Food Quality and Preference 71 (2019) 395–405

Contents lists available at ScienceDirect

Food Quality and Preference

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

Crossmodal correspondence between color, shapes, and wine odors

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ARTICLE INFO

Keywords:
Wine
Aroma
Color
Shape
Crossmodal
Packaging

ABSTRACT

Crossmodal correspondence is of scientific and commercial interest in regard to the packaging of food and beverages. Research has shown that colors and shapes can be associated with certain aromas, but these interactions have been less extensively studied with authentic visual stimuli (i.e., packaging), or with complex food odors in a matrix. This study investigated odor-color-shape crossmodal interactions with complex odor stimuli (wine odors) and wine labels. The present research used projective mapping with 3D shapes and colors, along with a wine label matching study, to test whether chardonnay odors of different character (buttery, citrus, floral, smoky, and vegetable) were associated with certain colors and shapes. In the projective mapping experiment, most chardonnay odors were grouped similarly; however, the vegetable-forward wine was more associated with sharper shapes. In the label experiment, yellow labels tended to be better matched with all odors, except the vegetable-forward wine, which was matched equally to all colors. These findings indicate that, regardless of odor character, chardonnay is mostly associated with a yellow colored label. Interestingly, results also indicated that not all correspondences aligned with the most common color association of an odor character's (i.e., vegetative was not strictly associated with green, nor smoky with brown, etc.). Significant correlations were found between stimuli liking and matching scores, speaking to the role of hedonics in correspondences. Overall, the present research demonstrates evidence for odor-color-shape correspondences in complex odors and realistic visual stimuli, but not as strongly as in controlled environments and simplistic stimuli.

1. Introduction

There is a growing body of research regarding crossmodal correspondence and the role it can play in consumer experience. Crossmodal correspondence is the name given to the phenomenon of associating information from one sensory feature with another sensory feature from a different sensory modality (Marks, 1978; Spence & Deroy, 2013). Crossmodal correspondences are acquired, malleable, relative, and in transitive pairings between sensory dimensions (Deroy & Spence, 2013). In most cases the correspondences are frequent (if not universal) in the population (Levitan et al. (2014)), are stable across time (Gilbert, Martin, & Kemp, 1996), and appear to exist among all combinations of sensory modalities (Deroy, Crisinel, & Spence, 2013).

Three main mechanisms for crossmodal correspondences have been outlined by Schifferstein and Tanudjaja (2004), the first of which is that humans have an inherent ability to perceive the synesthetic quality of stimuli directly (Spence, 2011). Along these lines, there might also be natural biases, or correspondences across sensory systems (Deroy et al., 2013). Moreover, perceptual learning may drive the development of crossmodal correspondences. For example, over repeated exposure humans learn that the odor of lemons comes from the characteristically yellow fruit. Similarly, it has been hypothesized that culture and prior experience play a role in deciding our perception (Ayabe-Kanamura et al., 1998; Ferdenzi et al., 2011; Spence & Van Doorn, 2017) and as a result, odor-color associations may be seen as a function of the culture in which people live or have grown up in (Jacquot, Noel, Velasco, & Spence, 2016). Lastly, some correspondences may stimulate a particular association, which could prompt the concept of a specific color (Schifferstein & Tanudjaja, 2004).

In regard to food and beverage much of the research in this field has focused on how visual and auditory stimuli can influence more food specific sensations such as flavor perception. For example, the visual appearance of the packaging itself has been shown to influence perception of the product inside (Cheskin, 1957; Esterl, 2011). Cheskin reported an increase in lemony/lime flavor in soda as more yellow color was added to the can (Cheskin, 1957). More recently it was found that a green label on a beer bottle led to significantly higher ratings in terms of quality, taste, and dominance of fruity/citrus notes present in the beer, as opposed to a brown label (Barnett & Spence, 2016). In popular culture, Coca-Cola® experienced customer complaints that their cola tasted different when drank from white-colored holiday cans (Esterl, 2011). In another (unpublished) study, Deliza concluded that

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https://doi.org/10.1016/j.foodqual.2018.08.019
Received 15 June 2018; Received in revised form 24 August 2018; Accepted 26 August 2018
Available online 27 August 2018
0950-3293/

background packaging color can influence taste ratings (1996). More specifically, sweetness scores were increased by manipulating the amount of orange color on orange juice packaging (Deliza, 1996). Similarly, switching potato chips that were commonly associated with a blue packet, to a new green packet affected flavor perception, with participants often reporting erroneous flavors as a result (Piqueras-Fiszman & Spence, 2011). These examples tend to focus on basic tastes or single attributes, but all demonstrate that label manipulation can influence the perception of the contents within a package or product.

While color and flavor/taste interactions have been the focus of considerable research, associations between visual cues and olfaction have been much less explored. Demattè found that people have the ability to explicitly match colors to odors (Demattè, Sanabria, & Spence, 2006). Also from this study, an implicit association test was administered where participants made speeded discrimination responses between odors and color patches. Participants responded more quickly and correctly when odor-color pairings were highly associated than in those that had a weak association (i.e., strawberry odor and pink, as opposed to turquoise). Also, stronger odors are typically associated with darker colors (Kemp & Gilbert, 1997). Alternatively, in an older example, floral perfume was found to be more highly associated with a print based on light colors (Fiore, 1993). There are also indications of hedonic scores mediating crossmodal interactions of odors and colors. Namely, bright colors tend to be rated as pleasant, while darker colors tend more to be found unpleasant, and all of these are correlated to color/odor choices (Maric & Jacquot, 2013).

