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The impact of PROP and thermal taster status on the emotional response to beer

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ABSTRACT

With an increasingly competitive global market, understanding consumer emotional response to products can provide a different perspective to identify drivers of consumer food choice behaviour beyond traditional hedonic measurement. This study investigated how two taste phenotypes (Thermal taster status (TTS) and PROP taster status (PTS)) impacted liking and emotional response to beers varying in bitterness, carbonation and serving temperature. Volunteers (n = 60, balanced for TTS and PTS) were invited to express their liking and emotional response to 2 commercial beers of contrasting bitterness, presented at two different carbonation levels (commercial carbonation and low carbonation level) and served at two temperatures (cold and ambient). In general, when beers were served at their commercial carbonation level and at a cold temperature, they received higher liking scores and evoked more positive emotions and less negative emotions. Signficant temperature * carbonation interactions were found for liking and some emotion categories. At commercial carbonation levels, cold beer was better liked and evoked more positive emotions than beer served at ambient temperature, but no such temperature effect was observed at the low carbonation level. Although the sample size was relatively small, significant effects for liking were observed for PTS but not TTS, suggesting PTS is a more influential factor regarding liking than TTS. However, thermal tasters (TT) rated 6 out of 10 emotion categories significantly higher for beer than thermal non-tasters (TnT), indicating emotional response may be more sensitive to capture the differences across taste phenotypes than liking, and that TT show increased negative emotions to beer in general. PROP supertasters (ST) rated some emotion categories significantly higher than non-tasters (NT) and, in contrast to TTS these were the more positive emotions, such as *excited* and *content*. This is the first study to report an impact of both TTS and PTS on emotional response. Furthermore, this study observed significant relative effects of TTS and PTS on emotional response, where the effect of PTS was more pronounced in TnT. This highlights the importance of investigating the combined effects of different phenotypes on consumer response representing the reality of different consumer segments.

1. Introduction

Since their development in the 1950s, hedonic measures (Peryam & Haynes, 1957; Peryam & Pilgrim, 1957) have been widely used to help food and beverage manufacturers predict and compare how commercially successful their products are, or are going to be (O'Sullivan, 2017). However, in today's competitive markets, hedonic measurement alone may not be enough in terms of evaluating product associated experiences (King & Meiselman, 2010; Ng, Chaya, & Hort, 2013).

The study of the emotional responses evoked by food and beverage products has grown rapidly over the last decade (Meiselman, 2015). Emotions can be elicited by the food itself, as well as other factors such as the food experience and memories that are associated with a particular food (King, 2016). A number of studies have shown that measuring product-oriented emotion can provide additional useful information beyond liking, as emotional items have been shown to be more discriminating than liking on blackcurrant beverages (Ng et al., 2013), beer (Chaya, Eaton, et al., 2015), spices (King, Meiselman, & Thomas Carr, 2013) and hazelnut and cocoa spreads (Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015).

In order to quantify emotional response elicited by food and beverages, several self-reported questionnaires have been developed. These commonly comprise of a lexicon that varies in the nature of the emotion items and number (Cardello & Jaeger, 2016). The emotions that

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consumers experience during consumption of food can be either rated (unstructured line scale or labelled category scale) or checked (check-all-that-apply (CATA)) or ranked (best-worst-scaling). The EsSense Profile (King & Meiselman, 2010) and EsSense 25 (Nestrud, Meiselman, King, Lesher, & Cardello, 2016) were developed for a broad application to a wide variety of food and beverages. However, consumer defined emotion lexicons have been developed for specific products such as fruit salad (Manzocco, Rumignani, & Lagazio, 2013), blackcurrant beverages (Ng et al., 2013), coffee (Bhumiratana, Adhikari, & Chambers IV, 2014), beer (Chaya, Eaton, et al., 2015; Chaya, Pacoud, Ng, Fenton, & Hort, 2015) and wine (Danner et al., 2016) to ensure the emotion terms used are relevant for the product category.

In the field of sensory and consumer science how sensory properties link to consumer emotional response has been a focus of research. Thomson, Crocker, and Marketo (2010) identified a relationship between sensory properties and consumer conceptualisations reporting that, for dark chocolate for example, cocoa flavour is associated with emotion terms *powerful* and *energetic* and bitter is associated with *confident*. Ng et al. (2013) reported that for blackcurrant beverages, positive emotions were associated with 'natural sweetness' as opposed to artificial sweetness. Within the beer category, studies have also identified sensory properties associated with emotional response elicited by beer (Beyts et al., 2017; Chaya, Pacoud, et al., 2015; Dorado, Chaya, Tarrega, & Hort, 2016; Eaton, 2015). Dorado, Pérez-Hugalde, Picard, and Chaya (2016) found that temperature was associated with *shocked* emotion in beer, where warmer beer was rated as inducing more *shocked* emotion in a set of commercial lagers. Eaton (2015) investigated the emotional response to a range of lager beers including commercial products and spiked beer samples that varied in a broad range of sensory properties, and found that bitter beers were associated with *boring* and *underwhelming* emotions, but none of the emotion items investigated were associated with carbonation. However, Chaya, Eaton, et al. (2015), Chaya, Pacoud, et al. (2015) measured emotional response to a similar set of commercial and spiked beer samples with Spanish consumers, and found that low carbonation level decreased ratings of the emotional category *intensity (strong, powerful, intense)*. This indicates that the effect of a sensory property on emotional response, in this case carbonation, may depend on the segment of consumers.

