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# Seeing is smelling: Pictures improve product evaluations by evoking olfactory imagery

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## ABSTRACT

Scents can improve product evaluations, but incorporating scents in advertising and packaging is relatively inefficient and oftentimes hard to implement (e.g., online). We therefore present a theoretical framework that explains how pictures on packages and in advertisements can evoke imagined scents (olfactory imagery), thereby improving evaluations and increasing choice shares, without delivering any actual scent. Seven main studies (and four supplemental studies) demonstrate this visual-olfactory effect on product evaluations and choices, and reveal three conditions that accentuate, eliminate, and reverse this effect. First, the effect of olfactory imagery on product evaluation is greater among consumers with a stronger need for smell. Second, although many products are marketed with scented versions, we show that pictures only improve evaluations of products for which scent is a relevant or typical attribute. Moreover, although deodorizing products frequently utilize pictures of malodorous objects, we show that such pictures actually harm evaluations. By revealing that pictures can evoke imagined scents, which affect product evaluations even without an actual scent, this research demonstrates that scent has far more pervasive and powerful marketing potential than previously thought.

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## 1. Introduction

Surprisingly many products these days are scented, including not only traditional fragrance products such as perfumes, candles, and air fresheners, but also products for which scent is not traditional, like colored markers, water bottles, and greeting cards. With this large market comes a growing demand to advertise and package these scented products effectively, but therein lies a fundamental problem: Although scent is known to improve product evaluations (Morrin, 2010), incorporating scent in advertising and packaging is expensive, impractical (e.g., in online advertising) and only minimally engaging (e.g., only 11 % of consumers engage with scented magazine ads, GfK MRI, 2011). So then, how can marketers convey product scents?

We demonstrate a simple but effective method for creating smells in ads and on packages, critically, without the use of actual scents. Based on multisensory theories of object representation (Barsalou, 2008) and product evaluation (e.g., Elder and Krishna, 2010), we hypothesize that a mere picture of a scented object can evoke *olfactory imagery* – that is, an experience of the sensation of smell despite the absence of an actual scent (Stevenson and Chase, 2005) – which in turn can

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improve product evaluations. For example, a picture of a rose on a product package evokes the smell of a rose, and that imagined smell can improve perceptions of the product. However, we also show various types of scents and products for which scent-inducing pictures fail to improve, or can even harm, product evaluations.

This research substantially advances theoretical knowledge of olfactory marketing. Olfaction is the phylogenetically oldest sense, affecting a variety of consumer behaviors including emotions, memories, and motivations (Herz, 2010). However, relatively few prior studies have focused on olfaction in advertising or packaging (see Ellen and Bone, 1998), fewer have examined how pictures affect other sensory perceptions (see Elder and Krishna, 2010), and even fewer have examined how olfactory imagery affects consumer behavior (see Krishna, Morrin, and Sayin, 2014). Moreover, whereas prior research on olfactory imagery explicitly instructed participants to imagine the smells of foods (Krishna et al., 2014), here we extend the prior research in two important ways. First, we show that olfactory imagery can also occur without instruction, and hence it affects evaluations in more naturalistic consumption contexts. And second, here we instead examine evaluations of non-food products in order to isolate the contribution of olfactory imagery independent of gustatory imagery (Frank et al., 2010; Simmons, Martin, and Barsalou, 2005). Indeed, leading scholars have called for further research on olfaction and olfactory imagery in marketing (Krishna, 2012; Peck and Childers, 2008). We heed those calls by developing a broad theoretical framework that not only explains a novel and powerful way in which pictures on packages and advertisements can improve product evaluations (i.e., via olfactory imagery), but also reveals conditions under which olfactory imagery fails to improve evaluations.

This research also offers clear practical contributions. To begin with, some scented products are packaged and advertised without a picture of the scent-inducing object (for examples see Fig. 1). For instance, floral-scented Clorox kitchen cleaner shows no flowers on its package. Could adding scent-inducing pictures improve evaluations of such brands, or is merely printing “floral scent” sufficient? Of course, many scented products do include a scent-inducing picture on the ad or package, but this does not imply that marketers are aware of the power of pictures to evoke smells: Presumably, marketers often include pictures simply because they render the ad or package more visually attractive or informative. Unless marketers fully understand *why* such pictures are effective, they may make costly mistakes. For instance, the present research demonstrates that both the type of scent and the type of product moderate this effect of pictures on evaluation. By identifying conditions under which pictures do or do not improve evaluations, we thus provide practical guidance for effective marketing.

### 1.1. Survey of Current Practice

To estimate the prevalence of pictures of scented objects on the packages of scented products, we searched the online store of the largest retailer in the US (i.e., WalMart), and we retrieved all products in two product categories that are commonly scented (i.e., laundry detergents and all-purpose cleaning liquids). We retrieved a total of 957 products: 430 laundry detergents and 527 all-purpose cleaners. We applied a two-stage coding procedure. First, we inspected each product's packaging and description to determine whether the product was scented. Of the 430 laundry detergents, 299 were scented (70 %), and of the 527 all-purpose cleaners, 233 were scented (44 %). Thus, across these two product categories, 56 % of products were scented. In the second step of our procedure, we coded whether each scented product included a picture of the scented object on its packaging label. Only 92 of 299 scented laundry detergents contained a picture of the scented object on the label (31 %), and only 52 of 233 scented all-purpose cleaners contained pictures (22 %). Thus, perhaps surprisingly, only 27 % of scented products in these commonly-scented product categories included a picture of the scented object on their packages.

As a final, exploratory step in our analysis, we tested whether the presence of such a picture predicted consumers' evaluations of the given product. As a proxy for product evaluation, we used the customer ratings that are displayed alongside the product descriptions and images on the retailer's website (scale = 1 to 5 stars). Of the 532 scented products, 330 had at least one customer rating, and therefore were included in our analysis. An independent samples *t*-test revealed that customer ratings were significantly higher for products with a picture of the scented object on the package ( $M = 4.66$ ,  $SD = 0.27$ ) than for products without such a picture ( $M = 4.46$ ,  $SD = 0.76$ ),  $t(328) = 2.48$ ,  $p < 0.05$ , Cohen's  $d = 0.30$ . Thus, pictures of scented objects on packages are *associated* with better product evaluations. Next we test whether the former (i.e., pictures of scented objects) may *cause* the latter (i.e., more favorable product evaluations).

### 1.2. Web Study 1

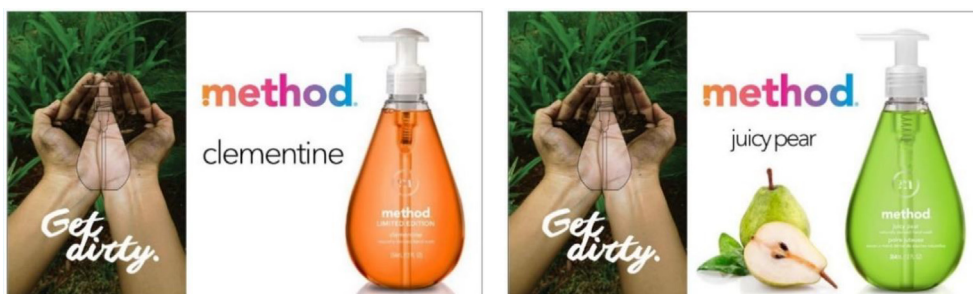
We conducted a preregistered, incentive-compatible test of whether including a picture of the scented object affects consumers' choices of scented products.<sup>1</sup> As shown above, this study reflects current market conditions, as scented products are marketed either with or without a picture of the scented object. In this study, 200 participants simply chose between two scented hand soaps (i.e., clementine, pear), after being informed that one random participant would be delivered six bottles of their chosen soap. Critically, the soaps were shown in an ad either with or without a picture of the scented object (see Fig. 2). Half the participants (List A) saw the clementine soap without a picture and saw the pear soap with a picture of pears,

<sup>1</sup> All preregistrations and all data are available in a Research Box (<https://researchbox.org/2061>).



Fig. 1. Examples of scented products without pictures of the scented object on their package.

#### List A



#### List B

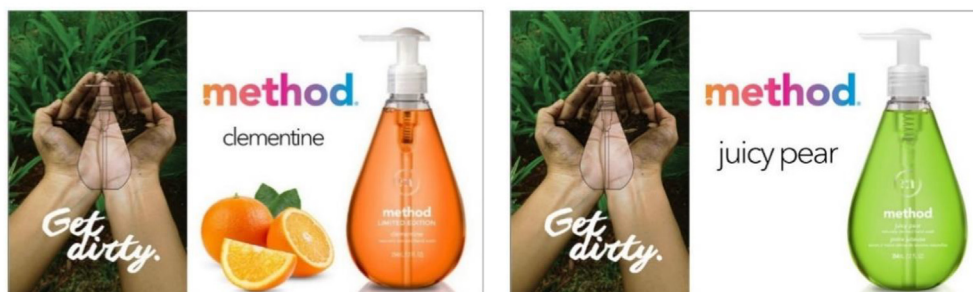


Fig. 2. Stimuli, Web Study 1. Half the participants chose between the products advertised either with or without a picture of the scented object in List A, and half chose from those in List B.

whereas the other half (List B) saw the clementine soap with a picture of clementines and saw the pear soap without a picture. Participants were asked “Which of these two hand soaps would you prefer to have?” For full detail see the [Web Appendix](#).

As predicted, participants preferred whichever soap included a picture of the scented object in the ad (59 % of choice overall). Participants preferred the clementine soap when its ad contained a picture of clementines (57 % choice), but preferred the pear soap when its ad contained a picture of pears (61 %).<sup>2</sup> This predicted interaction of experimental list and product scent was significant,  $\chi^2(1) = 6.15, p = 0.013$ . Thus, by simply including a picture of the scented object in an ad, we significantly reversed consumers' consequential choices of a real product. Below we explain why we believe that olfactory imagery underlies this effect, and in our studies we also test and rule out a range of possible alternative explanations (i.e., visual attractiveness, salience of the scent, awareness of the scent, and product effectiveness).

The foundation of our theoretical model is the prediction that pictures on packages or advertisements can improve product evaluations by evoking olfactory imagery. Below we explain these predictions in turn.

## 2. Theoretical framework

### 2.1. Seeing is Smelling

Much research has investigated differences between pictorial and textual information (Bagozzi, 2008; Childers and Houston, 1984; Childers, Houston, and Heckler, 1985; Meyvis, Goldsmith, and Dhar, 2012). Relative to purely textual information, pictures improve implicit and explicit attitudes and memory (e.g., Lutz and Lutz, 1977; Mitchell, 1986; Trendel, Mazodier, and Vohs, 2018). This is unsurprising, given that pictures attract more attention, are more distinctive, are understood faster, and are more visually appealing than words (Pieters and Wedel, 2004; Townsend and Kahn, 2013). However, pictures also affect attitudes in subtler ways. For example, advertisements with pictures are capable of evoking additional visual imagery that affects attitudes more than purely textual ads do (Babin and Burns, 1997). Thus, effects of pictures on the visual processing of products are well established, and much prior research has also examined visual imagery (e.g., Lutz and Lutz, 1977; Mitchell, 1986; Ostinelli and Böckenholt, 2017).

Crucially, however, that prior research on picture processing has not addressed the multisensory nature of object representations (Barsalou, 2008) and product evaluations (Elder and Krishna, 2010). Essentially, imagery is a sensory process, invoking highly similar neural and physiological processes as actual perception. Moreover, imagery is multisensory (MacInnis and Price, 1987; Unnava, Agarwal, and Haugtvedt, 1996). Experience of an object creates multisensory memory representations, and subsequent activation of a visual representation can also activate representations in other sensory modalities (Murray, Foxe, and Wylie, 2005). For instance, from one's experience with roses, one's mental representation of a rose includes not only its appearance, but also its smell and feel. And importantly, merely seeing a rose can also activate those other sensory features (Streicher and Estes, 2016). Such multisensory imagery has great potential to improve product evaluations.

Given the rapidly growing interest in scented products, we examine olfactory imagery (i.e., imagined scent). Olfactory imagery entails activation of sensory networks in the brain (i.e., smells), not merely semantic networks (i.e., thoughts; Sugiyama, Ayabe-Kanamura, and Kikuchi, 2006). Marketing scholars have revealed many fundamental insights about the impact of actual scents on product or store evaluations and sales (Bosmans, 2006; Cirrincione, Estes, and Caru, 2014; Herrmann et al., 2013; Morrin and Ratneshwar, 2000; Ruzeviciute, Kamleitner, and Biswas, 2020; Spangenberg et al., 2006), but very little is known of olfactory imagery in product evaluation.

Vision strongly affects olfaction. For instance, electrically stimulating the visual cortex improves scent discrimination, indicating that visual representations affect olfactory perception (Jadaui et al., 2012). Marketing researchers have also shown that vision and olfaction are interdependent (Krishna et al., 2014; Lwin, Morrin, and Krishna, 2010). For example, when red coloring was added to white wine, experts perceived it to smell more like red wine (Morrot, Brochet, and Dubourdieu, 2001). Moreover, the congruence of pictures and scents facilitates olfactory perception of even very faint scents (Gottfried and Dolan, 2003). Thus, we predicted that a mere picture of a scented object (e.g., a rose) can evoke olfactory imagery of that object (e.g., the smell of a rose) in the consumer's mind.

