# Smellizing Cookies and Salivating: A Focus on Olfactory Imagery

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ABSTRACT

The concept of olfactory imagery is introduced and the conditions under which imagining what a food smells like (referred to here as "smellizing" it) impacts consumer response are explored. Consumer response is measured by: salivation change (studies 1 and 2), actual food consumption (study 3), and self-reported desire to eat (study 4). The results show that imagined odors can enhance consumer response but only when the consumer creates a vivid visual mental representation of the odor referent (the object emitting the odor). The results demonstrate the interactive effects of olfactory and visual imagery in generating approach behaviors to food cues in advertisements.

One type of mental imagery—visual imagery—is well documented. Visual imagery involves imagining what an object looks like while one is not actually seeing the object or event. The effect of visual imagery on consumer behavior has been investigated for decades (Adaval, Isbell, and Wyer 2007; Adaval and Wyer 1998; Dahl, Chattopadhyay, and Gorn 1999; Escalas 2004; Hung and Wyer 2011; Peck and Shu 2009; Rajagopal and Montgomery 2011; Shiv and Huber 2000; Unnava, Agarwal, and Haugtvedt 1996; Wyer, Hung, and Jiang 2008). No research we are aware of, however, has investigated the effects of another type of mental imagery on consumer behavior, namely, olfactory imagery, or the ability "to experience the sensation of smell when an appropriate stimulus is absent" (Stevenson and Case 2005, 244). Our research seeks to fill this gap.

Until recently, researchers in psychology did not agree on the existence of olfactory imagery (Crowder and Schab 1995; Engen 1991; Herz 2000). However, a growing body of evidence suggests that olfactory imagery does exist, and that imagining what odors smell like affects human re sponse in ways similar to the effects of actual odors (see Stevenson and Case [2005] for a review). In the present research, we explore the effects of olfactory imagery in the context of food advertisements (ads). Why would olfactory imagery matter to marketers of consumer products? Consumers who engage in olfactory imagery may virtually reexperience events from the past more vividly, thus enhancing the appeal of products or services under consideration for purchase. Foods, places, and products with strong olfactory attributes would be especially likely to benefit from olfactory imagery.

We find across four studies that olfactory imagery has demonstrable effects on consumer response (as measured by salivation, consumption, and desire to eat), but that this response crucially depends on exposure to a visual image of the odor referent (i.e., the object that emits the odor). This work is the first we are aware of that demonstrates a multimodal sensory interaction between olfactory imagery and visual imagery processes.

The article is organized as follows. We first review relevant literature to support our conceptual framework and hypotheses and then present our empirical results. The general discussion section summarizes our findings and what they imply theoretically and for managers.

## LITERATURE REVIEW AND CONCEPTUAL DEVELOPMENT

The effect of scent on attention, memory, and attitude formation has attracted increased attention from consumer researchers (Bone and Ellen 1999; Ellen and Bone 1999; Krishna, Lwin, and Morrin 2010; Mitchell, Kahn, and Knasko 1995; Spangenberg, Crowley, and Henderson 1996), but the effect of olfactory imagery remains largely unexplored. Would merely imagining what an odor smells like have significant effects on consumer approach behaviors, and would such behaviors differ from those elicited by exposure to actual odors? Can a smell be imagined without access to a visual referent? To address these questions, we review the neurobiology of olfaction, its relation to responses such as human salivation, and the related literature on olfactory and visual imagery processing. The Neurobiology of Olfaction Odor molecules can be perceived in one of two ways: Orthonasally (by sniffing in) as in when one smells odors from the external environment, and retronasally (by breathing out) as in when one tastes food in the mouth. Retronasal smells are responsible for sensing food flavors and thus are indistinguishable from pure gustatory taste, producing what is commonly referred to as “in-the-mouth” taste (Rozin 1982). While retronasal smells related to flavor and taste perception are fascinating in their own right, the present research does not focus on the effects of odors perceived during the eating process. Rather, it is focused on orthonasal activity, namely, the effects of external or environmental cues on consumer behavior related to product purchasing —such as odors that might be encountered while looking at a print advertisement or while shopping in a store environment. The process of orthonasal odor perception involves first detecting an odor (i.e., crossing the threshold at which an odor is sensed), then having the brain determine just what it is (i.e., identifying it), and finally attaching a valence to it (i.e., determining whether it is pleasant or not). Whereas the traditional valence-centered view of odor perception suggests that the key attribute of odors for humans is their valence—whether they are liked or not (Haddad et al. 2010; Khan et al. 2007; Spangenberg et al. 1996; Yeshurun and Sobel 2010), more recent research reflecting findings on the neurobiology of olfaction supports a more object-centered (or scent identification-based) explanation for how odors are processed by humans (Gottfried 2010; Olofsson et al. 2012). In the object-centered framework, the hedonic characteristics of scents are extracted downstream in the perceptual process, with the liking of the scent established only after the scent has been semantically decoded or identified. Thus, the object-centered account of odor processing suggests that mental representations of scents are activated by comparing scents that are perceived with activated memory templates from previously encountered scents, which in turn triggers an affective or emotional response (Wilson and Stevenson 2006).

In terms of what happens from a neurobiological perspective, scent molecules enter the nasal cavity when a person sniffs in an odor, and some of these molecules activate receptor neurons located in the olfactory epithelium. With over 350 distinct odor receptors, millions of permutations of receptor activations are possible, each of which corresponds to the perception of a specific odor (Buck and Axel 1991; Krishna 2012). This scent information is relayed to the olfactory bulb, located in front of the frontal lobe of the brain, where the odor is represented by a unique spatial pattern of neural activation (Shepard 2012). The neural patterns of activation that odors represent on the olfactory bulb have been referred to as "identity maps" for odors (Schaefer and Margrie 2007) and are analogous to the visual patterns of activation that objects seen with the eyes create on the retina (Shepard 2012). (Note that these identity maps for odors have also been called "smell images" [Shepard 2012]; this is not the smell imagery we study. The smell imagery we focus on is the conscious attempt to mentally represent a previously experienced odor without the odor's presence.) From here the scent information is relayed to the olfactory cortex, where scents are represented based on memory and prior experiences (rather than direct sensory stimuli). Thus, it is in the olfactory cortex where different scents are identified or remembered. In this way, odors that are smelled are transformed from smell molecules into smell objects or mental representations of odor objects (Shepard 2012). From the olfactory cortex, the scent information then makes its way to the orbitofrontal cortex for additional processing.

Sniffing in odors of foods can elicit specific human responses such as salivation, as detailed in the next section (Pangborn, Witherly, and Jones 1979), as well as increased appetite (Rogers and Hill 1989) and desire to eat (Wisniewski, Epstein, and Caggiula 1992). The research reviewed below leads us to believe that salivation might serve as an effective physiological measure of consumer approach response to a specific type of food cue—imagined odors in advertisements.

## Effects of Food Cues on Salivation

Salivating is a largely nonconscious physiological process (Winsor 1930) controlled by the autonomic nervous system, which is stimulated while eating to aid in the digestion process

(Spence 2011). Salivation thus gears up the body to optimize digestion (Nederkoorn, Smulders, and Jansen 2000). However, salivation can also be elicited by learned or conditioned reflexes (Spence 2011) and thus can be stimulated by seeing or smelling appetizing foods (Ilangakoon and Carpenter 2011; Nederkoorn et al. 2000; Pangborn and Berggren 1973; Pangborn et al. 1979). Wisniewski et al. (1992) show that presenting a new palatable food stimulus leads to salivation as well as the desire to eat. In most of these studies, actual foods are used as the stimuli emitting odors. For example, sniffing a lemon was found to increase salivation in one study (Pangborn 1968). Seeing, sniffing, and touching food such as pizza and chocolate chip cookies were found to increase salivation in another study (Klajner et al. 1981). Thus, while salivation naturally increases while eating to aid in the digestive process, it has also been shown to increase in response to exposure to the sights and smells of food cues, as a preparatory response (Spence 2011).

