (-)	Peaceful (+)		Lucky <sup>b</sup> (+)
Deflated (- /)	Pleasant (+)		Offended <sup>b</sup> (-)
Delighted (+)	Pleased (+)		Sorry <sup>b</sup> (-)
Disappointed (-)	Polite (+ /)		Shame <sup>b</sup> (-)
Disgusted (-)	Proud (+ /)		Terrible <sup>b</sup> (-)
Dissatisfied (-)	Put-off <sup>c</sup> (-)		Thankful <sup>b</sup> (+)
Doubtful (-)	Reassured (+ /)		
Eager (+)	Regretful (-)		
Embarrassed (-)	Relaxed (+)		
Energetic (+)	Relieved (+ /)		
Enjoyment (+)	Sad (-)		
Enthusiastic (+)	Satisfied (+ /)		
Excited (+)			
Expectant (+)			

Note: “+” denotes positive emotion, “-” denotes negative emotion, and “/” denotes unclassified emotion as classified by discussion group participants.

<sup>a</sup>Removed, not an emotion terms according to published lists of emotions by Clore et al. (1987) and Laros and Steenkamp (2005) or not included on the EsSense Profile.

<sup>b</sup>Removed, not in response to product.

<sup>c</sup>Kept, not an emotion term according to published lists but a synonym term to an emotion mentioned more than once.

for each respective category. In the case of cluster four, *Pleasant* and *Grateful* were both assigned as the title term as they were selected an equal number of times. The same situation occurred in cluster 11 where *Unhappy* and *Sad* were both selected an equal number of times.

The final lexicon for meat and plant-based patties included 24 emotion categories, 11 positive, 11 negative, and 2 unclassified (Table 10). The classification of positive, negative, and unclassified was based on the title terms most frequent classification during the discussion groups. For example, “Hungry” was classified as positive

**TABLE 6** Emotion terms mentioned exclusively in each eating context.

Home only	Gastropub only
Afraid	Agitated
Alert	Bliss
Attracted	Cheated
Cheerful	Confident
Concerned	Deflated
Courageous	Grateful
Glum	Impatient
Greedy	Inspired
Grumpy	Mad
Insecure	Reassured
Lively	
Loving	
Scared	
Thoughtful	
Uncertain	
Unfulfilled	
Wanting more	
Wonder	

**TABLE 7** Original dissimilarity matrix hierarchical clustering analysis solution for 25 clusters using the R package factoextra (Kassambara & Mundt, 2020).

Hierarchical clustering solution using original dissimilarity matrix								
Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9
Accepting	Active	Adventurous	Affectionate	Amazed	Anticipation	Blissful	<u>Cared-for</u> <sup>a</sup>	Curious
At-ease	Alert	Brave	Attracted	Impressed	Expectant	Cheerful	<u>Good</u> <sup>a</sup>	Interested
Calm	Eager	Confident	Friendly	<u>Inspired</u> <sup>a</sup>	Hopeful	Delighted	Grateful	Intrigued
Comfortable	Energetic	Courageous	Loving	Surprised		Enjoyment	Pleasant	Wonder
Content	Enthusiastic	Daring	Tender			Glad	Pleased	
Peaceful	Excited		<u>Warm</u> <sup>a</sup>			Happy		
<u>Reassured</u> <sup>a</sup>	Keen					Joyful		
Relaxed	Lively					Merry		
<u>Secure</u> <sup>a</sup>								
<u>Relieved</u> <sup>a</sup>								
Cluster 10	Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16	Cluster 17	Cluster 18
<u>Fulfilled</u> <sup>a</sup>	Greedy	Nostalgic	Afraid	<u>Agitated</u> <sup>a</sup>	Bored	Cheated	<u>Critical</u> <sup>a</sup>	Deflated
<u>Proud</u> <sup>a</sup>	Hungry	Polite	Anxious	Angry	Tired	Deceived	Skeptical	Disappointed
<u>Satisfied</u> <sup>a</sup>	Impatient	<u>Thoughtful</u> <sup>a</sup>	Apprehensive	Annoyed	<u>Uninterested</u> <sup>a</sup>		Suspicious	
<u>Whole</u> <sup>a</sup>	Wanting-more		Avoidant	Frustrated				
			Cautious	Grumpy				
			Concerned	Irritated				
			<u>Fearful</u> <sup>a</sup>	<u>Mad</u> <sup>a</sup>				
			Insecure					
			Nervous					
			<u>Scared</u> <sup>a</sup>					
			Worried					
Cluster 19	Cluster 20	Cluster 21	Cluster 22	Cluster 23	Cluster 24	Cluster 25		
<u>Disgusted</u> <sup>a</sup>	<u>Doubtful</u> <sup>a</sup>	<u>Embarrassed</u> <sup>a</sup>	Glum	<u>Overwhelmed</u> <sup>a</sup>	<u>Tame</u> <sup>a</sup>	<u>Underwhelmed</u> <sup>a</sup>		
<u>Nauseous</u> <sup>a</sup>	Uncertain	<u>Guilty</u> <sup>a</sup>	Sad	Uncomfortable	Ambivalent	<u>Unfulfilled</u> <sup>a</sup>		
<u>Put-off</u> <sup>a</sup>	Confused	<u>Regretful</u> <sup>a</sup>	Unhappy	Uneasy	Indifferent	Unimpressed		
	Unsure		Upset		Mild	Uninspired		
					Neutral	Dissatisfied		

