Title
Verbal overshadowing in odor recognition

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 46(0)

Authors
Cao, Yaxiong
Majid, Asifa
Vanek, Norbert

Publication Date
2024

Peer reviewed

Verbal overshadowing in odor recognition

Yaxiong Cao (ycao258@aucklanduni.ac.nz)
School of Cultures, Languages and Linguistics, University of Auckland
18 Symonds Street, 1010 Auckland, New Zealand

Asifa Majid (asifa.majid@psy.ox.ac.uk)
Department of Experimental Psychology, University of Oxford
Anna Watts Building, Woodstock Rd, Oxford OX2 6GG, UK

Norbert Vanek (norbert.vanek@auckland.ac.nz)
School of Cultures, Languages and Linguistics, University of Auckland
18 Symonds Street, 1010 Auckland, New Zealand

Abstract

This study investigates the phenomenon of verbal overshadowing in olfaction. It focuses on how odor recognition is impacted after individuals sniffed and then described odors. Three key findings emerged. First, participants who refrained from describing a previously encountered target odor (control group) showed significantly superior performance in recognizing the target odor compared to those who had described it (verbal group). Second, the verbal overshadowing effect tended to diminish or completely disappear when participants were required to respond rapidly. Third, providing participants with instructions highlighting potential conflicts between olfactory and verbal representations did not alleviate the influence of the verbal overshadowing effect. To conclude, describing an odor elaborately can adversely affect odor memory, even when one is aware of this, but this is mitigated under speeded conditions.

Keywords: verbal overshadowing, odor recognition, rapid responses, cross-modal associations, odor description quality

Introduction

In 1971, Paivio introduced the Dual Coding Theory, which posits that information can be encoded and processed through verbal, nonverbal, or a combination of both modalities. Verbal and nonverbal representations, rather than being mutually exclusive, synergistically collaborate to enhance comprehension and memory. According to this theory, memory is strengthened when multiple retrieval routes are available for the same information. Contrary to the notion that verbal processing has positive effects on memory and recognition, the theory of verbal overshadowing (Schooler & Engstler-Schooler, 1990) challenges this perspective.

The verbal overshadowing effect, initially formulated by Schooler and Engstler-Schooler (1990), refers to the phenomenon wherein people exhibit a reduced facial recognition ability after describing a face compared to not describing it. Numerous subsequent studies (e.g., Alogna et al., 2014; Dodson et al., 1997; Finger & Pezdek, 1999; Melcher & Schooler, 2004; Ryan & Schooler, 1998) within the facial memory paradigm replicated this effect. However, some replication attempts resulted in what is known as the verbal facilitation effect (e.g., Brown & Lloyd-Jones, 2005; Davids et al., 2006; Itoh, 2005; Meissner et al., 2001; Sporer et al., 2015; Yu & Geiselman, 1993). Regarding the origins of the verbal overshadowing effect, Dodson et al. (1997) proposed two potential mechanisms, (a) source confusion between previously encoded visual and verbal representations of the face, and (b) a shift in the processing of test faces during recognition. The former mechanism suggests that participants in the verbal group might base judgments of the target face during the test phase more on linguistic memory than visual memory, leading to source confusion. The latter mechanism proposes that verbally describing the previously encountered target face could prompt participants to shift from global to local processing during face inspection. Remarkably, participants' awareness of the competition between the two memories (visual vs. verbal) does not appear to mitigate the verbal overshadowing effect (Dodson et al., 1997). Although it remains plausible that, given the spontaneous generation of verbal memories, disregarding instructions for verbal memories may not eliminate spontaneously generated verbal memory, suggesting that a second mechanism may play a more prominent role in driving these differences (Sauerland et al., 2008; Wickham & Lander, 2008).

The current study diverges from the well-explored terrain of visual memory and instead delves into the intricate relationship between olfactory memory and language processing. An intriguing feature of olfactory memory is its slow forgetting curve, as evidenced by results in recognition and identification tests (Engen & Ross, 1973; Lawless & Cain, 1975). Olfactory stimuli exhibit resilience in memory retention (Nordin, 2009). Items encoded with fewer features are thought to be matched correctly more easily during the test phase of a recognition experiment compared to those with more features, as the former entails less potential for confusion (Schab, 1991). Considering confusion, when language is added to an olfactory memory task, processing may risk interference with perceptual memories, diminishing their likelihood of being remembered, rather than bolstering their recognition accuracy. If the verbal overshadowing effect holds in the realm of odor recognition, it prompts a reevaluation of the intricate dynamics between verbalization and olfactory memory.

