Food Quality and Preference xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Food Quality and Preference

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

Integrating implicit and explicit emotional assessment of food quality and safety concerns

Alexandra M. Walsh [a], Susan E. Duncan [a,*], Martha Ann Bell [b], S.F. O'Keefe [a], Daniel L. Gallagher [c]

[a] Department of Food Science and Technology, Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg 24061, USA
[b] Psychology Department, Virginia Tech, Blacksburg 24061, USA
[c] Department of Civil and Environmental Engineering, Virginia Tech, Blacksburg 24061, USA

ARTICLE INFO

Article history:
Received 29 August 2016
Received in revised form 19 October 2016
Accepted 4 November 2016
Available online xxxx

Keywords:
Emotion
EEG
ECG
Facial expression
Food quality
Food safety
Meal

ABSTRACT

Tools for automatic facial expression analysis (AFEA), frontal cortex (EEG) and cardiac electrical activity (ECG) may bring additional support to traditional sensory techniques for a better understanding of implicit physiological and emotional response to food. To enhance the understanding of consumer emotional response to food, participants (age: 18–29 years; n = 40, female = 31) were presented with videos (average 40 s) of food concerns (safety, hygiene and spoilage; called evented videos) and matched control (no food concern; called control videos) videos, while implicit emotional responses (AFEA, EEG and ECG) and expressed explicit emotional responses were measured concurrently. AFEA analyzed facial expressions for the six basic emotions (0 = not expressed; 1 = expressed); EEG measured frontal cortex asymmetry for motivational behavior tendency (right hemisphere activation = withdrawal: scared, sad and disgust; left hemisphere activation = approach: happy, surprised and angry; 10/20 system, 32 channels, 512 Hz), while ECG measured heart rate (bpm) changes. Explicit emotions were assessed using a list of emotional terms (n = 43) in a check-all-that-apply method and acceptability was rated on a 7-point hedonic scale (1 = dislike extremely; 7 = like extremely). Withdrawal emotions, disgust and worried, were significantly chosen more for evented videos, while approach emotions (content, good, good-natured, interested, pleasant, pleased and satisfied) were significant for all control videos ($p < 0.05$). Acceptability scores were significantly lower ($p < 0.05$) for the evented meals. Significant differences in heart rate may indicate emotional response. AFEA results for quality (spoilage, hygiene) concerns found greater variety of emotion expression compared to the safety concern, while frontal cortex asymmetries were inconsistent. More research is needed to validate the use of implicit measures (EEG, ECG and AFEA) in providing information for understanding differences in emotional response to food safety, hygiene and spoilage events. The evaluation of displeasing or unpleasant characteristics of food, through the integration of implicit and explicit responses, will lead to a greater understanding of the consumer-food relationship.

1. Introduction

Understanding the influence of negative emotional 'side effect' experiences by the consumer is as important as understanding positive responses in food product design (Desmet & Hekkert, 2009). In many sectors of the food industry, including food service and retail establishments, this is essential for success. The idea of establishing consumer confidence in quality and safety is important for brand loyalty, satisfactory customer service, as well as for motivating customer return and purchasing behavior (Desmet & Hekkert, 2009; Lassoued & Hobbs, 2015). Increased interest in the consumer experience with food has inspired exploration of emotional influence on decision making and behaviors toward products and foods (Desmet & Hekkert, 2009; Gutjar et al., 2015). Kubberod, Ueland, Dingstad, Risvik, and Henjesand (2008) emphasize the reduction of undesirable emotions, such as disgust, to ensure positive food-associated emotional experiences. Barriers to purchase and consumption can develop when implicit or direct associations are made between negative experiences, such as food advertisements that create adverse emotions, and a food item (Kubberod et al., 2008; Shimp & Stuart, 2004). Most research on emotions in food science literature focuses on the discriminating capabilities of foods that are positive perceived, such as indicated by high level of acceptance, using traditional explicit or written ballot methodologies (Jiang, King, & Prinyawiwatkul, 2014; King, Meiselman, & Carr, 2010). However, little attention has been given