<sup>a</sup>Emotion terms removed from the emotion lexicon due to shifting clusters between the original and standardized clustering solutions.

nine times and negative two times, and so was classified as positive in the final lexicon. “Curious” did not clearly fit into one category as it was classified as positive 17 times, negative seven times, and unclassified 12 times, and so was unclassified. The emotion terms within a category not assigned as the title term can be provided to end users to give further clarification as to the meaning of an emotion category.

Table 10 also highlights that 10 of the 24 emotion categories are shared with the EsSense Profile and five terms (“Unhappy” and “Dissatisfied,” and “Happy” and Satisfied” are paired together in the CEQ) are shared with the valence × arousal CEQ (Jaeger et al., 2020). Additional synonym terms are shared between this lexicon and the EsSense Profile and CEQ. “Aggressive” from the EsSense Profile and “Tense/Bothered” from the CEQ share a similar meaning to “Angry.” From the CEQ “Jittery/Nervous” is similar to “Anxious.”

## 4 | DISCUSSION

This study developed an emotional lexicon for meat and plant-based patties. It used discussion groups in digital contexts and then a sorting task to group emotion terms with similar meaning and reducing lexicon size while remaining inclusive of the relevant emotion space. The

**TABLE 8** Standardized dissimilarity matrix hierarchical clustering analysis solution for 25 clusters using the R package factoextra (Kassambara & Mundt, 2020).

Hierarchical clustering solution using standardized dissimilarity matrix								
Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9
Accepting	Active	Affectionate	Amazed	Anticipation	Blissful	<u>Cared-for</u> <sup>a</sup>	Curious	<u>Fulfilled</u> <sup>a</sup>
At-ease	Adventurous	Attracted	Impressed	Expectant	Cheerful	<u>Proud</u> <sup>a</sup>	<u>Inspired</u> <sup>a</sup>	<u>Reassured</u> <sup>a</sup>
Calm	Alert	Friendly	Surprised	Hopeful	Delighted	<u>Whole</u> <sup>a</sup>	Interested	<u>Secure</u> <sup>a</sup>
Comfortable	Brave	Loving			Enjoyment		Intrigued	<u>Warm</u> <sup>a</sup>
Content	Confident	Tender			Glad		<u>Thoughtful</u> <sup>a</sup>	
<u>Good</u> <sup>a</sup>	Courageous				Happy		Wonder	
Peaceful	Daring				Joyful			
Relaxed	Eager				Merry			
<u>Satisfied</u> <sup>a</sup>	Energetic							
	Enthusiastic							
	Excited							
	Keen							
	Lively							
Cluster 10	Cluster 11	Cluster 12	Cluster 13	Cluster 14	Cluster 15	Cluster 16	Cluster 17	Cluster 18
Grateful	Greedy	Nostalgic	Afraid	<u>Agitated</u> <sup>a</sup>	Angry	Anxious	Avoidant	Bored
Pleasant	Hungry	Polite	Cautious	<u>Fearful</u> <sup>a</sup>	Annoyed	Apprehensive	<u>Doubtful</u> <sup>a</sup>	Tired
Pleased	Impatient	<u>Tame</u> <sup>a</sup>	Concerned	<u>Guilty</u> <sup>a</sup>	Frustrated	<u>Embarrassed</u> <sup>a</sup>	Insecure	
<u>Relieved</u> <sup>a</sup>	Wanting-more		Uncomfortable	<u>Overwhelmed</u> <sup>a</sup>	Grumpy	<u>Nauseous</u> <sup>a</sup>	Skeptical	
			Uneasy	<u>Regretful</u> <sup>a</sup>	Irritated	Nervous	Suspicious	
				<u>Scared</u> <sup>a</sup>			Worried	
Cluster 19	Cluster 20	Cluster 21	Cluster 22	Cluster 23	Cluster 24	Cluster 25		
Cheated	<u>Critical</u> <sup>a</sup>	Deflated	Glum	Uncertain	Unimpressed	Ambivalent		
Deceived	<u>Disgusted</u> <sup>a</sup>	Disappointed	<u>Put-off</u> <sup>a</sup>	Confused	Uninspired	Indifferent		
<u>Mad</u> <sup>a</sup>		<u>Underwhelmed</u> <sup>a</sup>	Sad	Unsure	<u>Uninterested</u> <sup>a</sup>	Mild		
		<u>Unfulfilled</u> <sup>a</sup>	Unhappy		Unsatisfied	Neutral		
			Upset					

<sup>a</sup>Emotion terms removed from the emotion lexicon due to shifting clusters between the original and standardized clustering solutions.

final emotional lexicon included 24 emotion categories of which 11 were positive, 11 were negative, and 2 were unclassified.