In L. K. Samuelson, S. L. Frank, M. Toneva, A. Mackey, & E. Hazeltine (Eds.), *Proceedings of the 46th Annual Conference of the Cognitive Science Society.*

Towards tests of verbal overshadowing in odor recognition

Dodson et al. (1997) investigated verbal overshadowing in the recognition of faces. The study involved 140 participants who watched a 30-second video depicting a bank robber in action, followed by a 20-minute filler activity designed to disrupt their prior visual memory. Participants were then randomly assigned to one of seven conditions. In four verbal conditions, participants spent 5 minutes describing in as much detail as possible the face of the previously observed robber. In the remaining three control conditions, participants completed a 5-minute filler activity. In the subsequent face recognition task, all participants viewed a slide featuring 8 similar faces, including the face of the previously observed robber, and were required to select the correct one from the array. The results indicated verbal overshadowing in face recognition. Notably, rapid recognition and awareness of potential competing memories (verbal vs. visual memory) were insufficient to eliminate the overshadowing effect.

Research on verbal overshadowing has predominantly concentrated on the visual domain, with limited exploration in other realms of "hard-to-describe" perceptual experiences. Examples include investigations into wine tasting (Melcher & Schooler, 1996) and Euclidean distance estimations (Fiore & Schooler, 2002). Unlike vision, the lexicon for describing odors is comparatively sparse across most languages and cultures (Majid, 2021). Given the inherent limitations in the descriptive vocabulary of smell, especially when contrasted with the richness of visual descriptions, a question arises whether describing a previously encountered odor influences subsequent tasks related to odor recognition. The current research transitions from the visual domain to the olfactory domain, building upon Dodson et al.'s (1997) face recognition tests. The primary aim is to investigate the presence of verbal overshadowing in odor recognition. Additionally, the study explores whether rapid recognition and awareness of two competing memories (olfactory and verbal) influence the verbal overshadowing effect.

To address these objectives, three research questions guided this investigation. First, the study asked whether describing a previously encountered odor impairs subsequent recognition of that odor, which would indicate the presence of a verbal overshadowing effect. Drawing from prior face recognition studies (e.g., Schooler & Engstler-Schooler, 1990; Dodson et al., 1997), the hypothesis was that describing a previously smelled odor will hinder its subsequent recognition. The second research question examined the impact of speeded-test conditions during odor recognition on verbal overshadowing. Previous research by Schooler and Engstler-Schooler (1990) demonstrated a reduction in the verbal overshadowing effect under speeded test conditions, while Read and Schooler (1994) and Dodson et al. (1997) observed its stable persistence. Dodson et al. (1997) attribute the observed differences to the distinct effects resulting from static encoding and dynamic encoding. In the former study, faces were presented on a slide (static encoding) in both the face study and face test stages. Conversely, in the latter two studies, faces were presented as videos (dynamic encoding) during the face study stage and as slides (static encoding) during the test stage. One explanation for the difference could be that the encoding mode in the former study remained consistent between the study and test stages, whereas in the latter two studies, the encoding modes differed. This discrepancy implies that when participants experience the same encoding mode in both study and test stages, they are more likely to access visual representations and less likely to get interference from verbal information. In this regard, olfactory stimuli in the current study were presented using odor sticks, specifically Sniffin' Sticks (Hummel et al., 1997), favoring a consistent presentation. Participants learned or recognized odors by smelling these odor sticks, thereby maintaining a constant level of intricacy in the design. Therefore, the corresponding hypothesis was that the verbal overshadowing effect would be diminished under conditions of rapid recognition.

The final research question investigated whether the verbal overshadowing effect diminishes when participants are aware of potentially competing memories (verbal vs. olfactory) about the target odor, particularly under two-choice and ignore test conditions. Dodson et al. (1997) found that participants, even when aware of competing memories (verbal vs. visual) about a target face, were still affected by verbal overshadowing. The current study considered the potential influence of verbal descriptions on participants' recognition strategies. The hypothesis was that awareness of competing memories would not improve participants' recognition of the target odor, consistent with Dodson et al.'s (1997) findings in the visual domain. In sum, this study addresses a substantial void in the "hard-to-describe" olfactory domain related to the verbal overshadowing effect, by building upon the foundational work of Dodson et al. (1997) within the visual realm.

