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Listening to music can influence hedonic and sensory perceptions of gelati

Kevin Kantono [a], Nazimah Hamid [a, *], Daniel Shepherd [b], Michelle J.Y. Yoo [a], Gianpaolo Grazioli [c], B. Thomas Carr [d, e]

[a] School of Applied Sciences, Auckland University of Technology, Private Bag 92006, Auckland, 1142, New Zealand
[b] Department of Psychology, Auckland University of Technology, Private Bag 92006, Auckland, 1142, New Zealand
[c] Giapo Ice Cream and Research Kitchen, 279-281 Queen St., Auckland, 1010, New Zealand
[d] Carr Consulting, 1215 Washington Ave. Suite 203, Wilmette, IL, 60091, USA
[e] Charles Sturt University, Wagga Wagga, NSW, Australia

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ABSTRACT

The dominant taste sensations of three different types of chocolate gelati (milk chocolate, dark chocolate, and bittersweet chocolate) were determined using forty five trained panellists exposed to a silent reference condition and three music samples differing in hedonic ratings. The temporal dominance of sensations (TDS) method was used to measure temporal taste perceptions. The emotional states of panellists were measured after each gelati-music pairing using a scale specifically developed for this study. The TDS difference curves showed significant differences between gelati samples and music conditions ($p < 0.05$). Sweetness was perceived more dominant when neutral and liked music were played, while bitterness was more dominant for disliked music. A joint Canonical Variate Analysis (CVA) further explained the variability in sensory and emotion data. The first and second dimensions explained 78% of the variance, with the first dimension separating liked and disliked music and the second dimension separating liked music and silence. Gelati samples consumed while listening to liked and neutral music had positive scores, and were separated from those consumed under the disliked music condition along the first dimension. Liked music and disliked music were further correlated with positive and negative emotions respectively. Findings indicate that listening to music influenced the hedonic and sensory impressions of the gelati.

1. Introduction

How people experience food is largely determined by the gustatory and olfactory senses (Ramírez, Martínez, Fernández, Corti Bielsa, & Farina, 2010). However, beyond the dominance of taste and smell there are other sensory systems contributing to food perception, including the trigeminal, visual, tactile, and auditory systems. This multisensory nature of food perception is an on-going area of enquiry, and while it has yet to be determined how diverse sensory dimensions integrate (Sester et al., 2013), studies on cross-modal sensory integration suggest that one sensory modality can enhance the response of another if both are active concurrently (Sagiv & Ward, 2006).

When considering cross-modal sensory interactions in the food sciences, the most often overlooked modality is audition (Spence & Shankar, 2010), which is unfortunate, as for most people food is rarely consumed in silence. Indeed, the sonic background in which we consume our food has been shown to influence our food choices (Stroebele & De Castro, 2004), as well as rate of consumption, identification, and hedonic experiences (Spence & Shankar, 2010). However, while a number of cross-modal interactions have been reported in the literature, including taste and odour; flavour and irritation, and; flavour and colour (Lawless & Heymann, 1999), comparatively less is known about the effect of the auditory modality on food perception. Of the few studies reported in the literature, interactions between pitch of musical instrument and five basic tastes of food names (Crisinel & Spence, 2009), flavours of chocolate milk with varying fat content (Crisinel & Spence, 2011), and pleasantness ratings of chocolate (Crisinel & Spence, 2012)

* Corresponding author. School of Applied Sciences, Auckland University of Technology, 34 St Paul Street, Auckland, 1010, New Zealand.
E-mail address: nazimah.hamid@aut.ac.nz (N. Hamid).

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have been demonstrated. More recently, the interaction between music genre and both flavour and overall food impressions have been reported (Fiegel, Meullenet, Harrington, Humble, & Seo, 2014). In Fiegel's study, participants consumed emotional (milk chocolate) or non-emotional (bell peppers) food while listening to four music genres (classical, jazz, hip-hop, and rock). The milk chocolate sample was significantly higher for overall impression when participants listened to jazz music compared to hip-hop music. The authors considered several mechanisms when explaining their findings. These included mechanisms that involved direct interaction between sensory cortices (Schroeder & Foxe, 2005; Wesson & Wilson, 2011), a cross-modal contrast (Van Wassenhove, Buonomano, Shimojo, & Shams, 2008), attentional processes (Grabenhorst & Rolls, 2008), and association effects due to implicit links between sounds and tastes (Crisinel & Spence, 2009). However, participants in the study did not listen to music varying along dislike-like continuum, and emotion data was not collected to explore the differences in emotional responses elicited by the different music genres. These overlooked aspects will be investigated in the current study.