#### 4.1 | Comparison of the developed emotion lexicon to generic emotion lexicon

Developing a consumer-led emotion lexicon enables the lexicon to be tailored to a product category unlike, for example, the EsSense Profile which is general to all foods (King & Meiselman, 2010). Notably, 10 of 24 emotion categories in the final lexicon here are also present in the EsSense Profile which is one of the most popular emotion lexicon in the field of consumer science (Cardello & Jaeger, 2016). A key difference between this lexicon and the EsSense Profile is the inclusion of more negative emotion terms, which has also been found with other consumer-led lexicon for example, (Bhumiratana et al., 2014; Chaya et al., 2015; Mora et al., 2019; Ng et al., 2013). The EsSense Profile includes only three negative emotion terms while this lexicon includes 11. The EsSense Profile, mainly consist of positive emotion terms as it is designed for use with product users who typically like the product (Dalenberg et al., 2014). However, Meiselman (2015) argues that nonusers should also be studied in order to identify characteristics that work against product adoption. The inclusion of nonproduct users in the development of this lexicon likely contributed to the high number of negative terms. The inclusion of

these negative terms gives the lexicon the potential to capture aversion more accurately which is particularly important for novel products like plant-based patties where acceptance is relatively low.

In addition to a better balance of positive and negative terms, the developed lexicon covers a broad range of the valence × arousal space as recommended by Jaeger et al. (2018) and Prescott (2017). The valence × arousal CEQ (Jaeger et al., 2020) consists of 12 pairs of emotions which span the different circumplex segments. The lexicon developed in the current work directly shares five emotions (*Calm*, *Energetic*, *Bored*, *Happy/Satisfied*, *Unhappy/Dissatisfied*), and two synonym emotions (*Angry* and *Anxious*), with the CEQ pairs of emotions. These seven emotions are spread over the circumplex model spanning both the valence and arousal dimensions. Other terms from the developed lexicon are not directly used in the CEQ but would further cover the 12 segments of the circumplex model if mapped out based on the placement assigned to these emotions in Jaeger et al. (2018). The developed lexicon has the potential to cover a broad range of the valence × arousal space but using terms specific to meat and plant-based patties.

#### 4.2 | Specific emotions associated with novel foods

The emotion categories *Deceived*, *Anxious*, *Afraid*, *Uncertain*, and *Suspicious* are notably present here but absent on the EsSense Profile or

TABLE 9 Final emotion clusters.

1. Calm	2. Adventurous	3. Energetic	4. Pleasant/grateful	5. Loving
Accepting (16) At-ease (7) Calm (27) Comfortable (18) Content (20) Peaceful (12) Relaxed (19)	<u>Adventurous (27)</u> Brave (21) Confident (15) Courageous (8) Daring (7)	Active (18) Alert (8) Eager (16) <u>Energetic (25)</u> Enthusiastic (11) Excited (21) Keen (5) Lively (8)	<u>Grateful (12)</u> <u>Pleasant (12)</u> Pleased (6)	Affectionate (16) Attracted (5) Friendly (15) <u>Loving (25)</u> Tender (4)
6. Amazed	7. Hopeful	8. Happy	9. Hungry	10. Nostalgic
<u>Amazed (19)</u> Impressed (17) Surprised (14)	Anticipation (6) Expectant (11) <u>Hopeful (16)</u>	Blissful (4) Cheerful (5) Delighted (10) Enjoyment (10) Glad (2) <u>Happy (62)</u> Joyful (8) Merry (2)	Greedy (19) <u>Hungry (23)</u> Impatient (10) Wanting-more (9)	<u>Nostalgic (16)</u> Polite (10)
11. Unhappy/sad	12. Angry	13. Anxious	14. Afraid	15. Suspicious
Glum (3) Sad (36) <u>Unhappy (36)</u> Upset (14)	<u>Angry (41)</u> Annoyed (11) Frustrated (9) Grumpy (5) Irritated (13)	<u>Anxious (19)</u> Apprehensive (8) Nervous (7)	<u>Afraid (15)</u> Cautious (11) Concerned (11) Uncomfortable (10) Uneasy (11)	Skeptical (6) <u>Suspicious (13)</u> Avoidant (7) Worried (12)
16. Bored	17. Disappointed	18. Deceived	19. Dissatisfied	20. Neutral
Bored (21) Tired (5)	Deflated (4) <u>Disappointed (37)</u>	Cheated (12) <u>Deceived (23)</u>	Unimpressed (9) Uninspired (6) <u>Dissatisfied (20)</u>	Ambivalent (13) Indifferent (12) Mild (9) <u>Neutral (26)</u>
21. Curious	22. Uncertain	23. Satisfied	24. Disgusted	
<u>Curious (28)</u> Interested (22) Intrigued (5) Wonder (7)	<u>Uncertain (16)</u> Confused (12) Unsure (13)	Satisfied (22)	Disgusted (14)	

Note: Numbers in parenthesis reflect frequency at which term was selected as a title term. Underline: emotions selected at title term where needed.

