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"See me, feel me": Effects of 3D-printed surface patterns on beverage evaluation

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ABSTRACT

Research shows that packaging appearance can have a strong impact on taste experience and product evaluation. However, so far research has mainly focused on how visual appearances may steer sensory impressions including smell and taste. Taking into account new (technological) developments which allow for consideration of a wide range of previously unexplored packaging factors, the research presented here investigates the impact of 3D-printed surface patterns on taste evaluations as a function of product type (a bitter tasting coffee versus a sweet tasting chocolate drink) and verbal product claims (either stressing taste strength or taste softness). To this end, 3D-printed cups with angular and rounded surface patterns were manufactured and handed to shoppers participating in a taste session for a fictitious coffee or chocolate brand. Results show that an angular surface pattern increased perceived bitterness and taste intensity ratings, whereas a rounded surface pattern induced a sweeter taste evaluation and a less intense taste experience. Congruent pairings of drinks and tactile patterns resulted in more favorable outcomes. Finally, congruence was also found to be important with respect to taste descriptions, with verbal claims in line with surface pattern associations further enhancing product experience.

1. Introduction

When shopping at the supermarket, consumers face literally thousands of branded products screaming for attention. Packaging design is among the key means to secure consumer attention at the point of purchase, and later on, to sustain interest after consumption. Traditionally, visual elements such as shape, color, and size were the key candidates to do so, but recently manufacturers increasingly turn to other sensory elements such as smell and tactile elements in particular. For instance, Heineken recently reenergized one of its Mexican beer brands with a matte finish suggestive of a more masculine personality. But although researchers have looked into material influences on food and beverage evaluation (e.g., Biggs, Juravle, & Spence, 2016; Krishna, 2012; Piqueras-Fiszman & Spence, 2012, 2015; Schifferstein & Cleiren, 2005; Spence, 2016; Spence & Wan, 2015), research systematically assessing the influence of material surface patterns on food and beverage evaluation is limited. At the same time, new technologies such as 3D printing nowadays provide ample opportunities to experiment with surface patterns. Hence, the latter type of research is highly warranted, both from a practical and scientific point of view.

Inspired by this scarcity of research on the one hand and opportunities for product differentiation and sensory marketing on the other, this study seeks to address the interplay between surface patterns, taste experience, and product evaluation. In doing so, we will draw on research testifying to the importance of the angular-round continuum in relation to food and beverage evaluation (e.g., Becker, van Rompay, Schifferstein, & Galetzka, 2011; Spence, Ngo, Percival, & Smith, 2013; Velasco, Salgado-Montejo, Marmolejo-Ramos, & Spence, 2014; Velasco, Woods, Petit, Cheok, & Spence, 2016; Westerman et al., 2012, 2013).

Importantly, however, we will address this factor in relation to visuotactile surface patterns (i.e., perceived by touch and vision). Building forth on previous research addressing cross-modal correspondence, two types of patterns (with either angular or rounded elements) were developed and used in product sample containers for either a sweet chocolate drink or a bitter coffee. The research aim was to study whether associations triggered by visuotactile product experience would transfer to taste. Additionally, the role of verbal taste descriptions (i.e., a product claim stressing either the drink's 'soft taste' or 'strong taste') was taken into account. Before elaborating on the details of this study, first we will discuss the key notions involved.

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2. Shape angularity and product evaluation

When considering research addressing the influence of shape on product evaluation, it becomes readily apparent that shape angularity (versus roundedness) is one of the most important determinants of product preference (e.g., Bar & Neta, 2006; Zhang, Feick, & Price, 2006). Apart from its influence on consumers' aesthetic responses to product and brand elements, shape angularity has also been traced to specific symbolic meaning portrayals, with angular forms connoting potency-related meanings such as *strength*, *intensity*, and *power*, whereas curved forms rather express *softness* and *harmony* (e.g., Becker et al., 2011; Berlyne, 1960). In line with these notions, Becker et al. (2011) showed that people not only perceive packaging variants with angular (as opposed to rounded) shapes as more powerful, but that they also experience the taste of packaging contents (i.e., yoghurt) as more intense when associated with an angular packaging design.

These results show that consumers rely on symbolic meanings connoted by packaging features such as shape and materials to draw inferences about its contents, even when the product attributes under evaluation are unrelated to the package's appearance (i.e., packaging appearance and materials have no direct influence on drink or food taste). This sequence involves an automatic process in which consumers draw on implicit schemata in which impressions derived from one source (e.g., packaging materials) shape expectations for subsequent product impressions (e.g., product taste; Huber & McCann, 1982; Pinson, 1986). Consumers are most likely to draw on such implicit product schemata when the product is new or when experience is limited (cf. Deliza & MacFie, 2001), and when product attributes are perceived in rapid succession (Garber, Hyatt, & Starr, 2001). These notions and research findings indicate that consumers may base expectations regarding product taste on the 'look and feel' of the package, especially in supermarkets where new taste variants are introduced constantly, and time devoted to purchase considerations is generally limited.