Studies have also shown that salivation to food cues is greater in obese people than in people of normal weight (Epstein, Paluch, and Coleman 1996), in dieters versus nondieters (Herman et al. 1981; Legoff and Spigelman 1987), and in those gaining versus maintaining their weight (GuyGrand and Goga 1981). People have also been shown to salivate more in response to food cues when they are hungry (usually operationalized as duration of food deprivation) and when the anticipated palatability of the food cue is high (Wooley and Wooley 1973). A few studies have even shown that seeing desirable nonfood objects can increase salivation levels (Bogdonoff, Bogdonoff, and Wolfe 1961; Gal 2012). For example, consumers in a recent study salivated more when they saw a picture of money (vs. office supplies) after being made to feel powerless (Gal 2012).

It should be noted that in some studies, researchers report no increase in salivation from seeing or smelling an appetizing food product (when just seeing but not smelling a lemon;

Crowder and Schab 1995; Engen 1982; Kerr 1961; Shannon 1974), or when seeing pictures of food (where exposure to real foods but not pictures of foods resulted in salivation; Hayashi and Ararie 1963). Failure to find salivation change in these studies from seeing or smelling actual foods, or viewing pictures of foods, may be due to reliance on small sample sizes (Spence 2011), measurement of inappropriate salivary glands (Lee and Linden 1992), or unmeasured moderating factors. For example, Lee and Linden (1992) found that exposure to food odors (such as peppermint, vanilla, chocolate, beef, tomato, and lemon) elicited greater salivation in some salivary glands (the submandibular) but not others (the parotid).

The bulk of evidence nevertheless seems to suggest that salivation can be a useful physiological measure of consumer response to food cues, and we utilize it as one of our dependent measures (in studies 1 and 2). Because more conscious measures such as actual consumption (in study 3) and self-reported desire (in study 4) may be influenced by factors such as self-presentation concerns, salivation can be useful as a signal of desire not under the consumer's conscious control (Pecina and Smith 2010).

If palatable food odors can elicit consumer approach behaviors such as salivation and desire to eat, would imagined odors do the same? To the best of our knowledge, no studies have looked at whether merely imagining what a food smells like similarly elicits salivation or other types of consumer approach responses. We propose that imagined odors will elicit consumer approach responses when the consumer can create a clear visual mental image of the odor referent (the object that emits the odor). To support this theorizing we next review extant research on olfactory and visual imagery processes.

**Olfactory Imagery Processing**

Just as one can mentally visualize an object without seeing the object itself (i.e., engage in visual imagery), one can mentally "smellize" an object without smelling the object itself (i.e., engage in olfactory imagery). Until recently, several researchers doubted the existence of olfactory imagery (e.g., Crowder and Schab 1995; Elmes and Jones 1995; Engen 1982; Herz 2000), but evidence has been building to support its existence.

Algom and Cain (1991) presented subjects with five odors differing in intensity and asked them to provide numbers reflecting their perceived intensity. They found analogous relationships between the five intensities irrespective of whether the odors were real or imagined, supporting the existence of olfactory imagery. Lyman and McDaniel (1990) found that engaging in olfactory imagery facilitated the recognition of odors, just as engaging in visual imagery facilitated the recognition of pictures. Djordjevic et al. (2004) focused on the effect of scents (actual and imagined) on taste perception and showed that imagined odors can affect taste perception in ways similar to those of real odors. In Djordjevic et al.'s (2004) experiments, imagined strawberry scent enhanced the perceived sweetness of a water solution and imagined soy sauce scent enhanced the perceived saltiness of a sodium chloride solution. In other work, Djordjevic et al. (2005) used positron emission tomography to show that several of the same brain areas activated under olfactory perceptual processing (i.e., actually smelling something) are similarly activated during olfactory imagery (i.e., imagining what something smells like).

Researchers have also identified a motor component of olfactory imagery such that the act of sniffing contributes to the vividness of olfactory images (Bensafi, Pouliot, and Sobel 2005). Other studies show that the mere act of sniffing activates the olfactory cortex (Sobel et al. 1998), the location where, as discussed earlier, odor templates are stored based on previous experience. Thus, the evidence to date on olfactory imagery suggests that the effects of imagined odors are similar to those of odors that are sensorially perceived —in terms of brain activation patterns and effects on taste and intensity perceptions.

**Olfactory versus Visual Processing**

While some research suggests that olfactory imagery exists and operates in ways similar to that of actual scents, research also suggests that olfactory processing differs in important ways from that of the other senses, especially that of vision. It has been shown, for example, that although individuals can discriminate among thousands of different odors (Buck and Axel 1991) and are reasonably good at detecting odors they have smelled before (Gottfried 2010), they are quite poor at identifying odors they smell (Cain 1979). That is, individuals often have difficulty stating just what it is they happen to be smelling at any particular moment, unless they can see the odor referent. Thus, while most healthy individuals have little difficulty identifying or naming objects that they see, they have considerable difficulty naming objects that they smell—if they cannot see the object that is emitting the odor (Gottfried and Dolan 2003).

People also have difficulty forming a clear and vivid mental image of an object based on olfactory sensory input— as compared with inputs from the other sensory modalities. The relative lack of vividness of olfactory mental images as compared to, say, visual mental images, has been noted by Betts (1909). Betts (1909) asked individuals to rate how clear and vivid a mental image was when exposed to olfactory words (e.g., roses, cigar smoke, etc.), visual words (e.g., facial contours, setting sun, outfit colors, etc.), and auditory words (e.g., cat mewing, train whistle, car horn, etc.). He found that self-reported vividness ratings were lower for olfactory words than for words associated with the other senses. Studies also show that individuals experience olfactory imagery less often than they do visual imagery (Lawless 1997), and that more people claim they are unable to imagine what an object smells like versus what an object looks like (Lindauer 1969). Thus, as Stevenson and Case (2005) note, it is both less common and more difficult for people to evoke olfactory images (as compared to visual images); further, when they are evoked, olfactory images are less vivid in nature.

We propose that when consumers are asked to imagine what an object smells like (i.e., engage in olfactory imagery), memory retrieval of prior experiences with that odor will be facilitated if memory templates for the odor referent are cued, allowing the odor to be easily identified. One such memory-template cue would be a picture of the odor referent. Much research has shown that pictures improve the memory of verbal information (Paivio 1969, 2007) and that visual imagery enhances the retrieval of past events or episodes. Indeed, visual imagery and memory retrieval have been found to activate overlapping brain regions (Huijbers et al. 2011).

Since people's hedonic reaction toward odors is highly dependent on what they believe the odor is (Herz and von Clef 2001), seeing visual images of the odor referent (the object that emits the odor, such as the cookie that emits a chocolate chip cookie scent) should aid in odor identification (determining just what the odor is), enhance retrieval of prior sensory experiences with the odor referent (e.g., the eating and enjoyment of chocolate chip cookies), enable the consumer to create a clear and vivid visual mental image of the prior experience, and thus result in a positive hedonic response.