TABLE 10 Emotion lexicon for meat and plant-based patties containing 24 emotion categories.

Positive	Negative	Unclassified
Calm (EP, C)	Unhappy (C)/sad	Curious
Adventurous (EP)	Dissatisfied (C)	Neutral
Energetic (EP, C)	Angry	
Pleasant (EP)/grateful	Anxious	
Loving (EP)	Afraid	
Amazed	Suspicious	
Hopeful	Bored (EP, C)	
Happy (EP, C)	Disappointed	
Hungry	Deceived	
Nostalgic (EP)	Disgusted (EP)	
Satisfied (EP, C)	Uncertain	

Note: (EP) indicates emotion terms included on the EsSense Profile; (C) indicates emotion terms included on the CEQ.

the CEQ (apart from *Jittery/Nervous* which is similar to *Anxious*). Although emotion terms were collected as a list, rather than by sample, the researchers noticed that these terms were mentioned when

consumers were exposed to the two plant-based samples that intended to resemble meat (meat analogues). Terms indicating deception or suspicion may be particularly relevant inclusions for lexicons used to evaluate products, like plant-based meat analogues, that are attempting to mimic other products.

Collier et al. (2021) found that in Swedish consumers *Uncertainty* and *Skepticism* around the contents and composition of meat alternatives, especially those that visually resemble meat, were two main barriers for purchase and consumption. Terms indicating deception or suspicion emotions strongly associate with neophobia, a human trait that manifests in anxiety toward novel foods (Jiang et al., 2014) that is responsible for some consumers' failure to engage with new, often innovative, foods (Barrena & Sánchez, 2013; Jiang et al., 2014). In the present study, it is postulated that the inclusion of nonproduct users of meat analogues proved advantageous for lexicon development by revealing feelings such as *Anxious*, *Uncertain*, and their synonym terms which were frequently mentioned at the term generation stage. By contrast, feeling *Amazed* likely captured the exceeding of expectations for a product that consumers had preconceived negative sensory perceptions

for (Michel et al., 2021) This shows the importance of the development and use of product category specific emotion lexicon to better capture the emotions experienced when evaluating novel foods.

### 4.3 | Consideration of consumer language

*Neutral* and *Deceived* are terms not included on the published lists of emotions by Clore et al. (1987) and Laros and Steenkamp (2005) but were not excluded when filtering of terms, as they were suggested by more than one discussion group and were synonyms to terms included on the published emotion lists, *Indifferent* and *Cheated*, respectively. *Indifferent* and *Cheated* were included in the emotion list used in the grouping task but participants selected the terms “neutral” and “deceived” as the title term for their respective groups. This highlights that published lists may not always include the go-to terms used by consumers to convey such feelings, and highlights another advantage of a consumer-led lexicon.

### 4.4 | Effect of immersive context on emotional response

Of the initial 119 emotion terms, 18 were unique to the home context and 10 to the gastropub context. The greater number of unique terms in the home context is likely due to all participants assessing the samples in the home context first. There were positive and negative terms evoked uniquely in each context. However, notably terms such as *Afraid*, *Concerned*, *Insecure*, *Scared*, and *Uncertain* were only mentioned in the home context. Previous research has shown liking of a product can increase or decrease with repeat exposure (Köster, Couronne, Léon, Lévy, & Marcelino, 2003). Mere Exposure Theory (Pliner, 1982; Zajonc, 1968) suggests experience with a product can lead to increased liking due to dissipation of neophobia. While this theory is applicable to liking, it could explain why the negative terms mentioned previously were only mentioned in the home context as these negative emotions could have dissipated by the second time participants were exposed to the sample.

Comparing emotions generated in the different contexts was not an aim in this study, different contexts were used to widen the relevance of the lexicon across use case scenarios. However, the results suggest that, as unique emotions were perceived across different context, digital immersive techniques provide an efficient and useful tool to evoke and capture emotions that are representative across different real-life eating scenarios. Future research is needed to investigate the effect of using different immersive contexts on emotion lexicon generation using randomized balanced designs and including a control condition (no digital context).

### 4.5 | Applicability of lexicon to other plant-based products

This emotion lexicon was developed using a variety of patty samples including meat analogues, vegetable-based samples, and a beef

sample. There is potential that the lexicon can be a better substitute than a generic lexicon for studies investigating emotional response to plant-based meat analogues beyond patties. However, if this emotion lexicon was to be used with other plant-based/meat analogue products outside the scope of patties it is recommended the lexicon be tested first in a preliminary study (e.g., discussion groups) to ensure there are no missing emotion categories relevant to the new product set.

