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BRAND MEMORY EFFECTS OF RETRONASAL OLFACTION[1]

This research examines whether retronasal olfaction affects consumers' memory for unfamiliar brand names. Results suggest that retronasal olfaction does not affect brand recall, and that the impact of retronasal olfaction on brand recognition depends on the odorant used. Mood and cognitive load did not mediate this effect.

Scents and Consumer Responses

The marketing literature has investigated the role of ambient scent in influencing a variety of consumer responses. Scent is probably one of the most powerful ambient factor marketers have at their disposal. This is because the sense of smell is the only one of the five senses directly linked to the amygdala; it is thus implicated in emotional responses to stimuli associated with scent (Aggleton & Mishikin, 1986; Herz and Engen, 1996). Research on the effect of ambient scent on consumer responses to retail environments indeed suggests that pleasant ambient scents lead to more time spent in stores (Knasko, 1989), increased spending at slot machines (Hirsch, 1995), more favourable in-store product evaluations (Spangenberg, Crowley, & Henderson, 1996), and more positive product attitudes and purchase intentions (Fiore, Yah, & Yoh, 2000). Scents that are congruent with the store's product offering also result in positive consumer responses, such as more favourable product evaluations (Bosmans, 2006) or variety seeking (Mitchell, Kahn, & Knasko, 1995). Similarly, ambient scents that are congruent with other environmental elements, such as music increases consumers' perception of pleasure, evaluation of the store (Mattila & Wirtz, 2001; Spangenberg, Grohmann, & Sprott, 2005), approach behaviors, impulse purchases, and satisfaction (Mattila & Wirtz, 2001). Although most studies examined the impact of ambient scent on consumer responses to retail environments, there is also evidence that pleasant ambient scent increases consumer attention to brands and thus results in improvement in brand recall (Morrin & Ratneshwar, 2003).

Despite the promise ambient scents hold for retailers and marketers, there are several drawbacks to their use: First, complication in the use of ambient scents arise from the fact that ambient scents are most effective when congruent with the product category offered (Mitchell et al., 1995), or other elements in the retail environment (Mattila & Wirtz, 2001; Spangenberg et al., 2005). Selection of a single ambient scent may thus be challenging for retailers carrying a variety of product categories associated with different intrinsic scents (e.g., grocery stores).

A broad product assortment might mandate implementation of multiple scents in a retail environment, yet unless product categories are clearly separated, this may not be feasible. If product

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categories are physically separated within the store, retailers could use multiple scents to create different zones within their stores; such a strategy is likely to result in undesirable scent mixtures within the store, however. Not only may scent mixtures be less pleasant than individual scents, their effects on consumer responses are also unclear. Challenges also arise in selection of scents that are congruent with other elements of the retail envirionment. Research on congruence is relatively recent and sound guidelines for retail practice are thus lacking.

A second problem afflicting the use of ambient scents in retail environments is that consumers and regulatory bodies are increasingly skeptical with regard to the use of ambient scents in stores. Consumers are concerned with the possibility that ambient scents may help retailers manipulate consumer behaviour. In addition, there is an increasing concerrn about potential health implications arising from the use of ambient scents (Fumento, 2000; Greenberg, 1999). Discussions regarding the role of ambient scents and personal fragrances in the somewhat controversial emergence of multiple chemical sensitivities syndrome (MCS) seem to suggest that the use of scents—including ambient scents in retail environments—could be more limited in the future (McLaren, 2000).

Regulation of ambient scents may deprive consumers of some of the positive consequences associated with their use, however. Although retailers seem to be the primary beneficiaries of the effects of ambient scent on consumer responses—such as in the form of more favourable merchandise evaluation (Spangenberg et al., 1996) or increased spending at slot machines (Hirsch, 1995)—there is no strong evidence that ambient scents in retail environments are effective in manipulating consumer behavior (Herz, 2007). It appears, however, that pleasant ambient scents benefit consumers by providing a more enjoyable shopping and browsing environment (Fiore et al., 2000), and by enhancing consumer decision making (Mitchell et al., 1995) and consumer memory (Morrin & Ratneshwar, 2003).