Moreover, there are likely individual differences or traits that moderate this process. In particular, some individuals are more adept at visually imaging objects and events (Brown 1968). These high visual imagers are better able to call to mind previous experiences from long-term memory and to virtually reexperience them in their mind's eye (McKelvie and Demers 1979; Nouchi 2011). As such, we would expect low visual imagers to be less likely to generate olfactory memory templates in response to scent exposure, unless they also have access to an external picture of the odor referent. Hence, pictures should be more likely to enhance the response to olfactory cues of low (vs. high) visual imagers. High visual imagers, on the other hand, are more adept at mental visual imaging and thus should be less reliant on external pictorial inputs for their response to odor cues. Please see figure 1 for the conceptual model that reflects our theorizing.

Insert figure 1 about here

**Hypotheses**

The foregoing discussion leads to our formal hypotheses:

**H1**: Imagined-Scent Effect. Imagining (vs. not) what a food smells like will enhance consumer response to an advertised food only if the consumer is exposed to a visual representation of the odor referent, and not otherwise. In contrast, actual scent will enhance consumer response to a food regardless of whether a visual representation is available or not.

**H2**: Individual Differences. A picture (vs. none) of an advertised food will be more likely to enhance the effect of scent on consumer response to the advertised food for low as compared to high visual imagers.

Collectively, the hypotheses predict the effects of imagined and actual scent (vs. no scent) on consumer response, as well as the role that visual images (externally or internally generated) play in moderating these scent effects. Next, we present an overview of our four studies, which test the hypotheses, followed by the studies themselves.

## OVERVIEW OF STUDIES

In study 1, we demonstrate that imagining a food odor while looking at an ad with a picture of food increases salivation. In study 2, we look at the effect of imagining a food odor on salivation—with versus without access to a picture of the advertised food product (and in comparison to actual scent exposure). In study 3, we manipulate scent and picture at all levels (none, imagined, actual) to explore in more detail the interplay between olfactory and visual imagery, using actual food consumption as the dependent measure. In study 4, we provide all subjects with the advertised food product's scent and explore the effect of picture exposure on desire to eat as a function of individual visual imagery ability.

## STUDY 1: IMAGINED SCENT AND SALIVATION

While several studies have shown that smelling appetizing food odors can increase salivation, there is limited evidence demonstrating the effects of merely imagining what a food smells like. In this study, all participants view a picture of an advertised food product (i.e., chocolate chip cookies) in a print advertisement. Our goal is to see whether consumers who imagine smelling the scent of the advertised product (compared to a no scent control) while seeing a picture of the food salivate more, as predicted in hypothesis 1. If so, this would provide initial evidence for the effects of imagined food odors on consumer response to food ads that contain pictures of the odor referent.

### Design and Method

This study had a one-way design (scent condition: imagined scent vs. no scent control), with random assignment to condition. We created a cookie advertisement with a picture of four chocolate chip cookies and a tagline "Fancy a freshly baked cookie?" (app. A). All participants were shown the same advertisement. While looking at the ad, participants were (or were not) asked to imagine what the pictured cookies smelled like. Salivation was measured at two points in time: a baseline taken just before exposure to the advertising stimulus and a post-stimulus measure taken again after ad exposure (described in more detail below).

### Procedure

Fifty-nine undergraduate students at the University of Michigan participated in the study for partial course credit. Participants were informed that they would be taking part in food product evaluation studies where their memory for product information would be tested. They were further told that as part of this effort we needed to measure their saliva levels before and during their participation. More specifically, they were told that this study was about consumer memory processing and that their memory for the product attribute information contained in print advertisements would be tested later (a cover story).

After collection of baseline salivation levels, participants responded to several unrelated tasks for 10 minutes and then encountered the stimuli of the study and answered a few questions. In the imagined scent condition they were instructed to "Look at the picture and

IMAGINE the smell of the cookies" for 2 minutes. The control condition participants were instructed to "Look at the picture" for 2 minutes. At the end of 2 minutes all participants were instructed to remove the cotton pads from their mouths and place them in bags provided.

We then had participants complete some additional questions. At the end of the experiment, participants were asked to write down what they thought the purpose of the study was. None of the subjects guessed the true purpose of the study. Given that subjects had cotton pads in their mouths, of the 59 participants, 13 did mention something related to salivation (such as mouth-watering, saliva, or salivation). However, the likelihood of mentioning saliva-related terms did not differ by condition ($p > .25$).

**Measures**

Our key dependent measure is change in salivation. There are several methods for measuring saliva flow rate including counting the number of times an individual swallows during a time period (Nederkoorn et al. 2000), allowing saliva to drain into a test tube, periodic spitting (Jenkins and Dawes 1964), and vacuum-pump whole-mouth suction (Herman et al. 1981). The most common procedure, which we adopt here, employs cotton dental rolls to collect saliva and is known as the Strongin-Hinsie-Peck dental roll procedure (Gal 2012; Peck 1959; Wooley and Wooley 1973).

Three pre-weighed 3.8-cm cotton dental rolls were distributed to participants in zippered bags. Participants were asked to place these cotton dental rolls in their mouths (the first and second ones between the cheek and lower gum, and the third one under the tongue). The experimenter demonstrated how to place the cotton pads in the correct locations in the mouth to guarantee participants' correct placement of the cotton pads. Saliva was collected via the dental rolls in participants' mouths for 3 minutes in each of two collection phases. In both phases, after collection, participants put the three dental rolls back into zippered bags and handed these bags to the experimenter. The weights of each set of three dental rolls (with saliva) were recorded to the nearest 0.1 grams. The baseline measure is used to control for differences in how much individuals normally salivate. Note that change in salivation can be negative in magnitude if it is less in phase 2 than in phase 1.

In addition to salivation change, we measured ad recall to support the cover story. We also measured desire to eat the cookies ("How much do you want to eat the cookies?" on a scale of 1 = I do not want to eat them to 7 = I definitely want to eat them) to establish how correlated this self-report measure is with salivation. As covariates we measured mood ("Currently I am in a good mood"), hunger ("Currently I am hungry"), and cookie liking ("Do you like cookies?") on 1 to 7 scales ("Strongly disagree" to "Strongly agree"), as well as dietary status ("Are you on a diet now?" Yes/No).

**Results**

*Salivation.* We conducted an ANCOVA on the difference in salivation (post- vs. pre-stimulus exposure) as a function of scent condition with covariates for mood, hunger, cookie liking, and dietary status. The only covariate that was significant was cookie liking ($F(1, 53) = 4.92$, $p < .05$), with salivation higher among those who liked cookies more. Scent condition was also significant ($F(1, 53) = 5.04$, $p < .05$). Salivation increased from the unscented control ($M = -0.13$) to the imagined scent condition ($M = .23$, $p < .05$), as predicted in hypothesis 1 (figure 2). Further, salivation change (a non-conscious physiological response) was significantly correlated with self-reported desire to eat ($r = .27$, $p < .05$).

Insert figure 2 about here

**Discussion**.

We see that while looking at a picture of the odor referent (chocolate chip cookies in this case), imagining its scent enhances consumer salivatory response compared to a no scent control, in support of hypothesis 1. Further, salivation, a nonconscious physiological measure of response, is significantly correlated with desire to eat, a conscious self-report measure. What is not clear from this study is whether or not the picture of the advertised food product played a role in the effectiveness of olfactory imagery. This issue is explored in the next study.

