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The lasting smell of temptation: Counteractive effects of indulgent food scents

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ABSTRACT

Despite the popularity of using indulgent food scents to boost sales of indulgent food in retail settings, research has only recently shown that the duration of the indulgent scent influences consumer motivation in food consumption. We conceptually replicate and extend Biswas and Szocs (2019). Specifically, we show that the effects of indulgent food scents on preference for indulgent food items, which Biswas and Szocs (2019) identify in joint decision tasks, hold when foods are evaluated separately. More importantly, we posit a novel mechanism for this effect. Based on counteractive-control theory, we propose that extended exposure to an indulgent olfactory cue influences motivation by activating one's diet goal, resulting in reduced intended indulgent food consumption. A set of 5 studies offer systematic support to this proposition, and managerial and consumer implications are discussed.

1. Introduction

Many companies use indulgent food scents strategically to lure shoppers into their stores (Peterson, 2014). For example, Cinnabon, a U. S. bakery chain, uses cinnamon scents in and around the store to entice consumers to come in and make purchases. Stores place baking ovens closer to shoppers and bake new rolls every 30 min so that the sweet cinnamon scent can stay in the air for a more extended period. Some Cinnabon stores even bake cinnamon sugar paper to emit the signature scent (Nassauer, 2014). The rationale behind this practice is that the longer shoppers are exposed to the sweet cinnamon scent, the more likely they are to be tempted by it and purchase the cinnamon rolls.

However, existing research implies that this common practice may backfire. For instance, a recent study suggests that extended exposure to indulgent scent extended exposure to an indulgent ambient scent compensates for actual consumption and decreases the likelihood of choosing the indulgent option (Biswas & Szocs, 2019). For instance, after being exposed to a chocolate scent for an extended period, people purchased and chose healthy snacks more than unhealthy snacks. In particular, the authors argue that indulgent scents can enhance the perceived rewarding experience and further thus diminish indulgent food consumption intentions.

In the spirit of a conceptual replication with a significant extension, we sought to theoretically replicate their findings, but do so with two additional goals in mind. The first goal was to explore whether the effect can hold in separate evaluations. In Biswas and Szocs (2019), all evaluations were made in a joint evaluation/choice mode which included both healthy and unhealthy options. As prior research has shown that consumers often make different decisions when they are evaluating products in a joint versus a separate evaluation mode (Hsee, 1996), it is important to understand whether the duration effects of scent would hold without a direct tradeoff between healthy and unhealthy food items. Preferences are constructed and thus are influenced by alternatives within the choice set (Lichtenstein & Slovic, 2006). For example, Wilcox et al. (2009) found that the mere inclusion of healthy options led people to choose more unhealthy options and consume more calories. In addition, consumers commonly make purchase decisions about indulgent food without comparing it with healthy options (e.g., Cinnabon).

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Thus, examining the impact of indulgent food scents in separate evaluation contexts allows us to understand whether indulgent food scent deters intended indulgent food consumption or promotes intended healthy food consumption. As such, we examine how indulgent food scent affects preferences for unhealthy (as well as healthy) food in separate evaluation contexts.

Secondly, we explore an additional process mechanism that may work separately, or in concert with, the mechanism proposed by Biswas and Szocs (2019). While they showed evidence for cross-modality compensation through enhancing a rewarding experience, we propose that intended indulgent food consumption is reduced via counteractive self-control in the diet domain. In other words, indulgent food scent might activate a diet goal, consequently reducing people's desire to consume unhealthy food. Diet goals (i.e., consumers' willingness to resist food temptation and maintain or lose weight) are one of the most critical determinants of indulgent food consumption (Buckland et al., 2013; Redden & Haws, 2013; Zhang et al., 2010). In this research, drawing on counteractive-control theory (Trope & Fishbach, 2000), we hypothesize that exposure to an indulgent olfactory cue for an extended period (vs a relatively short period or no time at all) can activate a diet goal, and reduce intended indulgent food consumption. We test this possibility in this research.

2. Theoretical background

Research on the impact of food scent on food consumption has mostly focused on how food scent can trigger or satiate individuals' desire to consume food. It has been found that extended exposure to indulgent food scents can decrease the desire to consume the indulgent scent-related food. For instance, people who smelled a banana (vs chicken) for five minutes reported that the item they smelled was less pleasant (Rolls & Rolls, 1997), suggesting that food scent satiates the gustatory desire to consume the scent-related food. Biswas and Szocs (2019) extended the notion of satiation by showing that indulgent food scents decrease indulgent food consumption by enhancing reward activation. They investigated indulgent scent effects on consumers' preference for healthy versus unhealthy food. In their study, after being exposed to a chocolate chip cookie scent in a school cafeteria for an extended period, middle schoolers purchased healthy snacks more than unhealthy snacks. The authors argued that indulgent scents increase healthy food choices as indulgent food scents offer a pleasant (rewarding) experience and thus diminish the desire to consume indulgent food. They focused primarily on the impact of food scents on satiating the desire to eat indulgent food rather than on self-regulation via the activation of a specific diet goal associated with consumption decisions.

In contrast with the above research that focuses on the role of scents in desire fulfillment (e.g., satiation; Fernandez et al., 2013; Rolls et al., 1981), the current research proposes a new function of scents. Specifically, we propose a diet goal-based account of how indulgent food scents cause resistance to food temptations.

2.1. Counteractive control theory and scent as a counteractive goal activator

Counteractive control theory (Trope & Fishbach, 2000) introduces that indulgent foods may trigger diet goal activation and reduce indulgent food consumption. According to counteractive control theory, a temptation can paradoxically activate a goal to counteract that temptation (Fishbach et al., 2003). For example, Fishbach et al. (2003) investigate whether the presence of indulgent food activates a diet goal for restrained eaters. In their studies, respond faster to diet-related words after exposure to a relevant temptation-related word than an irrelevant temptation-related word. In addition, this diet-goal activation produces an increase in goal pursuit behavior toward their long-term health goal (Myrseth et al., 2009). People who viewed indulgent foods (e.g., looked at dessert cooking books) consumed less chocolate than those not exposed to the visual food temptation (Fishbach et al., 2003). Similarly, people exposed to pictures of chocolate report increased goal importance, goal intentions, and goal-directed behavior (Kroese et al., 2009).

Other sensory features can make indulgent temptations more salient, affecting people's indulgent food consumption. For example, potato chips presented in a large (vs small) package size reduced consumers' likelihood to open the package as well as the actual consumption amount (Coelho do Vale et al., 2008). In a similar vein, Deng and Srinivasan (2013) show that when chocolates were contained in a large transparent package, people ate fewer pieces than when the chocolates were less visible in a same-size, opaque package. The results suggest that diet goals are more likely to be triggered when people perceive a food temptation as threatening to their diet goals.

Findings in scent research suggest the possibility that an indulgent food scent can act as a diet goal activator. People form semantic associations through repeated exposure to scents in different contexts (Stevenson & Boakes, 2003). That is, food scents can communicate information about the nutrient composition of their associated foods (Boesveldt & de Graaf, 2017; Boesveldt & Lundström, 2014). Due to learned associations between a food scent and consumption consequences (Brunstrom & Mitchell, 2007; Small et al., 2008; Yeomans & Boakes, 2016; Yeomans et al., 2016), exposure to a food scent can elevate people's weight concerns. McCrickerd and Forde (2016) also argue that food scents direct attention not only to the food source but also to the nutrients or energy associated with its consumption. This finding suggests that people infer high calories come from indulgent food scents and anticipate the negative consequences of indulgent food consumption. Coelho et al. (2009) offer support for the proposition that an indulgent food scent can bolster self-regulation. After being exposed to baked chocolate chip cookie scents, individuals concerned about their weight ate fewer chocolate cookies than weight-concerned individuals not exposed to the scents. This finding suggests that indulgent scents activate indulgent food consumption's counteractive goal, namely a diet goal.