The question addressed in this research is whether there are strategies that allow consumers to enjoy olfactory cues without negatively affecting other consumers. Most research on olfaction in marketing contexts has focused on the effect of ambient scents that are absorbed orthonasally (i.e., through the nostrils). Olfactory cues may also be perceived retronasally (i.e., through the mouth), however. Retronasal olfaction arises from olfactory cues that are administered individually and orally, for example in the form of a chewing gum or food. Opportunities for application of retronasal olfaction arise from incidental consumption of food, beverages or chewing gum by consumers, or through more targeted food sampling strategies, such as those already employed by marketers in grocery store or mall settings. In either case, unlike exposure to ambient scent, acceptance of a retronasal odorant is based on consumers' own decision to try the stimulus.

This research focuses on whether retronasal olfaction affects consumer responses; the focus here is on the effect of retronasal olfaction on consumers' memory for brands. This research extends the literature by examining (1) whether effects of retronasal odorants on brand memory can be obtained via retronasal administration, and (2) what role mood and task load perceptions associated with retronasal stimulus administration play in this relationship. The next section presents the theoretical background and hypotheses that were tested in a lab experiment. A discussion of results and implications for consumers and retailers will conclude this paper.

Effects of Retronasal Olfaction on Brand Memory

This research focuses on retronasal olfaction, that is, olfaction resulting from odorants reaching the nasopharynx via the mouth (Pierce & Halpern, 1996). Retronasal olfaction occurs during eating and drinking, and combines with the sense of taste, audition, and somatosensory perception of texture and fattiness to form flavour experience (Duffy, Cain, & Ferris, 1999).

Orthonasal and retronasal olfaction are perceived differently (Koza, Cilmi, Dolese, & Zellner, 2005; Rozin, 1982); effects observed for ambient scents may thus not necessarily hold to the same extent for retronasally administered olfactory cues: In a comparison of orthonasal and retronasal odorant administration, Zoladz and Raudenbush (2005), for example, found that the effect of retronasally administered odorants is task-dependent and less general than that of orthonasally administered odorants. Retronasally administered odorants also seem to have a weaker effect than orthonasal odorants (Zoladz & Raudenbush, 2005). Nevertheless, retronasally admininstered odorants enhance performance on memory tasks: both immediate and delayed recall of words increased following the administration of retronasal odorants (Wilkinson, Scholey, & Wesnes, 2002). It is therefore expected that retronasal olfaction enhances consumers' recall and recognition of unfamiliar or newly introduced brand names they have only been exposed to once.

H1: Retronasal olfaction increases (a) band recall and (b) brand recognition, compared to a non-odorant control condition.

In experimental studies on retronasal olfaction, odorants are typically administered via chewing gum (e.g., Wilkinson et al., 2002; Zoladz & Raudenbush, 2005). Although mastication alone improves blood flow to the brain (Sesay, Tanaka, Ueno, Lecaroz, & De Beaufort, 2000) and triggers an insulin response that potentially facilitates cognitive task performance (Stephens & Tunney, 2004a), research also suggest that an effect of retronasal odorants on cognitive activity goes beyond that of mastication. In Wilkinson et al.'s (2002) study, for example, chewing flavoured gum enhanced recall compared to chewing a non-flavoured gum. The finding that both chewing and sucking spearmint gum enhanced learning and recall of word lists compared to a no gum control (Baker, Bezance, Zellaby, & Aggleton, 2004) further supports that the retronasal odorant rather than chewing activity itself produces the observed memory effects.

Research to date does not reveal what retronasal odorants are the most effective in inducing memory effects, however. Despite evidence that performance on cognitive tasks varies with chewing gum flavor (Morinushi, Masumoto, Kawasaki, & Takigawa, 2000), there are only a few studies comparing specific odorants. As a result, Stephens and Tunney (2004b) call for more research on this topic. This research compares the effects of two widely available, frequently used, and qualitative dissimilar retronasal odorants: peppermint and cinnamon.

Orthonasally administered peppermint odorant has been associated with an increase in athletic performance (Raudenbush, Corley, & Eppich, 2001) and a reduction in perceived physical and temporal workload, and frustration (Raudenbush, Meyer, & Eppich, 2002). In studies involving retronasally administered peppermint odorant, these effects on athletic performance could not be replicated, however (Zoladz, Raudenbush, Fronckoski, and Price, 2003). In a memory task, Zoladz and Raudenbush (2005) compared retronasally administered odorants and found that peppermint increased performance on memory tasks over a no gum and no flavor gum condition, but was consistently outperformed by cinnamon odorant. Thus, while both odorant conditions should result in performance that is better than in a control condition (Baker, Bezance, Zellaby, & Aggleton, 2004; Wilkinson et al., 2002), these findings suggest that cinnamon odorant also enhances performance on memory tasks compared to peppermint (Zoladz & Raudenbush, 2005).