Method

Participants

The study comprised 148 Chinese university students with no reported olfactory dysfunction. To ensure their normal olfactory abilities, all participants completed a self-report questionnaire (Manescu et al., 2013; Vanek et al., 2021) and underwent a revised version of the Sniffin' Sticks test (originally presented in Hummel et al., 1997) to assess their odor discrimination ability. Participants who failed to achieve a score of at least 10 correct answers out of 16 on the Sniffin' Sticks test (n = 8), were excluded from participation.

Olfactory stimuli

Eight odor pens, referred to as Sniffin' Sticks (Hummel et al., 1997), were used as olfactory stimuli. One of these odors was designated as the target odor, which represented the correct answer in the subsequent odor recognition tests. The remaining seven odors, alongside the target odor, constituted the test odors, collectively forming the eight options presented during the test phase. A pilot test was conducted to evaluate the difficulty of identifying thirty-two different odors. Three Chinese participants, all without olfactory impairments, participated in the pilot. They were instructed to use a 9-point Likert scale to rate the difficulty of identifying each odor and to identify the odor. Based on the average recognition difficulty ratings, odors with low scores and those that were not successfully recognized were selected. Ultimately, *leather* was chosen as the target odor. The criterion for selecting the remaining test odors was based on shared olfactory quality characteristics with the target odor in comparison to the larger set. As a result, the selected test odors were *raspberry*, *melon*, *smoked meat*, *coconut*, *cinnamon*, *liquorice*, and *rose* (Figure 1).

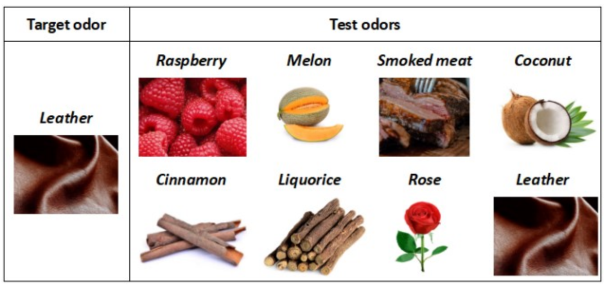

Figure 1. Olfactory stimuli used in the experiment.

Procedure

The experiment was programmed in Praat (Boersma & Weenink, 2014). A well-ventilated and quiet classroom served as the testing environment. A laptop was used to present instructions. Upon entering the room, the odor encoding phase of the study began. Participants were told to focus on smelling the odor for a fixed duration and to memorize it to the best of their ability. During this phase, participants were explicitly instructed not to speak or make physical contact with the odor sticks. During the odor recognition phase, participants sequentially smelled eight different test odors presented in a randomized order and labeled with serial numbers. Their task was to recognize the target odor they had been given during encoding. Participants had to select a serial number on the laptop's answer page to indicate the odor that matched the target. Importantly, participants had the option to state the target odor was not among the test odors. A demonstration, using *coffee*, was provided to acquaint participants with the procedure of encoding and recognizing an odor.

For the experiment, all participants were exposed to the target odor (*leather*) for 5 seconds. They were then given a 20-minute distractor language task unrelated to odor, which involved reading an article and answering comprehension questions, including multiple-choice and true-false questions. The text for the distractor language task was sourced from College English Test Questions (commensurate with the participants' level of English as a foreign language) with the purpose of interference to participants' odor memory.

Following Dodson et al., (1997), this study employed a between-participants design, with 140 participants randomly assigned to one of the seven conditions ($n = 20$ per condition): *Self-paced* (Verbal self-paced vs. Control self-paced), *Speeded* (Verbal speeded vs. Control speeded), *Two-choice* (Verbal two-choice vs. Control two-choice), and *Verbal ignore* condition. The aim of the Self-paced condition was to establish the verbal overshadowing effect in odor recognition. The *Speeded* test condition was devised to evaluate the potential advantage of rapid responses. The *Two-choice* and *Ignore* conditions investigated whether instructions indicating that there may be conflicting sources of information (verbal memory vs. olfactory memory) would influence the verbal overshadowing effect.

In the four verbal conditions, participants were instructed after the encoding phase to spend 5 minutes providing a comprehensive description of the target odor. They were asked to freely describe the target odor on an answer sheet without a word limit. In contrast, participants in the three control conditions were required to continue doing the distractor language task for another 5 minutes. This meant that participants in the control conditions had a total of 25 minutes allocated for the distractor language task.