It is well known that sensory perception varies greatly across individuals (Bachmanov et al., 2014; Hayes & Keast, 2011) and so the question arises as to whether individual variation in sensory perception also impacts emotional response. Research has shown that factors such as culture (Eaton, 2015; Silva et al., 2016) and gender (King & Meiselman, 2010) can affect emotional response and recently Kim, Prescott, & Kim (2017) revealed that sweet likers elicited stronger positive emotions when consuming sweeter products than sweet dislikers. PROP taster status (PTS) and Thermal taster status (TTS) are two other taste phenotypes known to affect sensory perception (Bajec & Pickering, 2008; Yang, Hollowood, & Hort, 2014). However, to date, no studies have investigated the effect of TTS and PTS on emotional response elicited by food and beverages.

TTS, discovered by Cruz and Green (2000), is a relatively new taste phenotype. They found that when a small area of tongue is rapidly warmed or cooled, some individuals perceive a taste sensation without any tastants present. Those who perceive a taste are named thermal tasters (TT), and those who do not perceive any tastes from temperature stimulation are named thermal non-tasters (TnT) (Green & George, 2004). Between 20% and 50% of the tested population have been reported as TT, representing a large segment of the population (Bajec & Pickering, 2008; Green & George, 2004; Yang et al., 2014). TT do not only have the ability to perceive a taste from temperature itself, but have also been shown to report heightened responsiveness to some basic tastes such as sweet, bitter, sour and salty (Bajec & Pickering, 2008; Yang et al., 2014) and temperature (both warm and cold) compared to TnT (Bajec & Pickering, 2008; Cruz & Green, 2000; Yang et al., 2014). Recently Hort, Ford, Eldeghaidy, and Francis (2016) reported that TT are more discriminating towards CO_2 levels in carbonated water than TnT. When looking at the impact of TTS on overall liking of beer, wine and a range of food items, TT had an overall increased intensity perception to oral sensations elicited by beer, wine and food items that were predominantly bitter, however this did not translate into differences in overall liking (Pickering, Bartolini, & Bajec, 2010; Pickering, Lucas, & Gaudette, 2016; Pickering, Moyes, Bajec, & Decourville, 2010). A recent study by the same group found no significant difference in intensity ratings of food categories such as raw vegetables, milk products, sweet treats, textured foods and salty snacks. However, TnT gave higher liking ratings than TT for creamy foods (a variety of milks and creams) and what the authors termed 'aversive' foods, as they are dominated by aversive sensations (bitter, sour, and/or astringent), such as broccoli and cranberry juice (Pickering & Klodnicki, 2016). Yang (2015) also found that as product-serving temperature got warmer or colder, TT liked a strawberry flavoured drink significantly less than TnT. Emotional response may give better insights into food choice behaviour than liking (Ng et al., 2013) but to date no study has investigated the impact of TTS on emotional response.

PTS is a well-known taste phenotype that has been studied extensively since the 1930s (Bartoshuk, Duffy, Lucchina, Prutkin, & Fast, 1998; Bartoshuk, Duffy, & Miller, 1994; Delwiche, Buletic, & Breslin, 2001; Blakeslee & Fox, 1932; Yang et al., 2014) and classifies individuals as non-tasters (NT) if they do not perceive PROP to be bitter, medium tasters (MT) if they perceive it to be moderately bitter and supertasters (ST) if they perceive it as extremely bitter whilst holding the same concentration of 6-n-propylthiouracil (PROP) in their mouth (Herbert, Platte, Wiemer, Macht, & Blumenthal, 2014). Many studies have also reported that PROP tasters have a general heightened sensitivity to other bitter compounds (Ly & Drewnowski, 2001), as well as some other tastes such as sweet, salty and sour, compared to NT (Bajec & Pickering, 2008; Yang et al., 2014). Two previous studies have also found that ST rated the intensity of warmness and coldness from a thermode device significantly more intense than NT (Bajec & Pickering, 2008; Yang et al., 2014). Clark (2011) observed that in carbonated water MT most preferred the low carbonation sample and least preferred the high carbonation sample, whereas no clear preferences were found for ST and NT. A number of studies have also found that PTS has an impact on preference of fruits and vegetables that contain bitter elements, as well as on fatty food, sweet food and alcoholic beverages (Drewnowski, Henderson, Hann, Berg, & Ruffin, 2000; Duffy et al., 2004; Keller, Steinmann, Nurse, & Tepper, 2002; Tepper & Nurse, 1997; Ullrich, Touger-Decker, O'Sullivan-Maillet, & Tepper, 2004; Yeomans, Tepper, Rietzschel, & Prescott, 2007). However, there are also studies that failed to find a relationship between PTS and food preference (Catanzaro, Chesbro, & Velkey, 2013; Deshaware & Singhal, 2017; Feeney, O'Brien, Scannell, Markey, & Gibney, 2014). Whether PTS affects emotional response to beverages is yet to be determined.

Both TTS and PTS appear to play a role in oral sensitivity and could potentially affect food preferences as well as associated emotional response. However, to date, little research has looked into how individual variation affects emotional response to food and beverages. This study aimed to i) investigate the impact of bitterness (beer type), carbonation level and serving temperature on liking and emotional response; ii) investigate the impact of taste phenotype (TTS and PTS) on liking and emotional response to beers varying in bitterness, carbonation level and serving temperature; and iii) investigate the relative effect of TTS and PTS on emotional response elicited by beer.

2. Materials and methods

2.1. Subjects

This study was approved by the University of Nottingham Medical School Research Ethics Committee and all subjects gave informed