#### 2.1.1. Web Study 2

To test whether pictures of scented objects in marketing communications induce olfactory imagery, we conducted a pre-registered, between-participants experiment using Koubaa and Eleuch's (2021) verbal protocol procedure for an open-ended, text-based measure of olfactory imagery. (For full detail see the [Web Appendix](#).) We created two ads for a lavender-scented laundry detergent, one with a picture of lavender (*picture condition*) and one with no picture (*control condition*; see [Fig. 3](#)). Participants ( $N = 200$ ) first viewed one of the ads and then completed a short distractor task. Then, without seeing the ad again, participants were asked to describe their thoughts about (1) the previously shown ad, and (2) the smell of the advertised product.

<sup>2</sup> In a pilot version of this study ( $N = 199$ ) with hypothetical choice, participants completed the exact same procedure as the main study, but instead were asked “Which of these two hand soaps would you be more likely to buy?” The predicted interaction of experimental list and product scent was again significant,  $\chi^2(1) = 6.19, p = .013$ . As in the main study, participants preferred the clementine soap when its ad contained a picture of clementines (60% choice) but preferred the pear soap when its ad contained a picture of pears (57%).



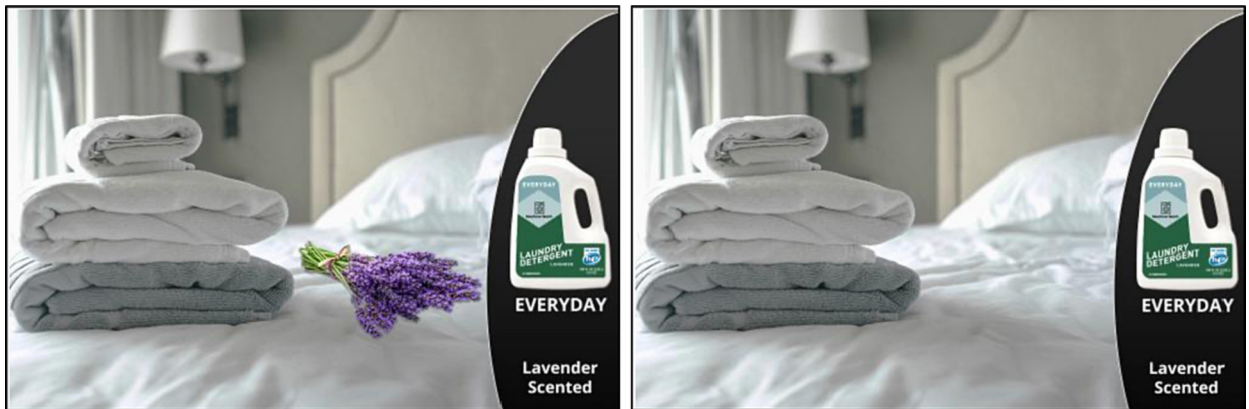


Fig. 3. Stimuli, Web Study 2. Participants verbally described the product advertised either with or without a picture of the scented object.

As predicted, in their general descriptions of the ad, participants were significantly more likely to mention scent-related words (i.e., scent, lavender, smell, olfaction, aroma, fragrance, or any synonym of these) in the picture condition (82 %) than in the control condition (56 %,  $p < 0.001$ ). Also as predicted, in participants' descriptions of the product smell, olfactory imagery (as rated by three independent judges) was significantly higher in the picture condition than in the control condition ( $d = 0.46$ ,  $p = 0.001$ ). Thus, the picture of lavender in the ad increased both the likelihood of describing the ad with scent-related words and the extent of olfactory imagery when describing the product's scent. These results demonstrate that a picture of a scented object in a marketing communication enhances olfactory imagery.

## 2.2. Does Olfactory Imagery Affect Product Evaluation?

Scents are well known to affect product and brand evaluation (e.g., Bone and Jantrania, 1992; Bosmans, 2006; Morrin and Ratneshwar, 2000; Ruzeviciute et al., 2020). However, only very limited prior research has investigated whether olfactory imagery (i.e., in the absence of an actual scent) similarly affects evaluations. Krishna et al. (2014) showed that instructing participants to imagine the smell of food can increase craving, salivation, and eating. They also showed that viewing pictures of food can accentuate the effect of olfactory imagery on eating-related behaviors. Our theorizing led us substantially beyond that prior research in two important ways. First, whereas Krishna et al. (2014) explicitly instructed participants to imagine the smell of a high-calorie food (e.g., chocolate chip cookies), we did not instruct or even encourage our participants to imagine scents. We instead investigated whether olfactory imagery affects evaluations without instruction, in a manner more akin to ordinary evaluation and choice contexts. Second, pictures of high-calorie foods activate gustatory networks in the brain, and in fact, they activate visual and gustatory imagery more strongly than olfactory imagery (Frank et al., 2010; Simmons et al., 2005; Tiggemann and Kemp, 2005). We therefore aimed to isolate olfactory imagery as a causal factor affecting product evaluation by examining non-food products (e.g., cleaning products).

According to the theorizing described above, a picture of a scented object (e.g., a rose) may evoke olfactory imagery (i.e., imagined rose scent), which in turn may improve product evaluations. Together these yield our predicted effect, which for simplicity we will call the *visual-olfactory effect*, and its hypothesized cognitive process.

**H<sub>1</sub>:** Relative to no picture or a picture of an unscented object, a picture of a pleasant-scented object on a package or advertisement (in the absence of an actual scent) improves evaluation of that product (*visual-olfactory effect*).

**H<sub>2</sub>:** The visual-olfactory effect is mediated by the generation of olfactory imagery.

Of course, pictures could improve evaluations (**H<sub>1</sub>**) via multiple psychological mechanisms. For instance, pictures may enhance the visual attractiveness of the pack or ad, or they may increase the salience and/or awareness of the product's scent, or even its perceived effectiveness. As such, our studies were designed to discriminate among these alternative explanations of the effect, by either controlling for them or demonstrating moderating conditions that favor the olfactory imagery explanation. If pictures do indeed affect product evaluations via olfactory imagery, then three corollary predictions follow: Pictures of scented objects should improve evaluations (i) especially among consumers with a strong need for smell, (ii) only of products for which scent is relevant or typical, and (iii) only when the imagined scent is pleasant. Thus, our research documents the effect (**H<sub>1</sub>**) and its mediating process (**H<sub>2</sub>**), and then contributes further by identifying critical moderators that can reduce, eliminate, or even reverse the effect, as described next.

### 2.3. Need for Smell

Some consumers are more sensitive than others to sensory aspects of products. For instance, consumers vary substantially in how strongly they value aesthetics in product and package design (Bloch, Brunel, and Arnold, 2003), and consumers who value product aesthetics more highly expect to pay more for products with attractive packaging (Orth, Campana, and Malkewitz, 2010). Similarly, consumers vary in the need to touch products for informational or hedonic purposes (Peck and Childers, 2003), and people with a high need for touch are more prone to problematic smartphone use (Elhai et al., 2016) and are less willing to buy their groceries online (Kühn, Lichters, and Krey, 2020). People who are highly sensitive to taste are less likely to try new foods (Kauer et al., 2015), and because they perceive alcohol to taste extremely bitter, they are less susceptible to alcoholism (Duffy, Peterson, and Bartoshuk, 2004).

Of course, consumers also vary in their sensitivity to smells. For instance, the Odor Awareness Scale (Smeets et al., 2008) differentiates individuals on the basis of their general awareness of smells in one's environment, such as noticing the ambient smells when walking in the woods, or the smell of another person's breath. Koller et al. (2023) recently investigated consumers' use of smell specifically in consumption contexts, ultimately developing a highly reliable measurement scale (Evaluation of the Need for Active Smell, or *ENFAS*). They defined the *need for smell* as the individual's desire to actively obtain and use scent in purchasing decisions, and they identified two independent dimensions of the need for smell. An informational dimension captures consumers' desire to smell products primarily for avoidance-related behaviors (e.g., smelling fruits to avoid rotten ones), whereas a hedonic dimension reflects smelling products for approach-related behaviors (e.g., choosing among scented laundry detergents). Koller and colleagues showed that the *ENFAS* predicted consumers' preference for in-store over online shopping, their preference for unpackaged products, and their tendency to smell products in-store.

We hypothesized that individuals' need for smell moderates the effect of pictures on product evaluation. If olfactory imagery underlies the effect of pictures on product evaluation, then the effect should be accentuated among consumers' who have a stronger need for smell. For people with a low need for smell, a picture of a scented object on a pack or in an ad should have relatively little impact, as those individuals simply do not rely much on smell when evaluating products. However, for people with a high need for smell, a picture of a scented object should substantially improve their product evaluations, because the olfactory imagery that it induces should provide a sense of the product's scent.

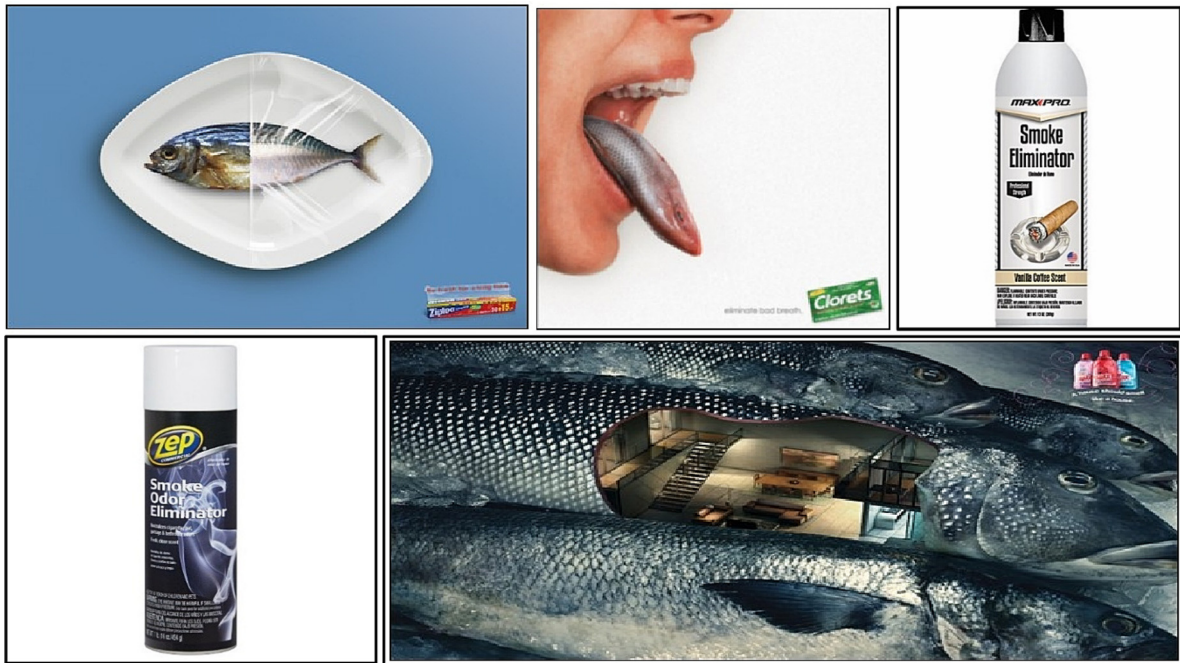
**H<sub>3</sub>:** The visual-olfactory effect is moderated by individuals' need for smell, such that pictures of pleasant-scented objects improve evaluations more for people with a high need for smell than for those with a low need for smell.

### 2.4. Scent Centrality

Just as consumers vary in their sensory sensitivity (Bloch, Brunel, and Arnold, 2003; Koller et al., 2023; Peck and Childers, 2003), products also vary in the extent to which the senses are relevant or typical. For a wine, consumers' perceptions may depend not only on the flavor (taste), but also on its color (vision) and fragrance (olfaction), its lightness or liquidity (texture), and even the sound of its fizz (audition). For a computer microchip, in contrast, its physical sensory properties (e.g., its appearance or texture) are unimportant to most consumers, who are more concerned with its functionality. We refer to this general property of products – that is, the relevance or typicality of the senses (e.g., sight, sound) as attributes of a given product – as *sensory centrality*. Specific sensory modalities are also more relevant or typical for some products than for others. For instance, chocolate and violins are both generally high in sensory centrality, but taste is more relevant for chocolate, whereas sound is more relevant for violins. Our research focuses specifically on scent.

Scent is a more central attribute for some products (e.g., perfume) than for others (e.g., umbrella). In their study of scented products, Ruzeviciute et al. (2020) called this *scent centrality*, and they found that scent centrality did not moderate the effect of a product's scent on its perceived proximity (i.e., its perceived distance from the observer). We define *scent centrality* as the relevance or typicality of scent as an attribute of the given product, and we examine its potential effect on olfactory imagery rather than actual product scent. For high-centrality products such as air fresheners and cleaning products, pictures of pleasant-scented objects should improve evaluations by inducing olfactory imagery, as described above. For low-centrality products such as staplers and wallets, in contrast, this process should not occur. Because scent simply is not relevant or typical for such products, a picture of a pleasant-scented object on a pack or in an ad should not improve evaluations of those products. For instance, consider a rose-scented umbrella. This product would presumably strike most consumers as rather odd. But the current question is whether including a picture of a rose in an ad would improve evaluations of that umbrella. If pictures improve product evaluations simply by rendering the product more attractive, then the rose-scented umbrella should be evaluated more positively with a picture of a rose than without it. Alternatively, if pictures improve product evaluations via olfactory imagery, then a picture of a rose should not improve evaluations of the umbrella, because the scent is not relevant and typical for this product. Thus, our olfactory imagery account predicts that the effect of pictures on product evaluation should be moderated by centrality.