### 4.6 | Limitations and recommendation

This is the first study to develop an emotion lexicon for meat and plant-based patties but had some limitations. Discussion group participants were screened to fit in different age and meat consumption consumer groups. This study did not balance for gender, and only two men took part in the discussion groups. Even though some studies justify this imbalance by noting that women are more adept with emotional language (Eaton, Hort, Chaya, & Smart, 2019), other studies have shown differences in emotional response between genders (Chaya et al., 2015; Mora et al., 2018) and so inclusion of more men may have contributed additional emotion terms to this lexicon. Gender information was not collected for the sorting-task activity and so the gender balance for this portion of the lexicon development is unknown. For the discussion groups, participants attended with other members of the same age and meat consumption groups. Separating the participants by age could have prevented intergeneration discussion which may have triggered additional emotion terms.

Ideally, to avoid attention bias toward terms at the top of the list in the sorting task, the positive terms (and negative terms) would be presented together but in a randomized order that is, participant one would receive the positive terms in a different order to participant two, however, this was not possible within the functionality of the software. When all words were randomized together during the pilot (i.e., positive terms mixed with negative terms), the activity was discerned to be too confusing for participants. Furthermore, 119 terms was a challenging number for participants to group which in some cases may have led to in “lazy” grouping. If using this approach, it is recommended to reduce the list of emotion terms prior to this stage if possible.

Discussion group participants were informed they would be assessing both meat and plant-based samples but tasted the samples blind and so were unaware of which samples they were tasting. Schouteten et al. (2016) found that negative emotion terms toward plant-based burger patties were used less frequently when participants were aware, compared to unaware, of the main composition ingredient of the patty. Therefore, the uncertainty of the composition of samples in the current study may have contributed to the relatively high number of negative terms generated depending on their expectations. If participants had not assessed the samples blindly, as they would in real-life, it is acknowledged that different emotion terms may have been generated.

It is acknowledged that patties are not usually consumed on their own but as part of a meal (burger bun, sauce, lettuce, etc.). When

consumed as part of a meal emotional response to the patties could change. However, this study aimed to focus on collecting emotions related to patties that differed in main protein source avoiding any impact of other foods. Future research should investigate comparing emotional response to consuming patty samples on their own and as a component of a burger or other meal.

The lexicon presented here was developed with English speakers in New Zealand. van Zyl and Meiselman (2015), have demonstrated that cross cultural differences in emotion expression exist within the same language as well as across languages. Therefore, caution is warranted regarding direct use this list of emotions in other languages or cultures as different emotions may need to be represented or emotions may be better represented with a different term. Preliminary checks in such culture and languages are recommended.

## 5 | CONCLUSIONS

This is the first study to determine an emotional lexicon for meat and plant-based burger patties. The emotional lexicon consists of 24 emotion categories, 11 positive, 11 negative, and 2 unclassified. It provides an important tool for further research concerning links between sensory and emotional drivers of plant-based patty consumption across different types of patty consumers but could be adopted for a wider product set. Although not specific research objectives, the approach taken also highlighted the importance of using different use case scenarios and levels of product users in the development of a consumer-led lexicon. Further research will validate the ability of the lexicon generated to differentiate a wide range of patty products. Measuring emotion with a consumer-led lexicon, over a generic lexicon, has the potential to facilitate increased success in determining potential engagement with plant-based products.

### AUTHOR CONTRIBUTIONS

**Rebekah E. Orr:** Methodology, investigation, analysis, writing—original draft. **Caroline Giezenaar:** Methodology, investigation, writing—review and editing, supervision. **A. Jonathan R. Godfrey:** Methodology, analysis, supervision. **Joanne Hort:** Conceptualization, methodology, supervision, writing—review and editing, funding acquisition.

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### CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