H2: A retronasally administered cinnamon odorant increases (a) brand recall and (b) brand recognition, compared to a peppermint odorant.

The Role of Mood and Cognitive Load

The literature raises a number of possibilities with regard to the mechanism underlying the effects of olfaction on memory: The first is that an increase in mood associated with a pleasant odorant enhances recall and recognition. The presence of pleasant odorants has been associated with mood enhancement (Baron & Thomley, 1994), yet results are mixed: In the domain of orthonasal olfaction, both Spangenberg et al. (1996) and Morrin and Ratneshwar (2003) failed to find an impact of a pleasant ambient scent on mood. Other studies (Knasko, 1995; Ludvigson & Rottman, 1989), however, report more positive self-reported mood in the presence of chocolate, baby powder, and lavender, but not clove, scent. These observations may be in line with Bone and Ellen's (1999) conclusion that mood effects of ambient scent may depend on positive associations evoked by specific scents rather than the mere presence of scents. Overall, evidence for a scent–mood relationship is relatively weak, but an effect of scent on mood cannot be entirely ruled out.

Mood responses due to odorants are relevant to recall and recognition tasks, because there is evidence of context-dependent memory effects, also referred to as state-dependent learning: if mood at encoding and retrieval of stimuli is consistent, this consistency facilitates performance on memory tasks (Bower, 1981). Although a viable approach to inducing consistent mood at both encoding and retrieval stages is the administration of the same odorant (Morrin & Ratneshwar, 2003), results with regard to odor-induced state-dependent learning are not convincing: Morrin and Ratneshwar (2003) did not find that administration of the same ambient odorant at the learning and retrieval stages resulted in enhanced memory for brands. A factor that complicates the formation of specific hypotheses with regard to the effects of scent on mood and a potential mediating role of mood in the context of retronasal olfaction is the fact that all of the studies considering odorant effects on mood were conducted in the context of ambient scent. As there is a lack of research on retronasal olfaction, this research empirically tests whether mood is a potential mechanism underlying the effect of retronasal odorants on consumer memory. In light of the often contradictory findings with regard to scent, mood, and memory links, no specific hypotheses are advanced, however.

The second mechanism that could underlie an effect of retronasal olfaction on consumer memory is the cognitive load consumers experience, especially at the retrieval stage. Based on dual models of mental processing (e.g., Kahneman & Frederick, 2002; Sloman, 1996), an increase in cognitive load inhibits functioning of the deliberate, controlled processing system—usually in favor of more automatic, affective processing (Rottenstreich, Sood, & Brenner, 2007; Shiv & Fedorikhin, 1999). The use of affective processing, however, will inhibit rather than facilitate performance on a memory task that requires deliberate processing (i.e., the recall and recognition of factual information consumers have been exposed to in the learning stage). Thus, a higher level of cognitive load should in general result in decreased performance on a cognitive task, such as brand recall and brand recognition. If cognitive load is reduced, cognitive resources are freed up to and can be dedicated to the task. Performance on memory tasks should then increase.

The literature suggests that the administration of odorants may reduce cognitive load. It is thus possible that olfaction enhances memory through the reduction of cognitive load. In studies on the effect of olfaction on both physical and cognitive performance using a multi-dimensional measure of task load (Hart & Staveland, 1988), there is some evidence that olfaction influences mental task load, even though results are mixed and seem to suggest that effects are odorant-specific: In research on the effect of ambient odorants on athletic performance, peppermint odorant did not affect mental task load, but reduced physical and temporal task load (i.e., perceived time pressure); jasmine odor, on the other hand, did not have such an effect (Raudenbush, Meyer, & Eppich, 2002). Raudenbush and colleagues (2004) then found a significant decrease in mental task load in response to orthonasal administration of peppermint odorant compared to jasmine or control in a study on the effect of odorants on pain perception. In a study on the effects of orthonasal odorants on cognitive performance, however, there was no reduction in mental task load due to peppermint or any other odorant (Zoladz & Raudenbush, 2005).

In sum, the body of literature on the effect of olfaction on cognitive load is limited at best and focuses on orthonasal administration of odorants; the effect of retronasal olfaction on cognitive load has not been examined yet. Based on the lack of literature on this relationship, it is premature to advance specific hypotheses with regard to the effect of odorants on cognitive load and or a potential mediating effect of cognitive load on the odorant—brand memory relationship. Since the possibility of odorants reducing cognitive load is intriguing and promising for marketing practice, however, a first step in the investigation of the effect of retronasal odorants on brand memory will be taken in this research.

