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Hedonic mediation of the crossmodal correspondence between taste and shape

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ABSTRACT

Crossmodal correspondences between gustatory (taste), olfactory (smell), and flavour stimuli on the one hand and visual attributes on the other have been extensively documented in recent years. For instance, people have been shown to consistently match specific tastes and flavours to particular visual shapes. That said, further research is still needed in order to clarify how and why such correspondences exist. Here, we report a series of four experiments designed to assess what drives people's matching of visual roundness/angularity to both 'basic' taste names and actual tastants. In Experiment 1, crossmodal correspondences between taste names and abstract shapes were assessed. Next, the results were replicated in a larger online study (Experiment 2). Experiment 3 assessed the role of liking in the association between taste words and morphed shapes along the roundness/angularity dimension. In Experiment 4, basic tastants were mapped to the roundness/angularity dimension, while the mediating role of liking for each taste was assessed. Across the 4 experiments, participants consistently matched sweetness to roundness. What is more, people's liking for a taste (but not their liking for imagined tastes) appeared to influence their shape matching responses. These results are discussed in terms of crossmodal correspondences, and a potential role for hedonics is outlined.

Introduction

When probed, people will associate tastes with a variety of non-gustatory sensory stimuli (e.g., Knöferle & Spence, 2012; O'Mahony, 1983). In fact, the concept of crossmodal correspondences (e.g., Deroy & Spence, 2013; Spence, 2011, 2012), sometimes referred to as synaesthetic correspondences or synaesthetic associations (e.g., Marks, 1978; Marks & Mulvenna, 2013), has been proposed to describe the fact that people match information across the senses (often in ways that may initially seem surprising – hence the link to synaesthesia). To date, a variety of crossmodal correspondences have been documented between tastes/flavours and information in other sensory modalities (e.g., Spence, 2012; Spence & Deroy, 2013; Velasco, Salgado-Montejo, Marmolejo-Ramos, & Spence, 2014). Correspondences between tastes/flavours and shapes are particularly intriguing as the same food or ingredient is often presented in various different shapes (or forms), depending on the culinary ingredients, preparation, or packaging.

As highlighted by Spence and Deroy (2013), crossmodal correspondences between flavours and shapes also surface in language, with adjectives such as 'round' and 'sharp' being used to describe certain foods and drinks (e.g., wine). Indeed, roundness and angularity appear to play an important role in these intuitive associations between tastes and shapes (see Spence, 2012), which are not restricted only to the few reported cases of taste/flavour-shape synaesthesia, but also occur in the population at large (see Cytowic, 2003; Spence & Deroy, 2013, for reviews). In point of fact, synaesthetic metaphor, or the emergence of crossmodal metaphor in language (i.e., in phrases such as "a sharp taste" or a "bright sound"), has been reported elsewhere in the literature (e.g., Marks, 2013).

Using the shape stimuli originally outlined by Köhler (1929), Spence and Gallace (2011) reported that certain foodstuffs, such as, for example, sparkling water and Maltesers (a form of honeycomb-centred chocolate confectionary), were associated with angular shapes, whereas others, like Brie (a French cheese) or chocolate-covered caramel, were instead better associated with rounded shapes (see also Ngo, Misra, & Spence, 2011; Obrist et al., 2014; Spence, 2013; Spence & Ngo, 2012; Spence, Ngo, Percival, & Smith, 2013). Similarly, correspondences have also been documented between angularity and bitterness and between

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roundness and sweetness (Spence & Deroy, 2013). Crucially, these correspondences do not only appear under conditions of restricted choice (e.g., when participants are given just two options to choose between, e.g., Deroy & Valentin, 2011).

It appears that some of these correspondences can be observed across cultures, as shown by Ngo et al.'s (2013) study in which it was demonstrated that both in Colombia and the UK sweeter fruit juices were associated with rounder shapes whereas sourer-tasting juices were matched with more angular shapes (though see Bremner et al., 2013, for a cross-cultural study suggesting differences between cultures in the case of people matching chocolate and carbonation to shape, see also Wan et al., 2014a). Importantly, taste/shape crossmodal correspondences can influence human information processing as well, as shown by Liang, Roy, Chen, and Zhang (2013), who reported that rounded shapes, which were rated as more pleasant than other shapes, enhanced sweetness sensitivity (at least at near-threshold levels), whereas angular shapes did not.