## STUDY 2: IMAGINED SCENT, SCENT, AND SALIVATION: THE KEY ROLE OF VISUAL INPUT

In this study, we test hypothesis 1—whether imagined odors will impact salivation only when people are exposed to a visual representation of the odor referent (a picture of the food that emits the odor), whereas actual scent will increase salivation regardless of visual input. Here we manipulate olfactory input (none, imagined, actual), as well as visual input (none, actual), in order to assess the interactive effects of olfactory and visual input. We expect that, since it is difficult to picture an odor referent in one's mind without external visual input (e.g., while seeing a picture of the odor referent), imagining the odor of an advertised food product is unlikely to increase salivation when the consumer does not see a picture of the food. Actual olfactory input, in contrast, will not exhibit the same interactive effect with pictures.

**Design and Method**

This study had a 3 (scent: actual, imagined, no scent control) x 2 (picture of odor referent: yes, no) full factorial design, with random assignment to condition. We created an advertisement with a picture of chocolate cake and the following tagline: “Feel like a chocolate cake?” (app. B). Participants were shown the advertisement with or without a picture of the cake and were asked to either smell the chocolate cake scent (which was attached to the advertisement in a sachet), to imagine the scent of chocolate cake, or neither (unscented control condition). For the actual scent condition, we prepared scent sachets by putting ground-up chocolate cake into small rectangular shapes made out of coffee filters and attached them to the print ad to simulate rub and sniff panels found in scented ads.

**Procedure**

One hundred forty-two undergraduate students at the University of Michigan participated in the study for partial course credit. Participants were told they would be taking part in a study about advertising and product evaluation, and that this required measuring their saliva levels. Salivation was measured before and after stimulus exposure as in study 1.

After providing their evaluations, participants reported their mood, hunger, cookie liking and dietary status as in study 1. At the end of the experiment, subjects were asked to write down what they thought the purpose of the study was. No one guessed the true purpose of the study. Of the 142 participants, 10 mentioned something related to salivation (such as mouth-watering, saliva, or salivation); the likelihood of mentioning saliva-related terms did not differ by condition ($p$'s > .20)).

**Results**

We conducted an ANCOVA with change in salivation level (post- vs. preexposure) as the dependent variable, and scent (actual scent, imagined scent, and no scent control) and picture condition (picture, no picture) as the independent variables, plus covariates to control for hunger, mood, dietary status, and cookie liking. None of the covariates was significant ($p$'s > .30). We observe significant main effects for both scent ($F$ (2, 132) = 25.96, $p < .01$) and picture ($F$(1, 132) = 35.87, $p < .01$) as well as a significant interaction ($F$(2, 132) = 3.77, $p < .05$; see Table 1 and figure 3).

Insert table 1 and figure 3 about here

Exploring the interaction between the picture and scent conditions, we see that when there is no visual input, that is, the consumer sees *no picture*, only the presence of an actual scent (versus no scent) is capable of significantly increasing salivation ($M_{NoPictureNoScent}$ = -.01 versus $M_{NoPictureScent}$ = .67, $F$(1, 132) = 37.8, $p < .01$). Just asking people to imagine the smell of the cake (versus no scent) does not have a significant effect on salivation ($M_{NoPictureNoScent}$ = -.01 versus $M_{NoPictureImaginedScent}$ = .12, $F$(1, 132) = 1.24, $p > .25$). In contrast, when there is a *picture present*, both actual and imagined scents (versus no scent) significantly increase salivation levels ($M_{PictureNoScent}$ = .36 versus $M_{PictureScent}$ = .85, $F$(1, 132) = 17.25, $p < .01$; $M_{PictureNoScent}$ = .36 versus $M_{PictureImaginedScent}$ = .75, $F$(1, 132) = 11.49, $p < .01$).

The results support H1 and again show that actual scent enhances salivation regardless of whether visual input is present or not. However, imagined scent only has a significant effect on salivation in the presence of a visual referent. The critical result here is with regard to the effect of olfactory imagery. Our results show that just asking people to imagine the odor of an appetizing food product will not increase salivation *unless the consumer also sees a picture* of the food product.

The design of the study also allows us to look at the effect of pictures under different odor conditions. As the data show, adding a picture (versus no picture) in the no scent condition increases salivation ($M_{NoPictureNoScent} = -.01$ versus $M_{PictureNoScent} = .36$, $F(1, 132) = 11.05$, $p < .01$); as does adding a picture (versus no picture) in the imagined scent condition ($M_{NoPictureImaginedScent} = .12$ versus $M_{PictureImaginedScent} = .75$, $F(1, 132) = 30.07$, $p < .01$). However, adding a picture (versus no picture) in the actual scent condition does not increase salivation beyond the high level elicited by scent alone ($M_{NoPictureScent} = .67$ versus $M_{PictureScent} = .85$, $F(1, 132) = 2.51$, $p > .10$).

**Discussion**

The pattern of results obtained here is the first demonstration we are aware of showing that the effect of imagining odors on salivation is dependent upon exposure to visual images. These results provide initial evidence for the interplay between olfactory and visual imagery processing. The fact that imagining odors increases salivation only in the presence of a picture suggests that consumers who engage in olfactory imagery (i.e., try to imagine what an object smells like) need to be able to create a clear visual mental image of the odor referent in order for olfactory imagery to elicit effects. Seeing a picture of the odor referent likely facilitates retrieval of memory templates of the odor referent from the olfactory cortex—which results in enhanced consumer response.

While we have considered imagined scents in studies 1 and 2, we have not yet explored imagined scents in conjunction with imagined pictures. In the next study, we use a more complex design that includes both imagined scents and imagined pictures.

## STUDY 3: OLFACTORY AND VISUAL IMAGERY—INTERACTIVE EFFECTS ON FOOD CONSUMPTION

Here we examine more fully the interplay between olfactory and visual sensory input with a special focus on the effects of imagining scents versus imagining pictures on food consumption. The design is a 3 (no scent, imagined scent, actual scent) X 3 (no picture, imagine picture, actual picture) full factorial. We utilize a behavioral measure of consumer response in the form of cookie consumption. We expect first to replicate our previous findings (from studies 1 and 2) regarding the dependence [independence] of imagined scent [actual scent] on the presence of a picture of the odor referent. But, in this study, we also explore whether just an imagined picture is sufficient to activate the effect of imagined scent on consumer response to advertised food.

### Method

The procedure for this study was similar to that of the previous studies. As in the previous studies, participants ($n = 226$ undergraduates) were informed that they would be participating in a study about "consumer product evaluations." They were told that we were interested in their "evaluations of products, such as those [they] might purchase in a grocery store." Participants received the ad for chocolate chip cookies with a brand name and short body copy (appendix C) in one of six formats based on the study's design (scent: none, imagined, actual; picture: none, imagined, actual). Additional lines of body copy were included depending on condition: "Imagine the smell of the cookies!" (for imagine scent condition); "Imagine what the cookies look like!" (for imagine picture condition); "Please smell the cookie in the sachet attached" (for actual scent condition). The actual scent was presented in sachets with crumbled cookies as in study 2. The picture of the cookies was included only in the actual picture conditions. The study was run on 14 separate days (all weekdays), randomizing conditions across day of week and time of day.