Method

Stimuli, Participants, and Procedures

The central question addressed in this research is whether retronasal olfaction influences consumers' memory for unfamiliar brands. A secondary set of questions relates to potential mediating mechanisms, namely mood and cognitive load. To examine these questions, consumers' recall and recognition is compared across two conditions in which peppermint or cinnamon constitute the retronasally administered odorants, and a control condition, in which no odorant is administered. Odorants were administered in the form of chewing gum. In order to control gum-related factors, such as chewing resistance (Suzuki et al., 1994), soft chew gums similar in size, appearance, and consistency were selected for both odorant conditions. The chewing gum stimuli used in this study were sugar-free to rule out an effect of glucose on cognitive performance.

One-hundred and fifty undergraduate students (48% male, median age = 21) participated in a one-factor experimental lab study (retronasal odorant condition: cinnamon, peppermint, control) in exchange for a moderate amount of course credit. The experiment was conducted over three days, and odorant conditions were rotated across days and times of day. After being screened for potential sensitivities to gum ingredients, participants were provided with either an Extra soft chew peppermint or Dentyne soft chew cinnamon gum, or no gum in the control condition. They were asked to fill in a two-page paper-and-pencil questionnaire that ostensibly served to study gum consumption habits among students. Participants in the odorant conditions were given the option of discarding the gum into paper cups located on their desks whenever they wanted, yet all of the participants chose to chew throughout the experimental session.

Once all participants had completed the gum questionnaire, they were told to start a PC-based study, in which they rated eleven foreign brand names in terms of familiarity, attitude, and appropriateness for various product categories. Participants completed an unrelated filler task, and were then asked to list any brand names they recalled seeing earlier. Next, participants completed a brand name recognition task that consisted of the eleven targets as well as eleven distracters presented in random order. Finally, participants completed process measures, and demographic information.

Measures

Memory measures consisted of brand recall and recognition. Brand recall was the count of correctly recalled brand names. Brand recognition was measured by showing eleven target and eleven distractor brand names to participants who had to indicate whether they had seen the brand name earlier in the experimental session (yes/no). Two recognition measures were created: the number of correctly recognized brand names (hits) and the number of correctly identified distracters (correct rejections).

Process measures included a four-item, seven-point mood scale ("Currently, I am in a good mood," "As I answer these questions, I feel cheerful," "For some reason, I am not comfortable right now," "At this moment, I feel edgy or irritable"), and eight items adopted from task load index (NASA-TLX workload components: mental, physical, temporal, overall, task difficulty, performance, stress, fatigue; Hart & Staveland, 1988). Other measures pertained to smoking habits, state of hunger, age, and sex.

Measure validation through factor analyses indicated that mood was not a unidimensional construct, even when items were reverse coded. The positive mood items loaded on one factor (51.9% of variance explained), while negative mood items loaded on a second factor (29.9% of variance explained). Separate measures for positive mood (r = .70) and negative mood (r = .54) were thus included in the analysis. For the task load index, a two-factor solution emerged; all but one item loaded on a common factor (32.1% of variance explained) and a task load index was created by averaging these items (α = .70). The fatigue item loaded on a second factor (15.9% of variance explained) and was treated separately in the analyses.

Results

Among the participants, 27 (17.6%) indicated that they are smokers. Some researchers report excluding smokers from their analyses (e.g., Olofsson & Nordin, 2004); the analyses reported next were thus conducted for non-smokers, as well as for the full sample. As the results were did not change, regardless of whether smokers were included or not, the discussion of results presented here pertains to the full sample. In addition, due to reported differences in perceptions of odorant intensity and processing between men and women (Lundström & Hummel, 2006; Olofsson & Nordin, 2004), participants' sex was included in the analyses.

Since state of hunger did not affect the results, it is not discussed further. In addition, the gum questionnaire participants filled in at the beginning of the session indicated that there was no significant difference in gum intensity (p > .49) and gum pleasantness (p > .07) between the two retronasal odorant conditions. Neither intensity nor pleasantness emerged as significant covariate in the analysis and are thus not considered further.