2.2. Extended exposure as a pre-condition

We further conceptually replicate a vital pre-condition for an indulgent scent to activate a diet goal. Based on results found in Biswas and Szocs (2019), we posit that sufficient exposure to a scent is critical for people to evoke the goal related to the scent. This is because processing olfactory cues takes longer than processing other sensory cues. For example, detecting olfactory cues takes approximately 400 ms, which is 10 times slower than the time it takes to detect visual cues of an object (Herz & Engen, 1996), and olfactory cues are more difficult to process (Alivisatos et al., 2012). Besides, initial counteractive goals may cancel with the increased temptation since brief exposure to an indulgent scent can increase appetite (Biswas & Szocs, 2019; Geyskens et al., 2008; Spence, 2015). It is only through extended exposure that the counteractive goal becomes dominant as the strength of goal primes may increase over time (Fitzsimons et al., 2008) and the temptation may decrease over time as people get habituated to the temptation (Morewedge et al., 2010). In particular, as discussed in Biswas and Szocs (2019), olfactory cues exert automatic influence because of the direct connection with the limbic system which might make the initial temptation feelings quite strong.

Research has also found that regulatory systems act slower than automatic responses to temptations (Evans & Stanovich, 2013; Hoch & Loewenstein, 1991). Similarly, biases in judgment and decision-making, which reflect initial responses to stimuli, are weaker when there is sufficient time to process them. For example, under time pressure, people show a higher belief bias (i.e., a greater tendency to rely on prior beliefs rather than logic) in syllogistic reasoning (Evans & Curtis-Holmes, 2005), a higher matching bias (i.e., a greater tendency to see cases as

relevant when lexical context matches the applicable rule) in the Wason selection task (Evans et al., 2009), and a stronger positive/negative framing effect (Shen & Wyer, 2008). These findings indicate that people first rely on their intuition, and then the deliberative system may intervene in the process. In the scent domain, other than Biswas and Szocs (2019), many of the studies that show negative effects of scent on consumption use long-duration scents either explicitly or implicitly (Coelho et al., 2009). Similarly, we predict that overcoming temptation needs cognitive reflection; thus, the counteractive goal of food consumption (e.g., diet goal) will be activated only with extended exposure to the scent. This replicates the finding that brief exposure to an indulgent scent (e.g., less than 30 s) increases rather than decreases unhealthy food choice (Biswas & Szocs, 2019). Thus, we replicate that exposure to an indulgent food scent decreases indulgent food consumption intentions over time rather than immediately but through an alternate mechanism (i.e., diet goal activation). Accordingly, in our experiments, we contrast extended exposure to brief or no exposure conditions.

3. Overview of research

A set of five studies provide a systematic investigation into how extended exposure to an indulgent food scent activates a diet goal and decreases indulgent food consumption. Studies 1A, 1B, and 1C offer conceptual replications of Biswas and Szocs (2019) but do not measure individual's restrained eating tendency. In addition, they also isolate the effect of indulgent scents through a separate versus joint decision-making paradigm. Finally, they extend Biswas and Szocs (2019) to other unrelated indulgent food. Study 2 offers direct evidence of counteractive goal activation account through an established response measure, a lexical decision task (LDT, hereafter). Finally, Study 3 shows that the duration effect shown in this paper is indeed due to diet goal priming as well as tests our effect for those who are chronic restrained eaters.

4. Study 1A

Study 1A examines the duration effect of an indulgence in Biswas and Szocs (2019) in a conceptual replication using a separate evaluation context without presenting other food options. We expect that compared with an indulgent scent, a scent perceived as non-indulgent will be less likely to reduce indulgent food consumption. To this end, we use a citrus scent as the control, non-indulgent scent because it is associated with freshness and lightness (Chebat & Michon, 2003). This scent typically offers an equally pleasant experience in a retail environment (Chebat et al., 2009) but differs from chocolate in indulgence perceptions.

4.1. Method

We used a 2 (scent type: chocolate vs citrus) × 2 (exposure duration: 1 min vs 5 min) between-subjects design. In total, 381 university college students at a mid-Atlantic university participated in the study in exchange for course credit (M_{age} = 19.42, SD = 1.27; 167 females). We randomized the scent manipulation, chocolate/citrus, daily so that all students who took the study on a particular day were in the same scent condition. We created a scented room with a scent diffuser system that maintained the scent intensity throughout the study (Morrin & Ratneshwar, 2003). Participants were invited to a large computer lab that had a continuously running scent machine. The study was run with 10–20 participants at a time. Upon arrival at the lab, participants were asked to watch a nature documentary video as a part of a media consumption study and were asked to imagine they were invited to their friend's place on a Saturday night, and the friend served chocolate ice cream. They were presented with an image of a bowl of chocolate ice cream and indicated their chocolate ice cream consumption intentions at that moment on the following measures: "How much would you like to eat the chocolate ice cream?" (1 = "not at all," 7 = "very much") and "Imagine this ice cream is available in your local supermarket (appendix A for actual study stimuli). How likely would you be to purchase this chocolate ice cream?" (1 = "not at all," 7 = "very much"). Please see the following link for the video from this study as well as all subsequent studies in the paper (OSF repository: https://osf.io/yxfpj).

4.2. Results

We ran a 2 (scent type: chocolate vs citrus) × 2 (exposure duration: 1 min vs 5 min) ANOVA with the chocolate ice cream consumption intention index ($r = 0.77$, $p < .001$) as the dependent variable. The two-way interaction between scent type and exposure duration was significant ($F(1, 377) = 8.17$, $p < .01$, $\eta_p^2 = 0.02$). The main effect of exposure duration was significant ($F(1, 377) = 9.61$, $p < .01$, $\eta_p^2 = 0.02$) but not that of scent type ($F(1, 377) = 1.10$, $p = .29$, $\eta_p^2 = 0.003$).

More importantly, replicating the scent effect identified in the previous studies, participants in the chocolate-scent conditions were less likely to consume the chocolate ice cream when they were exposed to the scent for five minutes rather than for one minute ($M_{5min} = 4.24$, SD = 1.90 vs $M_{1min} = 5.28$, SD = 1.59; $F(1, 377) = 17.80$, $p < .001$; Table 1). By contrast, this difference did not occur among participants in the citrus-scent conditions ($M_{1min} = 4.96$, SD = 1.63 vs $M_{5min} = 4.92$, SD = 1.67; $F(1, 377) = 0.03$, $p = .86$). Furthermore, extended exposure to a scent reduced indulgent food consumption only when the scent was indulgent. That is, the chocolate (vs citrus) scent significantly reduced participants' consumption only in the extended exposure conditions ($F(1, 377) = 7.58$, $p < .01$); in the brief exposure conditions, scent type did not make a difference ($F(1, 377) = 1.65$, $p = .20$).

4.3. Discussion

Study 1A investigates whether scent indulgence moderates the scent duration effect. Extended exposure to an indulgent scent reduced indulgent food consumption, but the effect was absent for a non-indulgent scent. However, extended exposure to a healthy food scent did not reduce indulgent food consumption, suggesting that the extended duration effect may not generalize to all pleasant food scents. This finding may also suggest that the pleasantness of a scent experience is not sufficient to reduce indulgent food consumption. In addition, we show that the effects occur in separate evaluation contexts.

5. Study 1B

Study 1B presents another conceptual replication using a different scent context and a no-scent control group.

5.1. Method

5.1.1. Study Design and Participants

One hundred ten undergraduate students at a mid-Atlantic university ($M_{age} = 19.81$, SD = 1.96; 48 females) individually completed this study in exchange for a cash payment. The study employed a 2 (chocolate scent: present vs absent) × 2 (exposure duration: 1 min vs 5 min) between-subjects design.

5.1.2. Procedure and Materials

There was a 30-minute break between sessions to ensure that the

Table 1
Mean (standard deviation) consumption intention in Study 1A.