**H<sub>4</sub>:** The visual-olfactory effect is moderated by scent centrality, such that pictures of pleasant-scented objects improve evaluations of high-centrality products, but not of low-centrality products.



**Fig. 4.** Examples of advertisements and product packages showing bad-smelling objects (brands clockwise from top left: Ziploc, Clorets, Max Pro, Ajax, and Zep).

### 2.5. Pleasantness of Imagined Scent

The prior marketing research on scents has, quite understandably, focused almost exclusively on pleasant scents (e.g., Bone and Ellen, 1999). Some research has suggested that a more neutral ambient scent can actually improve evaluations of target objects (Cirrincione et al., 2014; Spangenberg et al., 1996), but retailers are unlikely to intentionally diffuse less pleasant scents into their shops. Many products, in contrast, often do involve unpleasant scents: Scented products such as air fresheners, deodorants, candles, and cleaning products are often used to mask, contain, or remove unpleasant odors. In fact, given their functional goal of removing unpleasant scents, some product packages and ads even include images of bad-smelling objects that they purport to counteract. For example, many bathroom and kitchen cleaning products include pictures of mold or mildew, and brands such as Febreze and Ziploc use ads with pictures of smelly objects like dead fish (see Fig. 4) to illustrate the product's effectiveness at removing or containing those unpleasant scents.

Indeed, if pictures improve product evaluations by persuading consumers of the product's effectiveness, then a picture of an unpleasant-scented object should improve product evaluations just as pictures of pleasant-scented objects do. Alternatively, however, our olfactory imagery account predicts the opposite. Given that a picture of an unpleasant-scented object (e.g., a dead fish) should evoke in consumers' minds unpleasant olfactory imagery, it should be perceived as less pleasant to use, and hence it should harm product evaluations, at least for products intended to neutralize bad smells.

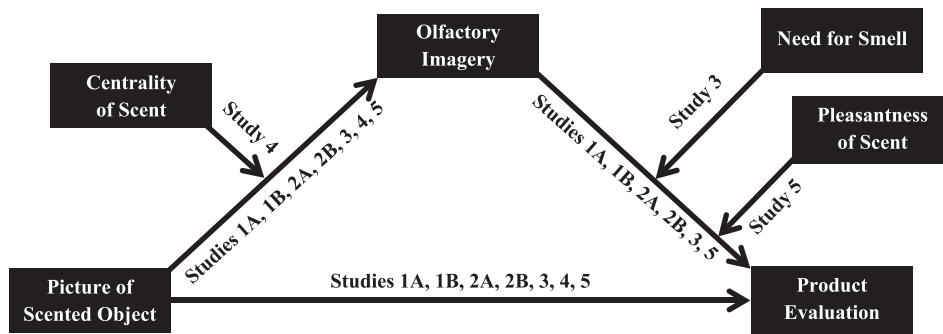
**H<sub>5</sub>:** For products for which bad smells are central, a picture of an unpleasant-scented object on a package or advertisement (in the absence of an actual scent) decreases evaluation of that product.

## 3. Overview of studies

The theorizing described above yields our conceptual model, shown in Fig. 5. We report seven main studies (and four additional studies in the Web Appendix) that test the five hypotheses of our conceptual model. In each study we compare evaluations of scented products that either do or do not include a picture of a scented object. Studies 1A and 1B demonstrate the visual-olfactory effect with pictures that induce more (e.g., cut lemons) or less (e.g., whole lemons) olfactory imagery (H<sub>1</sub>). Studies 2A and 2B provide preregistered demonstrations that the visual-olfactory effect is mediated by olfactory imagery (H<sub>2</sub>; see also Web Study 3). Studies 3, 4, and 5 then respectively demonstrate that this effect is moderated by the individual's need for scent (H<sub>3</sub>; see also Web Study 4), the product's scent centrality (H<sub>4</sub>), and the imagined scent's pleasantness (H<sub>5</sub>).

For generality we used different scents (i.e., clementine, pear, lemon, rose, lavender, fish), different marketing communications (i.e., packages, advertisements), different measures of olfactory imagery (i.e., rating scales, open text), and different





**Fig. 5. Conceptual model.** We hypothesized that a picture of a scented object improves product evaluation ( $H_1$ ) via olfactory imagery ( $H_2$ ), especially among individuals with a high need for smell ( $H_3$ ), but only when scent is relevant or typical (i.e., central) of the product category ( $H_4$ ), and only when the object's scent is pleasant ( $H_5$ ).

**Table 1**  
Summary of methods and results.

Study	Product	Picture of Scented Object	Control	Olfactory Imagery			Product Evaluation	
				Measure	Effect Size		Measure	Effect Size
1A	Dish soap	Cut lemons	Whole lemons	1 item	$d = 0.50$	***	Choice Share	71 % ***
1B	Air freshener	Rose	Sunflower	1 item	$d = 0.77$	***	Choice Share	62 % *
2A	Laundry detergent	Lavender	No picture	12 items	$d = 0.57$	***	Product Attitude	$d = 0.37$ **
2B	Hand soap	Clementine	Text-only	3 items	$d = 1.30$	***	Product Attitude	$d = 0.61$ ***
			Picture-only	3 items	$d = 0.10$		Product Attitude	$d = 0.27$ *
			Text + text	3 items	$d = 1.01$	***	Product Attitude	$d = 0.44$ ***
3	Dish soap	Cut lemons	Whole lemons	3 items	$d = 0.74$	***	Product Attitude	$d = 0.33$ ***
4	Surface cleaner	Lemons	No picture	3 items	$d = 0.82$	***	Product Attitude	$d = 0.50$ ***
5	Oven cleaner	Fish	Oven	1 item	$d = 1.01$	***	Product Attitude	$d = 0.73$ ***
Web 1	Hand soap	Clementine/Pear	No picture	—	—		Choice Share	59 % *
Web 2	Laundry detergent	Lavender	No picture	open text	$d = 0.46$	***	—	—
Web 3	Surface cleaner	Lemons	No picture	3 items	$d = 1.21$	***	Product Attitude	$d = 0.60$ ***
Web 4	Dish soap	Cut lemons	Whole lemons	3 items	$d = 0.67$	***	Choice Share	75 % ***

**Note.** Results of Study 4 include only the high scent-centrality condition, and only participants who correctly identified the product scent. In Study 4, olfactory imagery was measured in a post-test. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

measures of product evaluation (i.e., product choice, rating scales) across the various studies. Our studies were also designed to test alternative explanations of the presumed effect. First, the presence of a picture could simply make the pack or ad more visually attractive. To address this concern, in several studies we compare the scent-inducing picture to an equally attractive picture that evokes no scent (e.g., sunflower versus rose) or comparatively less scent (e.g., whole lemon versus cut lemon). Another alternative explanation is that the picture of the scented object, in addition to the scent label (e.g., “lavender”), provides a second cue to the product's scent. This additional scent cue could improve evaluations by rendering the product's scent more salient and/or making consumers more aware of it. To address those concerns, we compare the scent-inducing picture (e.g., “lavender” and a picture of lavender) to a control condition in which the scent is printed twice (e.g., “lavender” appears twice). Table 1 summarizes our methods and results. All preregistrations and all data are available in a Research Box (<https://researchbox.org/2061>).

## 4. Study 1

### 4.1. Study 1A

Study 1A provided a simple test of the visual-olfactory effect ( $H_1$ ), while also controlling visual attractiveness and scent salience (i.e., number of scent cues provided). We created two labels for a lemon-scented dish soap, one with a picture of cut lemons and the other with an equally attractive picture of whole lemons (see Fig. 6A). Participants viewed both product labels and indicated which version of the dish soap they would be more likely to buy. Because both labels included a picture of the scented object, and because the two pictures were equally attractive, any preference for one label over the other was not attributable to visual attractiveness or scent salience. As a preliminary test of  $H_2$ , participants also rated the extent to which each label evoked a scent in their minds. Because cut lemons are more fragrant than whole lemons, we predicted that the label with a picture of cut lemons would evoke greater olfactory imagery and would be preferred over the label with whole lemons.

**A.** Participants indicated whether they would be more likely to buy the product with a picture of cut lemons (higher olfactory imagery) or whole lemons (lower olfactory imagery) on the label.



**B.** Participants indicated whether they would be more likely to buy the product with a picture of rose (higher olfactory imagery) or sunflower (lower olfactory imagery) on the label.



**Fig. 6.** Stimuli, Study 1A (panel A) and Study 1B (panel B). **A.** Participants indicated whether they would be more likely to buy the product with a picture of cut lemons (higher olfactory imagery) or whole lemons (lower olfactory imagery) on the label. **B.** Participants indicated whether they would be more likely to buy the product with a picture of rose (higher olfactory imagery) or sunflower (lower olfactory imagery) on the label.

#### 4.1.1. Methods

**Pretest: Attractiveness.** Forty US-based respondents on Mechanical Turk rated the visual attractiveness (“The lemons are visually attractive”) of four pictures of cut lemons and four pictures of whole lemons (order randomized) on a scale from 1 (“strongly disagree”) to 5 (“strongly agree”). For use in the main study we selected the cut-lemon picture ( $M = 4.20$ ,  $SD = 0.85$ ) and the whole-lemon picture ( $M = 4.13$ ,  $SD = 0.76$ ) that were most closely matched for visual attractiveness ( $p = .60$ ), while also being highly attractive.

**Participants.** In all studies reported herein, unless otherwise justified, we sampled approximately 100 participants per condition. In Study 1A, 101 US-based respondents ( $M = 34$  years,  $SD = 9$ ; 48 males) on Mechanical Turk participated.

**Stimuli.** We created two versions of the target product (dish soap) by modifying the labels to include either the selected picture of cut lemons or the selected picture of whole lemons, as shown in Fig. 6A.

**Procedure.** Unless otherwise stated, in all studies reported herein we used the same *introductory block* in which participants first provided informed consent, indicated their sex and age, completed an attention check, and read some general instructions before advancing to the main study. In Study 1A, after this introductory block, participants were shown the two versions of the product (Fig. 6A) and were asked “Which of these would you be more likely to buy?” The two versions appeared side by side, and were randomly assigned to the left or right position. After indicating their choice, participants

advanced to the next page, where they rated the olfactory imagery ("This label evokes a scent in my mind") generated from each product label separately on a scale from 1 ("strongly disagree") to 5 ("strongly agree"). The two versions of the label (cut lemons, whole lemons) were presented on separate pages, in random order. Finally, participants completed a *concluding block* that was the same in all subsequent studies reported herein, unless otherwise stated. This block consisted of control measures in which participants indicated their liking of the scent ("I like the fragrance of lemons", 1–5 scale) and their involvement with the product category (2 items: "For me, choosing the right dishwashing soap is", 1 = not important, 5 = very important; "Choosing the right dishwashing soap", 1 = does not matter to me, 5 = matters a lot to me). The two involvement items correlated highly significantly in all studies reported herein (all  $r > 0.85$ ,  $p < 0.001$ ), so in all studies they were averaged to create an involvement index.

#### 4.1.2. Results and discussion

In all studies reported herein, we excluded all participants who failed the attention check. We additionally report results of each study, without removing any participants, in the [Web Appendix](#). In Study 1A, three participants failed the attention check and were excluded. Sex, age, and involvement with the product did not predict choice, all  $p > .57$ . However, liking of the scent significantly predicted choice, Wald  $\chi^2 = 6.75$ ,  $p < 0.01$ . Critically, a significant majority of participants (71 %) preferred the label with cut lemons,  $\chi^2(1) = 18.00$ ,  $p < 0.001$ .<sup>3</sup>

Olfactory imagery was also significantly higher from the cut-lemons label ( $M = 4.20$ ,  $SD = 0.94$ ) than from the whole-lemons label ( $M = 3.64$ ,  $SD = 0.98$ ),  $t(97) = 4.99$ ,  $p < 0.001$ ,  $d = 0.50$ . To test whether olfactory imagery predicted label preference, we subtracted ratings of the whole-lemon label from ratings of the cut-lemon label (positive scores indicate greater imagery from the cut lemons). A binary logistic regression, with liking of the scent as a covariate, confirmed that olfactory imagery significantly predicted label preference, Wald  $\chi^2 = 15.94$ ,  $B = 2.08$ ,  $p < 0.001$ . Olfactory imagery from the cut-lemon label alone (i.e., without subtracting olfactory imagery from the whole-lemon label) also significantly predicted label preference, Wald  $\chi^2 = 7.86$ ,  $B = 0.93$ ,  $p < 0.01$ .

In sum, the label with a picture of cut lemons induced greater olfactory imagery and was chosen more often than the label with whole lemons. Moreover, that greater olfactory imagery predicted the significant preference for the label with the cut lemons. This effect was not attributable to scent salience or visual attractiveness, as both labels included a picture of lemons, and the two pictures were shown in pretesting to be equally attractive. These results thus support  $H_1$ , and also reveal that  $H_2$  is plausible.

### 4.2. Study 1B

To ensure that the visual-olfactory effect is due to olfactory imagery rather than gustatory imagery, Study 1B tested for the effect ( $H_1$ ) with a non-food picture. We created two ads for a floral-scented air freshener, one with a picture of a rose and the other with a picture of a sunflower (see [Fig. 6B](#)). Critically, roses are more fragrant than sunflowers, but the pictures were equally visually attractive. As in Study 1A, participants indicated which air freshener they would be more likely to buy, and then rated the extent to which each ad evoked a scent in their minds. We predicted that the rose ad would elicit greater olfactory imagery and would be preferred over the sunflower ad.