Brand Recall

In a 3 (retronasal odorant: none, peppermint, cinnamon) × 2 (sex: male, female) between-subjects ANOVA, there was only a significant main effect for sex, such that recall was higher for female participants ($Mean_{females}$ = 2.72, $Mean_{males}$ = 2.01, $F(1,134) = 5.68$, $p < .05$). The main effect of retronasal odorant, and the retronasal odorant sex interaction were not significant (p's > .38). In sum, retronasal odorants did not significantly enhance brand recall. Hypotheses 1a and 2a were not supported.

Brand Recognition

To examine the effect of retronasal stimulus on brand recognition, the standardized difference between the means of the hit and false alarm distributions d' was used as dependent variable. This measure is the most commonly used indicator of sensitivity in signal detection theory, and thus appropriate for a recognition task.

In a 3 (retronasal odorant: none, peppermint, cinnamon) × 2 (sex: male, female) between-subjects ANOVA, there was a main effect of retronasal odorant ($F(2,134) = 4.68$, $p < .05$), but no other effects reached significance (*p*'s > .08). Mean comparisons with Bonferroni adjustments indicate a significant difference between the control and peppermint condition ($t(93) = 2.67$, $p < .05$), albeit in an unexpected direction: peppermint resulted in worse performance on the recognition task than control. A similar pattern emerged for a comparison of the cinnamon and peppermint conditions ($t(90) = 2.46$, $p < .05$): Peppermint gum resulted in worse performance than cinnamon. Cinnamon and control did not differ ($p > .99$). Overall, participants in the control and cinnamon conditions were better at recognizing unfamiliar brand names after one exposure, and at identifying brand names they had not seen before than participants in the peppermint condition. Table 1 shows the mean values and standard deviations for *d'*, as well as hits and false alarms to better illustrate recognition performance. The pattern of results for *d'* reported here also holds for hits and false alarms; hits and false alarms are thus not discussed in detail.

Table 1

Retronasal Olfaction Effects on Brand Recognition: Hits, False Alarms, and d'

Condition	N	Hits	False alarms	d'
Control	48	10.73 (.49)	.19 (.64)	4.26 (.65)
Peppermint	47	10.17 (1.65)	.64 (1.47)	3.76 (1.15)
Cinnamon	45	10.73 (.62)	.22 (.47)	4.23 (.63)

Note: Cell entries show means and standard deviations. Larger *d'* values indicate better performance on the recognition task.

To summarize, retronasal odorant had an impact on brand recognition, but in an unexpected way: While cinnamon resulted in performance comparable to control, performance in the peppermint conditions was worse than in both cinnamon and control conditions. Hypothesis 1b stating that both odorants would increase brand recognition compared to a no-odorant control was not supported. Hypothesis 2b stating that cinnamon would result in better performance on the brand recognition task compared to peppermint was supported.

Process Measures

To explore the effect of retronasal odorant on mood and cognitive load, a series of ANOVAs were conducted with retronasal odorant and sex serving as between-subjects factors. There was no significant main or interaction effect involving odorant on positive and negative mood (*p*'s > .23).

For mental task load as a single-item measure of cognitive load, no significant main or interaction effects involving odorant and sex emerged ($p > .35$).

When the task load index was considered as an alternative measure of cognitive load, there was no significant main effect for odorant ($p > .65$), but a significant main effect of sex, such that male participants reported a higher perceived task load than female participants ($M_{males} = 3.16$, $M_{females} = 2.82$, $F(1, 134) = 5.43$, $p < .05$). Retronasal odorant and sex did not interact ($p > .40$). Finally, there were no significant effects of retronasal odorant on fatigue (*p*'s > .26). In sum, neither mood nor task load (regardless of how task load was operationalized) were affected by the presence or nature of the retronasal odorants used.

Discussion

Results of this experiment investigating the impact of retronasal olfaction on consumers' memory for brand names suggest that retronasal olfaction did not have a significant impact on recall of unfamiliar brand names after one exposure. Retronasal olfaction did influence brand recognition, however: Peppermint odorant resulted in lower levels of brand recognition than both cinnamon odorant.

These results differ from the results of retronasally administered peppermint and cinnamon odorants in Zoladz and Raudenbush's (2005) that resulted in memory task performance in response to both odorants that was better than in a control condition. One of the reasons why Zoladz and Raudenbush (2005) may have found effects of retronasal odorant conditions compared to a control is that their experiment employed a within-subjects design, in which participants completed various cognitive tasks while being exposed to three odorant conditions, a no-odorant gum, and a no-gum condition. It is likely that participants were aware of the purpose of the study, as the authors report only omitting information regarding the specific odorants being used. This raises the possibility of demand cues influencing findings. This research used a between-subjects design, and in the learning phase—in which learning was incidental to a brand name rating task—participants were not aware that their memory for the brand names would be tested later on. As a result, participants were completely blind to the experimental manipulations and the purpose of the study. It is possible that this lack of awareness regarding the research's purpose produced different results.