	Chocolate Scent	Citrus Scent
1 min	5.28 (1.59)	4.96 (1.63)
5 min	4.24 (1.90)	4.92 (1.67)
1 min vs 5 min	$F(1, 377) = 17.80$, $p < .001$	$F(1, 377) = 0.03$, $p = .86$

ventilation system had enough time to remove the chocolate scent from the room before the next participant arrived at the behavioral lab. Upon arrival, participants were told that they would complete several unrelated tasks. The first task was a new product evaluation study that contained our scent manipulation. A study administrator provided the participants with a sealed packet containing a new *T*-shirt. The *T*-shirt's neck area was either scented with a few drops of chocolate essence oil (scented condition) or not (absent condition). Participants were asked to promptly put on the *T*-shirt (men's XXL size) for product evaluation. Then, while wearing the *T*-shirt, they watched a nature video presented as part of a media consumption study. The video displayed a series of natural landscapes and sceneries (e.g., icebergs in the ocean, mountains covered by snow) with classical music. The video played for one minute or five minutes. After the video ended, they immediately removed the shirt, and the study administrator removed it from the lab.

Next, participants were asked to imagine being served a bowl of chocolate ice cream in a friend's place. We measured individual consumption intentions with the same measures as in Study 1A.

5.2. Results

We combined consumption likelihood and purchase intentions to create a consumption index (r =0.53, p <.001). A 2 (chocolate scent: present vs absent) × 2 (exposure duration: 1 min vs 5 min) ANOVA revealed that neither the main effect of chocolate scent ($F(1, 106)$ = 2.54, p =.11, η_p^2 = 0.02), nor the main effect of exposure duration ($F(1, 106)$ = 0.79, p =.38, η_p^2 = 0.01) was significant. However, there was a marginally significant two-way interaction ($F(1, 106)$ = 3.27, p =.07, η_p^2 = 0.03). As predicted, when participants were exposed to a chocolate scent for five (vs one) minutes, they had lower consumption intentions ($M_{5min/present}$ = 4.02, SD = 1.77 vs $M_{1min/present}$ = 4.77, SD = 1.22; $F(1, 106)$ = 3.86, p =.05; Table 2). However, when the scent was absent, no difference occurred ($M_{5min/absent}$ = 4.96, SD = 1.33 vs $M_{1min/absent}$ = 4.71, SD = 1.41; $F(1, 106)$ = 0.40, p =.53). Further contrast analysis revealed that, in the 5 min conditions, exposure to the chocolate scent significantly reduced consumption intentions ($F(1, 106)$ = 6.14, p =.01). However, exposure to the scent made no difference in the 1 min conditions ($F(1, 106)$ = 0.02, p =.88).

5.3. Discussion

Study 1B shows that extended exposure to an indulgent scent reduced participants' intention to consume food related to the scent. However, the indulgent scent did not produce the same effect after a brief exposure (e.g., one minute), suggesting that mere exposure to an indulgent scent is not sufficient to decrease indulgent food consumption. This conceptually replicates Biswas and Szocs (2019) in a separate, as opposed to a joint, evaluation context.

6. Study 1C

Next, we tested the generalizability of the scent effect to the consumption of unrelated, indulgent or less indulgent foods in a separate evaluation context. We predicted that the effect occurs for indulgent rather than non-indulgent food. Biswas and Szocs (2019) previously found that the scent duration effect influenced the preference for unrelated indulgent foods in a joint evaluation context. Thus, in this study, we tested whether the generalizability of the effect is robust in a separate evaluation context.

Table 2
Mean (standard deviation) consumption intention scores in Study 1B.

	Present	Absent
1 min	4.77 (1.22)	4.71 (1.41)
5 min	4.02 (1.77)	4.96 (1.33)
1 min vs 5 min	$F(1, 106)$ = 3.86, p =.05	$F(1, 106)$ = 0.40, p =.53

6.1. Method

A 4 (food type: chocolate ice cream vs French fries vs fruit salad vs chocolate chip granola bar; within-subject) × 2 (exposure duration: 1 min vs 5 min; between-subjects) mixed design was employed. In total, 140 undergraduate students at a mid-Atlantic university participated in the study (M_{age} = 20.01, SD = 1.46; 89 females) for course credit. Participants were exposed to a chocolate scent for either one minute or five minutes while viewing the same nature video clip as in Study 1A as a part of a media consumption study. After watching the nature video clip for the assigned time, participants were asked to imagine they were invited to their friend's place on a Saturday night, and the friend prepared food on the table. Then, they were presented with four food item images: chocolate ice cream, French fries, fruit salad, and a chocolate chip granola bar. We chose the food stimuli based on two dimensions: relatedness to the exposed scent and food healthfulness. The chocolate ice cream was scent-related and unhealthy, the chocolate chip granola bar was scent-related but healthy, French fries were scent-unrelated but unhealthy, and fruit salad was scent-unrelated and healthy. Participants rated how much they would like to eat each food item on a scale from 0 to 100. We also measured food healthfulness perceptions ("How healthy do you think the following food item is? –4 = "unhealthy," 4 = "healthy"). The scent was not mentioned during the study.

6.2. Results

6.2.1. Manipulation Check

We first checked each food's healthfulness perceptions (Fig. 1). As zero was the midpoint, we tested whether participants perceived the healthy (fruit salad and chocolate chip granola bar) and unhealthy (French fries and chocolate ice cream) items as intended by comparing whether the average perception ratings were significantly different from zero using a series of one-sample t-tests. The results showed that participants indeed perceived chocolate ice cream (M = –2.37, SD = 1.42; $t(139)$ = –19.82, p <.001, Cohen's d = 1.67) and French fries (M = –3.12, SD = 1.23; $t(138)$ = –29.76, p <.001, Cohen's d = 2.54) as unhealthy, and the fruit salad (M = 3.39, SD = 1.09; $t(139)$ = 36.75, p <.001, Cohen's d = 3.11) and the chocolate chip granola bar (M = 0.62, SD = 1.87; $t(138)$ = 3.91, p <.001, Cohen's d = 0.33) as healthy.[1] We further tested whether the healthfulness perceptions between the two exposure duration conditions interacted with food type using a 4 (food type) × 2 (exposure duration) mixed ANOVA. The main effect of food type was significant ($F(3, 412)$ = 668.62, p <.001, η_p^2 = 0.83), but that of exposure duration was not ($F(1, 138)$ = 0.03, p =.86, η_p^2 = 0.0001). The two-way interaction between food type and exposure duration ($F(3, 412)$ = 0.18, p =.91, η_p^2 = 0.001) was not significant, suggesting that exposure duration did not influence food healthfulness perceptions.

6.2.2. Food Consumption Intentions

A 4 (food type: chocolate ice cream vs French fries vs fruit salad vs chocolate chip granola bar; within-subject) × 2 (exposure duration: 1 min vs 5 min; between-subjects) mixed ANOVA showed a marginally significant interaction effect ($F(3, 414)$ = 2.44, p =.06, η_p^2 = 0.02). Extended exposure to a chocolate scent reduced the intention to consume chocolate ice cream (M_{1min} = 65.82, SD = 30.64 vs M_{5min} = 49.74, SD = 33.80; F = 12.78, p <.001; Table 3), replicating the previous finding in Study 1A. Furthermore, we found the same effect for French fries consumption (M_{1min} = 73.48, SD = 25.20 vs M_{5min} = 63.35, SD =

[1] One participant did not rate the healthfulness of French fries, and another participant did not rate the healthfulness of the chocolate chip granola bar.

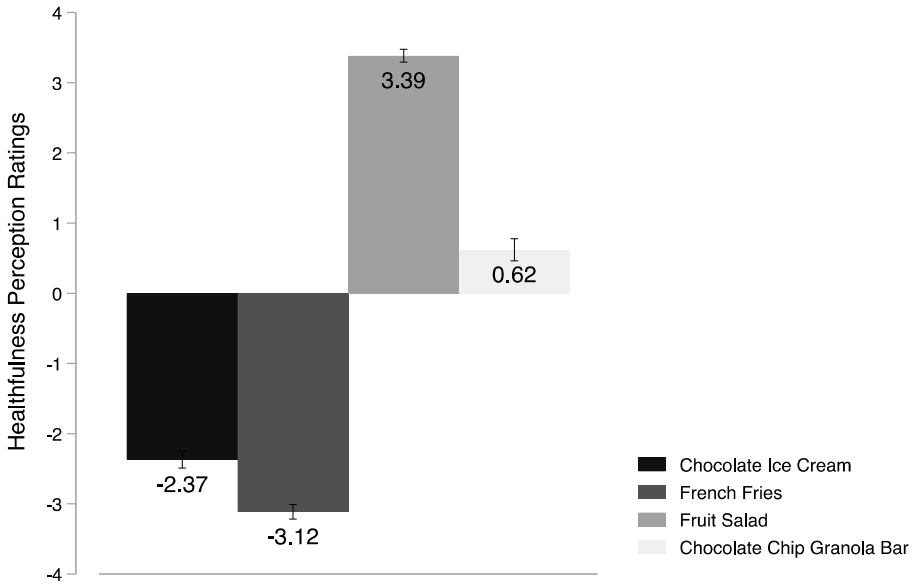

Fig. 1. Study 1C: Means of the healthfulness perception rating.