### ORCID

Joanne Hort  <https://orcid.org/0000-0001-8609-4543>

### REFERENCES

- Aschemann-Witzel, J., Gantriis, R. F., Fraga, P., & Perez-Cueto, F. J. A. (2021). Plant-based food and protein trend from a business perspective: Markets, consumers, and the challenges and opportunities in the future. *Critical Reviews in Food Science and Nutrition*, 61(18), 3119–3128. <https://doi.org/10.1080/10408398.2020.1793730>
- Barrena, R., & Sánchez, M. (2013). Neophobia, personal consumer values and novel food acceptance. *Food Quality and Preference*, 27(1), 72–84. <https://doi.org/10.1016/j.foodqual.2012.06.007>
- Beedie, C. J., Terry, P. C., Lane, A. M., & Devonport, T. J. (2011). Differential assessment of emotions and moods: Development and validation of the Emotion and Mood Components of Anxiety Questionnaire. *Personality and Individual Differences*, 50(2), 228–233. <https://doi.org/10.1016/j.paid.2010.09.034>
- Bhumiratana, N., Adhikari, K., & Chambers, I. V. E. (2014). The development of an emotion lexicon for the coffee drinking experience. *Food Research International*, 61, 83–92. <https://doi.org/10.1016/j.foodres.2014.03.008>
- Cambridge University Press. (2022a). *Adventurous*. Cambridge Dictionary. Retrieved from <https://dictionary.cambridge.org/dictionary/english/adventurous>
- Cambridge University Press. (2022b). *Eager*. Cambridge Dictionary. Retrieved from <https://dictionary.cambridge.org/dictionary/english/eager>
- Cambridge University Press. (2022c). *Energetic*. Cambridge Dictionary. Retrieved from <https://dictionary.cambridge.org/dictionary/english/energetic>
- Cardello, A. V., & Jaeger, S. R. (2016). Measurement of consumer product emotions using questionnaires. In H. L. Meiselman (Ed.), *Emotion measurement* (pp. 165–200). Cambridge, MA: Woodhead Publishing. <https://doi.org/10.1016/B978-0-08-100508-8.00008-4>
- Chaya, C., Eaton, C., Hewson, L., Vázquez, R. F., Fernández-Ruiz, V., Smart, K. A., & Hort, J. (2015). Developing a reduced consumer-led lexicon to measure emotional response to beer. *Food Quality and Preference*, 45, 100–112. <https://doi.org/10.1016/j.foodqual.2015.06.003>
- Clore, G. L., Ortony, A., & Foss, M. A. (1987). The psychological foundations of the affective lexicon. *Journal of Personality and Social Psychology*, 53(4), 751–766. <https://doi.org/10.1037/0022-3514.53.4.751>
- Collier, E. S., Oberrauter, L.-M., Normann, A., Norman, C., Svensson, M., Niimi, J., & Bergman, P. (2021). Identifying barriers to decreasing meat consumption and increasing acceptance of meat substitutes among Swedish consumers. *Appetite*, 167, 105643. <https://doi.org/10.1016/j.appet.2021.105643>
- Dalenberg, J. R., Gutjar, S., ter Horst, G. J., de Graaf, K., Renken, R. J., & Jager, G. (2014). Evoked emotions predict food choice. *PLoS One*, 9(12), 1–16. <https://doi.org/10.1371/journal.pone.0115388>
- Dorado, R., Chaya, C., Tarrega, A., & Hort, J. (2016). The impact of using a written scenario when measuring emotional response to beer. *Food Quality and Preference*, 50, 38–47. <https://doi.org/10.1016/j.foodqual.2016.01.004>
- Eaton, C., Hort, J., Chaya, C., & Smart, K. A. (2019). Comparing a full and reduced version of a consumer-led lexicon to measure emotional response to beer. *Journal of Sensory Studies*, 34(2), e12481. <https://doi.org/10.1111/joss.12481>
- Euromonitor International. (2020). *Going plant-based: The rise of vegan and vegetarian food*. Retrieved from [https://go.euromonitor.com/rs/805-KOK-719/images/Rise\\_Vegan\\_Vegetarian\\_Food.pdf](https://go.euromonitor.com/rs/805-KOK-719/images/Rise_Vegan_Vegetarian_Food.pdf)
- Feldman Barrett, L. (2017). *How emotions are made: The secret life of the brain*. Boston, MA: Houghton Mifflin Harcourt.
- Ferrari, R., Carbognin, C., Casarotti, E. M., Nicolis, E., Nencini, A., & Meneghini, A. M. (2010). The emotional response to wine

