Appetite 108 (2017) 383–390

Contents lists available at ScienceDirect

Appetite

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

"Smooth operator": Music modulates the perceived creaminess, sweetness, and bitterness of chocolate

Felipe Reinoso Carvalho [a, b, *], Qian (Janice) Wang [c], Raymond van Ee [b, d, e], Dominique Persoone [f], Charles Spence [c]

[a] Department of Electronics and Informatics (ETRO), Vrije Universiteit Brussel, Brussels, Belgium
[b] Brain & Cognition, Laboratory of Experimental Psychology, KU Leuven, Leuven, Belgium
[c] Crossmodal Research Laboratory, Department of Experimental Psychology, Oxford University, Oxford, UK
[d] Donders Institute, Radboud University, Department of Biophysics, Nijmegen, The Netherlands
[e] Philips Research Laboratories, Department of Brain, Body & Behavior, Eindhoven, The Netherlands
[f] The Chocolate Line, Bruges, Belgium

ARTICLE INFO

Article history:
Received 27 April 2016
Received in revised form
11 October 2016
Accepted 21 October 2016
Available online 23 October 2016

Keywords:
Taste
Sound
Music
Chocolate
Crossmodal correspondences
Multisensory perception

ABSTRACT

There has been a recent growth of interest in determining whether sound (specifically music and soundscapes) can enhance not only the basic taste attributes associated with food and beverage items (such as sweetness, bitterness, sourness, etc.), but also other important components of the tasting experience, such as, for instance, crunchiness, creaminess, and/or carbonation. In the present study, participants evaluated the perceived creaminess of chocolate. Two contrasting soundtracks were produced with such texture-correspondences in mind, and validated by means of a pre-test. The participants tasted the same chocolate twice (without knowing that the chocolates were identical), each time listening to one of the soundtracks. The 'creamy' soundtrack enhanced the perceived creaminess and sweetness of the chocolates, as compared to the ratings given while listening to the 'rough' soundtrack. Moreover, while the participants preferred the creamy soundtrack, this difference did not appear to affect their overall enjoyment of the chocolates. Interestingly, and in contrast with previous similar studies, these results demonstrate that in certain cases, sounds can have a perceptual effect on gustatory food attributes without necessarily altering the hedonic experience.

1. Introduction

The sound and/or noise in those places where we eat and drink - such as restaurants and bars - can affect our perception of taste and flavor (see Spence, 2012; Spence, Michel, & Smith, 2014; Stafford, Fernandes, & Agobiani, 2012, for reviews). Furthermore, chefs and a number of other food industry professionals have recently become increasingly interested in the latest scientific findings regarding multisensory flavor perception. As such, a number of them are starting to use such insights in order to progressively innovate the design of the multisensory dining experiences that they develop (see Spence, 2015b, for a review). Studies assessing the influence of the sound of the food itself have revealed that this can add significant value to people's experience of food and drink (e.g., Knight, 2012; Spence & Shankar, 2010; see Knöferle & Spence, 2012 and Spence, 2015a, for reviews). However, it is important to distinguish here between those sounds that are made by the food itself when masticated/consumed (see Spence, 2015a, for a review on the sounds of consumption) and other unrelated sounds and music that may also influence taste/flavor perception.

The research reported here focuses on how sounds that are unrelated to the food itself can nevertheless still influence people's taste/flavor perception. For instance, recent studies have isolated a number of specific sonic and musical parameters (such as pitch and instrumentation) that can be used to modify tasting experiences, thus potentially adding significant value and pleasure to the consumer's overall eating/drinking experience (e.g., Bronner, Bruhn, Hirt, & Piper, 2012; Crisinel et al., 2012; Reinoso Carvalho, Van Ee,

* Corresponding author. Vrije Universiteit Brussel, ETRO, Pleinlaan 2, 1050, Brussels, Belgium.
E-mail address: f.sound@gmail.com (F. Reinoso Carvalho).

http://dx.doi.org/10.1016/j.appet.2016.10.026
0195-6663/

& Touhafi, 2013; Reinoso Carvalho et al, 2015a,b,c; Reinoso Carvalho, Wang, Van Ee, & Spence, 2016; Wang & Spence, 2015a, 2015b, 2016). In particular, Reinoso Carvalho et al. (2015a, 2016), Wang and Spence (2016), and Crisinel et al. (2012) have all demonstrated that it is possible to compose soundscapes that systematically affect the perceived flavor of food and/or drinks. These studies used soundtracks that had been produced specifically for the purpose of modulating basic taste attributes of food, such as sweetness and/or bitterness (Reinoso Carvalho et al., 2015a; see Knoeferle, Woods, Käppler, & Spence, 2015; Knöferle & Spence, 2012; Spence & Shankar, 2010, for overviews). Recent research has also reported that the more a person likes a sound, the more pleasant they will perceive a subsequently-presented odor (Seo & Hummel, 2011). Moreover, the rated pleasantness of odors can increase in the presence of congruent sounds (Seo, Lohse, Luckett, & Hummel, 2014). Both of the aforementioned examples clearly have relevance to the assessment of food and drink, since flavor perception involves taste and smell (Spence & Piqueras-Fiszman, 2014). In addition, similar studies have focused on assessing how music tends to have an effect in the hedonic and perceptual ratings on tasting experiences, with sound potentially being able to enhance the general enjoyment of food and drinks (i.e., Kantono et al., 2015, 2016; Reinoso Carvalho et al., 2015b). Here, sensation transference has been discussed as an active mechanism that may account for these effects. The aforementioned studies argue that the positive feelings that we associate with music end up being transferred towards the pleasure associated to the food or beverages in question (i.e., Reinoso Carvalho et al., 2016; see Cheskin, 1972, and Spence, 2016, for an overview of the literature on sensation transference).

