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Package images modulate flavors in memory: Incidental learning of fruit juice flavors

Nanami Mizutani [a,1], Ippeita Dan [b], Yasushi Kyutoku [b], Daisuke Tsuzuki [c], Lester Clowney [b], Yuko Kusakabe [d], Masako Okamoto [e,*], Toshimasa Yamanaka [a]

[a] Graduate School of Comprehensive Human Sciences, University of Tsukuba, 1-1-1, Tennodai, Tsukuba, Ibaraki 305-8577, Japan
[b] Functional Brain Science Laboratory, Center for Development of Advanced Medical Technology, Jichi Medical University, 3311-1, Yakushiji, Shimotsuke, Tochigi 329-0498, Japan
[c] Graduate School of System and Information Engineering, University of Tsukuba, 1-1-1, Tennodai, Tsukuba, Ibaraki 305-8573, Japan
[d] Sensory & Cognitive Food Science Laboratory, National Food Research Institute, 2-1-12, Kannondai, Tsukuba, Ibaraki 305-8642, Japan
[e] Research Center for Animal Hygiene and Food Safety, Obihiro University of Agriculture & Veterinary Medicine, Inada-cho, Obihiro, Hokkaido 080-8555, Japan

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ABSTRACT

The effect of package images on incidental flavor memory for fruit juice was investigated. Ninety-two participants were allocated to three experimental conditions: (1) apple-label, (2) peach-label, and (3) control-label. In each condition, participants tasted a target flavor stimulus, a 1:1 mixture of 100% pure apple juice and 100% pure peach juice with pictures attached to the cups. Ten minutes later, participants were confronted with samples consisting of varying ratios of 100% peach to 100% apple juice, and were asked to rate their similarity to the target stimuli. Participants were also asked to rate how congruent the juice flavor and the image were at the initial tasting. Apple images modulated memories of the flavors of target stimuli: they shifted toward that of apples. This modulation occurred in participants who perceived the label and flavor as congruent. Peach images did not modulate memories, possibly because the subjects had significantly less experience of drinking peach juice than apple juice. These results reveal that flavor memory can be biased toward that of the image labels during initial tasting. However, memory bias depends on the perceived congruency between labels and flavors, and tasters' prior experiences.

1. Introduction

What is remembered about food flavor can be as important as the perceived flavor itself. For example, when people select and buy foods, they usually cannot taste them, but must rely on recalling memories of the flavor. Indeed, it has been reported that decision making at the time of food purchasing is influenced by the memory of 'taste', which actually means flavor memory (Dijksterhuis & Mojet, 2005). This naturally leads to the next question: how is flavor memory recalled?

It has been indicated, in research on visual stimuli, that memories are not completely accurate, but rather influenced by the interpretation of stimuli during their memorization (Roediger, 1996). Koffka (1935) noted that in reproducing figures based on memory, features of the figures are canonicalized and enhanced so that they look closer to how they are supposed to appear. For example, an image of a distorted crescent moon tends to be reproduced as a more canonical crescent moon. In addition, Carmicheal, Hogan, and Walter (1932) found that verbal labeling can influence memory distortion. In their study, ambiguous figures were presented with verbal labeling. When recalling them, participants altered the figures to more closely match those suggested by the labels (Carmicheal et al., 1932). A similar effect was observed using shape stimuli with drawn-in figures as labels (Cermak, 1977), ambiguous color stimuli with verbal labels (Bornstein, 1976), and ambiguous facial expressions with verbal labels (Halberstadt & Niedenthal, 2001). Thus, in the case of visual memory, the interpretation of stimuli, or labels added to them, seems to influence memory recall.

Thus, there appears to be a question as to whether labeling influences flavor memory in a way similar to that of visual stimuli. Commercial drinks often come in packages showing images and text, and it is common for people to drink them without looking at the actual drink. Regarding the influence of packaging on flavor perception, Mizutani et al. (2010) found that orange juice flavors were evaluated differently depending on the kinds of images presented with the juice. As this finding suggests that images on packaging influence the interpretation of flavor, it seems likely that such images can also influence the memory of flavor; however, to the best of our knowledge, there is as yet no research on the effects of labeling on flavor memory.

* Corresponding author. Tel.: +81 155 49 5936; fax: +81 155 49 5938.
E-mail address: masakoo@obihiro.ac.jp (M. Okamoto).
[1] Present address: R&I Center, Nihon L'Oreal K.K., KSP West, 3-2-1, Sakado, Takatsu, Kawasaki, Kanagawa 213-0012, Japan.

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Regarding changes in taste memory, there are conflicting findings. Baker and Weaver (1983) studied memory formation for the absolute intensity of sweetness using sucrose solutions, and found that taste stimuli are remembered as being weaker than encoded stimuli. In contrast, Vanne, Laurinen, and Tuorila (1998) reported that participants tended to recall the taste intensities of sucrose solutions as more intense than they had actually been. Similarly, an increase in taste intensity was also found for flavor stimuli (Tuorila, Theunissen, & Ahlstrom, 1996). Thus, although it has been shown that taste in memory can change, there is still disagreement about its direction, and no consideration as yet of the effect of labeling.