Table 3
Average (standard deviation) consumption intention scores in Study 1C.

	Chocolate Ice Cream	French Fries	Fruit Salad	Chocolate Granola Bar
1 min	65.82 (30.63)	73.48 (25.20)	69.17 (29.35)	42.52 (30.65)
5 min	49.74 (33.80)	63.35 (28.54)	64.29 (27.87)	42.81 (27.73)
F-value	12.78	5.07	1.18	< 0.01
p-value	< 0.001	0.02	0.28	0.95

28.54; $F = 5.07$, $p = .02$), implying that the scent effect generalizes to the consumption of other indulgent food, even when that food did not share the same olfactory cues. However, the scent effect was absent for consumption of a healthy food regardless of its scent relatedness: the chocolate scent did not influence consumption of the chocolate chip granola bar (scent-related but healthy; $M_{1min} = 42.52$, SD = 30.65 vs $M_{5min} = 42.81$, SD = 27.73; $F < 0.01$, $p = .95$) or the fruit salad (scent-unrelated and healthy; $M_{1min} = 69.17$, SD = 29.35 vs $M_{5min} = 64.29$, SD = 27.87; $F = 1.18$, $p = .28$).

Next, we re-analyzed the data by categorizing the four types of food into two factors, namely food healthfulness and scent relatedness. We predicted that extended exposure to a chocolate scent would decrease food consumption intentions only when the food is unhealthy, regardless of scent relatedness. We ran a 2 (exposure duration: 1 min vs 5 min; between-subjects) × 2 (food healthfulness: unhealthy vs healthy; within-subject) × 2 (scent relatedness: scent-related vs scent non-related; within-subject) mixed ANOVA with consumption intention as a dependent variable. The three-way interaction was not significant ($F(1, 138) = 1.62$, $p = .20$, $\eta_p^2 = 0.01$). The two-way interaction between exposure duration and scent relatedness ($F(1, 138) = 0.01$, $p = .93$, $\eta_p^2 = 0.0001$) was also not significant. However, as predicted, the two-way interaction between exposure duration and food healthfulness was significant ($F(1, 138) = 4.97$, $p = .03$, $\eta_p^2 = 0.04$). Extended exposure to a chocolate scent significantly reduced food consumption intention when the food items were indulgent ($M_{1min} = 69.65$, SD = 28.21 vs $M_{5min} = 56.54$, SD = 31.91; $F(1, 138) = 18.04$, $p < .001$) but not when they were non-indulgent ($M_{1min} = 55.85$, SD = 32.75 vs $M_{5min} = 53.55$, SD = 29.72; $F(1, 138) = 0.55$, $p = .46$).

6.3. Discussion

Study 1C further replicates Biswas and Szocs (2019) in a separate rather than joint evaluation mode. The generalizability of the scent effect on indulgent foods would be in line with prior research that showed that exposure to an indulgent food scent increases healthy choices generally.

7. Study 2

Study 2 provides direct evidence for the proposed underlying mechanism. To validate our goal activation account, we employ a lexical decision task (LDT), which is a well-established response time measure methodology. When a particular goal is activated (vs not), people generally respond faster to words related to the goal (Fishbach et al., 2003). We further investigate whether the activated goal is contextual (i.e., diet goal specific to food consumption) or general (i.e., generic self-regulation goal). Scents have been known to activate a contextual goal (i.e. cleaning goal from multi-purpose detergent; Holland et al., 2005). While we focus on a context-specific goal (i.e., a diet goal), it is possible that the scent may trigger a broader behavioral avoidance goal. We thus investigate this possibility as well. To validate that extended exposure to an indulgent scent is essential for goal activation, we use a 1 min vs 5 min scent exposure conditions as control vs experimental conditions in this study. We predict that participants in a prolonged indulgent scent condition will respond faster to diet-related words than those exposed to the scent for a relatively short period.

7.1. Method

This study was a 2 (exposure duration: 1 min vs 5 min; between-subjects) × 3 (word type: diet-related vs regulation-related vs neutral; within-subject) mixed design. In total, 147 students at a mid-Atlantic university took part in the study, and all were native English speakers. We used responses from 121 participants ($M_{age} = 19.47$, SD = 1.78; 52 females) in the analysis after excluding 17 participants who provided

wrong answers to any of the questions in the LDT and 9 participants who experienced technical difficulties.

In a scented room, participants were randomly assigned to either the 1 min or 5 min condition. Participants watched a nature documentary for a randomized amount of time and completed a lexical decision task. The lexical decision task asked participants to make a judgment on whether a series of letters indicated a word or not as quickly and accurately as possible. Response time for each judgment served as the dependent variable (for a similar procedure, see Geyskens et al., 2008). Before the main task, participants completed a practice task, which consisted of eight trials (four words and four non-words trials). The main task consisted of 15-word trials and 15 non-word trials, and the presentation order was fully randomized. The word trials consisted of three different types of words: neutral words ("uniform," "landscape," "magazine," "library," and "gasoline"), diet-related words ("healthy," "diet," "slim," "fit," and "shape"), and regulation-related words ("restrain," "regulate," "resist," "discipline," and "willpower"). We selected the diet-related words from previous studies that used LDT to measure diet-goal activation (Fishbach et al., 2003; Gaillet et al., 2013; Geyskens et al., 2008) and regulation-related words and neutral words from the SUBTLEX-US corpus by matching the word frequencies with those of the goal-related words (Brysbaert & New, 2009). Non-words came from the ARC Nonword Database (Rastle et al., 2002), and the lengths of the words were matched between words and non-words (M_{words} = 6.87, SD = 2.07 vs $M_{non\text{-}words}$ = 6.13, SD = 1.73; $t(28)$ = –1.06, p =.30, Cohen's d = 0.39; see Appendix B for the full word list).

7.2. Results

We regressed log-transformed response time (in seconds) on exposure duration (1 min vs 5 min) interacted with word type (0 = neutral vs 1 = diet-related vs 2 = regulation-related; dummy coded) using a mixed effect linear regression model with subject-level random intercepts. The two-way interaction between exposure duration and word type was significant (χ^2 = 7.99, p =.018; Fig. 2 and Table 4). In response to diet-related words, participants in the 5 min condition responded faster than those in the 1 min condition (M_{5min} = 0.63 *sec*., SD = 0.12 vs M_{1min} = 0.70 *sec*., SD = 0.19; χ^2 = 4.22, p =.04). However, the difference was not significant in responses to neutral words (M_{5min} = 0.66 *sec*., SD = 0.14 vs M_{1min} = 0.71 *sec*., SD = 0.18; χ^2 = 2.54, p =.11) or to regulation-related words (M_{5min} = 0.75 *sec*., SD = 0.20 vs M_{1min} = 0.76 *sec*., SD = 0.20; χ^2 = 0.10, p =.75).

7.3. Discussion

This study offers evidence that directly supports the goal activation process. When participants were exposed to a chocolate scent for five minutes, they responded faster to the diet-related words than those exposed for one minute, suggesting that extended exposure to an indulgent scent activates a diet goal. It also implies that sufficient exposure time is critical for diet-goal activation. Finally, exposure to an indulgent scent does not influence response time to regulation-related words, suggesting that an indulgent scent activates a contextual goal specifically related to food consumption.