#### 4.2.1. Methods

**Pretest.** 40 US-based respondents on Mechanical Turk rated the visual attractiveness ("The flower is visually attractive") of five pictures of a rose and five pictures of a sunflower (order randomized) on a scale from 1 ("strongly disagree") to 7 ("strongly agree"). All roses were yellow, so they would be visually similar to a sunflower. For use in the main study we selected the rose picture ( $M = 5.70$ ,  $SD = 1.09$ ) and the sunflower picture ( $M = 5.65$ ,  $SD = 1.29$ ) that were most closely matched for visual attractiveness ( $p = .81$ ), while also being relatively high in attractiveness.

**Main study.** 100 US-based respondents ( $M = 36$  years,  $SD = 11$ ; 47 male) from an online pool participated. Stimuli are shown in [Fig. 6B](#), and the procedure was identical to Study 1A.

#### 4.2.2. Results and discussion

One participant failed the attention check and was excluded. None of the control measures (sex, age, liking of the scent, involvement with the product) significantly predicted choice, all  $p > .32$ . Most importantly, a significant majority of participants (62 %) preferred the ad with a rose,  $\chi^2(1) = 5.34$ ,  $p = 0.02$ .<sup>4</sup> Olfactory imagery was also significantly higher from the rose ad ( $M = 4.09$ ,  $SD = 0.74$ ) than from the sunflower ad ( $M = 3.10$ ,  $SD = 1.11$ ),  $t(98) = 7.46$ ,  $p < 0.001$ ,  $d = 0.77$ . To test whether olfactory imagery predicted ad preference, we subtracted ratings of the sunflower ad from ratings of the rose ad (positive scores indicate greater imagery of the rose). A binary logistic regression confirmed that olfactory imagery significantly predicted ad preference, Wald  $\chi^2 = 21.73$ ,  $B = 1.32$ ,  $p < 0.001$ . Olfactory imagery from the rose ad alone (i.e., without subtracting olfactory imagery from the sunflower ad) also significantly predicted ad preference, Wald  $\chi^2 = 10.15$ ,  $B = 1.34$ ,  $p < 0.001$ . In sum, the

<sup>3</sup> In an earlier version of this study ( $N = 98$ ), participants viewed these same packages, but instead were asked "Which of these labels do you prefer?" A significant majority of participants (77%) again preferred the label with cut lemons,  $\chi^2(1) = 27.38$ ,  $p < 0.001$ .

<sup>4</sup> In an earlier version of this study ( $N = 100$ ), participants viewed these same ads, but instead were asked "Which of these is more likely to persuade you to buy Fresca air freshener?" A significant majority of participants (69%) again chose the ad with a rose,  $\chi^2(1) = 13.50$ ,  $p < 0.001$ .

ad with a picture of a scented object (rose) induced greater olfactory imagery and elicited more positive evaluations than the ad with an equally attractive but non-scented object (sunflower). Moreover, that greater olfactory imagery predicted the significant preference for the ad with the scented object (rose). These results thus support  $H_1$ , exclude gustatory imagery as a possible explanation, and also reveal that  $H_2$  is plausible.

## 5. Study 2

### 5.1. Study 2A

Having established that pictures of scented objects induce olfactory imagery and improve product evaluations, Study 2A provided a preregistered test of whether the visual-olfactory effect ( $H_1$ ) is mediated by olfactory imagery ( $H_2$ ). We used the same stimuli as in Web Study 2 (see Fig. 3), and we used several different measures of olfactory imagery. Specifically, we adapted items previously used by Bone and Ellen (1991, 1992) and Babin and Burns (1998), and we also added some items that we developed, including the one used in Studies 1A and 1B. Participants viewed one of the ads, evaluated the product, and then rated the olfactory imagery and visual attractiveness of the package. Visual attractiveness served as a control measure.

We argue that a picture of the scented object on the ad improves product evaluations via olfactory imagery. Alternatively, however, the picture might improve product evaluations simply by making consumers more aware of the product scent. Or stated conversely, lower evaluations of a no-picture control ad could be driven by consumers not noticing the product scent. In this study, we controlled the awareness of the product scent by requiring all participants to correctly identify the scent before they could advance to the main study. Thus, any difference in product evaluations observed between the picture and control conditions could not be due to awareness of the product scent.

#### 5.1.1. Methods

Two hundred UK-based respondents ( $M = 37$  years,  $SD = 10$ ; 116 females) on Prolific were randomly assigned to one of two conditions (picture, control). Stimuli are shown in Fig. 3. Participants first completed the introductory block (see Study 1A), which we elaborated in two ways to ensure that consumers were aware of the product scent in both conditions. First, we explicitly informed participants that the product they would evaluate is lavender-scented, and we highlighted the words “lavender-scented” in the text. Then, in lieu of an attention check, we tested participants’ knowledge of the product scent via a multiple-choice question (options: lemon, vanilla, lavender, no scent). Participants could not advance to the main study until they answered this question correctly. Thus, all participants in both conditions were fully and explicitly aware that the product was lavender-scented, and hence any difference in evaluations between conditions could not be attributed to awareness of the product scent.

Upon advancing to the main study, participants viewed the ad for five seconds, during which time they were prevented from advancing to the next page. After five seconds, the ad remained onscreen while three product attitude items (“I think that I would like this laundry detergent”, “I would be interested in buying this laundry detergent”, “I would look for this product, next time I go to buy a laundry detergent”) appeared below it. On the next two pages, the ad remained onscreen while participants evaluated the olfactory imagery evoked by the ad and its visual attractiveness (on separate pages, randomly ordered).

The page measuring olfactory imagery included thirteen items. From Bone and Ellen’s (1991, 1992) general measure of mental imagery, we adapted three items measuring the *ease of imagining* (“How difficult or easy was it to imagine the scent indicated in the ad?”, “How quickly were you able to imagine the scent indicated in the ad?”, “I had no difficulty imagining the scent”), rated on scales from 1 (extremely difficult, not quickly at all, strongly disagree) to 5 (extremely easy, very quickly, strongly agree). From Babin and Burns’ (1998) general measure of mental imagery, we adapted three items measuring *elaboration* (“I imagined the scent of the product”, “I imagined how the product would smell”, “I fantasized about the scent of the product in the ad”) and four items measuring *vividness* (“While seeing this ad, the scent that I imagined was. . . clear, detailed, vivid, well-defined”). Finally, we also included three items that we developed (“While looking at the ad, I imagined the smell of lavender”, “This ad evokes a scent in my mind”, “I can imagine a fragrance by seeing this ad”).<sup>5</sup>

On the other page, participants evaluated the visual attractiveness of the ad via three items (“This ad is visually attractive”, “The ad is visually appealing”, “The ad is aesthetically pleasing”). Unless otherwise stated above, all items for product attitudes, olfactory imagery, and visual attractiveness were rated on a scale from 1 (“strongly disagree”) to 5 (“strongly agree”). Finally, on a separate page, participants completed the concluding block (see Study 1A).

#### 5.1.2. Results and discussion

None of the control measures (sex, age, liking of the scent, involvement with the product) differed significantly between conditions, all  $p > .23$ .

<sup>5</sup> We excluded items from the *quantity* subscale (Babin and Burns, 1998; Bone and Ellen, 1991, 1992) because they measure sensory modalities beyond scent imagery (e.g., “All sorts of pictures, sounds, tastes and/or smells came to my mind while I listened to the ad”). We also excluded four items from their *vividness* scale (i.e., “weak, fuzzy, vague, sharp”) because they apply more directly to sensory modalities other than scent imagery.



**Validity and Reliability of Olfactory Imagery.** As preregistered, we submitted the thirteen olfactory imagery items and the three product attitude items to a principal components analysis (with Varimax rotation), which confirmed two latent factors (i.e., with eigenvalue > 1.0) representing olfactory imagery and product attitudes that together explained 73 % of the variance in ratings. One item from Bone and Ellen (1992; “I fantasized about the scent of the product in the ad”) did not load clearly onto either factor. The remaining twelve olfactory imagery items loaded more strongly onto the olfactory imagery factor (all loadings > 0.68) than onto the product attitude factor (all < 0.33), and all three product attitude items loaded more strongly onto the product attitude factor (all > 0.89) than onto the olfactory imagery factor (all < 0.22). Thus, (i) the olfactory imagery items produced a generally cohesive measure of olfactory imagery, and (ii) olfactory imagery and product attitudes emerged as distinct constructs. As preregistered, we averaged those twelve olfactory imagery items into an olfactory imagery index ( $\alpha = 0.95$ ); see the Web Appendix for additional analyses of the olfactory imagery measure. We also averaged the three product attitude items into a product attitude index ( $\alpha = 0.93$ ) and the three visual attractiveness items into a visual attractiveness index ( $\alpha = 0.96$ ).

**Visual-Olfactory Effect.** As predicted, independent samples *t*-tests revealed significantly greater olfactory imagery in the picture condition ( $M = 3.91, SD = 0.92$ ) than in the control condition ( $M = 3.26, SD = 1.34$ ),  $t(198) = 4.01, p < 0.001, d = 0.57$ , and significantly more positive attitudes toward the ad in the picture condition ( $M = 3.05, SD = 1.00$ ) than in the control condition ( $M = 2.69, SD = 0.96$ ),  $t(198) = 2.62, p < 0.01, d = 0.37$ . The product was also significantly more visually attractive in the picture condition ( $M = 3.01, SD = 1.12$ ) than in the control condition ( $M = 2.36, SD = 1.02$ ),  $t(198) = 4.31, p < 0.001, d = 0.61$ .

**Mediation by Olfactory Imagery.** A sweetspot analysis (Pieters, 2017) indicated that olfactory imagery and product attitude exhibited sufficient discriminant validity ( $r = 0.46, p < 0.01$ ) for meaningful mediation. We therefore conducted a bootstrap mediation analysis (Hayes, 2013, PROCESS model 4, 10 K samples) with ad condition as independent variable (control = 0, picture = 1), olfactory imagery as mediator, and product attitude as dependent variable. As preregistered, we also included visual attractiveness as a covariate. As predicted, the lavender picture increased olfactory imagery (A-path;  $B = 0.34, t = 2.23, p < 0.05$ ), which in turn improved product attitude (B-path;  $B = 0.20, t = 3.64, p < 0.001$ ), thus producing a significant indirect (mediation) effect,  $B = 0.07, CI_{95} = [0.01, 0.14]$ . The direct effect was nonsignificant,  $CI_{95} = [-0.27, 0.20]$ . The indirect effect was also significant and even larger when visual attractiveness was not included as a covariate,  $B = 0.24, CI_{95} = [0.12, 0.38]$ . Thus, an ad with a picture of lavender improved product attitudes by increasing olfactory imagery of lavender, even after controlling for visual attractiveness and scent awareness.

### 5.1.3. Web Study 3

In the Web Appendix we report another preregistered study demonstrating that olfactory imagery mediates the effect of pictures on product attitudes, using a product label instead of an ad, lemon scent instead of lavender, and a reduced 3-item measure of olfactory imagery. Individually and collectively these results support  $H_1$  and  $H_2$ .

## 5.2. Study 2B

Study 2A provided initial evidence that olfactory imagery underlies the visual-olfactory effect, under conditions that reflect market reality: The product scent was printed in both ads, whereas the picture of the scented object appeared in only one of the ads. We argue that the picture of the scented object in the ad improves product evaluations via olfactory imagery, and we excluded visual attractiveness and scent awareness as explanations of the effect. Alternatively, however, the picture might improve product evaluations by making the product scent more salient. That is, whereas the ad in the picture condition included two cues to the product's scent (i.e., text and picture), the control condition included only one scent cue (i.e., text only). This difference in the number of scent cues likely rendered the product's scent more salient in the picture condition than in the control condition, and crucially, that presumed difference in scent salience could explain the observed difference in product attitudes. (Note, however, that this explanation was excluded in Study 1A.).

To test whether scent salience can explain the effect, and conversely also to provide a stronger test of whether olfactory imagery underlies the effect ( $H_1, H_2$ ), Study 2B included two additional comparison conditions. In this study, we manipulated the salience of the product scent by presenting it in an ad either once or twice. We showed participants an ad for a clementine-scented hand soap (cf. Web Study 1), in a 2 (salience of scent: 1 cue, 2 cues)  $\times$  2 (picture of scented object: absent, present) between-participants design. The 1-cue ads presented the product scent either via text only (i.e., “clementine”; *text-only* condition) or via a picture only (i.e., a picture of clementines; *picture-only* condition). The 2-cue ads presented the scent either twice via text (i.e., “clementine” shown twice; *text + text* condition) or once via text and once via picture (i.e., “clementine” and a picture of clementines; *text + picture* condition). Stimuli are shown in Fig. 7.