Some research has demonstrated that applying images to a drink container, as well as manipulating the colors of the label, can influence the hedonic or sensory properties of the product (Mizutani et al., 2010; Piqueras-Fiszman & Spence, 2011). Sparkling water has been shown to be better matched with angular shapes, and still water with organic shapes (Spence & Gallace, 2011), which is interesting in the context of packaging as sparkling water sometimes has an image of a star on the label (e.g. San Pellegrino), and still water is sometimes accompanied by a more organic fluer-de-lis on the label (e.g. Acqua Panna) (Ngo, Piqueras-Fiszman, & Spence, 2012). However, in general, work exploring crossmodal interactions regarding shapes and basic tastes/aromas has used abstract visual shapes with varying degrees of sharpness/roundness, typically involving line scales anchored with 2D shapes, in which a subject will indicate how sharp or round a basic taste or aroma seems (Köhler, 1929; Ramachandran & Hubbard, 2001). Other studies have employed multiple 2D abstract shapes (Seo et al., 2010) or even allowed participants the freedom to draw shapes in order to visualize their odor associations (Kaeppler, 2018).

One way to explain crossmodal correspondences of shapes and taste is that consumers are primed to notice to certain sensory attributes that are related to certain tastes based on the shapes presented (regardless of whether they are seen or touched), which enhances the perception of those attributes (Machiels, 2018; Spence & Deroy, 2014; Spence, 2012; Velasco, Woods, Petit, Cheok, & Spence, 2016). Angular shapes are generally associated with bitter and sour or “sharp” tastes, while round shapes are more associated with sweet and rich tastes (Ngo, Misra, & Spence, 2011). Manipulation of the shape of the receptacle itself may influence how complex odors are perceived (Delwiche & Pelchat, 2002; Hummel, Delwiche, Schmidt, & Hüttenbrink, 2003), and angular packaging has shown increased intensity of taste sensations (Becker, Van Rompay, Schifferstein, & Galetzka, 2011). Furthermore, it was demonstrated that when cola was presented in a cola glass, it was rated as sweeter, more intense and more pleasant than when presented in a water glass or bottle (Cavazana, Larsson, Hoffmann, Hummel, & Haehner, 2017). One study involving craft beer and the shape of glass found that Yenda Pale Ale was rated as significantly fruitier when served from a rounded glass as opposed to one with straight sides (Mirabito, Oliphant, Van Doorn, Watson, & Spence, 2017). In another study, surfaces of cup holders were manipulated, influencing ratings of bitter coffee and sweet hot-chocolate, with bitterness ratings ~27% higher for an angular surface, and sweetness ratings ~18% higher for a rounded surface pattern (Van Rompay, Finger, Saakes, & Fenko, 2016). Crossmodal correspondences have also been reported in the serving plates of desserts, where rounder plates resulted in higher sweetness scores (Chen, Woods, & Spence, 2018; Stewart & Goss, 2013).

Interactions in shape and aroma have also been documented. Angular shapes have been shown to be associated with more intense and unpleasant aromas (Demattè et al., 2006). Rounded shapes have been associated with less intense or more pleasant aromas (Adams & Doucé, 2017; Hanson-Vaux, Crisinel, & Spence, 2013). Recently, curved shapes were shown to be associated with vanilla aroma, and angular shapes with citrus (Blazhenkova & Kumar, 2018).

There has been evidence to support some level of association between visual cues and aromas at the basic level, but the visual stimuli have remained simple in kind. Visual stimuli have typically included simple color chips or fabric swatches and line scales anchored with 2D shapes of varying sharpness/roundness with which to test interactions. More complex visual stimuli have been investigated only in a few select studies (Kaeppler, 2018; Seo et al., 2010). And, it appears that the complexity and multi-dimensional features that underlie odor-color correspondences are not yet fully understood (Jacquot et al., 2016).

The work on odor-visual interactions thus far has not been studied extensively in a complex odor matrix. With this gap in understanding, it is unclear whether crossmodal correspondence between visual cues and aroma manifest themselves within a subset of complex odors. Furthermore, there is little data on crossmodal correspondences that include realistic nuances in aroma character. The flavor of whisky, which shares wine odor complexity and nuance in character across the product category, was found to be modulated by visual and audio stimuli (Spence & Deroy, 2013). These crossmodal effects were observed by modifying the environment, but, to most food and beverage producers, the most accessible method of controlling visual stimuli would be through packaging. Food and beverage packaging, such as wine labels, are often the first impression a consumer has of a product and are known to influence preference and purchasing behavior. Like many products, wine packaging needs to communicate relevant and appropriate information about the quality of the liquid within (Tootelain & Ross, 2000). Using packaging to enhance the impression and perception of quality of the wine is a key component to the maximizing of the consumer experience.

This study sought to investigate more deeply odor-color-shape crossmodal interactions, specifically with a complex odor matrix. Chardonnay wine was chosen as the odor matrix on the basis of a relatively wide range of odor profiles existing within the category; also some key aroma-active compounds have been characterized. As well it has also been shown that changing the shape of a wine glass exerts a direct impact on the perception of wines (Delwiche & Pelchat, 2002; Hummel et al., 2003; Hüttenbrink, Schmidt, Delwiche, & Hummel, 2001), and leads to the hypothesis that certain wine aromas might be matched better to certain shapes/colors. The present research also sought to explore odor-color-shape crossmodal correspondences in a complex odor matrix, using both abstract stimuli and realistic visual stimuli (i.e., wine labels).

2. Materials and methods – Experiment 1 – projective mapping

2.1. Participants

Fifty participants (32 females; 18 males) with a mean age of 32 years (range of 20–60) took part in the study. All the participants were recruited based on their answers to an online pre-screening questionnaire. Potential participants who reported no visual or smell impairments and who had consumed white wine in the past 6 months were invited to participate. Additionally, all participants were checked for colorblindness, as determined by the Ishihara test for color deficiency (Ishihara, 1917). Sessions took place over the course of three