Over and above the various correspondences that have been documented to date, it is still an open question as to how and why the roundness/angularity of shapes should be associated in the first place to tastes/flavour, and in particular to basic tastes, (see Spence & Ngo, 2012). One suggestion that has come from the study of crossmodal correspondences involving olfactory stimuli (Kenneth, 1923; Seo et al., 2010) is that participants tend to match pleasant odours to rounder shapes, while matching unpleasant odours to more angular shapes instead (see Hanson-Vaux, Crisinel, & Spence, 2013; also Velasco, Balboa, Marmolejo-Ramos, & Spence, 2014, for hedonic correspondences). A potential explanation for this phenomenon comes from the fact that people generally prefer curved over angular visual objects (e.g., Bar & Neta, 2006). Does this explanation generalise to basic tastes? Since reactions to tastes come with an hedonic component, would the fact that humans react more positively to sweetness and more negatively to bitter tastes (e.g., Steiner, Glaser, Hawilo, & Berridge, 2001) explain their choices of matching shapes? Four experiments were conducted in the present study to systematically investigate the way in which people match basic tastes[1] (names and tastants) to roundness/angularity (Experiments 1–3), and the role of liking in these associations (Experiments 3–4).

Experiment 1

Methods and materials

Twenty-six participants (17 females, mean age = 26.3 years, SD = 6.5) took part in the study. All of the experiments reported here were reviewed and approved by the Central University Research Ethics Committee at the University of Oxford. The participants signed a standard consent form, and the experiment lasted for approximately 5 min.

The experiment was designed and conducted using E-Prime 2.0 software (Psychology Software Tools, Inc.). The participants were seated approximately 60 cm in front of a 17 inch CRT-monitor, with a resolution of 1024 × 768 pixels, and a screen refresh rate of 60 Hz, in a darkened, sound-proofed experimental booth.

The taste words ('bitter', 'salty', 'sour', and 'sweet') were presented on the monitor in Courier New, font size 20. The participants' task consisted of rating those taste names along shape symbolic scales anchored with angular or rounded shapes (see Fig. 1) that have previously been used in various research on crossmodal correspondences between tastes and shapes (e.g., Spence & Deroy, 2013; Spence & Ngo, 2012, for reviews). Each pair of shapes shown in Fig. 1 was used as an anchor for one of the four different visual analogue scales (VAS) ranging from 0 to 100. Pairs A and D were anchored with the rounded shape on the left side and the angular shape on the right, while pairs B and C were anchored with the angular shape on the right and the rounded shape on the left instead. This counterbalancing was incorporated into the design in order to avoid any lateralized anchor position effects. The four taste names were paired with each of the four scales combinations and each pairing was shown twice, giving rise to a total of 32 trials. Trial order was randomised across participants. In every trial, the participants were asked to think of a food that has the taste presented in the trial, and to try to match it to a point on the scale. Analysis of the data was carried out using in SPSS (IBM, Chicago) and R statistical software (R Core Team, 2013).

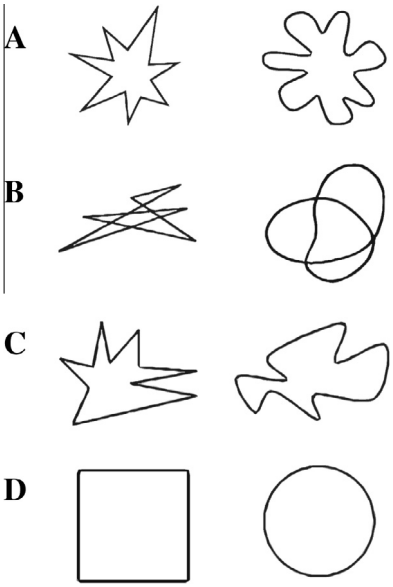

Fig. 1. The four pairs of angular and rounded shapes used as anchors for the different scales in Experiments 1, 2, and 4.

Results and discussion

Preliminary analysis revealed very similar pattern of results for the 4 scales. Consequently, they were collapsed into a broader category of shape roundness/angularity in order to assess any difference in taste-shape correspondences as a function of the taste word under consideration. A one-way repeated measures analysis of variance (RM-ANOVA), using the Greenhouse Geisser correction, revealed a significant effect of taste word, $F(1.857, 46.422) = 17.508$, $p < .001$, $\eta^2_{\text{partial}} = .412$. Pairwise comparisons (Bonferroni corrected) revealed that sweet was rated as rounder than any of the other tastes ($p \leqslant .001$, for all comparisons, see Fig. 2A).

In addition, one-sample *t*-tests were performed in order to determine whether the ratings on each taste differed from the mid-point of the scale (50). This analysis revealed that participants rated bitter, $t(25) = 3.711$, $p = .001$, salty, $t(25) = 3.257$, $p = .003$, and sour, $t(25) = 2.921$, $p = .007$, significantly toward the angular end of the scales, and sweet significantly toward the round end of the scales, $t(25) = -5.421$, $p < .001$. These results therefore suggest that rather than there being taste specific associations to roundness/angularity, the correspondence between shape and taste only seems to capture the distinction between sweetness and the other three most commonly mentioned basic tastes (bitter, salty, and sour). In order to confirm and extend this finding, the same design

[1] The ongoing debate as to whether there are 'basic' tastes, and how they should be defined (see Delwiche, 1996; Erickson, 2008), will not be discussed here.