Esther Klingbiel
Fundamentals of Visual Perception: Final Paper
5/3/2019

Crossmodal Perception and Package Design

Crossmodal perception is the phenomenon which involves the combination of two or more different senses. Many psychological studies have been undertaken which specifically concern the crossover of visual perception of food or beverage packaging and their effects on perceived taste of a product. Interestingly, results have found that across cultures and contexts (Piqueras-Fiszman, Velasco & Spence, 2012), the manifestations of crossmodality between sight and taste are relatively universal. Most significantly, sweet tastes have been found to be associated with rounded shapes and packaging (Velasco et al., 2016), as well as rounded typefaces (Velasco et al, 2013). Sour tastes are most often associated with angular shapes, packaging (Velasco et al., 2016), and typefaces (Velasco et al, 2013). However, sight-taste dyads are not the only crossmodal interactions studied within the realm of package design. Investigations of sight-odor have also yielded consistent results much in the same way as sight-taste across a variety of experiments. This paper includes summaries of studies which investigate the phenomenon of crossmodality within the realm of food and beverage package design. Further directions and limitations are also discussed. Finally, a tentative proposal as to *why* crossmodal perception seems to be consistent across cultures is also included.

Velasco et al. (2016) wrote a review of the studies of crossmodal perception within the context of shapes and tastes. On average, rounded shapes are associated with sweeter flavors and angular shapes are associated with sour flavors. Such correspondences have been replicated in many studies and have been found to be stable over time (Heatherly et al., 2019, p. 395). The

association of sweetness to roundness and sourness to angularity also applies to packaging design. Not only do tastes affect shape preference, but shapes also affect perceived taste (Heatherly et al., 2019, p. 395). When evaluating the shape of packages, participants tend to rate rounder designs as containing a sweet product at a higher rate than angular designs, and vice-versa (Velasco et al., 2013). Additionally, Liang et al. (2013) found that participants who viewed a round shape just before tasting a bland solution were more likely to rate it as sweet as opposed to when they viewed an angular shape instead.

The pleasantness of a taste may also influence the association of taste with shapes. It is possible that a more pleasant taste (sweetness) may be associated with roundness (as opposed to angularity) because round shapes are more aesthetically pleasing than angular shapes. Conversely, less pleasant tastes, such as sourness, may be associated with angular shapes because they are less pleasing to the eye than rounded shapes. This may be one reason that crossmodal associations in package design have time and time again found similar results across studies—perhaps an underlying preference towards sweet tastes and rounded shapes are the cause of their association. Furthermore, the authors discuss previous exposure and familiarization of product taste and packaging shape/features in the life of an everyday consumer. However, they concede that how the exact mechanism of this influence affects crossmodal association is not entirely clear.

Researchers have also explored the link between sight and smell in crossmodal perception of package design. Heatherly et al. (2019) studied the links between package design (specifically color and shapes on labels) and certain odors of chardonnay. Chardonnay was chosen because it has a wide variety of smell variation. The link between smell and sight in the

context of package design have been explored far less than the link between taste and sight. However, past research has established that pleasant odors are associated with lighter colors and unpleasant odors associated with darker colors (Maric & Jacquot, 2013).

In their first experiment, the authors studied the association of chardonnay odor to shape and color. Participants (N=50, M_{age}=32) were presented with 5 odor categories: buttery, citrus, floral, smoky, and vegetable. They were then presented with a variety of 3-D printed colors and shapes (Fig. 1) and asked to select which colors and shapes best matched the odors. The participants tended to match all the chardonnay smells (except for vegetable) with green and yellow. They matched the vegetable odor with angular shapes, such as stars and triangles. The other odors were associated more closely with a 3-D hemisphere shape. Participants rated the angular shapes less aesthetically pleasing, and the vegetable wine odor less pleasant as well. Furthermore, more pleasant aromas (buttery, citrus, floral, and smoky) were associated with more pleasant-looking rounded shapes. These findings are consistent with other sight-taste crossmodal findings, where pleasant tastes (sweetness) are associated with pleasant shapes (rounded figures), and unpleasant tastes (sourness) are associated with less pleasant shapes (angular figures).