- consumption. *Food Quality and Preference*, 21(7), 720–725. <https://doi.org/10.1016/j.foodqual.2010.06.004>
- Fiorentini, M., Kinchla, A. J., & Nolden, A. A. (2020). Role of sensory evaluation in consumer acceptance of plant-based meat analogs and meat extenders: A scoping review. *Food*, 9(9), 1334. <https://doi.org/10.3390/foods9091334>
- Fortune Business Insights. (2021). *Meat substitutes market size, share & COVID-19 impact analysis, by source, distribution channel, and regional forecasts, 2021-2028*. Retrieved from <https://www.fortunebusinessinsights.com/industry-reports/meat-substitutes-market-100239>
- Galiñanes Plaza, A., Delarue, J., & Saulais, L. (2019). The pursuit of ecological validity through contextual methodologies. *Food Quality & Preference*, 73, 226–247. <https://doi.org/10.1016/j.foodqual.2018.11.004>
- Giacalone, D., Clausen, M. P., & Jaeger, S. R. (2022). Understanding barriers to consumption of plant-based foods and beverages: Insights from sensory and consumer science. *Current Opinion in Food Science*, 48, 100919. <https://doi.org/10.1016/j.cofs.2022.100919>
- Giezenaar, C., & Hort, J. (2021). A narrative review of the impact of digital immersive technology on affective and sensory responses during product testing in digital eating contexts. *Food Research International*, 150, 110804. <https://doi.org/10.1016/j.foodres.2021.110804>
- Gutjar, S., Dalenberg, J. R., de Graaf, C., de Wijk, R. A., Palascha, A., Renken, R. J., & Jager, G. (2015). What reported food-evoked emotions may add: A model to predict consumer food choice. *Food Quality and Preference*, 45, 140–148. <https://doi.org/10.1016/j.foodqual.2015.06.008>
- Jaeger, S. R., & Giacalone, D. (2021). Barriers to consumption of plant-based beverages: A comparison of product users and non-users on emotional, conceptual, situational, conative and psychographic variables. *Food Research International*, 144, 110363. <https://doi.org/10.1016/j.foodres.2021.110363>
- Jaeger, S. R., Roigard, C. M., Jin, D., Xia, Y., Zhong, F., & Hedderley, D. I. (2020). A single-response emotion word questionnaire for measuring product-related emotional associations inspired by a circumplex model of core affect: Method characterisation with an applied focus. *Food Quality and Preference*, 83, 103805. <https://doi.org/10.1016/j.foodqual.2019.103805>
- Jaeger, S. R., Spinelli, S., Ares, G., & Monteleone, E. (2018). Linking product-elicited emotional associations and sensory perceptions through a circumplex model based on valence and arousal: Five consumer studies. *Food Research International*, 109, 626–640. <https://doi.org/10.1016/j.foodres.2018.04.063>
- Jiang, Y., King, J. M., & Prinyawiwatkul, W. (2014). A review of measurement and relationships between food, eating behavior and emotion. *Trends in Food Science & Technology*, 36(1), 15–28. <https://doi.org/10.1016/j.tifs.2013.12.005>
- Kassambara, A., & Mundt, F. (2020). *Factoextra: Extract and visualize the results of multivariate data analyses*. In (version R package version 1.0.7). Retrieved from <https://CRAN.R-project.org/package=factoextra/>
- King, S. C., & Meiselman, H. L. (2010). Development of a method to measure consumer emotions associated with foods. *Food Quality and Preference*, 21(2), 168–177. <https://doi.org/10.1016/j.foodqual.2009.02.005>
- Köster, E. P., Couronne, T., Léon, F., Lévy, C., & Marcelino, A. S. (2003). Repeatability in hedonic sensory measurement: A conceptual exploration. *Food Quality and Preference*, 14(2), 165–176. [https://doi.org/10.1016/S0950-3293\(02\)00075-7](https://doi.org/10.1016/S0950-3293(02)00075-7)
- Laros, F. J. M., & Steenkamp, J.-B. E. M. (2005). Emotions in consumer behavior: A hierarchical approach. *Journal of Business Research*, 58(10), 1437–1445. <https://doi.org/10.1016/j.jbusres.2003.09.013>
- Loewenstein, G., & Lerner, J. S. (2003). The role of affect in decision making. In R. Davidson, H. Goldsmith, & K. Scherer (Eds.), *Handbook of affective sciences* (pp. 619–642). Oxford, UK: Oxford University Press.
- Low, J. Y. Q., Lin, V. H. F., Jun Yeon, L., & Hort, J. (2021). Considering the application of a mixed reality context and consumer segmentation when evaluating emotional response to tea break snacks. *Food Quality and Preference*, 88, 104113. <https://doi.org/10.1016/j.foodqual.2020.104113>
- Martins, Y., & Pliner, P. (2005). Human food choices: An examination of the factors underlying acceptance/rejection of novel and familiar animal and nonanimal foods. *Appetite*, 45(3), 214–224. <https://doi.org/10.1016/j.appet.2005.08.002>
- Meiselman, H. L. (2015). A review of the current state of emotion research in product development. *Food Research International*, 76, 192–199. <https://doi.org/10.1016/j.foodres.2015.04.015>
- Meiselman, H. L. (2017). Emotion measurement: Theoretically pure or practical? *Food Quality and Preference*, 62, 374–375. <https://doi.org/10.1016/j.foodqual.2017.05.011>
- Meiselman, H. L., Jaeger, S. R., Carr, B. T., & Churchill, A. (2022). Approaching 100 years of sensory and consumer science: Developments and ongoing issues. *Food Quality and Preference*, 100, 104614. <https://doi.org/10.1016/j.foodqual.2022.104614>
- Michel, F., Hartmann, C., & Siegrist, M. (2021). Consumers' associations, perceptions and acceptance of meat and plant-based meat alternatives. *Food Quality and Preference*, 87, 104063. <https://doi.org/10.1016/j.foodqual.2020.104063>
- Mora, M., Dupas de Matos, A., Fernández-Ruiz, V., Briz, T., & Chaya, C. (2020). Comparison of methods to develop an emotional lexicon of wine: Conventional vs rapid-method approach. *Food Quality and Preference*, 83, 103920. <https://doi.org/10.1016/j.foodqual.2020.103920>
- Mora, M., Giussani, B., Pagliarini, E., & Chaya, C. (2019). Improvement of an emotional lexicon for the evaluation of beers. *Food Quality and Preference*, 71, 158–162. <https://doi.org/10.1016/j.foodqual.2018.06.007>
- Mora, M., Urdaneta, E., & Chaya, C. (2018). Emotional response to wine: Sensory properties, age and gender as drivers of consumers' preferences. *Food Quality and Preference*, 66, 19–28. <https://doi.org/10.1016/j.foodqual.2017.12.015>
- National Alliance on Mental Illness. (2021). *Anxiety and fear: What's the difference?* Retrieved from <https://www.nami.org/blogs/NAMI-Blog/May-2021/Anxiety-And-Fear-What-s-the-difference>
- Ng, M., Chaya, C., & Hort, J. (2013). Beyond liking: Comparing the measurement of emotional response using EsSense Profile and consumer defined check-all-that-apply methodologies. *Food Quality and Preference*, 28(1), 193–205. <https://doi.org/10.1016/j.foodqual.2012.08.012>
- Onwezen, M. C., Verain, M. C. D., & Dagevos, H. (2022). Positive emotions explain increased intention to consume five types of alternative proteins. *Food Quality and Preference*, 96, 104446. <https://doi.org/10.1016/j.foodqual.2021.104446>
- Piqueras-Fiszman, B., & Jaeger, S. R. (2014). The impact of evoked consumption contexts and appropriateness on emotion responses. *Food Quality and Preference*, 32(Part C), 277–288. <https://doi.org/10.1016/j.foodqual.2013.09.002>
- Pliner, P. (1982). The effects of mere exposure on liking for edible substances. *Appetite*, 3(3), 283–290. [https://doi.org/10.1016/S0195-6663\(82\)80026-3](https://doi.org/10.1016/S0195-6663(82)80026-3)
- Prescott, J. (2017). Some considerations in the measurement of emotions in sensory and consumer research. *Food Quality and Preference*, 62, 360–368. <https://doi.org/10.1016/j.foodqual.2017.04.005>
- R Studio Team. (2021). *RStudio: Integrated Development Environment for R*. RStudio, PBC. Retrieved from <http://www.rstudio.com/>
- Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, 39(6), 1161–1178. <https://doi.org/10.1037/h0077714>
- Schouteten, J. J., De Steur, H., De Pelsmaeker, S., Lagast, S., Juvinal, J. G., De Bourdeaudhuij, I., ... Gellynck, X. (2016). Emotional and sensory profiling of insect-, plant- and meat-based burgers under blind, expected and informed conditions. *Food Quality and Preference*, 52, 27–31. <https://doi.org/10.1016/j.foodqual.2016.03.011>
- Schouteten, J. J., Verwaeren, J., Lagast, S., Gellynck, X., & De Steur, H. (2018). Emoji as a tool for measuring children's emotions when tasting