8. Study 3

Study 3 offers additional evidence for our diet goal activation account. First, we directly manipulated a diet goal and tested whether priming a diet goal would attenuate the duration effect. We have argued that the diet goal will be activated when people are exposed to an indulgent scent for an extended period. In other words, a brief exposure to an indulgent scent is not sufficient to activate the diet goal. Thus, in the short duration, the introduction of a diet goal via priming to people will decrease their indulgent food consumption intentions as observed in the extended exposure.

We further examine the moderating role of individual differences in diet motivation. An important assumption in our theory is that individuals should perceive a food temptation, such as an indulgent food scent, as enhancing weight concern, thus activating a diet goal. In fact, goal activation is possible only when a discrepancy between the current and the desired end state exists (e.g., Fitzsimons et al., 2008; Förster et al., 2007). Thus, we expected the duration effect of indulgent scent should hold only for restrained eaters. In other words, if individuals do not have weight concerns, an indulgent food scent should not be perceived as threatening. If so, exposure to an indulgent food scent would not reduce indulgent food consumption among people with a low chronic dieting motivation. To this end, Study 3 utilizes the full Restrained Eating Scale (10 items) from the Dutch Eating Behavior Questionnaire (Van Strien et al., 1986; RES hereafter), a measure of behavioral engagement in eating restriction for dieting, to investigate how individual difference in diet motivation moderates the scent effect.

Lastly, we tested the perceived reward as a mediator. Biswas and Szocs (2019) proposed that extended exposure to indulgent (vs non-indulgent) food scents increases healthy choice via reward activation. We adopted the measurement from Biswas and Szocs (2019) and tested the mediating role of reward perception.

8.1. Method

A total of 286 undergraduate students in an East Asian university participated in the study in exchange for bonus points (M_{age} = 19.45, SD = 1.27; 195 females). Responses from ten participants were excluded due to technical issues (e.g., internet disconnections which caused a restart of the survey in the middle of the study), leaving 276 responses for the analysis (M_{age} = 19.45, SD = 1.28; 189 females). We show how individuals' indulgent food consumption intentions differ across three conditions: brief exposure to scent without any diet priming (1 min-control), a brief exposure with a diet goal priming (1 min-diet priming), and an extended exposure without any diet goal priming (5 min-control). Participants were randomly assigned to one of these three experimental conditions (scent condition: 1 min-diet priming vs 1 min-control vs 5 min-control). Individuals' dieting tendency, RES, was measured toward the end of the study.

We expect people in the 1 min-diet priming and 5 min-control conditions will show lower indulgent food consumption intentions than those in the 1 min-control condition (who were exposed to an indulgent scent without a diet goal). In contrast, responses between the 1 min-diet priming and 5 min-control conditions will not differ. Further, we expect that the difference among conditions will be observed among people who score high on the RES scale (i.e., who have a strong diet motivation).

The behavioral lab was scented with a chocolate scent using a scent diffuser system as in Studies 1C and 2. As this study was conducted during the COVID-19 pandemic, all participants as well as study administrators wore a facial mask during the entire course of the study to minimize the health risk. Each session included a maximum of twelve participants who first met a study administrator in a scent-free waiting area. Participants sat individually in cubicles in the scented lab and watched a slideshow, being randomly assigned to one of three conditions: 1 min-control vs 1 min-diet priming vs 5 min-control. Participants in the 1 min-control and 5 min-control groups watched a series of nature images (e.g., landscape, sunset, butterflies, etc.), and each image was displayed for 5 s. Instead, participants in the 1 min-diet priming condition watched a slideshow containing 6 nature images and 6 diet-related images (e.g., scale, slim body in large pants, etc.). Participants were informed that this was part of a media consumption study. After watching the slideshow, same as in Study 1C, participants were asked to imagine they were invited to their place on a Saturday night, and the friend prepared food on the table. Then, they were asked to rate how likely they would like to eat four food items (French fries, ice cream, cookies, and bubble milk tea) using a 100-point scale (0 = not at all, 100

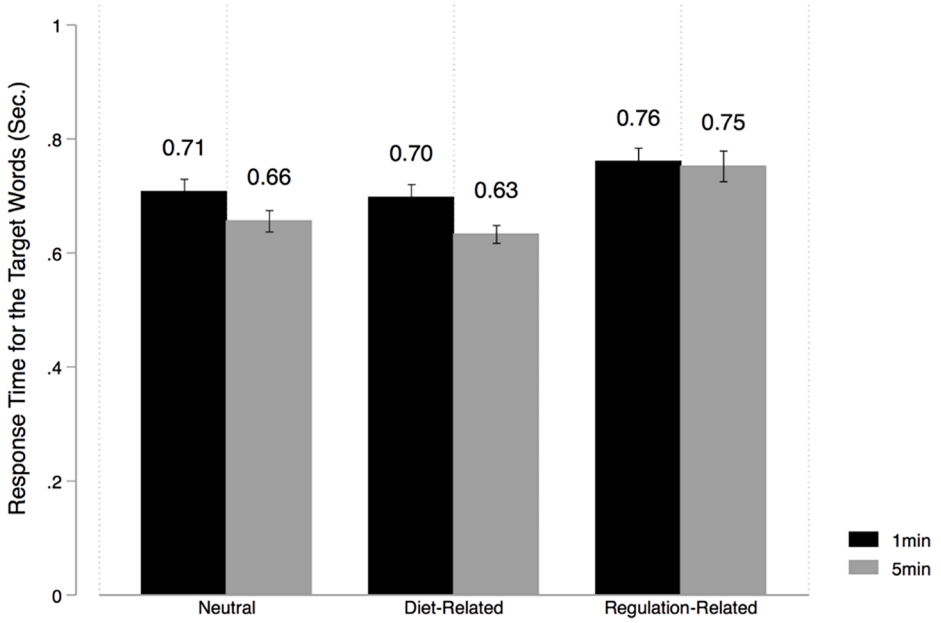

Fig. 2. Study 2: Average raw response times (in seconds) for the word types between the two exposure groups.

Table 4
Mean (standard deviation) response times (in seconds) in Study 2.

	Neutral	Diet-Related	Regulation-Related
1 min	0.71 (0.18)	0.70 (0.19)	0.76 (0.20)
5 min	0.66 (0.14)	0.63 (0.12)	0.75 (0.20)
1 min vs 5 min	$\chi^2 = 2.54$, $p = .111$	$\chi^2 = 4.22$, $p = .04$	$\chi^2 = 0.10$, $p = .75$

= very much). Then, participants indicated enjoyment and pleasantness of their experience of the scent (1 = "very low enjoyment/not at all pleasant", 7 = "very high enjoyment/very pleasant") as in Biswas and Szocs (2019) using a 7-point scale for their reward perception. Next, we measured how much they liked sweet snacks, in general, using a 7-point Likert scale ("In general, I like sweet snacks"; 1 = "strongly disagree", 7 = "strongly agree"). This measure was added as the population consisted of East Asian rather than US participants. US participants typically tend to eat more sugar and prefer sweeter snacks (as evidenced by the US' first place in consumption of sugar in the World; Ferdman, 2015). As in Study 1C, participants indicated four food items with a 9-point scale (-4 = "unhealthy", 4 = "healthy"). Finally, they completed the RES scale, the 10 items for the Restrained Eating construct in the Dutch Eating Behavior Questionnaire (e.g., "Do you deliberately eat foods that are slimming?", "When you have eaten too much, do you eat less than usual the following day?", "Do you take into account your weight with what you eat?"; 1= "Never", 5 = "Very Often"), and the average score of the 10 items (RES score) was used in the analysis (Cronbach's alpha = 0.88).