The text-only and text + picture conditions conceptually replicate Study 2A. More importantly, if the effect is merely due to the higher number of scent cues increasing the salience of the product scent – a process that need not entail olfactory imagery – then the text + text condition should also improve product attitudes just as the text + picture condition does. Alternatively, any difference in product attitudes observed between the text + text and text + picture conditions could not be due to salience of the product scent. Moreover, if the picture-only condition were to evoke effects similar to the text + picture condition, that would further support our claim that the effect is due to pictures per se rather than merely the number of olfactory cues. Thus, our olfactory imagery account uniquely predicts a main effect of the ‘picture’ factor, such that ads with a picture of the scented object (i.e., picture-only and text + picture conditions) should evoke stronger olfactory



**Fig. 7. Stimuli, Study 2B.** Participants evaluated the product advertised with either one scent cue or two cues, and either with or without a picture of the scented object.

imagery and more positive product attitudes than ads without such a picture (i.e., text-only and text + text conditions). The salience account could not explain such a finding. This study was preregistered.

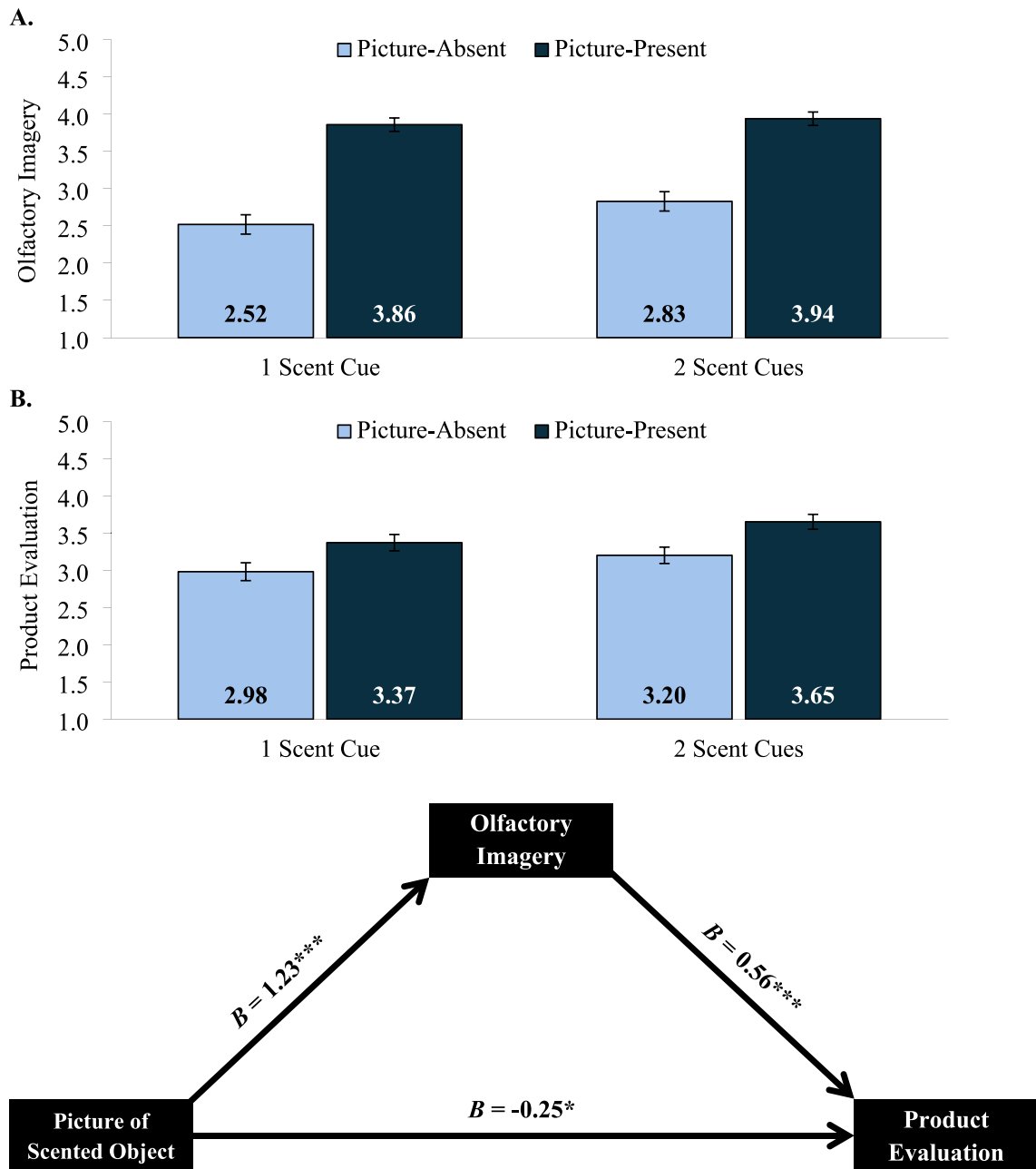
### 5.2.1. Methods

Four hundred one UK-based respondents ( $M = 42$  years,  $SD = 15$ ; 256 females) on Prolific were randomly assigned to one condition of the 2 (salience of scent: 1 cue, 2 cues)  $\times$  2 (picture of scented object: present, absent) between-participants design: text-only, picture-only, text + text, or text + picture. Stimuli are shown in Fig. 7. We used *Method* brand hand soaps because they have no pictures on their packaging, and we edited one of their real ads to manipulate the text and picture. Participants first completed the introductory block (see Study 1A; the attention check was excluded here) and were briefly introduced to the *Method* brand. They then viewed one of the four ads, which remained onscreen while three product attitude items appeared below it (see Study 2A). On the next page, the ad remained onscreen while participants evaluated the olfactory imagery evoked by the ad, using the 3-item measure validated in Study 2A (“While looking at the ad, I imagined the smell of clementines”, “This ad evokes a scent in my mind”, “I can imagine a fragrance by seeing this ad”; see Web Appendix for validation). Finally, on a separate page, participants completed the concluding block (see Study 1A).

### 5.2.2. Results and discussion

None of the control measures of sex, liking of the scent, or involvement with the product differed significantly between conditions, all  $p > .16$ . However, a 2 (salience: 1 cue, 2 cues)  $\times$  2 (picture: present, absent) ANOVA identified a significant main effect of salience on age,  $F(1, 397) = 4.82$ ,  $p = 0.029$ . That is, despite random assignment to conditions, participants in the 1-cue conditions happened to be older ( $M = 43$  years,  $SD = 15$ ) than those in the 2-cue conditions ( $M = 40$ ,  $SD = 14$ ). Therefore, as preregistered, age is included as a covariate in all analyses reported below. Inclusion or exclusion of this covariate had no effect on the pattern of significant results (see the Web Appendix). Results are illustrated in Fig. 8.

**Visual-Olfactory Effect.** Separate 2 (salience)  $\times$  2 (picture) ANCOVAs on olfactory imagery ( $\alpha = 0.94$ ) and product attitudes ( $\alpha = 0.94$ ), with age included as a covariate, revealed significant main effects of picture on both olfactory imagery,  $F(1, 396) = 124.28$ ,  $p < 0.001$ ,  $d = 1.11$ , and product attitudes,  $F(1, 396) = 15.69$ ,  $p < 0.001$ ,  $d = 0.39$ . As predicted, the picture-present conditions evoked greater olfactory imagery ( $M = 3.90$ ,  $SD = 0.91$ ) than the picture-absent conditions ( $M = 2.68$ ,  $SD = 1.27$ ), and more positive attitudes ( $M = 3.51$ ,  $SD = 1.05$ ) than the picture-absent conditions ( $M = 3.09$ ,  $SD = 1.14$ ). This result supports  $H_1$ . The effect of salience was marginal on olfactory imagery,  $F(1, 396) = 3.64$ ,  $p = 0.057$ ,  $d = 0.16$ , and significant on product attitudes,  $F(1, 396) = 6.63$ ,  $p = 0.010$ ,  $d = 0.22$ , with greater olfactory imagery from two olfactory cues in the ad ( $M = 3.39$ ,  $SD = 1.23$ ) than from only one cue ( $M = 3.19$ ,  $SD = 1.29$ ) and more positive attitudes



**Fig. 8.** Olfactory imagery (panel A;  $M \pm SE$ ), product evaluation (panel B;  $M \pm SE$ ), and mediation results (panel C; \*\*\*  $p < 0.001$ ), Study 2B. Higher scores indicate greater olfactory imagery and more positive product evaluations. A picture of a scented object evoked greater olfactory imagery, which in turn improved product evaluations, regardless of the number of scent cues in the ad.

from two cues ( $M = 3.43$ ,  $SD = 1.06$ ) than from one cue ( $M = 3.18$ ,  $SD = 1.15$ ). Thus, the salience of the scent does matter; two scent cues are more effective than one. The salience  $\times$  picture interaction was nonsignificant on both olfactory imagery,  $p = .324$ , and product attitudes,  $p = .694$ .

In addition to the main effect of picture reported above, we also preregistered more specifically that the text + picture condition should evoke stronger olfactory imagery and more positive attitudes than both the text-only and the text + text conditions. As predicted, the text + picture condition indeed evoked stronger olfactory imagery,  $F(1, 197) = 85.74$ ,  $p < 0.001$ ,  $d = 1.30$ , and more positive attitudes,  $F(1, 197) = 21.64$ ,  $p < 0.001$ ,  $d = 0.61$ , than the text-only condition. These results replicate the findings of our prior studies. Crucially, the text + picture condition also evoked stronger olfactory imagery,  $F(1, 199) = 50.90$ ,  $p < 0.001$ ,  $d = 1.01$ , and more positive attitudes,  $F(1, 199) = 10.19$ ,  $p = 0.002$ ,  $d = 0.44$ , than the text + text

condition. Thus, the visual-olfactory effect is not attributable to scent salience, as both of these conditions include two scent cues. These results provide strong evidence of the visual-olfactory effect ( $H_1$ ).

Additional analyses (not preregistered) revealed that the picture-only condition evoked stronger olfactory imagery,  $F(1, 196) = 73.32$ ,  $p < 0.001$ ,  $d = 1.22$ , and more positive attitudes,  $F(1, 196) = 5.80$ ,  $p = 0.017$ ,  $d = 0.34$ , than the text-only condition.<sup>6</sup> For further analyses comparing the remaining conditions, see the [Web Appendix](#).

**Mediation by Olfactory Imagery.** A sweetspot analysis (Pieters, 2017) indicated that olfactory imagery and product attitude exhibited sufficient discriminant validity ( $r = 0.58$ ,  $p < 0.001$ ) for meaningful mediation. We therefore conducted a bootstrap mediation analysis (Hayes, 2013, PROCESS model 4, 10 K samples) with picture condition as independent variable (picture-absent = 0, picture-present = 1), olfactory imagery as mediator, product attitude as dependent variable, and age as covariate. Due to the lack of salience  $\times$  picture interaction, this mediation analysis collapses across the salience variable (i.e., text-only and text + text conditions are combined, and picture-only and text + picture conditions are combined). As predicted, the picture of clementines increased olfactory imagery (A-path;  $B = 1.23$ ,  $t = 11.10$ ,  $p < 0.001$ ), which in turn improved product attitude (B-path;  $B = 0.56$ ,  $t = 13.65$ ,  $p < 0.001$ ), thus producing a significant indirect (mediation) effect,  $B = 0.68$ ,  $CI_{95} = [0.53, 0.84]$ . The direct effect was also significant,  $B = -0.25$ ,  $CI_{95} = [-0.46, -0.05]$ . When age was not included as a covariate, the indirect effect was again significant and virtually identical,  $B = 0.68$ ,  $CI_{95} = [0.54, 0.84]$ . When salience was included as an additional covariate (text-only and picture-only = 0, text + text and text + picture = 1), the indirect effect was again significant and virtually identical,  $B = 0.67$ ,  $CI_{95} = [0.53, 0.83]$ .

**Discussion.** To summarize, the ads with a picture of clementines improved product attitudes by increasing olfactory imagery of clementines, regardless of the number of olfactory cues (i.e., scent salience). These results reveal that one advantage of including a picture of the scented object is that the picture provides an additional cue of the product's scent, as shown by the significant main effect of scent salience on product attitudes. However, these results also demonstrate that scent salience alone cannot explain the pattern of product attitudes. The salience account cannot explain why the picture-only condition elicited more positive attitudes than the text-only condition, nor why the text + picture condition elicited more positive attitudes than the text + text condition. Rather, these results are most parsimoniously explained via olfactory imagery. A picture of the scented object evoked greater olfactory imagery, which in turn improved product attitudes, regardless of the number of scent cues in the ad.

## 6. Study 3

Having established in Studies 2A and 2B that olfactory imagery mediates the effect of a scent-inducing picture on product evaluation ( $H_2$ ), we next tested whether individuals' need for smell moderates that effect ( $H_3$ ). We used the stimuli from Study 1A, that is, dish soaps that included a picture of either whole lemons (lower olfactory imagery) or cut lemons (higher olfactory imagery; see Fig. 6A). Participants rated both versions of the dish soap on our 3-item measure of product evaluation. We then measured participants' need for smell via the ENFAS scale (Koller et al., 2023). We predicted that (i) consumers would evaluate the dish soap more positively with a picture of cut lemons on the label than with a picture of whole lemons ( $H_1$ ), (ii) this effect is mediated by olfactory imagery ( $H_2$ ), and (iii) this effect is stronger among consumers who have a higher need for smell ( $H_3$ ). As shown in Study 1A, the cut-lemons picture should evoke greater olfactory imagery than the whole-lemons picture. For people with a low need for smell, that increased olfactory imagery should have relatively little impact on their evaluations. But for people with a strong need for smell, the increased olfactory imagery from the cut-lemons label should be especially important for their product evaluations. This study was preregistered.

