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The influence of auditory and visual stimuli on the pleasantness of chocolate gelati

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ABSTRACT

Unrelated auditory cues may alter gustatory and hedonic perceptions to food, but it is unclear whether similar effects will be observed with congruent eating-environment sounds. This is the first experimental work to demonstrate how different eating-environment sounds, varying in quality, may influence pleasantness of food samples. In this study, trained participants (n = 90) were separated into two balanced groups. The first group provided temporal pleasantness measurements during consumption of three different chocolate gelati while listening to various eating-environment sounds, and a silent control condition. This procedure was followed using a second group though with the provision of pictures related to the eating-environment sounds. Both psychoacoustical and psychological measures of sound quality were associated with gelati pleasantness. Combined audiovisual cues further amplified pleasantness ratings compared to auditory cues only. The results are further explained in terms of the effects of mood and arousal on sensory perception. Findings from this study may assist in elucidating the real life implications of the effect of sounds on food pleasantness.

1. Introduction

The multisensory nature of eating is an understudied but crucial element that can influence eating behaviour. Pellegrino et al. (2015) showed that only 3.7% of the participants in their study preferred eating in silence, whilst the rest preferred eating in conditions with sounds in the background. Fell (2012) further inferred that our preference of eating with noise could be due to our increased exposure to machines and technologies in our daily lives. Auditory cues such as environmental sounds and music can be used to enhance gastronomic experiences. Recent studies showed that factors from top-down processes such as expectancy (Verhagen & Engelen, 2006), complex emotions (Canetti, Bachar, & Berry, 2002), and contextualization (Meiselman, Johnson, Reeve, & Crouch, 2000) can influence food perception. Sounds related to food such as crispness or crunchiness have been found to influence the texture perception of both wet and dry food samples (Demattè et al., 2014). Sounds that are completely unrelated to food such as music (Fiegel, Meullenet, Harrington, Humble, & Seo, 2014), and white noise (Woods et al., 2011) can also alter sensory perception of food.

Woods et al. (2011) reported that background noise influenced not only the textural perception of food but also its taste. Playing loud white noise consistently decreased liking and taste perception across a range of sweet and savoury food samples. Background music has been shown to influence taste perception of alcoholic beverages. Stafford, Fernandes, and Agobiani (2012) demonstrated that exposure to music led to higher sweetness ratings of alcoholic beverages compared to control and other sound conditions (i.e., a repeating news story, and a combination of repeating news story and music). These studies support the sensory dominance theory that explains how audition can dominate over certain gustatory/olfactory processes during the perception of food (Woods et al., 2011).

It has long been known that acoustic and visual cues can activate appetitive and defensive motivational circuits in the brain (Lang, Bradley, & Cuthbert, 1998; Lang et al., 1998). Affective dimensions of valence (i.e., pleasantness) and arousal elicited by naturally occurring sounds (e.g., church bell, beer, *etc.*) have been

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investigated by Bradley and Lang (2000). Sounds that are low in valence (i.e., unpleasant) may induce higher anxiety (Martin-Soelch, Stöcklin, Dammann, Opwis, & Seifritz, 2006), while sounds that produce higher levels of affective arousal may induce greater emotion response (Bradley & Lang, 2000). In addition, dominating sounds have been shown to direct attention (Frith & Allen, 1983; Medvedev, Shepherd, & Hautus, 2015). One study incorporated waiting time as an attentional-distraction factor in order to investigate food choice and enjoyment (Nowlis, Mandel, & McCabe, 2004). A review by Macht (2008) reported that emotions varying in valence influenced eating behaviour. Negatively valent emotions such as anger, fear, and sadness may increase impulsive eating, increase consumption of junk food, and decrease food pleasantness. In contrast, positively valent emotions such as joy and other positive emotions can increase food pleasantness and consumption of healthy foods (Macht, 1999; Macht, Roth, & Ellgring, 2002).

The Pleasure-Arousal-Dominance (PAD) model of emotion, commonly known as the Mehrabian Russel (M-R) model (Russell & Mehrabian, 1977), has been applied in numerous business and retail consumer studies (Yani-de-Soriano & Foxall, 2006). For example, Jang and Namkung (2009) utilized the extended M-R model to investigate consumer's evaluation of restaurant quality. Using structural equation modelling they found that atmospherics and service enhanced positive (i.e., approach) emotions, while food quality acted to relieve negative (i.e., avoidance) emotional responses.