As mentioned above, a spate of recent studies has questioned whether sound can enhance basic taste attributes (i.e., sweetness, bitterness, sourness, etc.). Moving forward, there is now a growing interest in determining whether sound can also influence people's perception of other flavor attributes as well (Spence, 2015a). For instance, can the presentation of appropriate sounds (that are not necessarily related to eating/drinking) make food/drinks appear more/less crispy, crunchy, creamy, and/or carbonated?

In the present study, we hypothesized that specific soundtracks might affect the perceived texture of chocolate, in particular its creaminess. Here, it is important to mention that previous similar research has assessed the various different ways in which the perceived texture of food can be associated – and potentially altered – by the different combinations of sensory stimuli. For instance, round shapes tend to be associated with creaminess (Yorkston & Menon, 2004). Furthermore, differences in the texture of a food's surface can also alter its perceived sourness (Slocombe, Carmichael, & Simner, 2016). Previous research has also demonstrated that sweeter chocolates are usually associated with rounder shapes, whereas more bitter chocolates are more commonly matched with angular shapes instead (Gallace, Boschin, & Spence, 2011; Ngo, Misra, & Spence, 2011; see Spence & Deroy, 2012, and Bremner et al., 2013, for overviews).

In the experiment reported here, the participants tasted and rated the same chocolate twice (without knowing that the chocolates were identical), each time under the influence of one of two soundtracks. The soundtracks were produced to evoke either creaminess or roughness (in this case, roughness has been defined as the opposite of creaminess). The production of these soundtracks was based on the published empirical literature. First, the bouba-kiki effect (also known as the "maluma-takete" effect) was taken into consideration as a starting point. People tend to associate round/smooth visual/auditory cues with "bouba"-like words, whereas sharp/rough stimuli may be naturally associated with more "kiki"-like words (Bremner et al., 2013; Köhler, 1929, 1947). With this in mind, one might associate purer waveforms with smoothness (bouba/maluma) and more complex waveforms with roughness (kiki/takete). Eitan and Rothschild (2010) also provided some potential musical guidance here. These researchers addressed musical parameters, such as pitch, loudness, timbre, and how they may affect auditory-tactile metaphorical mappings. They found, for example, that a flute's simpler sound wave was rated as smoother than the more complex sound of a violin.

2. Methods

2.1. Participants

116 participants (65 females and 51 males; mean age = 35.11 years, SD = 14.49) took part in the experiment, after giving their informed consent. They reported that they did not have a cold or any other known impairment of their sense of smell, taste, or hearing at the time of the study. The participants were informed that they would be tasting chocolates while sometimes listening to different pieces of music. The experiment lasted for approximately 10 min.

2.2. Stimuli

2.2.1. Taste stimuli

In order to test the effect of the sound stimuli on different types of chocolates, two chocolate formulas were chosen for this study. While designing these chocolate samples, we realized that the only chocolate formulas that wouldn't have significant changes in color would be the ones that do not include milk. It was important for us to keep the color of the chocolate samples as similar as possible, so that it would not influence participants' responses. Therefore, it was decided to use only cocoa-based formulas. However, prior the definitive choices of cocoa percentages, pilot studies were performed in order to determine which combination of cacao would be appropriate to use for the experiences. These pilots were developed along with professional chocolatiers, and included several different formulas. Finally, the chosen formulas had 71% and 80% cocoa content (both milk-free chocolate formulas, with the following basic ingredients: cocoa mass, sugar, cocoa butter and natural vanilla flavor). Moreover, each formula was presented in two different molds (see Fig. 1, top). In total, four different chocolate types were available, one for each group of participants (see Fig. 1, bottom). The chocolates were developed at The Chocolate Line factory in Bruges, under the supervision of the award-wining Belgian chocolatier Dominique Persoone (www.thechocolateline.be).

Note that all of the experimental chocolate samples had the same dark brown color, and similar volume (approximately 2.0 cm^3).

2.2.2. Auditory stimuli

Two soundtracks were prepared for this experiment, one corresponding to smoothness/creaminess, and the other to roughness. Along with the bouba-kiki effect (Köhler, 1929, 1947), the relationship between touch and sound highlighted by Eitan and Rothschild (2010) acted as a starting point for the production of the soundtracks. We reasoned that soft/smooth sounds are usually correlated with long-consonant-legato notes. By contrast, hard/rough sounds are most likely represented by short-dissonant-staccato notes. For example, in Eitan and Rothschild's (2010) study, higher – and louder – pitches/notes were rated as rougher/harder. Moreover, the sound of the violin was rated as rougher/harder and drier as compared to the sound of the flute. That being said, the first soundtrack (produced to be congruent with creaminess, namely the 'creamy soundtrack') consisted of a