### 6.1. Methods

Because we were testing for moderation, we increased the sample size relative to Study 1A: We recruited 400 residents of the UK ( $M = 45$  years,  $SD = 14$ ; 177 males) on Prolific. The stimuli were identical to those of Study 1A. However, we modified the procedure in three ways. First, instead of choosing which product they would be more likely to buy, participants evaluated both versions of the product (i.e., within-participants; order randomized) on the 3-item measure used in Studies 2A and 2B. Second, here we used the 3-item measure of olfactory imagery validated in Study 2A (see [Web Appendix](#)) instead of the single-item measure used in Study 1A. Third, after evaluating the olfactory imagery evoked by each label, participants completed the 11-item ENFAS measure of the need for smell (Koller et al., 2023), which consists of an informational dimension (e.g., "When I smell a product, it helps me judge its quality") and an affective dimension (e.g., "I like to smell certain products"). ENFAS items were rated on a scale from 1 (strongly disagree) to 7 (strongly agree).

<sup>6</sup> We did not preregister any predictions involving the picture-only condition, because we believe that condition has several countermanding factors that prevent clear predictions. On one hand, according to our theorizing, the picture of a scented object should induce olfactory imagery and improve product evaluations. But on the other hand, it rarely if ever occurs in the real market that a scented product is presented without any textual indication of the product's scent, and the oddity of this condition could decrease evaluations. The lack of textual confirmation of the scent could also induce uncertainty, which would also decrease evaluations. The likely net effect of these countermanding factors was unclear, so we were theoretically agnostic about the picture-only condition.



## 6.2. Results and discussion

One participant failed the attention check and, as preregistered, was excluded from analyses. We averaged the ratings of product evaluation separately for the cut-lemon label ( $\alpha = 0.90$ ) and the whole-lemon label ( $\alpha = 0.89$ ). Similarly, we averaged the olfactory imagery ratings separately for the cut-lemon ( $\alpha = 0.90$ ) and whole-lemon ( $\alpha = 0.91$ ) labels. Finally, we also averaged the ENFAS items ( $\alpha = 0.90$ ). None of the control measures of sex, age, involvement with the product or liking of the scent significantly predicted product evaluation, all  $p > .06$ .

**Visual-Olfactory Effect.** As predicted, paired-samples  $t$ -tests revealed significantly greater olfactory imagery from the cut lemons ( $M = 4.18$ ,  $SD = 0.75$ ) than from the whole lemons ( $M = 3.48$ ,  $SD = 0.92$ ),  $t(398) = 14.78$ ,  $p < 0.001$ ,  $d = 0.74$ , and significantly more positive evaluations of the product with the cut-lemons label ( $M = 3.72$ ,  $SD = 0.82$ ) than with the whole-lemons label ( $M = 3.48$ ,  $SD = 0.78$ ),  $t(398) = 6.67$ ,  $p < 0.001$ ,  $d = 0.33$ . These results conceptually replicate those of Study 1A.

**Mediation by Olfactory Imagery.** A sweetspot analysis (Pieters, 2017) indicated that olfactory imagery and product evaluation exhibited sufficient discriminant validity (whole lemons:  $r = 0.47$ ,  $p < 0.001$ ; cut lemons:  $r = 0.59$ ,  $p < 0.001$ ) for meaningful mediation. We therefore conducted a bootstrap mediation analysis (Montoya and Hayes, 2017, MEMORE model 1, 10 K samples) with picture condition as independent variable (whole lemons = 0, cut lemons = 1), olfactory imagery as mediator, and product evaluation as dependent variable. The cut-lemon label significantly increased olfactory imagery ( $B = 0.70$ ,  $t = 14.78$ ,  $p < 0.001$ ), which in turn significantly improved product evaluations ( $B = 0.56$ ,  $t = 19.64$ ,  $p < 0.001$ ), and hence the indirect (mediation) effect was significant,  $B = 0.39$ ,  $CI_{95} = [0.32, 0.47]$ . The direct effect was also significant,  $B = -0.15$ ,  $CI_{95} = [-0.21, -0.08]$ . Thus, as predicted in **H<sub>2</sub>**, olfactory imagery mediated the effect of a scent-inducing picture on product evaluations.

**Moderation by Need for Smell.** Scores on the ENFAS need for smell scale were highly variable (Range = 2.00 – 7.00,  $M = 5.30$ ,  $SD = 0.91$ ) and normally distributed (skew = -0.46). There currently is no statistical test for moderated mediation in repeated-measures designs like this one. We therefore preregistered a two-step procedure for testing moderated mediation. We first tested whether the need for smell (i.e., ENFAS scores) moderated the effect of the picture (i.e., cut vs. whole lemons) on product evaluations (Montoya, 2019, MEMORE model 2, 10 K samples). The index of moderation was significant,  $B = 0.13$ ,  $t(397) = 3.14$ ,  $p = 0.002$ . For illustrative purposes, the conditional effect of the picture on product evaluation at one  $SD$  below the mean ENFAS score was  $B = 0.13$ ,  $t(397) = 2.54$ ,  $p = 0.01$ , whereas the effect at one  $SD$  above the mean was  $B = 0.36$ ,  $t(397) = 6.98$ ,  $p < 0.001$ . Thus, the need for smell moderated the effect of the picture on product evaluation, with a larger effect among consumers with a stronger need for smell. This finding supports **H<sub>3</sub>**. Further analyses revealed that this moderation also remained significant when both the informational and affective dimensions of the ENFAS scale were analyzed separately.

The second step in our preregistered analysis specifically tests whether the need for smell moderates the B-path of our conceptual model (see Fig. 5). That is, does the stronger olfactory imagery evoked by the cut-lemon label improve evaluations more for consumers with a high need for smell than for those with a low need for smell? For this analysis, we subtracted ratings of the whole-lemon label from ratings of the cut-lemon label, as in Study 1A (for both olfactory imagery and product evaluation). We then tested whether the need for smell moderated the effect of olfactory imagery on product evaluation (Hayes, 2013, PROCESS model 1, 10 K samples). Neither the main effect of olfactory imagery ( $CI_{95} = [-0.22, 0.44]$ ) nor the need for smell ( $CI_{95} = [-0.07, 0.07]$ ) was significant. However, as predicted, the interaction (i.e., moderation) was significant,  $B = 0.08$ ,  $t(395) = 2.59$ ,  $p = 0.01$ . The conditional effect at one  $SD$  below the mean ENFAS score was  $B = 0.46$ ,  $t(395) = 10.76$ ,  $p < 0.001$ , whereas the effect at one  $SD$  above the mean was  $B = 0.60$ ,  $t(395) = 16.12$ ,  $p < 0.001$ . Thus, the need for smell moderated the B-path of the olfactory imagery process.

**Discussion.** In sum, participants evaluated the dish soap more positively with a picture of cut lemons than with a picture of whole lemons, and olfactory imagery mediated that preference. These results support **H<sub>1</sub>** and **H<sub>2</sub>**. Additionally, individuals' need for smell moderated that effect: The stronger olfactory imagery evoked by the cut-lemon label (relative to the whole-lemon label) improved evaluations more for consumers with a high need for smell than for those with a low need for smell. This result supports **H<sub>3</sub>**. These results were not attributable to visual attractiveness, which was matched across conditions (see Study 1A). Nor were they attributable to the salience or awareness of the scent, as both labels had the same number of scent cues.

## 6.3. Web Study 4

We conceptually replicated Study 3, again using the stimuli from Study 1A, and here also using the choice paradigm of Study 1A. Participants ( $N = 400$ ) chose between dish soaps that included a picture of either whole lemons (lower olfactory imagery) or cut lemons (higher olfactory imagery; see Fig. 6A), and we again measured participants' need for smell via the ENFAS (Koller et al., 2023). This study was preregistered (for full detail see the Web Appendix). Consumers were more likely to choose the dish soap with a picture of cut lemons on the label (75 %,  $p < 0.001$ ), replicating the result of Study 1A and supporting **H<sub>1</sub>**. Moreover, as predicted, this preference was stronger among consumers who have a higher need for smell ( $B = 0.31$ ,  $p = 0.021$ ), replicating the result of Study 3 and supporting **H<sub>3</sub>**.

## 7. Study 4

If the picture of a scented object improves product evaluations by inducing olfactory imagery, then the effect should only occur when scent is relevant or typical (i.e., *central*) for the given product ( $H_4$ ). Alternatively, if pictures improve product evaluations via some non-olfactory mechanism, then centrality should not moderate the effect. For instance, if visual attractiveness underlies the effect, then it should occur for both high- and low-centrality products. Study 4 therefore tested for the visual-olfactory effect in both a high-centrality product (cleaning spray) and a low-centrality product (lint roller). Thus, in a  $2 \times 2$  between-participants design, participants evaluated either a lemon-scented multipurpose cleaner (*high-centrality*) or a lemon-scented lint roller (*low-centrality*) that either included a picture of cut lemons on the package (*picture*) or not (*control*). Stimuli are shown in Fig. 9.

This study also tested whether the effect of pictures on product evaluation might be due to increased awareness of the product scent rather than increased olfactory imagery of that scent. Study 2A controlled for this possibility by requiring all participants to correctly identify the product scent before they could advance to the main study. In Study 4, we instead allowed scent awareness to vary naturally across participants, and we directly measured their awareness of the product scent, with or without a picture. We then tested whether the visual-olfactory effect occurs among fully aware participants.

### 7.1. Methods

**Pretest: Scent Centrality.** Forty-nine UK-based respondents on Prolific rated ten products (order randomized) on centrality, measured via two items: “Scent is relevant for this product” and “This product is typically scented.” Both items were rated on a scale from 1 (“strongly disagree”) to 5 (“strongly agree”). The products were presented in purely textual form (e.g., “air freshener”), without any images. We included five products that we intuitively believed to be high in centrality (air freshener, dishwashing liquid, laundry detergent, multipurpose cleaner, oven cleaner), and five that we thought were low in centrality (lint roller, paper, pencil, printer ink, umbrella). In fact, among the presumed high-centrality products were those used in the experiments reported in this paper. Across the ten products, relevance ratings and typicality ratings correlated significantly,  $r(49) = 0.60$ ,  $p < 0.001$ . We therefore averaged the two items to create a scent centrality index for each product. The five high-centrality products ( $M = 4.12$ ,  $SD = 0.48$ ) differed significantly from the five low-centrality products ( $M = 1.42$ ,  $SD = 0.41$ ),  $t(48) = 36.39$ ,  $p < 0.001$ , thereby confirming that the stimuli in our various studies were all high in centrality. For the high- and low-centrality products in the present study, we respectively selected multipurpose cleaning spray (centrality = 4.15) and lint roller (centrality = 1.49). These two products differed significantly in centrality,  $t(48) = 20.12$ ,  $p < 0.001$ .

**Pretest: General Product Perceptions.** Given that this study (unlike our other studies) entailed comparison of two different products, we conducted another pretest to assess consumers’ general perceptions of the two selected products. Thirty-eight US-based respondents on Mechanical Turk rated the familiarity (“I am familiar with [lint rollers / multipurpose cleaning liquids]”), perceived effectiveness (“In general, [lint rollers / multipurpose cleaning liquids] are effective”), and interestingness of each product (“In general, [lint rollers / multipurpose cleaning liquids] are interesting”), all measured on a scale from 1 (“strongly disagree”) to 5 (“strongly agree”). All participants evaluated both products, which were presented in random order. Paired samples *t*-tests indicated that the multipurpose cleaning spray and lint roller did not differ in familiarity ( $M_{\text{roller}} = 4.36$ ,  $M_{\text{spray}} = 4.46$ ,  $p = .60$ ), perceived effectiveness ( $M_{\text{roller}} = 3.92$ ,  $M_{\text{spray}} = 4.08$ ,  $p = .35$ ), or interestingness ( $M_{\text{roller}} = 2.54$ ,  $M_{\text{spray}} = 2.69$ ,  $p = .24$ ). Thus, the cleaning spray and lint roller differed in centrality, but not in other relevant consumer perceptions such as perceived effectiveness.

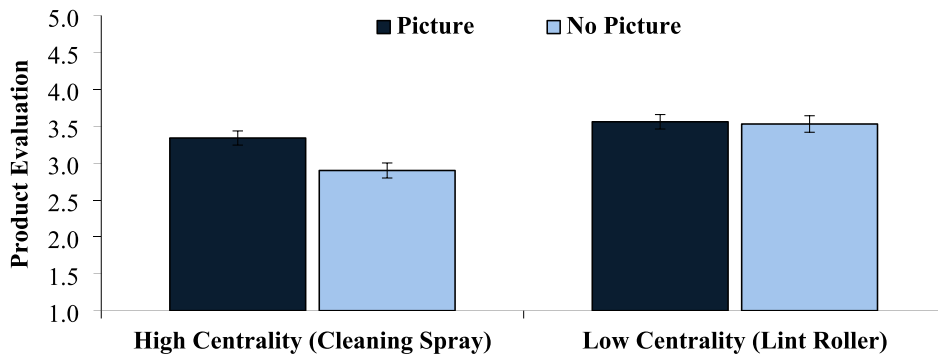
**Main study.** Four hundred two US-based respondents ( $M = 36$  years,  $SD = 12$ ; 189 males) on Mechanical Turk were randomly assigned to one condition of a  $2$  (centrality: high, low)  $\times$   $2$  (picture: present, absent) between-participants design. Stimuli are shown in Fig. 9. Participants first completed the introductory block (see Study 1A). Then they viewed one of the products for five seconds, during which time they were prevented from advancing to the next page. After five seconds, the product remained onscreen while three product attitude items appeared below it. The 3-item product attitude measure was the same as in Studies 2A and 2B. The items were presented in random order and were rated on a scale from 1 (“strongly disagree”) to 5 (“strongly agree”). Finally, on a separate page, participants completed the concluding block (see Study 1A), and as a scent-awareness test, participants were asked to identify the product scent from four alternatives (lavender, lemon, mint, no scent). We did not measure participants’ liking of lemon scent (control item), nor their olfactory imagery of lemons (mediator), because such measurements would interfere with the scent-awareness test, or vice versa.