8.2. Results

8.2.1. Food Healthfulness Perceptions

As in study 1B, one-sample *t*-test results for individuals' perception of the healthfulness of each food item confirmed that these four food items are perceived as unhealthy. The mean values ranged from −1.62 to −2.43 (M_{fries} = -2.41, SD = 1.40; $M_{ice\text{-}cream} = -1.91$, SD = 1.47; $M_{cookies}$ = -1.62, SD = 1.68; $M_{bubble\text{-}milk\text{-}tea}$ = -2.43, SD = 1.38), significantly lower than 0 (the mid-point: neutral; fries: $t(275) = -28.60$, $p < .001$, Cohen's d = 1.72; ice cream: $t(275) = -21.61$, $p < .001$, Cohen's d = 1.30; cookies: $t(275) = -15.95$, $p < .001$, Cohen's d = 0.96; bubble milk tea: $t(275) = -29.31$, $p < .001$, Cohen's d = 1.76). Thus, we used the averaged consumption intention score of these four food items of each participant in the analysis (Cronbach's alpha = 0.87). We further tested whether the healthfulness perceptions across the three experimental conditions interacted with food type using a 4 (food type; within-subject) × 3 (experiment conditions; between-subject) mixed ANOVA. The main effect of food type was significant ($F(3, 819) = 54.36$, $p < .001$, $\eta_p^2 = 0.17$), but that of the experimental conditions was not ($F(2, 273) = 0.26$, $p = .77$, $\eta_p^2 = 0.002$). The two-way interaction between food type and exposure duration ($F(6, 819) = 0.96$, $p = .45$, $\eta_p^2 = 0.007$) was not significant, suggesting that there was no significant difference in food healthfulness perceptions across the three experimental conditions.

8.2.2. Consumption Intentions

A one-way ANOVA result with each participant's general sweet snack liking as a covariate showed that there was a marginally significant main effect of the experimental conditions ($M_{1min\text{-}control} = 62.37$, SD = 18.69 vs $M_{1min\text{-}diet\ priming} = 56.69$, SD = 22.55 vs $M_{5min\text{-}control} = 56.93$, SD = 21.26; $F(2, 272) = 2.60$, $p = .076$, $\eta_p^2 = 0.02$) and the main effect of general sweet snack liking ($F(1, 272) = 74.60$, $p < .001$, $\eta_p^2 = 0.22$). We expected that participants in the 1 min-diet priming and 5 min-control conditions would show a lower indulgent food consumption intention than those in the 1 min-control condition (who were exposed to an indulgent scent without a diet goal). In contrast, responses between the 1 min-diet priming and 5 min-nature conditions would not differ each other. Planned contrast analyses confirmed our prediction. People in the 1 min-control group showed a stronger consumption intention to indulgent food than those in the other two conditions (1 min-control vs [1 min-diet priming and 5 min-control combined]: $t(272) = -2.15$, $p = .032$). Still, there was no significant difference in consumption intentions between the 1 min-diet priming and 5 min-control conditions ($t(272) = 0.73$, $p = .467$).[2]

[2] Another contrast analysis treating each condition separately revealed a significant difference between the 1min-control and 1min-diet priming condition ($t(272) = 2.24$, $p = .026$). The difference between the 1min-diet priming and 5min-control conditions was not significant ($t(272) = -0.73$, $p = .467$). The difference between the 1min-control and 5min-control conditions was not significant ($t(272) = 1.48$, $p = .141$).

8.2.3. The Role of Individual's Restrained Eating Tendency

More importantly, we tested whether an individual's tendency to restrain eating behavior moderates the effect. To test this, we regressed the averaged consumption intention score on the three experimental conditions that interacted with the RES scores, and each participant's general sweet snack liking was included as a covariate. Across the three conditions, there was no significant difference in tendency to restrain eating behavior ($M_{1min\text{-}control} = 2.64$, SD = 0.73 vs $M_{1min\text{-}diet\ priming} = 2.48$, SD = 0.76 vs $M_{5min\text{-}control} = 2.62$, SD = 0.88; $F(2, 273) = 1.09$, $p = .337$, $\eta_p^2 = 0.008$).

The result showed a significant interaction between experimental conditions and RES ($F(2, 269) = 4.18$, $p = .016$, $\eta_p^2 = 0.03$). Further spotlight analysis results (Table 5; Fig. 3) showed that for less restrained eaters (-1SD), there was no significant difference in consumption intention among the three conditions (joint test at −1SD: $F(2, 269) = 0.14$, $p = .871$). In contrast, for high restrained eaters (+1SD), the 1 min-diet priming condition and the 5 min-control conditions combined showed significantly lower consumption intention than the 1 min-control condition (1 min control vs [1 min diet prime and 5 min control]; $t = 3.38$, $p < .001$).[3] Separating out the 1 min-diet priming condition and 5 min-control condition and comparing the high RES participants to the 1-min control condition showed the same results (1 min-control vs 1 min-diet priming: $t = 3.64$, $p < .001$; 1 min-control vs 5 min-control; $t = 2.35$, $p = .019$). And there was no significant difference in consumption intention between the 1 min-diet priming condition and the 5 min-control condition (t = -1.48, $p = .140$; joint test at + 1SD: $F(2, 269) = 6.84$, $p = .001$).

8.2.4. Perceived Reward

We also tested whether the perceived reward is a mediator of consumption intentions using the same measures used by Biswas and Szocs (2019). We compared the 1 min-control and 5 min-control conditions, but the mediation effect was not significant (95% CI of the indirect effect was from −2.31 to. 0.65).

8.3. Discussion

Study 3 results showed that when a diet goal was directly activated with short exposure to an indulgent scent, participants showed decreased indulgent food consumption intentions similar to when participants were exposed to just the indulgent scent for a longer duration. Indeed, the decreased consumption intentions as compared to short duration scent exposure were observed only from participants with greater concerns about their eating behavior. These results imply that directly activating diet goals could attenuate the scent duration effect for high RES participants. Furthermore, the scent duration effect is more prominent when participants have concerns about their eating behaviors that can be threatened by indulgent scents, which supports our diet goal activation account.

Unlike Biswas and Szocs (2019), we did not find evidence that the perceived/experienced reward from indulgent scents explained our findings in this study. This suggests that the goal activation mechanism may, in some cases (e.g., single evaluation contexts), act alone or in concert, in producing the same effect as Biswas and Szocs (2019). However, it was also possible that participants' perceived reward/enjoyment was not as strong as that in Biswas and Szocs (2019) as this study was conducted during the heart of the COVID-19 pandemic, and participants had to follow safety measures that could affect their scent experiences (e.g., wearing face masks during the study). Another possibility might be that in Biswas and Szocs (2019), participants were exposed to an indulgent scent either for 30 s or for 2 min, while in the current study, participants were exposed to an indulgent scent either for 1 min or 5 min. Thus, it was possible that perceived reward was already heightened with 1-minute exposure compared to that with 30 s exposure, leading to the inconsistent result with Biswas and Szocs (2019).

Table 5
Estimated marginal mean consumption intention scores at +/-1SD from the mean RES score, and contrast results in Study 3.

	Low RES (−1SD; at RES = 1.79)	High RES (+1SD; at RES = 3.38)
1 min-control (N = 94)	57.5 (2.93)	66.0 (2.70)
1 min-diet priming (N = 93)	59.5 (2.58)	51.5 (2.94)
5 min-control (N = 89)	58.9 (2.69)	57.3 (2.57)
1 min-control vs 1 min-diet priming	t(269) = -0.52, p =.605	t(269) = 3.64, p <.001
1 min-control vs 5 min-nature	t(269) = -0.36, p =.718	t(269) = 2.35, p =.019
1 min-diet priming vs 5 min-control	t(269) = 0.16, p =.876	t(269) = -1.48, p =.140

Standard errors are presented in the parenthesis.

[3] A Condition (1min-control vs [1min-diet priming and 5min-control]) ×RES ANOVA with the sweet snack liking covariate result showed a significant interaction effect ($F(1, 271) = 6.70$, $p < .001$, $\eta_p^2 = 0.02$).

9. General discussion

Retailers frequently use indulgent food scents in the hope of increasing consumption intention and sales of indulgent food. Consistent with prior research but inconsistent with current practices, this research finds that the use of indulgent scents can backfire: extended exposure to an indulgent food scent decreases indulgent food consumption.