- food. *Food Quality and Preference*, 68, 322–331. <https://doi.org/10.1016/j.foodqual.2018.03.005>
- Spinelli, S., & Jaeger, S. R. (2019). What do we know about the sensory drivers of emotions in foods and beverages? *Current Opinion in Food Science*, 27, 82–89. <https://doi.org/10.1016/j.cofs.2019.06.007>
- Spinelli, S., Masi, C., Dinnella, C., Zoboli, G. P., & Monteleone, E. (2014). How does it make you feel? A new approach to measuring emotions in food product experience. *Food Quality and Preference*, 37, 109–122. <https://doi.org/10.1016/j.foodqual.2013.11.009>
- Thomson, D. M. H., & Coates, T. (2021). Concept profiling—Navigating beyond liking. In H. L. Meiselman (Ed.), *Emotion measurement* (2nd ed., pp. 381–438). Cambridge, MA: Woodhead Publishing. <https://doi.org/10.1016/B978-0-12-821124-3.00012-0>
- Tso, R., Lim, A. J., & Forde, C. G. (2020). A critical appraisal of the evidence supporting consumer motivations for alternative proteins. *Foods*, 10(1), 24. <https://doi.org/10.3390/foods10010024>
- van Zyl, H., & Meiselman, H. L. (2015). The roles of culture and language in designing emotion lists: Comparing the same language in different English and Spanish speaking countries. *Food Quality and Preference*, 41, 201–213. <https://doi.org/10.1016/j.foodqual.2014.12.003>
- Wakeling, I. N., & MacFie, H. J. H. (1995). Designing consumer trials balanced for first and higher orders of carry-over effect when only a subset of k samples from t may be tested. *Food Quality and Preference*, 6(4), 299–308. [https://doi.org/10.1016/0950-3293\(95\)00032-1](https://doi.org/10.1016/0950-3293(95)00032-1)
- Weerawarna, N. R. P. M. (2021). *Evaluating temporal multiple sip approaches to characterise product experience*. A thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Food Technology at Massey University, Palmerston North Campus, New Zealand (Doctoral, Massey University). Retrieved from <http://hdl.handle.net/10179/16401>
- Willett, W., & Rockström, J. (2019). *Summary report of the EAT-lancet commission healthy diets from sustainable food systems*. The Lancet. Retrieved from [https://eatforum.org/content/uploads/2019/07/EAT-Lancet\\_Commission\\_Summary\\_Report.pdf](https://eatforum.org/content/uploads/2019/07/EAT-Lancet_Commission_Summary_Report.pdf)
- Yik, M., Russell, J. A., & Steiger, J. H. (2011). A 12-point circumplex structure of core affect. *Emotion*, 11(4), 705–731. <https://doi.org/10.1037/a0023980>
- Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology*, 9, 1–27. <https://doi.org/10.1037/h0025848>

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