### 7.2. Results and discussion

Five participants who failed the attention check were excluded. Separate  $2$  (centrality)  $\times$   $2$  (picture) ANOVAs on the control factors revealed an age difference between the picture and control conditions,  $F(1, 393) = 3.82$ ,  $p = 0.051$ , and a significant interaction on product involvement,  $F(1, 393) = 7.57$ ,  $p < 0.01$ . Therefore, age and involvement were both included as covariates in the subsequent analysis. Sex did not differ between conditions ( $p = .39$ ). See the [Web Appendix](#) for results without including these covariates.



**Fig. 9. Stimuli, Study 4.** Participants evaluated a product for which scent is either central (cleaning spray) or not (lint roller), either with or without a picture of the scented object on the label.



**Fig. 10. Product evaluations results ( $M \pm SE$ ), Study 4.** Higher scores indicate more positive product evaluations. A picture of a scented object (i.e., lemon) improved evaluations of a product for which scent is relevant and typical (i.e., cleaning spray) but not of a product for which is scent is less relevant and typical (i.e., lint roller).

Overall, 91.20 % of participants correctly identified lemon as the scent of the product. However, the picture of lemons significantly increased participants' awareness,  $\chi^2 = 17.22$ ,  $p < 0.001$ . Specifically, 97.01 % of participants correctly identified the lemon scent in the picture conditions, whereas only 85.20 % in the control conditions identified the lemon scent. Thus, one advantage of including a picture of the scented object is that it increases awareness of the scent. Nevertheless, to examine the effect of pictures on product attitudes – independent of this awareness benefit – we excluded those 8.80 % of participants who failed to correctly identify the lemon scent. Thus, 362 participants were included in the following analyses. See the [Web Appendix](#) for results without removing these participants.

The three attitude items ( $\alpha = 0.94$ ) were averaged. A 2 (centrality: high, low)  $\times$  2 (picture: present, absent) ANCOVA revealed significant main effects of centrality,  $F(1, 356) = 16.21$ ,  $p < 0.001$ , and picture,  $F(1, 356) = 5.37$ ,  $p < 0.05$ . More importantly, the predicted interaction was significant,  $F(1, 356) = 4.34$ ,  $p < 0.05$ . As shown in [Fig. 10](#), a picture of a scented object (lemon) improved evaluations of a high-centrality product (cleaning spray),  $t(188) = 3.50$ ,  $p < 0.001$ ,  $d = 0.51$ , but had no effect on a low-centrality product (lint roller),  $p = .38$ .

**Olfactory Imagery Post-Test.** Although our olfactory imagery account correctly predicted the interaction on product attitudes obtained in Study 4 (see [Fig. 10](#)), that main study did not provide any direct measure of olfactory imagery. Therefore, to test more directly whether olfactory imagery could indeed explain that interaction, we conducted a replication of Study 4, except that the scent awareness test was removed and the product attitude measure was replaced by an olfactory imagery measure (i.e., the 3-item measure validated in Study 2A;  $\alpha = 0.91$ ). Four hundred UK-based respondents ( $M = 39$  years,  $SD = 11$ ; 145 males) on Prolific were randomly assigned to one condition of a 2 (centrality: high, low)  $\times$  2 (picture: present, absent) between-participants design. Six participants who failed the attention check were excluded from analyses. A 2  $\times$  2 ANOVA revealed significant main effects of both picture,  $F(1, 390) = 29.13$ ,  $p < 0.001$ , and centrality,  $F(1, 390) = 8.07$ ,  $p = 0.005$ . Critically, however, those effects were qualified by a significant interaction,  $F(1, 390) = 10.28$ ,  $p = 0.001$ . An independent  $t$ -test revealed that the presence of a picture on the product package significantly increased olfactory imagery from the cleaning spray,  $t(196) = 5.78$ ,  $p < 0.001$ ,  $d = 0.82$ , but not from the lint roller,  $p > .10$ . Inclusion of the six participants who failed the attention check did not affect the pattern of results, with a significant interaction ( $F(1, 396) = 10.64$ ,  $p = 0.001$ ), a significant effect of picture on the cleaning spray ( $t(198) = 5.77$ ,  $p < 0.001$ ,  $d = 0.82$ ), and no effect on the lint roller ( $p > .10$ ). These results indicate that centrality moderates the generation of olfactory imagery, such that a picture of a scented object increases olfactory imagery for high-centrality products but not for low-centrality products. Thus, olfactory imagery in this post-test exhibited the same pattern of results as product attitudes in the main Study 4, suggesting that olfactory imagery may indeed underlie that effect on product attitudes.

**Discussion.** These results support **H<sub>4</sub>**. A picture of a fragrant object improved evaluations of a product for which scent is a central attribute (i.e., cleaning spray), but had no effect on a product for which scent is less central (i.e., lint roller).<sup>7</sup> This finding casts further doubt on whether the effect is due simply to the attractiveness of the picture. If it were, then the lemon picture should have improved evaluations of both products. Moreover, although including the picture on the label increased participants' awareness of the product scent, that increased scent awareness cannot explain the visual-olfactory effect, which was observed even after excluding scent-unaware participants. The post-test revealed that centrality moderates olfactory imagery in the same way that it moderates product attitudes, suggesting that the former may underlie the latter.

**Follow-Up Experiment.** Results of the main Study 4 reported above demonstrate that, although the picture on the package increased participants' awareness of the product scent, that increased awareness did not explain the visual-olfactory effect. So then, what exactly does explain the effect? We argue that the effect is due to the picture inducing pleasant olfactory imagery (e.g., the smell of lemons). More specifically, our explanation assumes that the picture increases perceptions that the

<sup>7</sup> In an earlier version of this study ( $N = 199$ ), we used an even lower-centrality product: an umbrella (centrality = 1.15). In that study, attitudes toward the umbrella were significantly worse with a lemon picture ( $M = 2.93$ ,  $SD = 0.96$ ) than without a picture ( $M = 3.31$ ,  $SD = 1.06$ ),  $t(197) = 2.64$ ,  $p < 0.01$ ,  $d = 0.37$ .



product would be pleasant to use (because of imagined scent). Alternatively, however, the effect could be due to the perceived effectiveness of the product. That is, given that lemons are acidic, and given that acids are effective cleaning agents, the lemon picture may have improved product evaluations by increasing perceived effectiveness.

We tested these competing explanations in a follow-up experiment, using the cleaning spray stimuli from the main study (see Fig. 9). Two hundred five UK-based respondents ( $M = 35$  years,  $SD = 11$ ; 73 males) on Prolific were randomly assigned to one of the two conditions (picture: present, absent). Participants first rated the product's perceived effectiveness ("This product looks effective at cleaning"), and then on the next page, its perceived pleasantness of use ("Cleaning with this product would be pleasant"), both on a scale from 1 ("strongly disagree") to 5 ("strongly agree"). One participant who failed the attention check was excluded from analyses. Perceived effectiveness did not differ with the lemon picture ( $M = 3.16$ ,  $SD = 0.97$ ) and without it ( $M = 2.99$ ,  $SD = 0.93$ ),  $t(202) = 1.25$ ,  $p = .21$ . As predicted, however, product use was perceived as significantly more pleasant with the lemon picture ( $M = 3.69$ ,  $SD = 0.81$ ) than without the picture ( $M = 3.21$ ,  $SD = 0.88$ ),  $t(202) = 4.05$ ,  $p < 0.001$ ,  $d = 0.54$ . Thus, the picture of lemons increased the perceived pleasantness of using the cleaning spray, rather than its perceived effectiveness.

## 8. Study 5

Having shown in Study 4 that pictures of pleasant-scented objects (e.g., lemon) do not always improve product evaluations, Study 5 further tested whether for products that are intended to neutralize bad smells, pictures of unpleasant-scented objects may actually harm product evaluations ( $H_5$ ). Our theorizing about olfactory imagery predicts that pictures of unpleasant-scented objects (e.g., a fish) should activate malodorous imagery and hence should decrease product evaluations, at least for products intended to neutralize bad smells. Note, however, that this prediction appears contrary to managerial wisdom. In fact, for products intended to remove (e.g., mildew removal products), contain (e.g., Ziploc bags), or mask unpleasant odors (e.g., Febreze), pictures of malodorous objects are frequently included on packages and in advertisements in order to communicate their functionality (for real-world examples see Fig. 4). We therefore created two packages of an oven cleaning product with equally attractive pictures, but critically, one of the pictured objects has an unpleasant scent (fish) and the other has no scent (oven). Both packages stated that the product was "lemon scented" and "neutralizes fishy smell" (see Fig. 11). Participants viewed one of the two packages, rated the olfactory imagery of lemon and of fish, and evaluated the product.

### 8.1. Methods

**Pretest: Attractiveness.** Forty US-based respondents on Mechanical Turk rated the visual attractiveness ("The picture is visually attractive") of five pictures of a fish and five pictures of an oven (order randomized) on a scale from 1 ("strongly disagree") to 7 ("strongly agree"). For use in the main study we selected the fish picture ( $M = 4.29$ ,  $SD = 1.38$ ) and the oven picture ( $M = 4.32$ ,  $SD = 1.35$ ) that were most closely matched for visual attractiveness ( $p = .94$ ), while also being relatively high in attractiveness.

**Main study.** Two hundred one US-based respondents ( $M = 39$  years,  $SD = 13$ ; 94 males) on Mechanical Turk were randomly assigned to one of the two conditions (picture: fish, oven). Stimuli are shown in Fig. 11. In this study, the introductory block (see Study 1A) additionally included measures of participants' liking of lemon and fish scents and their involvement with the product (i.e., the concluding block was merged into the introductory block, to ensure that the manipulation did not affect the controls). Participants then viewed one of the packages for five seconds, at which point two olfactory imagery items (from Study 1A; "While looking at this label, I imagine the scent of [lemon/fish]") and three product attitude items (from Study 2A; all items were rated on a 1–5 scale) appeared below it. The olfactory imagery items preceded the attitude items, separated by a second attention check.

### 8.2. Results and discussion

Six participants who failed one of the two attention checks were excluded. None of the control measures (sex, age, liking of lemon scent, liking of fish scent, involvement with the product) differed significantly between conditions, all  $p > .37$ . We averaged the three attitude items ( $\alpha = 0.94$ ). Lemon olfactory imagery ratings were subtracted from fish olfactory imagery ratings ( $r = -0.36$ ,  $p < 0.001$ ) to form a single measure of olfactory imagery, whereby positive scores indicate stronger olfactory imagery of fish, and negative scores indicate stronger olfactory imagery of lemon. As predicted, the fish picture ( $M = 1.93$ ,  $SD = 1.91$ ) elicited stronger fish olfactory imagery than the oven picture ( $M = -0.14$ ,  $SD = 1.62$ ),  $t(193) = 8.16$ ,  $p < 0.001$ ,  $d = 1.01$ , and the fish picture also elicited less positive product evaluations ( $M = 2.41$ ,  $SD = 1.08$ ) than the oven picture ( $M = 3.20$ ,  $SD = 0.92$ ),  $t(193) = 5.56$ ,  $p < 0.001$ ,  $d = 0.73$ .

A sweetspot analysis (Pieters, 2017) indicated that olfactory imagery and product attitude ratings exhibited sufficient discriminant validity ( $r = -0.56$ ,  $p < 0.001$ ) for meaningful mediation. Indeed, a bootstrap mediation analysis (Hayes, 2013, PROCESS model 4, 10 K samples; oven = 0, fish = 1) revealed that the fish picture increased olfactory imagery of fish (A-path;  $B = 2.07$ ,  $t = 8.16$ ,  $p < 0.001$ ), which in turn reduced product evaluation (B-path;  $B = -0.26$ ,  $t = 7.26$ ,  $p < 0.001$ ), thus producing a significant negative indirect (mediation) effect,  $B = -0.54$ ,  $CI_{95} = [-0.74, -0.37]$ . The direct effect was not



**Fig. 11. Stimuli, Study 5.** Participants evaluated a product with a picture of either a malodorous object (fish) or a neutral object (oven) on the label.

significant,  $B = -0.25$ ,  $CI_{95} = [-0.54, 0.04]$ . The indirect effect was also significant when olfactory imagery of fish alone (i.e., without subtracting olfactory imagery of lemon) was included as the mediator,  $B = -0.14$ ,  $CI_{95} = [-0.27, -0.005]$ . Thus, a package with a picture of fish harms product evaluations by increasing olfactory imagery of fish.<sup>8</sup> Evidently, the harmful effect of inducing odorous imagery (e.g., fish) overpowered any potential benefit of informing consumers about the product's functionality (i.e., neutralizing odors). These results support  $H_5$ .