* Corresponding author at: 104C Hutcheson Hall, 250 Drillfield Dr., Virginia Tech, Blacksburg 24061, USA.
E-mail address: duncans@vt.edu (S.E. Duncan).

http://dx.doi.org/10.1016/j.foodqual.2016.11.002
0950-3293/

to understanding the attributes of food that may cause negative effects that influence consumer dissatisfaction, customer complaints, brand damage or declining or low sales activity (Kubberod et al., 2008; Shimp & Stuart, 2004; Wardy, Sae-Eaw, Sriwattana, No, & Prinyawiwatkul, 2015). Increased interdisciplinary engagement between psychology and food science and advancements in technology for measuring implicit emotional response are creating new approaches and a deeper understanding of the emotional and motivational behavior tendencies in connection to food. Implicit or non-verbal responses, such as facial expressions and brain activity, as well as physiological measures of heart activity, skin conductance and skin temperature are being explored for application to food science questions. Observing emotional responses and motivation behaviors to displeasing food experiences may be valuable in providing a more complete understanding of the relationship between the consumer and food. Understanding food attributes that have the potential for both lowering consumer acceptability and increasing implicit or direct association of negative emotions is important for product developers and other food professionals to understand (Wardy et al., 2015).

Assessment of emotional response to foods is a rapidly growing area of food science; how emotions affect responses to food acceptability, intent to purchase, food choice, attitudes and food behaviors are a few of the areas already studied (Jiang et al., 2014; Wardy et al., 2015). However, studies on emotional response to food hazards and concerns are limited. Wardy et al. (2015) found that unwholesome eggs, defined as eggs lacking a safety attribute, received significantly lower liking scores as well as lower 'safe' emotion selection and higher 'worried' and 'disgusted' term selection. It is hypothesized that the feeling of disgust originally developed to protect against unsafe or contaminated food demonstrating a bad taste (Rozin, 1996, 1999, 2007; Rozin & Fallon, 1987). Tastes recognized with disgust response are associated with illness and the feeling of nausea, separating its meaning from dislike or distaste to a food (Rozin, 1996). Additionally, Olsen, Røssvoll, Langsrud, and Scholderer (2014) determined that 'fear' and 'disgust' term usage safeguarded individuals against potential risky foods (e.g. undercooked hamburgers). Thus obstacles to purchasing and/or consumption of a food can be created not only from one's preference, but also when the feeling of disgust is associated with the product or brand (Kubberod et al., 2008). Specifically, foods from animal origins that have begun to decay or spoil or have been tainted by poor hygiene are all disgust elicitors.

The well-studied universal facial expression of disgust and other communication modalities (Rozin, 1996, 2007; Rozin & Fallon, 1987) include an upper lip raise, wrinkling of the nose, and the bottom lip lowering in a gaping fashion, which bear importance for communicating a revulsion or withdrawal response to a food (Rozin, 1996, 2007; Rozin & Fallon, 1987; Zeinstra, Koelen, Colindres, Kok, & de Graaf, 2009). Wendin, Bredie, and Tan (2014) further suggest these communicative facial expressions are either a warning signal to others for a potential danger or designate a distaste response. Conversely, positive facial expressions serve as an affirmation for safe consumption or of sensory pleasure (Wendin et al., 2014). Facial expressions are not the only means of communication of disgust; Shimp and Stuart (2004) found food advertisements of undercooked meat products elicited strong written disgust responses. Phrases such as "gross," "obnoxious," "... not appealing," and "... looked nasty" were all used to describe meat in the meal presented in the advertisement. These examples emphasize the importance of understanding all attributes of a food to reduce unintentional negative affect that could influence purchase intent (Shimp & Stuart, 2004).