In line with these notions, experiments have shown that people intuitively make connections between different sensory domains, a phenomenon referred to as 'cross-modal correspondence' (e.g., Biggs et al., 2016; Crisinel, Jacquier, Deroy, & Spence, 2013; Schifferstein & Spence, 2008; Spence, 2012). For instance, a considerable body of research indicates that across food and beverage categories (including tea, cheese, chocolate, yoghurt, and fruit juice), cross-modal correspondences exist between angularity and a variety of taste evaluations (e.g., bitterness and sourness; see Velasco et al., 2016 for a review). For example, Ngo, Misra, and Spence (2011) visually presented different shapes in combination with different types of chocolate ranging from sweet to bitter. They showed that bitterness is readily associated with angular shapes. In contrast, sweetness is associated with round or organic shapes. Although different studies have focused on different taste attributes, a common, underlying dimension of taste experience seems to revolve around taste intensity or potency (cf. Becker et al., 2011; Spence et al., 2013), an argument in line with Boring's (1942) claim that different sense sensations share the dimension of intensity.

The theoretical basis underlying angularity effects is generally traced to the embodied cognition framework in which abstract meanings are accounted for in terms of concrete bodily interactions (Barsalou, 1999; Lakoff & Johnson, 1980, 1999; Van Rompay, Hekkert, Saakes, & Russo, 2005; Van Rompay & Ludden, 2015). For instance, the finding that angular (as opposed to rounded) shapes are perceived as powerful can be traced to interactions with natural (e.g., stones) and manmade (e.g., products) objects, in which we find that angular objects make for a more intense, forceful impression on our skin, whereas rounded objects generate a gentle and smooth interaction (Arnheim, 1974; Van Rompay & Ludden, 2015; Zhang et al., 2006).

Thus because of these affective experiences arising in interactions with objects, we associate angularity with strength or intensity, and curvature with harmony and softness. Interestingly then, the basis of aforementioned findings may foremost be found in our haptic, tactile interactions with objects. If correct, then experimenting with surface patterns of product packaging may be a particularly promising avenue for influencing taste intensity and specific taste attributes in particular (bitterness and sweetness in current research). Specifically, and in line with the rationale presented above, angular (as opposed to rounded) surface patterns should increase taste intensity as they make a more forceful impression on our skin.

As discussed, previous research assessing shape-taste correspondences (e.g., Ngo et al., 2011; Velasco et al., 2016) indicates that people entertain associations between angular shapes and bitterness on the one hand, and between rounded shapes and sweetness on the other. Although the basis for these associations is still a matter of debate, Velasco et al. (2016) suggest that people might 'match pairs of taste/shape stimuli when they denote similar hedonic and intensity-related properties' (see also Salgado-Montejo et al., 2015 for a similar stress on hedonic valence as a potential explanation for shape-taste associations). Of further relevance here, Spence and Gallace (2011) discuss the association between shape angularity and taste sharpness. These notions and findings suggest that effects of shape angularity on taste may (also) be grounded in embodied interactions in which we experience angular objects with straight lines and edges as 'sharp'.

However, as also pointed out by Spence and Wan (2015) and Spence (2016), experimental research addressing transfer effects of material surface patterns to taste is limited. Nonetheless, several researchers have recently demonstrated that different materials make for qualitatively different taste experiences (Biggs et al., 2016; Piqueras-Fiszman & Spence, 2012; Schifferstein, 2009; Spence & Wan, 2015; Tu, Yang, & Ma, 2015). For instance, both Schifferstein (2009) and Tu et al. (2015) had their participants taste drinks from cups made of different materials. Whereas Schifferstein (2009) showed, among others, that participants enjoyed their soda better when drunk from a plastic (rather than ceramic) cup, Tu et al. (2015) showed that participants perceived cold tea contained in glass cups as sweeter compared to cold tea contained in plastic cups. Furthermore, Biggs et al. (2016) recently showed that biscuits taste sweeter when sampled from a smooth, as opposed to a rough plate. Apart from showing that packaging or container materials impact taste, findings across studies also suggest that congruency between material surface and drink type should be considered.

The importance of 'fit' or congruence among different elements is well acknowledged within consumer research (e.g., Peracchio & Meyers-Levy, 2005; Van Rompay, Pruyn, & Tieke, 2009). Of special relevance to the current research, Okamoto et al. (2009) showed that different tastes were liked better when they were combined with words that were related (i.e., congruent with) these tastes. Additionally, research indicates that when a matching taste or flavor description is presented before a product is tasted, taste perceptions are more intense (Distel & Hudson, 2001; Herz & von Clef, 2001). These findings are highly relevant to the product packaging context where implicit or abstract elements such as shape and surface pattern are usually combined with explicit taste descriptions laid down in product claims or slogans.

To better understand such congruence effects, the processing fluency framework is of particular interest (Reber, Schwarz, & Winkielman, 2004; Van Rompay et al., 2009). According to this account, stimuli that can be easily processed are preferred (because fluent processing indicates that things in the environ-

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