This research makes several theoretical and practical contributions. First, our research provides a conceptual replication and extension of Biswas and Szocs (2019) by investigating the impact of indulgent food scents in separate rather than joint evaluation contexts. While Biswas and Szocs (2019) showed that extended exposure to unhealthy food scents increased healthy food choices as compared to unhealthy food choices, we found that indulgent food scents only reduce indulgent food consumption intentions rather than increasing healthy food consumption intentions. This meaningful difference was not distinguishable in the joint evaluation mode utilized in Biswas and Szocs (2019). Thus, this research clarifies the paradoxical implication of indulgent food scent on food consumption.

Furthermore, it contributes to the literature on sensory marketing by exploring a new underlying mechanism of the impact of prolonged exposure to an indulgent scent on indulgent food consumption. Our research demonstrates that indulgent food scent directly activates a goal (i.e., a diet goal) that counteracts the desire for food consumption. It also provides direct evidence of diet goal activation by documenting that indulgent food scents lead people to respond faster to diet-related words in a Lexical Decision Task (LDT). Furthermore, it validates the diet goal activation account by documenting that priming diet goals attenuates the scent duration effect. In addition, individuals' weight concerns also moderate the scent duration effect. These findings suggest that a different/additional mechanism through which indulgent food scent can decrease indulgent food consumption might be at work.

Thirdly, this research also offers important implications for consumer well-being. It provides empirical support for how scents can help consumers regulate indulgent food consumption. Our findings on the role of scent as a diet goal activator imply that using an indulgent scent may aid dieters in maintaining their diet goals and avoiding eating indulgent foods. In this way, extended exposure to indulgent (versus healthy) food scents may help individuals control their weight more effectively by decreasing indulgent food consumption.

Overall, our main finding serves as a conceptual replication as well as an extension of what Biswas and Szocs (2019) have documented. Biswas

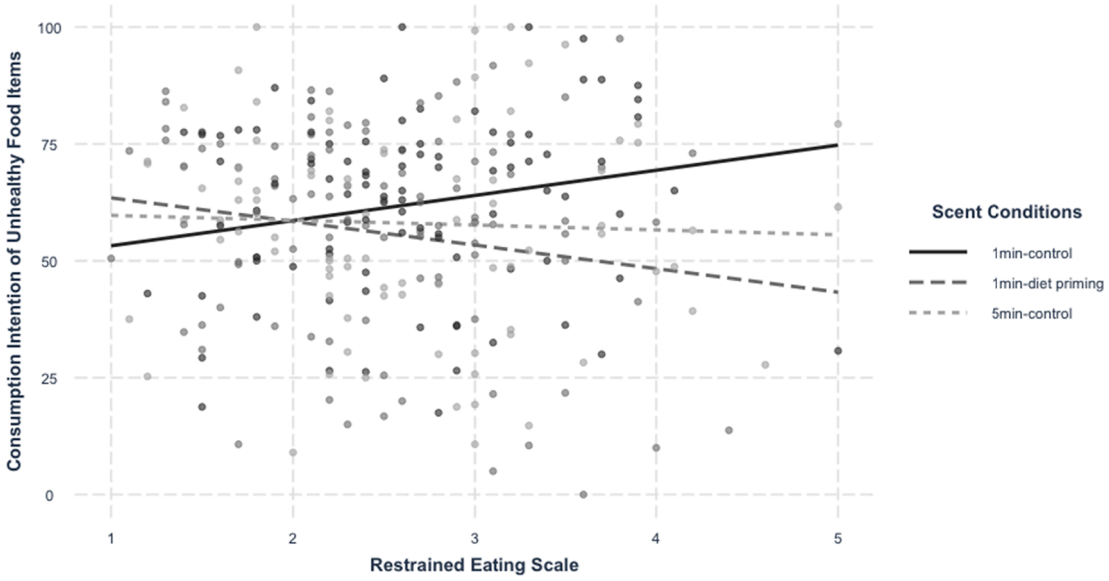

Fig. 3. The interaction between Scent Conditions and RES in Study 3.

and Szocs (2019) investigated indulgent scent effects on a consumer's relative food preference in a joint evaluation context in which consumers compared both types of products (healthy and unhealthy) with each other. Thus, whether the effects were driven by the change in preference for unhealthy or healthy food items is unclear. In this research, we examined the effect of indulgent scents on food consumption independently (e.g., in contexts in which no healthy food is present). In the independent food consumption context, extended exposure to indulgent scents reduces indulgent food consumption only and does not necessarily promote healthy food consumption. By doing so, this research clarifies the impacts of indulgent food scents on food consumption intention and behavior.

More importantly, our research offers a unique process explanation for decreased consumption of indulgent scents based on counteractive goal activation. Supporting our diet goal activation account, extended exposure to an indulgent food scent leads to a faster response to diet-related words as compared to brief exposure (Study 2) and a comparable effect with direct diet goal priming (Study 3). Furthermore, this research offers strategic insights for indulgent food retailers by showing various moderators that are directly applicable to retailer practices. Scent indulgence (Study 1A) and food healthfulness (Study 1C) moderate the impact of the indulgent scent on food consumption.

The current research offers insights into scent marketing. It also directly demonstrates the negative impact of extended exposure to an indulgent scent on indulgent food consumption in a separate evaluation mode (Hsee, 1996). In doing so, this study extends research that examines the scent effect in a joint evaluation mode, which focuses on consumer choice between healthy and unhealthy food items (Biswas & Szocs, 2019). In practice, many restaurants, such as Cinnabon, do not offer choices between healthy and unhealthy items; instead, they only provide binary choices of buying versus not buying an unhealthy product. It also shows that many scents, in practice, may be perceived as visceral and tempting only when they are first encountered, thus limiting research findings on smell impulsivity to shorter time horizons (Hoch & Loewenstein, 1991; Loewenstein, 1996). In longer time horizons, decreased purchasing behavior due to smells may be a more likely outcome. As such, the current research provides more practical insights for food retailers that seek evidence of the direct implication of scent marketing on their indulgent food sales.

The finding that an indulgent scent activates a counteractive goal also has significant implications for retailers. For example, as indulgent food activates a diet goal, non-food retailers whose business can benefit by increasing diet motivation, such as fitness centers could consider using an unhealthy food scent to encourage dieting behaviors. In addition, this research offers additional practical suggestions on how to use indulgent scents strategically in retail contexts. Study 1A documents that an indulgent scent reduces indulgent food consumption while a control scent does not. If the goal of scent marketing is to create a pleasant store atmosphere and enhance the consumer experience, retailers can select a scent that helps achieve the goal, while not necessarily imposing any risk on indulgent food sales.

Furthermore, this research can help food retailers design their store layouts to optimize their goal of scent marketing. For example, we find that extended exposure decreases indulgent food consumption while a brief exposure does not. Food retailers selling indulgent food items could use this information strategically when deciding where to locate the source of indulgent scent in their store layout (e.g., where to put ovens). This research also offers insights into how retailers should position themselves relative to other retailers. In Study 1C, exposure to an indulgent scent affected not only scent-related indulgent food consumption (e.g., chocolate scent-chocolate ice cream) but also other indulgent food consumption (e.g., French fries) unrelated to the scent. This suggests that nearby indulgent scents in a retailing environment can affect preferences.

Finally, the moderating role of food healthfulness provides insights for food retailers in designing and developing communication messages about food items when indulgent food scents are available. For example, our research suggests that indulgent food retailers might develop messages to reduce consumers' concerns about diet (e.g., low-calorie chocolate cookies) rather than solely emphasizing indulgence and enjoyment of indulgent food items. Study 1C showed that food healthfulness perceptions moderate the effect: when participants perceived a food item as indulgent, extended exposure to the indulgent scent significantly reduced their consumption intention. This finding provides insights for retailers in designing and developing communication messages about food items. Rather than emphasizing indulgence and enjoyment of indulgent food items, retailers might develop messages to reduce consumers' concerns about dieting (e.g., low-calorie chocolate cookies).

9.1. *Limitations and future directions*

There are several limitations in the current research that merit future investigation. First, while our theory implies that other indulgent food

scents, such as popcorn scents, should reveal the same effect, empirical evidence is needed to support this proposition.