Participants in the *Self-paced* condition had the freedom to take the odor recognition test at their own pace, without time constraints, allowing them to smell the odors repeatedly if desired. Conversely, participants in the *Speeded* test condition had to complete the odor recognition test within a limited timeframe. They were instructed to smell the eight test odors sequentially, each lasting approximately 2 seconds, and refrain from repeated smelling. They had to select their answers immediately after smelling all eight odors (Figure 2).

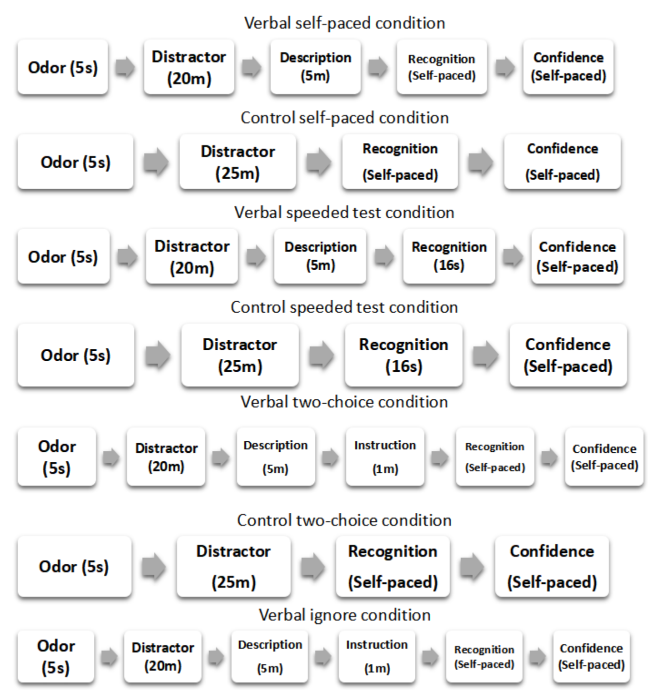

Figure 2. Experimental flow chart for the seven conditions. Note: *Odor* refers to the Odor encoding phase, *Distractor* refers to Distractor language task, *Description* refers to Odor description, *Recognition* refers to Odor recognition test, *Confidence* refers to Self-confidence assessment.

In the *Verbal ignore* condition, participants were instructed to disregard their memory of odor descriptions and rely exclusively on their olfactory memory in the odor recognition test. In contrast, participants in the *Verbal two-choice* condition were made aware of the distinction between their olfactory memory and verbal memory (see Figure 2). Those in the *Verbal two-choice* condition faced a unique task in which they had to provide two choices during the test phase; one based on their olfactory memory (Answer 1) and the other based on their memory of their self-generated verbal descriptions (Answer 2). Participants in the *Control two-choice* condition were given a similar task, but were asked to provide an additional option, indicating the odor "second most consistent" with their olfactory memory (Answer 2). Evaluation of recognition ability in the *Two-choice* conditions was based solely on Answer 1. Overall, this experimental design enables the investigation of how explicit awareness of the potential for source confusion, as well as instructions to disregard verbal information, may influence olfactory memory and recognition. The goal is to elucidate the underlying mechanisms driving the verbal overshadowing effect in the olfactory domain.

Following the odor recognition test, participants used a 9-point Likert scale, adapted from Dodson et al. (1997), to rate their confidence in their answers. The scale ranged from 1 "extremely uncertain" to 9 "extremely certain". Participants in the *Two-choice* condition evaluated their self-confidence only for judgments matching their olfactory memory (Answer 1). As a token of appreciation, participants received small gifts at the end of the experiment and were instructed not to discuss any experiment content with fellow students.

Results

We used R (version 4.0.3, R Core Team, 2020) for analyses. All data are available at https://osf.io/2p5su/.

Odor recognition

The analyzed scores included participants' accuracy in odor recognition and their self-confidence ratings. Odor recognition and confidence scores were amalgamated into a composite score following Dodson et al. (1997). In instances of incorrect recognition, participants were assigned scores based on their reported confidence levels: a score of 1 for confidence levels 7, 8, or 9; a score of 2 for confidence levels 4, 5, or 6; and a score of 3 for confidence levels 1, 2, or 3. Conversely, for correct recognitions, participants received scores of 4, 5, or 6, corresponding to confidence levels 1-3, 4-6, or 7-9, respectively.