Here we utilize a behavioral measure to capture consumer response: actual food consumption, rather than salivation increase (as in studies 1 and 2). After the ad exposure, all participants were asked to eat as much or as little as they liked of two chocolate chip cookies (40 grams total). The cookies were presented in a sealed zip-locked bag, which was inside a sealed opaque paper envelope and not opened until this stage of the experiment. Participants were asked to evaluate the cookies ("Taste very good"; "Are high quality"; both on a scale of 1 to 8; $r = .81$, $p < .01$) to support the cover story. They were then instructed to put any remaining cookies back into the zip-locked bag (which was later weighed to determine grams consumed). Note: Amount of cookies consumed was significantly correlated with post-tasting cookie evaluation ($r = .20$, $p < .01$). Our analysis focuses on the behavioral response of consumption.

Participants also responded to measures for hunger ("Currently I am hungry"), and mood ("I am in a good mood") on 7 point scales (1 = disagree to 7 = agree), dietary status ("Are you on a diet now?" Yes/No), time since they last ate something (in hours and minutes), and cookie liking ("Do you like cookies in general?" from 1 = Not at all to 7 = Very much). At the end of the experiment, they were asked to write down what they thought the purpose of the study was. Of the 226 participants, none mentioned anything related to salivation as this measure was not used in this study. No other significant patterns were observed in the hypothesis probe responses. Types of things mentioned were, “our level of attention to ads” and “marketing strategy for product development.”

**Results**

*Amount Consumed.* We conducted an ANCOVA on amount of cookies eaten (in grams) as a function of picture condition, scent condition, and the interaction between these two variables, as well as covariates to control for day of the week, time since having last eaten, dietary status, hunger, mood, and cookie liking. The covariates that were significant were: time since last eaten ($F(1, 211) = 13.78$, $p < .01$), hunger ($F(1, 211) = 27.27$, $p < .01$), and cookie liking ($F(1, 211) = 8.75$, $p < .01$). More cookies were eaten if the participant was hungrier, if the participant liked cookies more, and if it had been longer since having last eaten.

The main effects of scent ($F(2, 211) = 21.91$, $p < .01$) and picture condition ($F(2, 211) = 31.38$, $p < .01$) were significant, as was their interaction ($F(4, 211) = 2.41$, $p < .05$). Following up on the main effects, we see that the amount of cookies eaten (in grams) increased from the no scent ($M = 9.6$) to imagined scent ($M = 12.0$, $F(1, 211) = 6.30$, $p < .05$) condition, and from the imagined scent to actual scent ($M = 16.5$, $F(1, 211) = 18.44$, $p < .01$) condition. Similarly, the amount of cookies eaten increased from the no picture ($M = 8.5$) to imagined picture ($M = 13.1$, $F(1, 211) = 22.06$, $p < .01$) condition, and from the imagined picture to actual picture ($M = 16.6$, $F(1, 211) = 10.34$, $p < .01$) condition (see table 2 and figure 4).

Insert table 2 and figure 4 about here

Exploring the interaction of the scent and picture conditions, first, we look at the effect of scent on amount of cookies eaten (see table 2). As in study 2, we find that in the no picture condition, actual scent (versus no scent) significantly increases consumption ($M_{NoPictureNoScent} = 7.2$ versus $M_{NoPictureScent} = 11.4$, $F(1, 211) = 6.30$, $p < .05$) whereas imagined scent (versus no scent) does not ($M_{NoPictureNoScent} = 7.2$ versus $M_{NoPictureImaginedScent} = 6.8$, $F(1, 211) = 0.06$, $p > .80$). However when a picture is available, both actual and imagined scents (versus no scent) significantly increase cookie consumption ($M_{ActualPictureNoScent} = 11.1$ versus $M_{ActualPictureImaginedScent} = 16.4$, $F(1, 211) = 32.56$, $p < .01$; $M_{ActualPictureNoScent} = 11.1$ versus $M_{ActualPictureImaginedScent} = 16.4$, $F(1, 211) = 32.56$, $p < .01$), supporting hypothesis 1.

Next, we look at analogous effects for pictures, and find that both real and imagined pictures (versus no picture) increase consumption, irrespective of scent condition (see table 2). Specifically, we find that an actual picture (versus no picture) increases cookie consumption, when there is no scent ($M_{NoPictureNoScent} = 7.2$ versus $M_{PictureNoScent} = 11.1$, $F(1, 211) = 4.73$, $p < .05$), when there is imagined scent ($M_{NoPictureImaginedScent} = 6.8$ versus $M_{PictureImaginedScent} = 16.4$, $F(1, 211) = 31.61$, $p < .01$), and when there is actual scent ($M_{NoPictureScent} = 11.4$ versus $M_{PictureScent} = 22.2$, $F(1, 211) = 33.74$, $p < .01$). Similarly, just *imagining* what a food looks like (versus no picture) also increases consumption regardless of scent condition ($M_{NoPictureNoScent} = 7.2$ versus $M_{ImaginedPictureNoScent} = 10.4$, $F(1, 211) = 3.97$, $p < .05$; $M_{NoPictureImaginedScent} = 6.8$ versus $M_{ImaginedPictureImaginedScent} = 12.9$, $F(1, 211) = 12.36$, $p < .01$; $M_{NoPictureScent} = 11.4$ versus $M_{ImaginedPictureScent} = 15.9$, $F(1, 211) = 6.47$, $p < .05$). These results suggest that merely imagining the visual referent of a food positively affects cookie consumption even when olfactory input is absent, indicating the power of visual imagery.

**Discussion**

We find that imagining (versus not) the scent of food in an ad increases consumption of the food only when the ad also has a picture of the food, in support of hypothesis 1. Further, visual imagery does not exhibit a similar dependency on olfactory input -- merely imagining what the food looks like significantly increases consumption (versus no picture), regardless of whether or not the consumer has a food scent or is imagining one.

This pattern of results supports our contention that olfactory imagery is highly dependent upon visual processing. Visual imagery, in contrast, appears to be less dependent upon olfactory imagery -- likely because of the ease of creating a clear and vivid mental picture of the food merely by imagining what it looks like. Olfactory and visual imagery therefore appear to operate in qualitatively different manners.

We also find that having actual scent in a food ad (versus not) increases consumption, independent of visual input (real, imagined, or no pictorial image). Additionally, we find that adding a picture (versus not) when the ad already has actual food scent significantly increases consumption. This result is in contrast to a null finding in study 2 where picture (versus none) in the presence of actual scent did not significantly increase salivation. We speculate that the difference in results for consumption (study 3) versus salivation (study 2) may occur because of differences between actual versus anticipated consumption. This difference offers an opportunity for additional research on the subject of anticipated versus actual consumption.

In the next study, we see whether the effect of picture exposure (in the presence of an actual scent) is moderated by individual differences in ability to imagine visual images (i.e., chronic visual imaging capability) as further support for the interplay between olfactory and visual sensory processing.

## STUDY 4: SCENT AND DESIRE TO EAT: THE MODERATING ROLE OF VISUAL IMAGERY ABILITY

In study 4, we gather additional evidence for the interactive effects of olfactory and visual sensory input as a function of an individual difference variable -- consumers' chronic tendency to engage in vivid visual imagery processing. Per hypothesis 2, we expect that with direct sensory input in the form of exposure to an appetizing food scent, additionally seeing a picture of the odor referent will be more likely to enhance consumer response among those who are *not* very adept at engaging in visual imagery, that is, among poor visual imagers. Good visual imagers, in contrast, should be able to adequately mentally visualize the odor referent after receiving only the olfactory sensory input and thus will not benefit much by also seeing its picture.