Healtherly et al. also conducted a second experiment, studying the association of chardonnay odor with wine bottle labelling. Participants (N=52, M_{age}=31) were instructed to smell the same wines from experiment 1. These wines were paired with a number of labels (Fig. 2), manipulated in color and rounded/angular line design. The authors found that buttery, citrus, floral, and smoky wines were all associated more often with yellow labels than red or brown labels. There was no significant effect found between vegetable odored-wine and label color. The

authors write that the association between the color yellow and the various odors of chardonnay may be caused by the fact that chardonnay is yellow in color. This points to the theory that previous perceptual learning (i.e., exposure to wine labels in everyday life) may affect crossmodal perception. One possible mechanism of removing this variable could be to select a sample of drinking-age participants who have never actually tried chardonnay. Furthermore, no associations were made between line shape and odor. The authors suggest that this may be in part because the lines within the label design were not visually significant enough to attract attention.

Piqueras-Fiszman, Velasco, & Spence (2012) conducted a series of experiments to test the cultural effects of crossmodal perception. Specifically, they tested the associations of sight-taste in package design and certain flavors of chips in Colombian and British samples.

In experiment 1, the authors used the implicit assumptions test (IAT) to establish unconscious associations between package color and taste, in a departure from the methodologies of the other experiments mentioned in this paper (where participants were explicitly asked to draw similarities between sight and smell or taste). Participants (N=24 Colombians (M_{age}=26), N=24 British (M_{age}=27)) viewed images (Fig. 3) of either blue or green chips packaging and the flavors ‘cheese and onion’, ‘salt and vinegar’, ‘plain’, and ‘lemon’. Both Columbian and British participants responded faster and more accurately when instructed to pair ‘plain’ with the color blue and ‘lemon’ with the color green. The authors concluded that even though the participants came from 2 different countries, the fact that they were both exposed to these consumer products, regardless of country (the packaging included were images of subsidiaries of Lays potato chips), the pre-experimental exposure of packaging in everyday life has an effect on the implicit associations between certain tastes and colors.

In the second experiment, participants (N=56 Colombians (M_{age}=27), N=56 British (M_{age}=32)) were shown black and white photos of fictional chip brands (Fig. 4), with packaging labelled with fake flavors, including 'seaweed and salt', 'tuna and mayo', and 'foie and figs'. They were then instructed to match these packages with color. The results of the second experiment revealed again that culture was not a mediating factor in associating taste with color. Both British and Colombian participants tended to rate the fictional flavors with similar color schemes (attributing 'foie and figs' to burgundy and brown, 'tuna and mayo' to pink and salmon, and 'seaweed and salt' to green and blue).

The most prominent limitation to the studies reviewed in this paper (and a problem which some authors have conceded may affect results) is that the participants used in these studies all came from cultural settings where they were exposed to, on a daily basis, a large volume of packaged foods and beverages. This is a possibly confounding variable because their previous exposure to design tropes in regards to packaging design of certain flavored foods (i.e., the difference between how sweet candy is packaged versus how sour candy is packaged) affect how they expect certain flavored consumables to be packaged. In order to eliminate or downplay the effects of this confounding variable, studies on crossmodal perception of packaging should be in conducted in cultures that have little exposure or access to ready-to-eat packaged foods.

Careful consideration should also be given to the effects of aesthetics on association between sight and taste and/or odor. Those studying this phenomenon should consider more heavily the possibility that taste, smell and image are linked together across senses based on hedonic properties rather than some other type of mechanism (some psychologists have proposed

the effects of neural networks and language on crossmodal perception (Velasco et al., 2016, p. 22)).