Raincloud plots visualize the distribution of composite scores across conditions (Figure 3). *Control Self-paced* (M=5.7, SD=0.21) showed superior performance compared to *Verbal Self-paced* (M=4.65, SD=0.45). Recognition performance in *Control Speeded* (M=3.5, SD=0.54) closely aligned with *Verbal Speeded* (M=3.5, SD=0.48). Furthermore, both *Two-choice verbal* and *Ignore verbal* conditions exhibited substantially lower recognition performance compared to the *Control Self-paced* condition: *Verbal Two-choice* (M=4.25, SD=0.49) vs. *Control Two-choice* (M=4.15, SD=0.53), and *Verbal Ignore* (M=4.45, SD=0.48).

A linear regression model was employed to conduct a statistical comparison between the verbal and control groups. A statistically significant difference was identified between verbal and control groups in the self-paced condition (p = 0.040), with a 1.050-unit (+/- 0.494) decrease in Control Self-paced for every unit decrease in Verbal Self-paced. This result shows the verbal overshadowing effect in olfactory recognition. However, in the speeded condition, no significant difference was observed between the verbal and control groups (p = 1). This suggests that a speeded recognition protocol may mitigate the impact of verbal descriptions on odor recognition. Compared to the Control self-paced condition, Verbal two-choice (p = 0.010) and Verbal ignore (p = 0.021) exhibited significantly lower odor recognition scores. This lends support to the hypothesis that promoting careful memory examination did not alleviate the impact of verbal overshadowing on odor recognition performance; instead, it increased its influence. However, no statistically significant difference was found between Verbal two-choice and Control two-choice (p = 0.891).

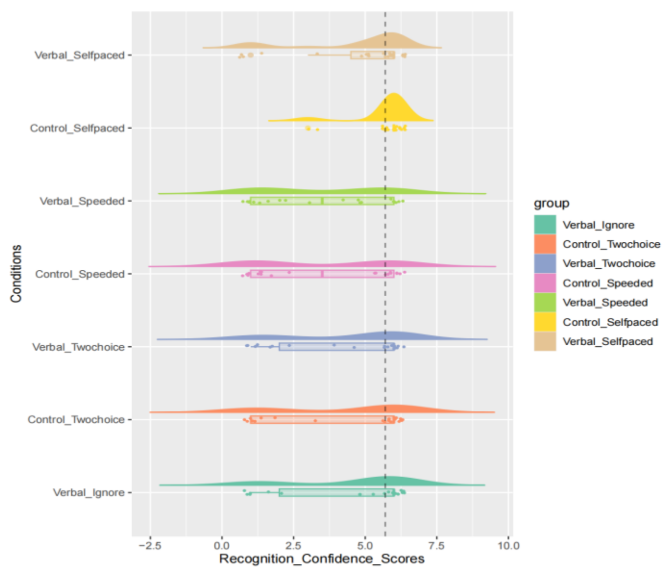

Figure 3. Raincloud plot showing the distribution of composite scores across conditions. The dashed line marks the mean of the *Control Self-paced* group.

Pearson correlation analyses were conducted to investigate the potential influence of participants' pretest scores (odor discrimination ability via Sniffin Sticks test) on composite scores for odor recognition. The results showed no significant relationship between these two variables (p<0.05) in any of the seven conditions.

Evaluating odor descriptions

To assess descriptions of the target odor, various verbal measures were employed including fluency, accuracy, elaboration, and flexibility. Verbal fluency was operationalized as the total number of words used to describe the target odor, assigning one point for each content word. Verbal accuracy gauged precision based on the following criteria: No points were awarded if no source was specified. One point was given for incorrect identification with 1 or 2 guesses, while 2 points were awarded for 3 or 4 guesses. For 5 or 6 guesses with incorrect identification, participants received 3 points. If the source was correctly guessed, they earned 4 points for 5 or 6 guesses and 5 points for 3 or 4 guesses. Additionally, correctly identifying the source with 2 or 1 guess resulted in 6 points. Verbal elaboration measured the level of detail on a 7-point Likert scale, ranging from superordinate and less precise (e.g., "*floral*") to specific (e.g., "*lily*"). Verbal flexibility assessed the types of descriptions given, extending beyond the odor source to qualities such as subjective feeling, intensity, irritation, and odor pleasantness, with a point awarded for each description type. Notably, in terms of odor description types, 26% of participants extended beyond olfaction, to include other perceptual domains such as taste, vision, and tactile sensation, which are not uncommon strategies (e.g. Speed & Majid, 2020).

To explore the association between the four key verbal indicators (fluency, accuracy, elaboration, and flexibility) and composite scores for odor recognition, a correlation analysis was performed for the verbal conditions. The results revealed that none of these verbal factors exhibited a significant correlation with the composite score of odor recognition, Fluency: $r(78)=-0.01$, $p=0.94$; Accuracy: $r(78)=-0.01$, $p=0.97$; Elaboration: $r(78)=-0.17$, $p=0.13$; Flexibility: $r(78)=-0.06$, $p=0.59$.