Hence, the current research was conducted in order to find out whether images on packaging are able to influence flavor memory. In this study, participants first tasted a 1:1 mixture of 100% pure apple juice and 100% pure peach juice, while at the same time viewing images of either apples, peaches, or a control. Later, participants were asked to taste juice mixtures, containing varying ratios of 100% peach to 100% apple juice, and then to rate their similarity to the original 1:1 mixture. It was hypothesized that memories of the target 1:1 juice flavor would be biased towards the flavors of fruit images presented during initial tasting, so that the mixtures with more of that particular flavor would be scored as being more similar to the initial 1:1 mixture.

Much of our memory of food is acquired incidentally, without any explicit attention or learning, and stored implicitly (Mojet & Koster, 2005). Therefore, in the current study, an incidental memory paradigm similar to that proposed by Mojet and Koster (2002) was employed, where the participants were not informed about the existence of a memory test at the initial tasting stage. In addition, the effects of labeling have been found to be more pronounced when labels and contents are perceived as congruent (Okamoto et al., 2009). In order to examine the effect of congruency on changes in flavor memory, participants were asked how congruent the juice flavor and the image were at the initial tasting.

2. Method

2.1. Participants

Participants were 92 undergraduate and graduate students recruited from the University of Tsukuba. Six participants realized the purpose of the study before conducting the recognition test, and were excluded from analysis. Thus, the data for the remaining 86 participants (37 males and 49 females, aged 18–30 years, $M = 21.3$, SD = 2.4) were used. None of them had participated in any stimuli screening process for this study. All had a self-reported normal sense of taste. Participants received 500 yen for their participation.

Participants were randomly assigned to one of three experimental conditions as follows: Apple-label: for 13 males and 16 females aged 18–29 years ($M = 21.5$, SD = 2.5), images of apples were used. Peach-label: for 12 males and 17 females, aged 18–24 years ($M = 21.4$, SD = 1.8), images of peaches were used. Control-label: for 12 males and 16 females, aged 18–30 years ($M = 21.0$, SD = 2.8), control images were used. The study was approved by the Institutional Ethics Committee of the Graduate School of Comprehensive Human Sciences, University of Tsukuba.

2.2. Image stimuli

Digitized color images were used for the apple and peach conditions, with the fruits in each image being similarly lined up (Fig. 1). The control image was created by averaging (pixel-wise) the RGB values of the peach and apple images and transforming the results into grayscale images. Then, a random pixel permutation was applied to generate a scrambled image. At this point, the control images were not recognizable as objects. The different images were printed on separate pieces of 50 mm^2 glossy paper using an ink-jet printer.

2.3. Flavor stimuli

In previous studies, memory changes have often been reported using ambiguous stimuli such as a morphed image of angry and happy faces (Halberstadt & Niedenthal, 2001) or a color between green and blue (Bornstein, 1976). Therefore, an ambiguous flavor was designed by combining two kinds of fruit juices. A screening test was conducted to select which combination of two fruit juices would be used in the experiment. Different binary combinations of juices A and B were examined. In the screening test, mixtures of equal parts of juices A and B were made, and then presented under a false name as juice A to two volunteers and as juice B to two different volunteers. Each volunteer was then asked to rate its likelihood of being A for the first group and B for the second using a five-point scale (1 = not at all likely; 5 = extremely likely). A mixture of apple (Calpis Co., Ltd., Tokyo, Welch's Apple100) and peach (Nippon Milk Community Co., Ltd., Tokyo, Nokyo Kaju Totteoki Kokusan Momo) was selected because they were similarly rated as likely to be A and as likely to be B (3.2 for the apple-label, and 3.6 for peach-label).

For the target stimuli (designated as A50), a 1:1 ratio of apple and peach juices was used. The distracters used were two mixtures of the same juices in varying ratios (1:3 and 3:1), and 100% apple juice and 100% peach juice. Thus, there were 1 target and 4 distracters whose ratio of apple and peach was equally varied (Apple: Peach = 0: 100(A0), 25: 75(A25), 50: 50(A50), 75: 25(A75) and 100: 0(A100)). Stimulus solutions were prepared 1–2 h before the experiment and served at room temperature, which was maintained at approximately 25 °C.

2.4. Procedure

An incidental memory paradigm was employed. Participants were given a dummy purpose for the experiment: they were told that the study focused on the effect of package images on subjective flavor ratings. Then they were given general instructions. Two sessions were conducted in this experiment, a learning session and a test session, with a between-session interval of 10 min. The participants were debriefed with the actual purpose after they had completed the post-experiment questionnaire.

2.5. Learning session

In the learning session, participants tasted the target mixture (A50) labeled with images, and then rated the pleasantness of the images and the palatability of the flavor. Fifteen milliliters of the target juice were placed in black disposable cups covered with aluminum foil, into which a straw was inserted. Images were attached to the tops of the covers. A five-step rating procedure was followed by participants: (1) view the images attached to the cover; (2) rate the pleasantness of the image; (3) rinse the mouth with mineral water and spit it out; (4) take all the juice from the cup into the mouth, taste it, and swallow it; and (5) rate the palatability of the flavor.

At the end of the session, participants were asked to stay and fill in a personality test form. Pleasantness ratings and the personality test were introduced to increase the likelihood that the participants believed the dummy aim of the study, ensuring learning of juice flavors was incidental. Thus, these results are not presented in the current report.