Vision has been shown to dominate our spatial perception even during the multisensory integration of audiovisual systems (Bulkin & Groh, 2006). Stein, London, Wilkinson, and Price (1996) demonstrated that a brief, broad-band auditory stimulus significantly enhanced perceived LED intensity. The effect was most pronounced at the lowest visual intensities, and was evident regardless of the auditory cue location. In addition, Baumgartner, Lutz, Schmidt, and Jäncke (2006) reported that pictures accompanied by matching music evoked higher emotional responses (e.g., *fear, happy, sad*) compared to pictures presented in isolation. Photographs of different restaurants were reported to influence cognitive representations such as costs, food quality, and ambience (Cherulnik, 1991). In another study, participants rated affective dimensions higher when exposed to atmospheric cues associated with elegant hotels compared to fast food cues (Stapel, Koomen, & Velthuijsen, 1998). Consumption contexts also influenced preference rankings and liking of coffee (Bangcuyo et al., 2015). Coffee samples were rated higher in immersive environments when accompanied by congruent audiovisual stimuli compared to a laboratory setting. Our study will investigate the effect of audiovisual stimuli of different eating environment on temporal food pleasantness.

Eating is a dynamic process that can be investigated using the time intensity (TI) method (Veldhuizen, Wuister, and Kroeze (2006). By adopting TI approaches, we hypothesize that there will be differences in hedonic ratings for different eating-environment sounds during food consumption. Hence the aim of this study is to investigate the effect of background café sounds (with and without visual cues) on the temporal pleasantness of chocolate gelati (dark chocolate, bittersweet, and milk chocolate). The affective state (arousal, valence, and dominance) of participants while consuming gelati will also be measured to help explain changes in pleasantness.

2. Materials and methods

2.1. Ethics statement

Ethics approval by the Auckland University of Technology Ethics Committee (AUTEC 12/79) was obtained for this study. Participants provided written consent prior to commencement of the study.

2.2. Participants

Ninety participants (42 males, 48 females) between 21 and 43 years of age participated in this study (Mean age = 29 years; SD age = 5 years). Participants were students and staff members from three universities based in Auckland, New Zealand. They were recruited online and received a voucher for their participation. The participants were non-smokers, and did not suffer from any eating disorders and health problems associated with food. The trials were carried out between 2 and 3 pm weekdays, and replicated twice. Participants were then randomly assigned to each test condition (audio only, or audiovisual condition) with balanced number of participants (n = 45) for each test condition.

2.3. Background noise stimuli

Background noises were recorded over lunch hour (13:00–14:00), on the same day of the week (Monday) in three different settings, a café, a fast food restaurant, and a bar. The Root Mean Square amplitudes of the audio samples were standardized to an internal reference to achieve equivalent sound pressure levels across all audio samples, and later scaled to 70 dB SPL, using a Brüel and Kjær sound level meter (Nærum, Denmark). This is considered a reasonable volume to present the sounds, while avoiding amplitudes that could cause discomfort (Bregman, 1978). Sound stimuli were delivered to each panellist using a Sennheiser headset (Series HD 518: Sennheiser Electronics GmbH and Co. KG, Wedemark, Germany) connected to a standard PC sound card. The order of stimuli presentation was randomised and counterbalanced using a Latin square design (MacFie, Bratchell, Greenhoff, & Vallis, 1989) to reduce participant and researcher bias. A silent (control) condition without sound was included to act as a reference condition.

2.4. Visual stimuli

Photos of the three different café settings corresponding to where the background sounds were recorded were obtained using a Nikon D3000 digital SLR camera (Nikon Inc., Melville, NY, USA). All adjustments of the camera were set to "Automatic". The camera was mounted on a Bogen-Manfrotto Maxi Repro Stand Lite assembly (Bogen Imaging Inc., Ramsey, N.J., U.S.A.) with the lens looking forward.

2.5. Food stimuli

Dark chocolate (DC), bittersweet chocolate (BC) and milk chocolate (MC) gelato samples were obtained from a local gelati shop. Samples were transported to a sensory laboratory using packed polystyrene boxes, and remained refrigerated (−14 °C) until served. Each gelato sample (5.0 ± 0.5 g) was placed separately in a 25 ml plastic container coded with a three-digit random number. All samples were tempered for 1 min at room temperature prior to serving. The 1 min increment was determined to be the most appropriate tempering time by observing the ice cream condition as a function of time at room temperature.

The serving temperature (−12 ± 2 °C) was strictly monitored to maintain consistency (Bower & Baxter, 2003). Samples were coded with a 3-digit number, randomized, and counter balanced (MacFie et al., 1989). The samples were served under white light. The gelati varied mainly in fat content, which was highest in MC (22%) followed by BC (17%) and DC (10%). In terms of cocoa content, DC contained the most cocoa (24%), followed by BC (15%) and MC (10%). The highest milk content was in MC (15%), followed by BC (8%), while DC did not contain any milk. The MC flavour also had the least cocoa-to-milk ratio and was less bitter than BC.