In this study, all subjects are provided with the actual scent of chocolate chip cookies. We manipulate whether or not participants also see a picture of chocolate chip cookies in the print ad (same picture as was used in study 1). We measure individual differences in visual imagery with the QMI-Vision scale (QMI-V, Sheehan 1967). QMI-V is a common measure used to assess an individual's chronic capacity to engage in visual imagery (Ellen and Bone 1991; MacInnis 1987). We are interested in whether the effect of picture-presence on the desire to eat varies as a function of chronic visual imagery ability (when actual food scent is controlled). We use the self-report measure of desire to eat to avoid the potential intrusiveness associated with the mouth pads used to collect saliva in studies 1 and 2.

**Method**

Participants (*n* = 170) were undergraduates who participated for partial course credit. They were informed that they would be participating in a study about consumer product evaluations. All participants received a ziplock bag from which they removed a small piece of blotter paper. They were instructed to hold the paper one inch from their nose and take three sniffs. They were asked to write down what they thought the odor was. Then participants viewed a print advertisement for chocolate chip cookies. . Half of the participants saw the advertisement with a tagline and picture of the chocolate chip cookies; the other half saw the ad without the picture (but with the tagline). All participants were asked to report their desire to eat the advertised cookies as in study 1. We then measured visual imagery ability with the QMI-Vision scale (Sheehan 1967). The QMI-V scale asks participants to rate the vividness of images that come to mind when they create a mental picture in response to prompts such as: "The exact contour of face, head, shoulders, and body" or "The different colors worn in some familiar outfit" for a relative or friend frequently seen. The mental images are rated on a five-point scale from "No image present at all, you only know that you are thinking of the object" to "Perfectly clear and as vivid as the actual experience." To assess visual imager status, we calculated the average of responses to the five QMI-V items ($\alpha$ = .67). This gave us a score for each participant's trait-level visual imagery ability. Due to the added length of the survey with the measurement of the QMI-V trait, we did not measure the set of covariates collected in the other studies.

At the end of the experiment, participants were asked to write down what they thought the purpose of the study was. Of the 170 participants, none mentioned anything related to salivation as this measure was not used in this study. No other significant patterns were observed in the hypothesis probe responses.

## Results

*Desire to Eat.* We conducted a regression on desire to eat the cookies after stimulus exposure as a function of picture condition, QMI vision score, and the interaction between these two variables. Picture condition was represented with a dummy variable (coded 1 = picture, 0 = otherwise). QMI vision was measured on a continuous scale and was mean-centered prior to analysis. The main effects of QMI vision ($b = .59$, $t = 2.12$, $p < .05$) and picture condition ($b = .77$, $t = 3.14$, $p < .01$) were significant, as was their interaction ($b = -.80$, $t = -2.15$, $p < .05$).

To explore the nature of the interaction, we analyzed the effect of picture on eating desire at focal points of QMI-V (Hayes 2012). This method for conducting spotlight analyses allows us to look at multiple points of interest along the QMI-V moderator instead of just at points a standard deviation above and below its mean (Spiller et al. 2013). The spotlight analysis reveals that the presence of a picture while smelling the odor of chocolate chip cookies increased the desire to eat the cookies only for poor to average visual imagers, that is only for those scoring in the $10^{th}$ (effect = 1.42, $t = 3.66$, $p < .01$), $25^{th}$ (effect = 1.26, $t = 3.78$, $p < .01$), and $50^{th}$ (effect = .78, $t = 3.17$, $p < .01$) percentiles of visual imaging ability; but not for those scoring in the $75^{th}$ (effect = .46, $t = 1.62$, $p > .10$) or $90^{th}$ (effect = .15, $t = .38$, $p > .70$) percentiles of visual imaging ability, as measured by QMI-V (see figure 5).

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Insert figure 5 about here

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### Discussion

Our results indicate that seeing (versus not seeing) the picture of the advertised food after smelling its odor significantly increased the desire to eat among consumers exhibiting low visual imaging ability, but not among those exhibiting high visual imaging ability, supporting hypothesis 2. Thus, as expected, individuals who are highly capable of generating vivid mental images of objects in their mind are not impacted as much by exposure to actual pictures of the odor referent (i.e., cookies), once they have been exposed to its odor. Apparently the odor is sufficient to generate a clear and vivid mental representation of the odor referent. The interplay of odors and pictures is thus again demonstrated in this study by showing that adding a picture in the presence of an actual food odor increases the desire to eat among only low visual imagers (i.e., those for whom the odor alone likely does not generate a highly vivid mental image).

## GENERAL DISCUSSION

Recent scent research in consumer behavior research has focused on the effect of exposure to actual odors (Bone and Ellen 1999; Krishna et al. 2010; Mitchell et al. 1995; Morrin and Ratneshwar 2003). However, no research we are aware of has investigated the effect of *imagined* odors on consumer response. We find significant effects of imagined scent on consumers' physiological (i.e., salivation), evaluative (i.e., desire to eat), and consumptive (i.e., amount eaten) responses to advertised food products *only* when the consumer can create a vivid visual mental representation of the odor referent. To the best of our knowledge, the effects of olfactory imagery and its interplay with visual mental representations have not been previously explored.

## Theoretical Implications

Some researchers have voiced doubts regarding the existence of olfactory imagery (Carrasco and Ridout 1993; Crowder and Schab 1995). The results presented here suggest that olfactory imagery may exist but that it is difficult for individuals to effectively engage in olfactory imagery unless they have access to a visual image of the odor referent (i.e., the object with which the odor is typically associated). The interaction effect we found between olfactory and visual imagery may help to explain the well-documented "tip of the nose" phenomenon whereby people have difficulty identifying odors (Cain 1979; Jonsson and Olsson 2003; Lawless and Engen 1977). Why are people very adept at recognizing an odor that has been previously smelled, but are seldom able to identify what they smell more than 50% of the time (Sulmont-Rosse, Issanchou and Koster 2005)? Our results suggest that people may have difficulty in correctly identifying odors because they cannot clearly picture them in their minds' eyes, so to speak. Since olfactory imagery's effects here emerged only when participants could create a vivid visual mental image of the odor referent (i.e., the object emitting the odor), it would appear that smelling odors alone is not likely to generate sufficiently vivid mental images of odor objects enabling identification.

Our results would seem to support recent research suggesting an object-centered, rather than a valence-centered view of odor perception (Olofsson et al. 2012). Per the object-centered view, odor stimulants first need to be identified before their valence is determined. Our results show that olfactory imagery effects are potentiated by exposure to a visual representation of the odor referent, which supports an object-centered view of odor perception. Interestingly, visual imagery does not exhibit the same sort of dependence on olfactory imagery processes.

Although our results are suggestive that olfactory imagery can impact behavior given a sufficient visual imagery context, it remains for future research to verify that olfactory imagery processing is indeed distinct from that of visual imagery processing. That is, it is possible that asking people to imagine an odor could simply activate a visual image (i.e., people are not capable of imagining odors) or it could activate a multiply-coded mental representation of an object. If so, olfactory imagery may be subsumed within a visually-dominated mental representation. If so, asking people to imagine an odor could merely act more generically as an elaboration manipulation, rather than elicit olfactory imagery per se. Neural evidence could help to clarify this issue. We also note that the current results were confined to contexts in which the odor objects were highly pleasant in nature (e.g., cake and cookies). Thus, it remains to be seen whether unpleasant odors would operate in a similar manner.