Finally, although I have mentioned possible causes for why crossmodal findings in packaging design and taste have been so universal, I would like to consider another possible factor. Could the association between certain tastes/odors and shapes/colors be rooted in an evolutionary past? Take for example, when human beings still lived a hunter-gatherer lifestyle. In seeking out (rather than cultivating) appropriate plants to eat, one had to be knowledgeable about what was fine to consume versus what would have tasted bad or made them sick. Perhaps the association of sweetness to round shapes has a basis in the kinds of foods we knew were available to eat. Could it be that this association was formed by millennia of scanning the visual field, perhaps with a bias for rounded, orange-red shapes (i.e., berries, apples, oranges) rather than slightly angular, yellow-green shapes (i.e., limes and lemons)? Of course, this is weak speculation, because many round fruits (such as certain types of grapes) are sour, and many angular fruits (such as bananas) are sweet. However, a more nuanced investigation of this question may yield interesting answers.

Regardless of the origins of the context and cultural stability of sight-taste and sight-odor crossmodal perception, the findings discussed in this paper have important implications for marketing and product design. It is important for companies to ascribe to the idea of sweet as round and sour as angular because a package that, for example, has ‘sweet’ associated visual features (rounded package, shapes, typefaces, names) but actually contains a sour-tasting product may lead to brand mistrust, and a lower likelihood of a consumer re-purchasing that product. Although the origins of crossmodal perception (with respect to package design) may be vague,

departing from its norms may have very real consequences for a product's ability to compete on the market.

References

Heatherly, M., Dein, M., Munafo, J.P., & Luckett, C.R. (2019). Crossmodal correspondences between color, shapes, and wine odors. *Food Quality and Preference, 71,* 395-405.

Liang, P., Roy, S., Chen, M.L., & Zhang, G.H. (2013). Visual influence of shapes and semantic familiarity on human sweet sensitivity. *Behavioral Brain Research, 253,* 42-47.

Maric, Y., & Jacquot, M. (2013). Contribution to understanding odour-colour associations. *Food Quality and Preference, 27,* 191-195.

Piqueras-Fiszman, B., Velasco, C., & Spence, C. (2012). Exploring implicit and explicit crossmodal colour-flavour correspondences in product packaging. *Food Quality and Preference, 25,* 148-155.

Velasco, C., Salgado-Montejo, A., Marmolejo-Ramos, F., & Spence, C. (2013). Predictive packaging design: Tasting shapes, typefaces, names, and sounds. *Food Quality and Preference, 34,* 88-95.

Velasco, C., Woods, A.T., Petit, O., Cheok, A.D., & Spence, C. (2016). Crossmodal correspondences between taste and shape, and their implications for product packaging: A review. *Food Quality and Preference, 52*, 17-26.

Figure 1. *Visual stimuli used in experiment 1 by Heatherly et al. (2019). Top row (A): 3-D printed colored hemispheres. Bottom row (B): 3-D printed uncolored shapes.*