A second possible reason for unexpected findings in this study is the relatively low level of difficulty of the memory task. The d' values in this research indicate that the recognition task was relatively easy. Chance performance on a recognition task are reflected in a d' close to zero, while larger d' values reflect better than chance performance. A more challenging recall and recognition task may have been a stronger test of the hypotheses. It is possible that the nature of the brand names chosen resulted in a ceiling effect in brand recall, such that brand recall was fairly high in all of the conditions, and statistical analysis suggested that there were no significant differences in recall between control and retronasal olfaction conditions. In managerial practice, easy recall and recognition of adopted brand names is highly desirable, however. The choice of real, but unfamiliar brand names in this experiment thus reflects this tendency to choose brand names that are easily recalled and recognized.

The lack of findings with regard to the effect of retronasal olfaction on mood and perceived task load are also unexpected, but do converge with observations in the domain of orthonasal olfaction. Morrin and Ratneshwar (2003), for example, found that ambient scents did not affect mood and ruled out a mediating effect of mood on the ambient scent-memory relationship. Alternatively, the fact that the memory task was relatively easy may have prevented the expected and significant reduction in task load and fatigue in the retronasal olfaction conditions compared to the no-odorant condition.

Conclusions and Future Research

This research shows that brand recognition, but not recall, is affected by retronasal olfaction. A retronasally administered cinnamon odorant increased recognition of unfamiliar brand names, compared to a peppermint odorant. Cinnamon odorant did not lead to an increase in performance on the recall and recognition task compared to the no odorant control, however.

Retronasal olfaction is a recent field of inquiry that is characterized by contradictory results regarding memory effects (see Stephens & Tunney; 2004a, 2004b). This suggests that more research is needed to better understand the effects of retronasal olfaction, particularly in light of its potential to enhance individual memory or physical performance without ambient manipulations. There are a number of avenues future research might take to resolve questions concerning the effects and working mechanisms of retronasal olfaction.

One of the most obvious limitations of the current research, and potential avenues for future research pertains to the effects of specific odorants. In this research, only two odorants, namely peppermint and cinnamon were examined. Research indicates, however, that the odorant itself plays a major role in the effects of retronasal olfaction. Although there is a wide range of odorants, only a few, namely cinnamon, peppermint, spearmint, and cherry, have been examined in experimental research (Wilkinson et al., 2002; Zoladz & Raudenbush, 2005). In a marketing context, where the focus is on what consumers can do themselves to increase memory, the most relevant odorants may be those that are already commercially available and easily accessible to consumers, such as berry, mandarin, or flavor mixtures (e.g., fruity Stride).

A second avenue for future research pertains to potential context-dependency of effects of retronasal olfaction. Just as in Wilkinson et al.'s (2002) research, the encoding and retrieval phases were administered in a single session in this research. Since all participants in the peppermint and cinnamon conditions chose to chew the gum throughout the session—a process that mirrors many of the studies on retronasal olfaction (e.g., Zoladz & Raudenbush, 2005)—this research does not illuminate whether the effects observed for brand recognition are context-dependent (i.e., could be reproduced only if participants chew at both the learning and the retrieval phase). Research on retronasal olfaction suggests that it is likely that the memory effects arising from chewing gum are context-dependent (Baker et al., 2004). Future studies could thus examine context-dependency further.

A third avenue for future research is an examination of mechanisms by which retronasal olfaction enhances consumers' memory. One of the most basic questions that is still unanswered is to what extent odorant versus heart rate and glucose response to mastication influence memory. The role of psychological mechanisms such as mood is also not quite clear, as research does not concur on whether such effects should be expected or not.

This research is one of the first to consider the effect of retronasal olfaction on consumer memory. Its goal was to examine the viability and effectiveness of alternative routes to ambient scent administration in retail environments. The results are encouraging in that different odorants seem to affect consumer memory differentially. This research was also the first to examine a potential effect of retronasal olfaction on mood; results converge with findings in the area of ambient scent where an effect of scent on mood has been questioned (Bone & Ellen, 1999). Overall, this research highlights that there is a need for more research to better understand the potential retronasal olfaction holds for consumers and marketers.

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