Second, extended exposure in our studies lasted for five minutes. It remains unclear whether even longer exposure time would continue to induce the effect observed in this paper. We have preliminary evidence that suggests that longer exposure times will likely still induce the effect. In this additional study (N = 162), participants were given 140 g of M&Ms and were asked to consume the M&Ms as much as they wanted after being exposed to a chocolate scent either for 1 min, or 5 min, or 15 min. We found that participants exposed to the chocolate scent for 5 min (12.79 g) or for 15 min (13.68 g) ate M&Ms significantly less than those exposed to the chocolate scent for 1 min (18.00 g), but there was no significant difference in M&Ms consumption between 5-minute exposure and 15-minute exposure. This provides initial evidence that exposure to an indulgent scent longer than 5 min can still reduce indulgent food consumption, but further research is necessary to understand whether the longer duration results are contributed by habituations or maintained diet goal.

Third, inconsistent with Biswas and Szocs (2019), we did not find a significant mediation effect of experienced reward. However, this could be because the safety measures participants had to comply with due to the COVID-19 pandemic (e.g., wearing masks during experiment procedures) could have affected participants' overall experience or enjoyment. Thus, experienced enjoyment or reward from the ambient scent was not as strong as in Biswas and Szocs (2019). Future research may need to more directly and systematically test how and when the experienced reward explanation and the goal activation account play their roles or they interact with the ambient scent effect.

Fourth, while we offer suggestive evidence for a counteractive goal priming effect, this is not an exhaustive series of studies on counteractive goal priming, particularly in the scented space. Therefore, we would be remiss in not offering consideration of a number of potential alternate explanations. In particular, the literature on goal priming does suggest that goal primes require triggering action towards a goal (Custers & Aarts, 2005; Fitzsimons et al., 2008). At first glance, this seems contradictory with our results that low RES participants do not exhibit this effect. One explanation for this could be that the stimuli act differently for those who hold the counteractive goal (high RES creating a counteractive goal) and those who do not (low RES using a more cognitive pathway response). Thus, only high RES might be exhibiting a counteractive goal priming effect. Future research could seek to understand the different pathways for counteractive responses (whether goal or cognitively oriented).

In addition, experiment 1 of Fitzsimons et al. (2008) does suggest that behavior increases with a time delay from the goal priming stimulus and does not decrease over time. This is generally consistent with our studies that show that scent counteractive goal effects only occur in long time durations. However, this does raise the question of other possible explanations for why counteractive goals are not activated with short duration scent exposure since research does suggest that activation should be immediate (Fitzsimons et al., 2008). We believe that it is likely that, since scents are rich stimuli, there is an element of either a high sensory threshold for counteractive goal activation or the richness of the stimuli creating noise that is either preventing the counteractive goal from forming or it is forming at too low of a threshold for us to reliably measure it. Future research should extend counteractive goal theory in the scent domain.

Also, a variety of research on priming has suggested that awareness can potentially interfere with priming (Fitzsimons et al., 2008), there is research that directly compared priming with and without awareness in the visual domain. For example, Cheesman & Merikle (1984) found higher levels of priming with awareness in the visual domain. This suggests that there are even cases where detectable priming can lead to greater priming effects than undetectable priming. This research suggests that we do not yet fully understand the boundaries of priming and all cases of when and how awareness interacts with it.

Lastly, our sample sizes were enough to detect a medium effect size. Post-hoc power analysis results using G*Power (Faul et al., 2007) indicated that with the current experimental designs, the probabilities to detect the observed effect sizes of all studies were 67%, on average. Also, the probabilities to detect a medium effect size (Cohen's f = 0.25) were 93% and those to detect a small effect size (Cohen's f = 0.1) were 39% in Studies 1A, 1B, 1C, and 3, respectively. Thus, these seem to indicate that the sample sizes were adequately powered to detect a medium-sized effect. The effect sizes (Cohen's f) of the lab studies in Biswas and Szocs (2019) were 0.18, on average, which was between small and medium effect sizes but closer to a medium effect size. The probability to detect the average effect size in Biswas and Szocs (2019) with our experimental designs was 79%. Thus, our research is highly powered enough to detect the types of effect sizes found in Biswas and Szocs (2019). Future research may need to test the findings with experimental designs that can detect a small-sized effect.

Future research could also examine how olfactory cues interact with other sensory cues to jointly affect the activation of diet-related goals. With obesity on the rise and people struggling to control the kind of food they eat, insights into how sensory cues can nudge people to adopt healthy behavior can be both theoretically and practically important. On a similar note, it will likely be important to understand if scent effects work similarly if the scent is attributed consciously to a non-food item such as a chocolate-scented candle.

CRediT authorship contribution statement

Boyoun (Grace) Chae: Conceptualization, Investigation, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Sangsuk Yoon:** Visualization, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization, Writing - original draft, Writing - review & editing. **Ernest Baskin:** Methodology, Data curation, Conceptualization, Formal analysis, Investigation, Resources, Writing - original draft, Writing - review & editing. **Rui (Juliet) Zhu:** Conceptualization, Funding acquisition, Supervision, Writing - original draft, Writing - review & editing.

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.

Data availability

Please see the following link for the videos studies in the paper (OSF repository: https://osf.io/yxfpj).

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Appendix A. Study instructions and stimuli used in study 1A

Scenario study

In this part of the study, we would like to know how consumers behave in a certain situation. You will be given a specific consumption context and will be asked to imagine consuming some food. Try to put yourself in the given context and imagine the consumption experience as vividly as possible.

Please imagine that you are invited to a dinner at your friend's place on Saturday night. It's time for dessert and you are served the chocolate ice cream below.

Now, imagine that the chocolate ice cream is placed in front of you as in the following picture.

Appendix B. Study instructions and stimuli in study 2

a. LDT task

Word Recognition Task.

In this study, you will see a series of letters.

If you think that the letters are a word, press '**J**', but if you think that they are not a word, press '**F**'. Please try to respond as accurately and fast as possible.

You can't go back so please continue to work on the task even if you make a mistake.

Before getting started, put your right index finger on 'J' button and your left index finger on 'F' button.

Are you ready?

Press the 'J' button to start practice.

Word or not?

[letters presented here].

No (F) Yes (J).

This is the end of practice.

The instruction shown during the practice session would no longer to be presented in the main experiment.

Are you ready?

Press the 'J' button to start the main experiment.

b. The list of the words used in Study 2

WordID	Word	Trial	Type	Target	Length
1	anchor	Practice	Word		6
2	desk	Practice	Word		4
3	wind	Practice	Word		4
4	fence	Practice	Word		5
5	gusped	Practice	Nonword		6
6	pseagg	Practice	Nonword		6
7	soncked	Practice	Nonword		7

(*continued on next page*)

(*continued*)

WordID	Word	Trial	Type	Target	Length
8	phoun	Practice	Nonword		5
1	healthy	Main	Word	Diet-related	7
2	diet	Main	Word	Diet-related	4
3	slim	Main	Word	Diet-related	4
4	fit	Main	Word	Diet-related	3
5	shape	Main	Word	Diet-related	5
6	discipline	Main	Word	Regulation-related	10
7	willpower	Main	Word	Regulation-related	9
8	restrain	Main	Word	Regulation-related	8
9	regulate	Main	Word	Regulation-related	8
10	resist	Main	Word	Regulation-related	6
11	uniform	Main	Word	Neutral	7
12	landscape	Main	Word	Neutral	9
13	magazine	Main	Word	Neutral	8
14	library	Main	Word	Neutral	7
15	gasoline	Main	Word	Neutral	8
16	veannth	Main	Non-word		7
17	otve	Main	Non-word		4
18	abik	Main	Non-word		4
19	wern	Main	Non-word		4
20	snaimthxpe	Main	Non-word		10
21	kwoaksen	Main	Non-word		8
22	thimms	Main	Non-word		6
23	grynt	Main	Non-word		5
24	crofs	Main	Non-word		5
25	pymfs	Main	Non-word		5
26	woogns	Main	Non-word		6
27	phlerph	Main	Non-word		7
28	gwoomn	Main	Non-word		6
29	floarmbr	Main	Non-word		8
30	skicsed	Main	Non-word		7

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