**Managerial Implications**

Our article has important implications for marketers. While scents are often used in ads for personal products (e.g., deodorant, perfume, roll-on, after-shave), they seem to be used less often in ads for food products. These results suggest that including real food odors in advertising and promotion efforts can enhance consumer response. Further, merely asking consumers to imagine what the advertised food smells like, or "smellizing" it, may be effective *if accompanied by a picture* of the food. Thus, if food advertisements do not have a food odor but have a picture of the food, merely encouraging consumers to imagine the scent of the food could increase desire for the food. The take-away for managers concerns the critical role of a visual representation of the odor referent -- imagined odors may increase desire for the food only in the presence of pictures. Thus, radio ads, banner ads on the computer, or print line ads (i.e., ads without a visual) would likely not benefit by asking consumers to imagine the smell of a breakfast muffin, for example.

Our finding that actual scents in a food ad enhance response whether or not the ad has a picture implies that food ads can benefit from scents even when they don't have a picture of the food. Secondly, even if a food ad has a picture of the food, it will still benefit from the addition of a real scent (e.g., via a scratch-n-sniff strip). That is, food odors are not superfluous in the presence of pictures of appetizing food cues. Overall, our results indicate that food advertisers may want to increase their use of both real and imagined scents in the ways discussed above.

In this article, when we focused on visual imagery ability (in study 4), we examined the effects of real scent and not imagined scent. Future research could examine the impact of visual imagery ability on olfactory imagery's effect on consumer response to food ads. In the future researchers could also examine the outcomes associated with inter-sensory conflict -- when sensory inputs communicate different or contradictory qualities of a food. This issue might be particularly interesting in terms of seeing whether the sense of vision dominates the relative impact of the conflicting inputs.

We hope that this article piques the interest of consumer behavior researchers to explore other effects of olfactory imagery. There is much scope for research in this field.

## DATA COLLECTION STATEMENT

The third author supervised the collection of data for the first and second studies (done by research assistants) at the University of Michigan in the fall of 2011. The second and third authors jointly collected the data for the third study at Koc University and Temple University in the spring and summer of 2013. The third author supervised the collection of data for the fourth study by a research assistant at the University of Michigan in the spring of 2012.

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**TABLE 1**

**Study 2 -- Mean change in salivation in each condition**

| | No Picture | Actual Picture | Mean |
|---|---|---|---|
| No Scent | $-.01^{a}$ | $.36^{b}$ | $.18^{1}$ |
| Imagined Scent | $.12^{a}$ | $.75^{c}$ | $.43^{2}$ |
| Actual Scent | $.67^{c}$ | $.85^{c}$ | $.76^{3}$ |
| Mean | $.26^{1}$ | $.65^{2}$ | |

**Notes: Different superscripts within a row or column indicate mean differences at $p < .05$. Means within the Mean column or Mean row differ from each other within that column or row at $p < .05$ if the numeric superscripts differ from each other.**

## TABLE 2

**Study 3 -- Mean amount of cookies consumed (in grams) in each condition**

| | No Picture | Imagined Picture | Actual Picture | Mean |
|---|---|---|---|---|
| **No Scent** | **7.2[a]** | **10.4[b]** | **11.1[b]** | **9.6[1]** |
| **Imagined Scent** | **6.8[a]** | **12.9[b]** | **16.4[*]** | **12.0[2]** |
| **Actual Scent** | **11.4[b]** | **15.9[c]** | **22.2[d]** | **16.5[3]** |
| **Mean** | **8.5[1]** | **13.1[2]** | **16.6[3]** | |

**Notes: Different superscripts within a row or column indicate mean differences at $p < .05$. We use the * to indicate that the mean in this cell (16.4) is significantly different from the mean in the cell above (11.1) and from the mean two cells to the left (6.8), but not from the mean one cell to the left (12.9). Means within the Mean column or Mean row differ from each other within that column or row at $p < .05$ if their numeric superscripts differ from each other.**