## 9. Discussion

Scented products and advertisements can elicit positive effects on a broad range of consumer behaviors such as product evaluations, memory, and sales (for a review see Krishna, 2012). The present research demonstrates that positive effects of scent can also be attained, critically, without the use of actual scents. As summarized in Table 1, the present studies show that a picture of a scented object can improve product evaluations by evoking olfactory imagery (imagined scent) in consumers' minds. We demonstrated this *visual-olfactory effect* on product evaluations with multiple products (i.e., hand soap, dish soap, air freshener, laundry detergent, surface cleaner, oven cleaner) imbued with multiple scents (i.e., clementine, pear, lemon, rose, lavender, fish) communicated via multiple sources (i.e., packages, advertisements). On average, the visual-olfactory effect was medium-sized.

No matter how we measured olfactory imagery (e.g., single-item ratings, multi-dimensional scales, open text responses), the effect of pictures on olfactory imagery was highly significant and, on average, rather large. And as olfactory imagery increased, product evaluations improved and choice shares increased. Moreover, we also revealed three moderators of this effect. The visual-olfactory effect was accentuated among consumers high in the need for smell (Study 3), it was eliminated among products for which scent is not a particularly relevant or typical attribute (e.g., a lint roller; Study 4), and it was reversed when the imagined scent was malodorous (e.g., fish; Study 5). These results clearly implicate olfactory imagery as the psychological mechanism underlying the effect: Olfactory imagery reliably predicted when the visual-olfactory effect appeared, disappeared, and reversed.

<sup>8</sup> In an earlier version of this study ( $N = 195$ ) that did not control for visual attractiveness, participants again indicated significantly greater fish olfactory imagery from the fish label ( $M = 2.51$ ,  $SD = 1.70$ ) than from the control label ( $M = -0.47$ ,  $SD = 1.83$ ),  $t(193) = 11.77$ ,  $p < 0.001$ ,  $d = 1.29$ , and significantly more negative attitudes toward the fish label ( $M = 2.27$ ,  $SD = 0.94$ ) than the control label ( $M = 3.34$ ,  $SD = 0.78$ ),  $t(193) = 8.61$ ,  $p < 0.001$ ,  $d = 1.05$ . The indirect (mediation) effect was again negative and significant,  $B = -0.54$ ,  $CI_{95} = [-0.79, -0.33]$ , and the direct effect was also significant,  $CI_{95} = [-0.81, -0.22]$ .

**Table 2**

**Evaluation of alternative explanations of the visual-olfactory effect across studies.** Olfactory imagery uniquely predicts and explains the pattern of results obtained across studies.

Study	Olfactory Imagery	Alternative Explanations of Effect			
		Visual Attractiveness	Scent Salience	Scent Awareness	Product Effectiveness
1A	✓	✗	✗	✗	✗
1B	✓	✗	✗	✗	✓
2A	✓	✗	✓	✗	✓
2B	✓	✓	✗	✗	✗
3	✓	✗	✗	✗	✗
4	✓	✗	✗	✗	✗
5	✓	✗	✗	✗	✓
Web 1	✓	✓	✓	✓	✓
Web 3	✓	✗	✓	✗	✗
Web 4	✓	✗	✗	✗	✗

**Note.** Check marks indicate that the given explanation is plausible, whereas crosses indicate that the explanation is implausible. Web Study 2 is excluded because it did not include a measure of product evaluation.

As summarized in Table 2, these studies also excluded four alternative explanations of the effect: visual attractiveness, salience of scent, awareness of scent, and product effectiveness. Visual attractiveness generally improves product evaluations (e.g., Kahle and Homer, 1985), and indeed, one advantage of including a picture of a scented object in an ad or on a package is that it can increase its visual attractiveness (Study 2A). In the present studies, however, we controlled visual attractiveness across conditions in order to reveal the independent effect of olfactory imagery, by either selecting stimuli of equal visual attractiveness (i.e., Studies 1A, 1B, 3, and 5 and Web Study 4) or measuring visual attractiveness and using it as a covariate (Study 2A and Web Study 3). Moreover, visual attractiveness cannot explain why the effect occurred with a high-centrality product but not with a low-centrality product, given that both product packages included the same picture (Study 4).

Another advantage of including a picture of a scented object on a pack or in an ad is that, by adding a second cue to product's scent, it may render the product's scent more salient. Like visual attractiveness, however, scent salience cannot wholly explain the visual-olfactory effect. The pictures of cut lemons and whole lemons were equally salient in Studies 1A and 3 and Web Study 4, and the pictures of a rose and a sunflower were equally salient in Study 1B, yet the cut lemons were reliably chosen over the whole lemons, and the rose was chosen over the sunflower. In Study 2B we instead manipulated scent salience, by presenting the scent either once or twice in each ad. We found a small but significant effect of scent salience, such that two scent cues improved product evaluations beyond one cue. However, the picture of the scented object significantly improved product evaluations regardless of the number of scent cues, and hence scent salience cannot explain the effect. In Study 5, both packages presented the product's scent (i.e., lemon) only once, so again scent salience was controlled across conditions, yet the effect of the picture on the label persisted. Finally, also in Study 4, scent salience fails to explain the pattern of results. If higher scent salience were sufficient to elicit improved product evaluations, then the picture of the scented object should have improved evaluations of both products rather than only the cleaning product.

Yet another, related advantage of including a picture of a scented object on a pack or in an ad is that it increases consumers' awareness of the product scent, or their likelihood of noticing it (Study 4). However, the visual-olfactory effect was observed even when excluding participants who were unaware of the product's scent (Study 4), and even when all participants were aware of the product's scent (Study 2A and Web Study 3). Also, given that in Studies 1A, 1B and 3 and Web Study 4 both packages included a picture (i.e., cut vs. whole lemons, rose vs. sunflower), awareness of the product scent presumably would be similar across conditions, and hence scent awareness cannot explain those effects either. Similarly, given that the number of scent cues was controlled and/or manipulated in Studies 2B and 5, scent awareness could not explain those results either.

Finally, we also tested and excluded the possibility that the effects were due to the picture of the scented object increasing consumers' perceptions of the product's effectiveness. For instance, given that citrus fruits contain acids that can be beneficial for cleaning, a picture of a lemon could convey greater effectiveness of a cleaning product. However, this alternative account cannot explain why the effect occurred in Studies 1A and 3 and Web Study 4, where both packages included an image of lemons (cut vs. whole). We also measured consumers' perceptions of product effectiveness in the Follow-Up Experiment after Study 4, and we found that including a picture of a lemon did not improve the cleaning product's perceived effectiveness. Rather, because the picture evoked olfactory imagery of the product scent, it improved the perceived pleasantness of using the product. And given the similarity of stimuli in Study 4, Study 2B, and Web Study 3 (i.e., all are cleaning products with or without a picture of a citrus fruit), this also casts doubt on whether perceived product effectiveness could explain the effects in Study 2B and Web Study 3.

### 9.1. Theoretical contributions

We view our overarching theoretical contribution as providing a broad and cohesive conceptual model for systematically understanding how vision can be utilized to evoke the benefits of scent for consumer behavior. Prior studies have revealed many important processes and consequences of the individual senses of vision (Krishna, 2012; Raghubir, 2010) and scent (e.g., Bone and Jantrania, 1992; Krishna, Lwin, and Morrin, 2010; Mattila and Wirtz, 2001; Morrin, 2010; Morrin and Ratneshwar, 2003; Spangenberg et al., 1996; Spangenberg et al., 2006). Much less is currently known about multisensory interactions in general (e.g., Elder and Krishna, 2010; Streicher and Estes, 2016), and visual-olfactory interactions in particular (Krishna et al., 2014; Lwin, Morrin, and Krishna, 2010). Building from the multisensory nature of object representations (Barsalou, 1999, 2008) and product evaluations (Elder and Krishna, 2010), we developed a theoretical framework that explains how and when pictures of scented objects affect product evaluations (see Fig. 5). Our framework is founded upon a novel process of olfactory imagery, and includes three novel moderators of that process. Thus, the present research contributes new knowledge in an area of sensory marketing that has rich potential but limited evidence (Krishna, 2012; Krishna, Cian, and Sokolova, 2016; Peck and Childers, 2008). Below we delineate more specific theoretical contributions that our framework provides.

This research provides the first demonstration that pictures affect consumer evaluations via olfactory imagery. The impact of pictures on consumer evaluations is well established (e.g., Lutz and Lutz, 1977; Mitchell, 1986; Trendel et al., 2018), but the role of olfactory imagery in that process has not previously been revealed. Krishna et al. (2014) demonstrated that showing participants pictures of food and instructing them to imagine the smell of the food can increase craving, salivation, and eating. However, because Krishna et al. used only gustatory stimuli (i.e., cakes and cookies) and did not measure olfactory imagery in any of their studies, it is unclear whether their effects were due to gustatory or olfactory imagery. Our research, in contrast, isolated olfactory imagery as a psychological mechanism underlying the effect of pictures on evaluations. Notably, this olfactory imagery was observed in comparison to an identical scent (i) presented textually (e.g., "lemon scented" but without a picture of a lemon) and (ii) presented visually but with a less accessible imagined scent (e.g., a picture of whole lemons), and it occurred without any instruction or encouragement to imagine the scent. Thus, we demonstrated that pictures can evoke olfactory imagery and improve product evaluations under conditions that reflect market reality.

Our conceptual model based on olfactory imagery also reveals three novel moderators of the visual-olfactory effect. First, if the effect of pictures on product evaluations is due to imagined scent, then individuals with a high need for scent should be more likely to exhibit the effect. This is because a picture of a scented object evokes an imagined scent, which should at least partially satisfy these individuals' need for product scent when choosing products. For people with little or no need for smell, in contrast, that imagined scent should have little or no impact on their product choices. Our results supported this prediction.

Second, if the effect is due to imagined scent, then it should only occur among products for which scent is relevant and typical (i.e., *central*). Alternatively, if the effect were due to visual attractiveness, then it should occur regardless of the product's centrality. We observed the effect among high-centrality products (e.g., cleaning spray), but not among low-centrality products (e.g., lint roller). We further extended previous research on scent centrality (Ruzeviciute et al., 2020) firstly by providing a clear definition of the term. We also created a simple, three-item measure of scent centrality, which can help future research in this area to precisely differentiate between products in terms of their scent centrality. Lastly, while previous research on real product scents did not find moderating effects of scent centrality, we found a moderating effect of scent centrality on imagined scents. Furthermore, we found that scent centrality moderated the generation of olfactory imagery from pictures of scented objects, a step that is absent when real scents are used. Therefore, our research highlights an area in which olfactory imagery differs from real scents. Such differences can help researchers and managers identify unique applications of olfactory imagery, as we have done in our studies.

Third, if the effect operates via imagined scent, then pictures of malodorous objects (e.g., fish) should decrease evaluations of products intended to remove or contain bad smells, because a picture of a malodorous object should evoke unpleasant olfactory imagery. Our results confirmed that pictures of smelly objects, as commonly shown on products that are used to remove or contain bad smells, harm rather than help product evaluations.

Collectively, these three moderators provide strong convergent evidence that pictures of pleasant-scented objects improve evaluations via olfactory imagery. An interesting direction for future research is to investigate the visual-olfactory effect for products that are intended to impart bad smells, such as animal repellents and some joke products (e.g., stink bombs). For these products, the worse the smell, the more effective it is. In such cases, pictures of malodorous objects may well increase product evaluations due to imagined smell of the intended odor.

### 9.2. Managerial implications

This research reveals a strikingly simple and effective means of implementing olfactory marketing – in the absence of any actual scent. Although many packs and ads of scented products do include pictures of scented objects, many others do not (see Fig. 1). We show that merely including a picture of a scented object can improve evaluations for certain kinds of products. Our research thus provides clear practical guidance on how to design packages and advertisements to optimize olfactory imagery and, ideally, increase consumers' choice of the product. Given the limited reach and high cost of scented ads, this alternative method of inducing imagined scent via pictures offers much broader reach at much lower cost.



The present research also informs marketing managers of the specific conditions under which such pictures can, or cannot, improve consumers' evaluations. To begin with, although pleasant-looking pictures alone can improve product evaluations, they improve evaluations even more when they also induce pleasant olfactory imagery. For example, a picture of a rose is more effective than an equally attractive picture of a sunflower. Moreover, pictures are most effective when they make it easier for consumers to imagine smelling the object's scent, such as a cut lemon rather than a whole lemon. Some brands even include pictures of scented objects on the packaging or in the ads of products for which scent is not directly relevant or typical, perhaps in attempt to increase the product's visual attractiveness or sensory richness. However, our results indicate that pictures of scented objects do not improve evaluations for these low-centrality products. Marketers thus appear to gain little from this strategy unless scent is genuinely a relevant attribute of the product.

Finally, many products that mask or remove odors are marketed by illustrating a bad-smelling object that they are intended to counteract (see Fig. 4). Our results indicate that this strategy may backfire: By evoking malodorous imagery, pictures of unpleasant-scented objects can actually harm product evaluations. Of course, such ads and packs may achieve other positive marketing outcomes, such as attracting attention and/or increasing memorability. If the goal is to optimize product evaluations, however, our research indicates that illustrating an unwanted odor (i.e., that the product masks or removes) may have negative consequences. In conclusion, this research reveals that pictures of pleasant-scented objects can improve product evaluations, especially for consumers with a strong need for smell, and especially of products for which scent is a relevant or typical attribute.

### CRedit authorship contribution statement

**Varun Sharma:** Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Zachary Estes:** Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.

### Data availability

Data is available on Research Box

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijresmar.2024.02.001>.

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