Both explicit written or oral responses and facial expressions provide valuable indications of emotion but are influenced by external factors. Measures of implicit response, such as heart and brain activity, to attributes of concern in food may provide additional cues related to emotions. Such information may provide clues to consumers' food preferences and behaviors, providing additional validation and support for interpreting facial expressions and explicit verbal emotional terms expressed. Explicit emotional response methods run the risk of being affected by cognitively determined factors (Jiang et al., 2014), which may affect validity of emotional assessment. Training for reliable and consistent manual coding of facial expressions is time intensive, requiring a minimum of 10–20 h (Kring & Sloan, 2007). Validating inter-rater reliability and limiting rater drift requires recurring verification and training, as needed, for improvement (Kring & Sloan, 2007), thus reducing the ease of use in industry settings. Automated facial expression analysis (AFEA) software tools have been developed as an alternative to manual coding of facial expression.

AFEA software tools analyze the face for muscle movements of the lips, eyes, cheeks, mouth, etc. and translates the combinations of facial movements to classify and provide an estimate of intensity for the six basic emotions (Loijens & Krips, 2012; Noldus Information Technology, 2012). AFEA has been used in a few food science studies (Arnade, 2013; Crist, Duncan, & Gallagher, 2016; Danner, Haindl, Joechl, & Duerrschmind, 2014; Danner, Sidorkina, Joechl, & Duerrschmind, 2013; de Wijk, He, Mensink, Verhoeven, & de Graaf, 2014; de Wijk, Kooijman, Verhoeven, Holthuysen, & de Graaf, 2012; Garcia Burgos & Zamora, 2015, 2013; He, Boesveldt, de Graaf, & de Wijk, 2014, 2016; Leitch, Duncan, O'Keefe, Rudd, & Gallagher, 2015; Walsh, Duncan, Potts, & Gallagher, 2015). In these studies (with the exception of: Garcia Burgos & Zamora, 2015, 2013), the general approach was to determine if product acceptability differences could be detected through facial expression analysis. Danner et al. (2014) and He et al. (2016) found neutral expressions to be more greatly associated with "liked" or "positively valanced" samples. Leitch et al. (2015) reported significant variation in responses among participants tasting sweetened teas. In general, there is literature evidence that disliked foods are more readily identifiable by discrete expression of disgust, whereas differentiating among liked foods based on discrete neutral and positive expressions is not readily accomplished (Zeinstra et al., 2009). Leitch et al. (2015) did note differences in the temporal relationship of emotions in teas sweetened with different sweeteners using a time series analysis method. Crist et al. (2016) further described the measurement of temporal effects on emotions in milk with acceptability scores in the 'liked slightly' range, illustrating differentiation of products based on emotional expression and timing. Products that were more less liked were also differentiated based on this method. However, deepening the understanding of expressed emotional responses to negatively-valanced or food experiences that elicit withdrawal responses would be a logical step. Such knowledge may be applied to reducing unwanted negative responses, ultimately leading to greater consumer satisfaction. In our search of published literature, we found no AFEA studies focused on understanding emotional withdrawal aspects related to common food quality and safety experiences.

Physiological measures, especially cardiac responses, are another emerging method for providing additional information about emotion processing associated with food. In a review article by Kreibig (2010), cardiac electrical activity, measured as heart rate (HR), is described as being both emotion specific as well as more broad and non-specific; HR response also is highly variable among individuals within a population. Emotion-specific literature suggests that happiness, joy, disgust (contamination), surprise and others, typically manifest as an increase in HR, while sadness (non-crying or acute), contempt (visual), anticipatory pleasure and others, to cause a decrease in HR (Kreibig, 2010). Fernandez et al. (2012) show cardiac responses as well as other autonomic

Please cite this article in press as: Walsh, A. M., et al. Integrating implicit and explicit emotional assessment of food quality and safety concerns. *Food Quality and Preference* (2016), http://dx.doi.org/10.1016/j.foodqual.2016.11.002