**FIGURE 1**

**CONCEPTUAL MODEL**

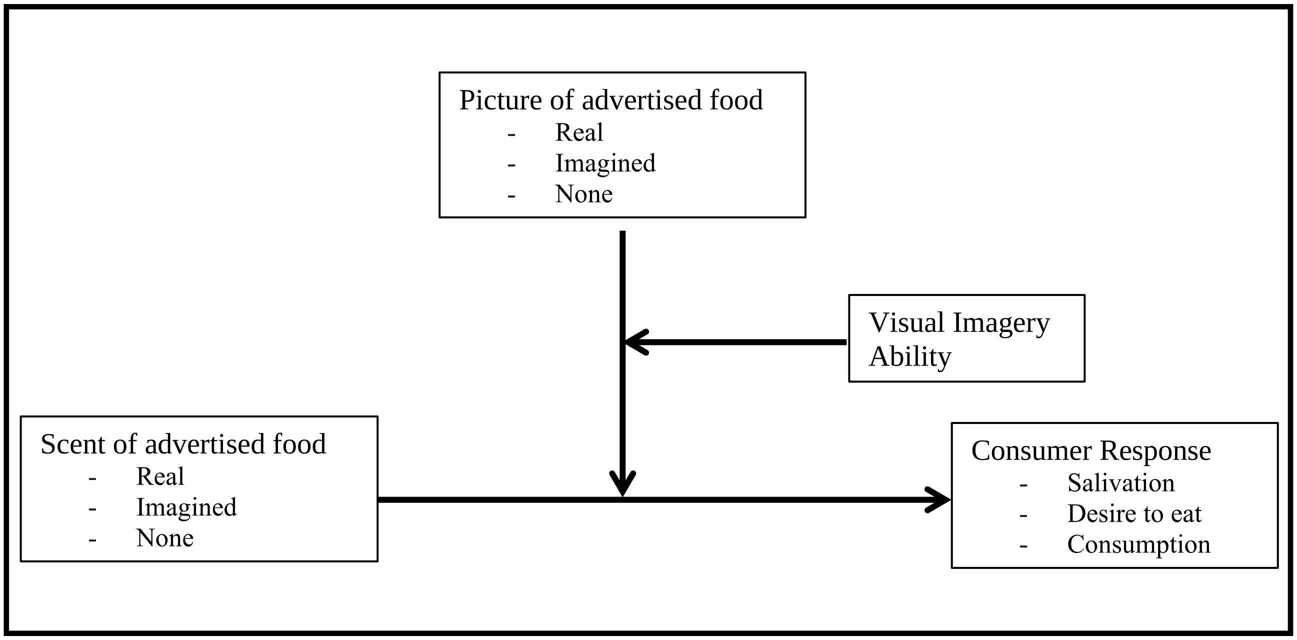


FIGURE 2

STUDY 1: EFFECT OF IMAGINED SCENT IN PRESENCE OF PICTURE ON CHANGE IN SALIVATION

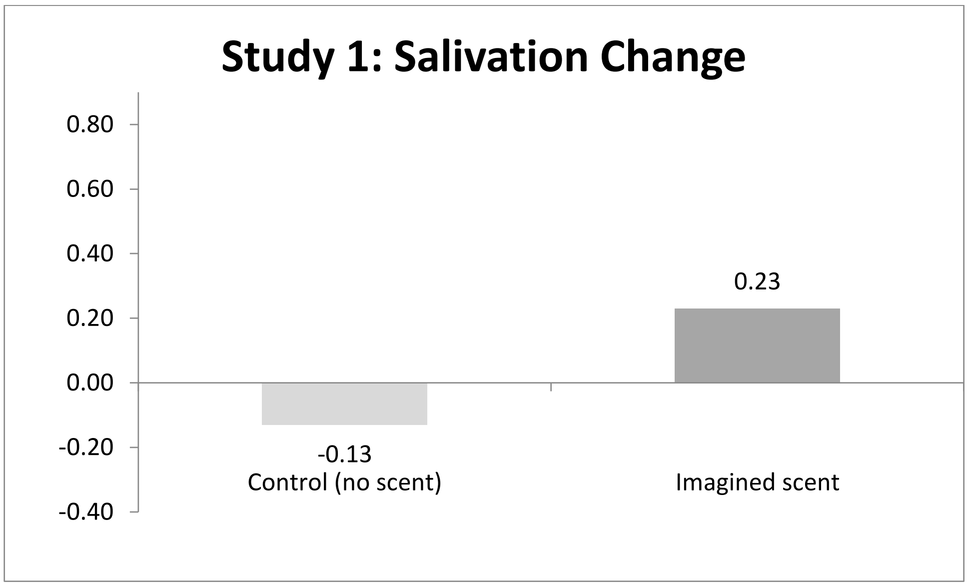


**FIGURE 3**

**STUDY 2: EFFECT OF SCENT AND PICTURE ON CHANGE IN SALIVATION**

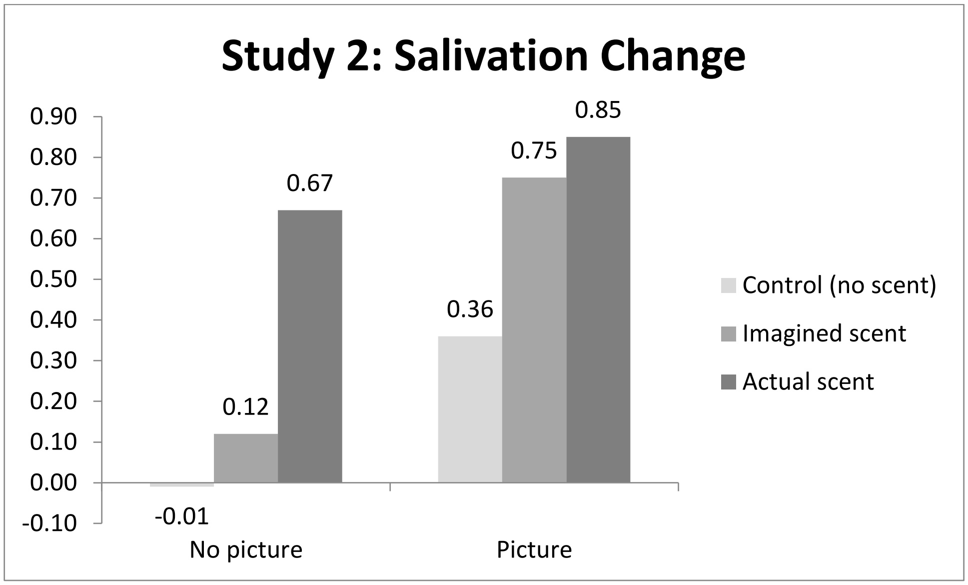


**FIGURE 4**

**STUDY 3: EFFECT OF PICTURE AND SCENT ON AMOUNT OF COOKIES EATEN**

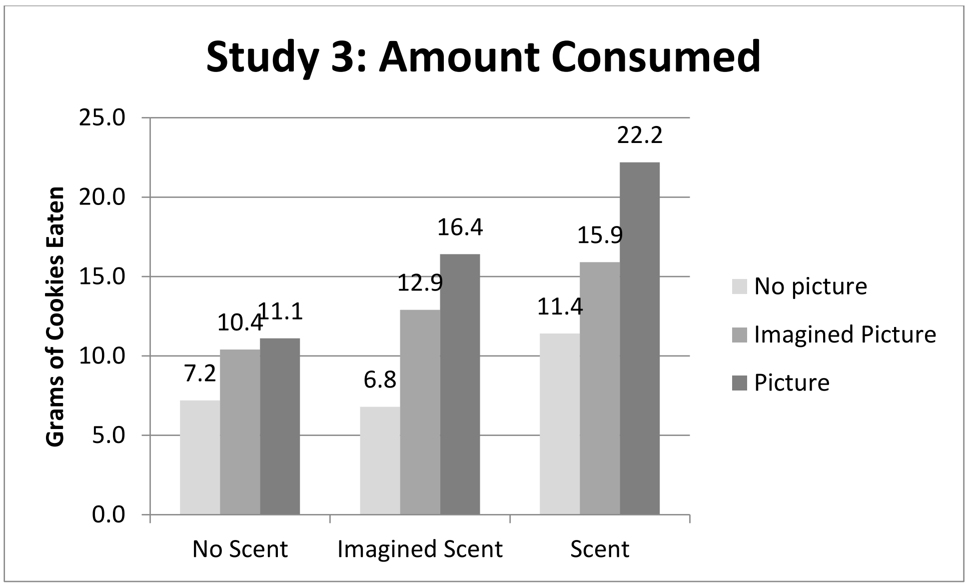
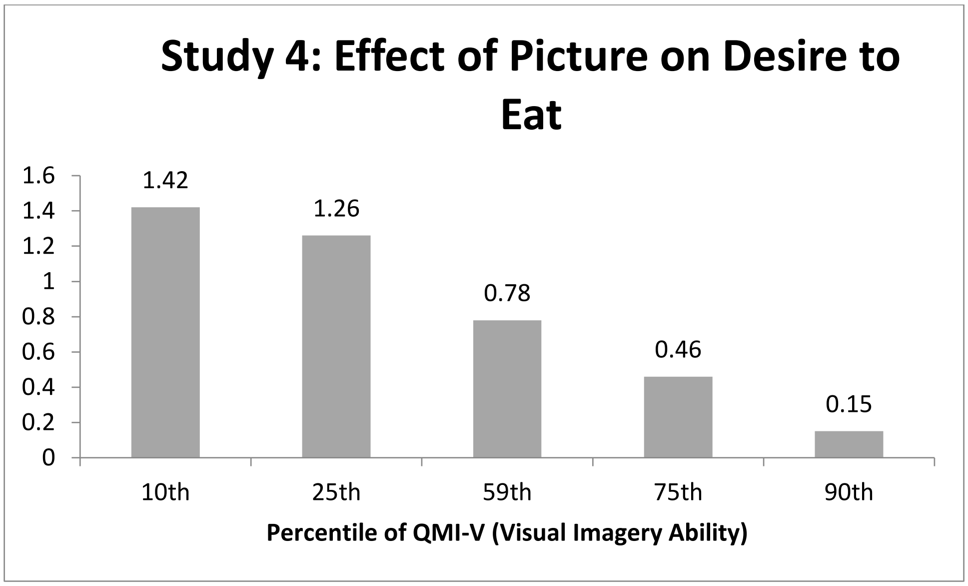


**FIGURE 5**

**STUDY 4: EFFECT OF PICTURE IN PRESENCE OF SCENT ON DESIRE TO EAT AS A FUNCTION OF VISUAL IMAGERY ABILITY (QMI-V)**



Appendix A

Advertising Stimulus Used in Studies 1 and 4

*Fancy a Freshly Baked Cookie?*

Appendix B

Advertising Stimulus Used in Study 2

*Feel Like a Chocolate Cake?*

Appendix C
Advertising Stimulus Used in Study 3

# Tastee® Brand Cookies

*Feel Like Eating a Freshly Baked Cookie?*
*Look for these soon in a store near you.*