Liking and congruency of sounds have been associated with food liking and pleasantness. A study by Woods et al. (2011) showed a positive correlation between sound liking and food liking. Various savoury and sweet stimuli from soft and crunchy food categories were all rated lower in terms of both liking and taste intensity in loud compared to quiet sound conditions. Seo and Hummel (2011) further reported that auditory stimuli that were congruent with odour would increase the pleasantness ratings of the odour stimulus. For example, the sound of a Christmas carol increased the pleasantness of cinnamon odour ratings. The authors suggested the valence of the sound could influence the valence of the odour, regardless of the valence liking of the odour itself. The more the participants liked the sound, the more pleasant the odour was rated.

Music has been known to influence mood and emotional states. Blood and Zatorre (2001) reported that playing pleasant music increased cerebral blood flow in the brain regions associated with reward, motivation, and emotion. In contrast, playing unpleasant music increased paralimbic activity, a brain region implicated with unpleasant emotions. It has been observed that mood states, in turn, can influence taste perception. Heath, Melichar, Nutt, and Donaldson (2006) reported that participants who were administered systemic monoamines to induce positive mood obtained lower sucrose thresholds and higher bitterness thresholds. Similarly, Platte, Herbert, Pauli, and Breslin (2013) showed that participants in a positive mood state rated sucrose solutions as sweeter while perceiving quinine sulphate solution to be less bitter, than when reporting a negative mood state.

The Temporal Dominance of Sensations (TDS) method measures the pattern of dominant sensations elicited by a stimulus over a certain time period, specifically the identification of dominant sensations and the rating of their intensity (Pineau et al., 2009). A recent study by Jager et al. (2014) utilized TDS to measure the temporal dominance of taste and flavour attributes elicited by chocolate, as well as the dominant emotions. They found an association between the sensory and emotional attributes that characterized flavoured and plain dark chocolates. Flavour attributes were dominant and positive/active emotions were reported present with flavoured dark chocolates. On the other hand, textural and taste attributes were dominant in the plain dark chocolates, which were associated with more negative/non-energetic emotions. This was also supported by Fiegel et al. (2014) suggesting that the changes in taste perceptions were attributed to emotions, which were easily transferrable to the ratings of emotional food (chocolate) compared to non-emotional food (bell peppers).

Our study builds upon the work of Fiegel et al. (2014), who investigated the static relationship between music and both flavour and overall impression of food, the implicit associations between musical instrument pitch and taste (Crisinel & Spence, 2009), and the effect of white noise to taste in the case of sweetness and saltiness of various food samples (Woods et al., 2011). In this study we employ TDS to measure temporal changes in taste perceptions while chocolate gelati is consumed in the presence of music that varied in liking. Only taste attributes were selected for the sake of simplicity for the participants. Compared to flavour, taste is only limited to the five taste attributes. This study will serve as the first baseline study investigating the effect of music to temporal gustatory perception, particularly taste. Temporal measures of gustatory perception were used as they provide a better description of the continuous effect of music on flavour and taste perception. This is important as music itself is a temporal stimulus (Tenney & Polansky, 1980). In addition, emotional states were measured at the end of each TDS trial for each music and food pairing. The central aim of this study was to determine whether changes in taste of chocolate gelati could be modulated by music and, if so, explained using emotion as a mechanism. The playing of music serves as an experimental manipulation of mood in this study, and takes into account individual variance in music preference.

2. Materials and method

2.1. Ethics statement

The Auckland University of Technology Ethics Committee approved the study (AUTEC 12/79), and panellists gave written informed consent prior to the commencement of the study.

2.2. Panellists

Forty-five panellists (20 males, 25 females) between 21 and 41 years of age participated in the study. They were recruited online through an advertisement posted on social networking services (i.e., Facebook and Instagram), and were rewarded for their participation. None of the panellists were smokers, and none reported hearing loss, eating disorders, or other health problems associated with food.

2.3. Panel training

Panel training was carried out over three sessions totalling 10 h. Panellists were informed that they would be listening to music while consuming chocolate gelati. In the first training session, panellists familiarized themselves with the measurement of taste sensations using the TDS procedure, and were introduced to the concept and measurement of dominance. Panellists were trained to familiarize themselves with 'dominance' attributes, defined as the attribute associated to the sensation catching the attention at a given time, and to understand that dominance might switch when a new sensation arrives (Labbe, Schlich, Pineau, Gilbert, & Martin, 2009; Pineau et al., 2009). In addition, panellists were required to rate the intensity of a selected dominant attribute, for example, *bitterness*. They were also instructed on how to use an unstructured line scale, anchored "none" and "extreme" at each end (Pineau et al., 2009). A dummy TDS trial was carried out in the second training session using samples of bittersweet chocolate gelato that was both *sweet* and *bitter* tasting. In the third session, panellists undertook simulated TDS trials on samples of bittersweet gelato while listening to 45 s of music, allowing them to familiarize with the computer interface and TDS methodology. In this final session, panellists were also acquainted with food-related emotional