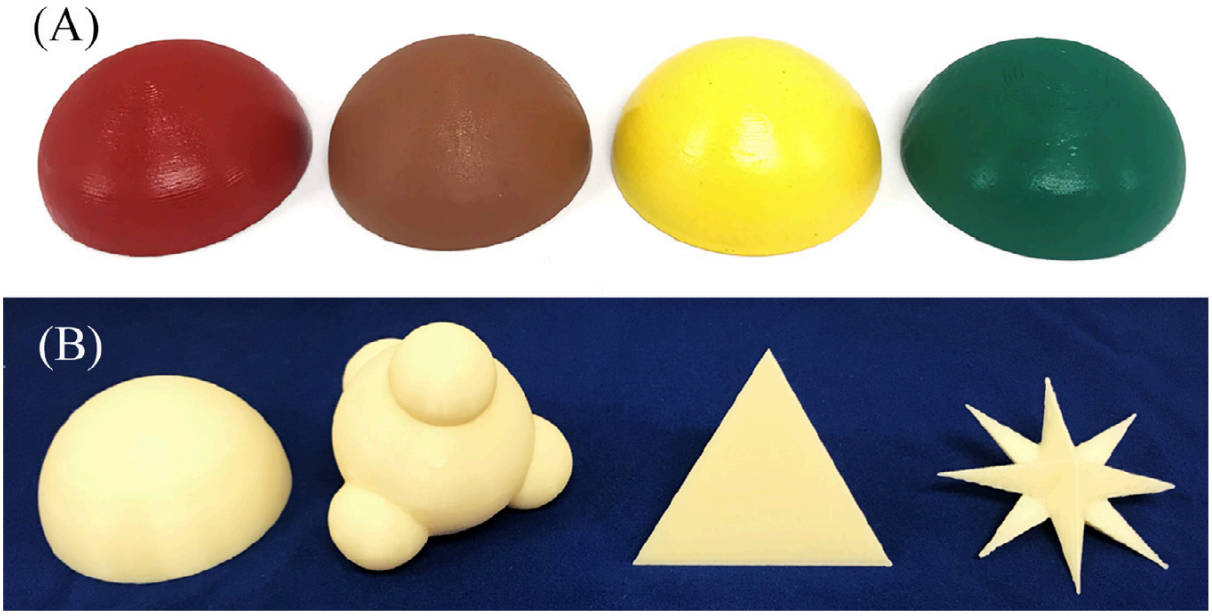

Figure 2. *Wine labels used in experiment 2 by Healtherly et al. (2019). Four colors, as well as two levels of angularity (top row: rounded; bottom row: sharp) on the labels were presented to participants.*

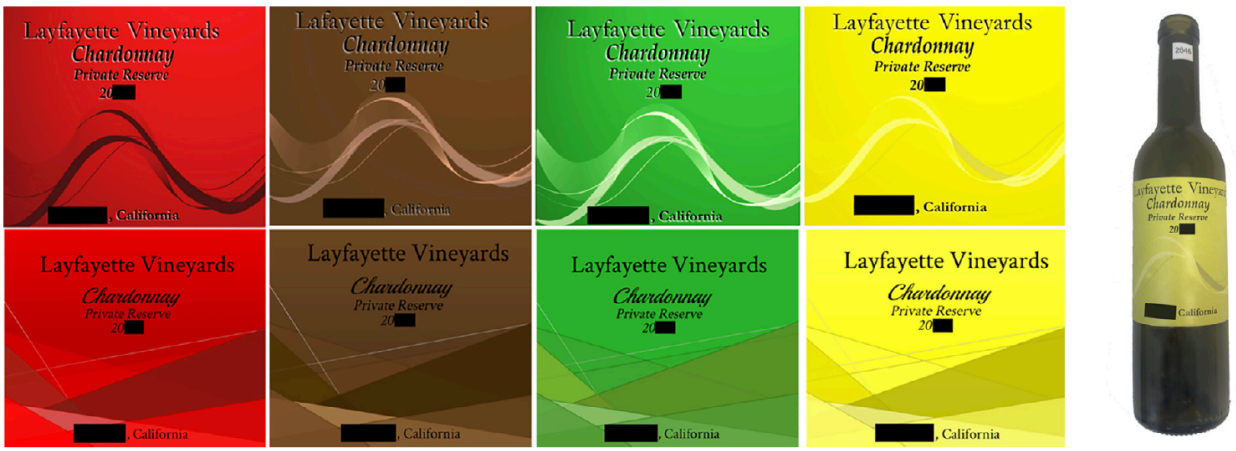

Figure 3. *Chips packaging presented during IAT experiment by Piqueras-Fiszman, Velasco, & Spence (2012). Top row (a): packages presented to Colombian participants. Bottom row (b): packages presented to British participants.*

Figure 4. *Examples of fictional chips packaging (with fake flavors) presented to participants in experiment by Piqueras-Fiszman, Velasco, & Spence (2012). Left image (a): package presented to Colombian participants. Right image (b): package presented to British participants.*