General Discussion

The present study aimed to investigate verbal overshadowing in odor recognition. Our results provide answers to three research questions. First, we successfully replicated the verbal overshadowing phenomenon originally demonstrated by Schooler and Engstler-Schooler (1990) in the context of visual recognition. Second, we observed that the verbal overshadowing effect tends to diminish or even dissipate under conditions that require rapid responses when maintaining a consistent encoding mode. Third, we found instructions emphasizing potential conflicts between olfactory and verbal representations did not mitigate the impact of the verbal overshadowing effect.

Verbal description hinders odor recognition

Participants who engaged in verbal description encountered a greater challenge when attempting to distinguish the target odor from a series of similar odors, unlike participants who were not required to provide descriptions. This disparity can be attributed to the fact that, compared to the control group—which relied solely on their olfactory memory of the target odor—the verbal group seem to have integrated linguistic cues into their memory representation. Reliance on verbal cues appears to have overshadowed their original olfactory memory. During verbal description, linguistic detail—of varying accuracy—could have been incorporated into memory and misled later odor recognition. This incongruity likely arises from the distorted and indirect nature of memory derived from verbal descriptions (Zaragoza & Lane, 1994). Such memories may not offer direct and accurate mnemonic cues to distinguish among similar odors, unlike more direct olfactory memory cues.

The verbal overshadowing effect in odor recognition may be explained by a mechanism of a shift in the processing of the test odors during the recognition phase. Verbal behavior may trigger a feature-oriented approach (Dodson et al., 1997; Wickham & Lander, 2008), as participants describing the target odor might unconsciously lean towards an elimination strategy, where they discard test odors that do not possess characteristics mentioned in the description. To illustrate, if participants describe the target odor as "stimulating," they may tend to exclude odors perceived as mild and non-stimulating during odor recognition. Participants in the verbal group(s) might rely on specific linguistic features for odor recognition, potentially overlooking non-linguistic olfactory cues. On the other hand, participants who refrain from describing the target odor can rely on their unprocessed olfactory memory for recognition, demonstrating a more holistic sensory memory (Dodson et al., 1997). When these participants employ a holistic strategy for odor recognition, they may base their detection of potential test odors on a global match. Previous research has suggested that holistic strategies tend to outperform feature-based strategies in recognition tasks (e.g., Carey & Diamond, 1977; Stern & Dunning, 1994; Wickham & Lander, 2008).

Rapid response advantage for consistent encoding

Our experiment successfully replicated the findings of Schooler and Engstler Schooler (1990) from rapid face recognition tests, demonstrating the absence of a verbal overshadowing effect. This underscores the advantage of fast responses with a consistent presentation, suggesting that olfactory representations in the verbal condition remain accessible and influential under time pressure. Participants in the verbal group seemed to rely on subconscious responses driven by their raw olfactory memory, potentially bypassing more complex verbal memories. Olfactory memory predominantly engages in basic, automatic processes, whereas verbal memory involves higher-order cognitive functions (Kihlstrom, 2009; Levine, 2009). Compared to facial recognition tests, our olfactory study revealed comparably lower odor recognition rates in speeded conditions. The observed disparity could be ascribed to the difficulties associated with maintaining olfactory memories, stemming from the "fuzzy" representation of smells (Sikström et al., 2018). This includes challenges such as the limited olfactory vocabulary in many cultures and the difficulty of naming smells in experiments (Majid, 2021). These factors contribute to less accurate recall than in vision, particularly under rapid test conditions.

Limited impact of awareness on overshadowing

In our study, participants generated their own verbal descriptions, which may be the key reason why they struggled to effectively manage memory confusion through source monitoring. When participants received explicit instruction to notice that there is a difference between their olfactory memory and verbal memory, the expectation was that their attention would be channeled to better distinguish between olfactory and verbal memories than with no such instruction (Dodson & Johnson, 1993; Zaragoza & Lane, 1994). However, instruction of this type did not facilitate odor recognition. It might be because there is no clear boundary between these memory types. When participants are aware of distinct olfactory vs. verbal memories, the information from the more robust verbal memory may tend to overshadow the olfactory memory. Consequently, conscious attempts to differentiate between these two types of memories can lead to interference from the more dominant verbal memory, resulting in confusion. This can explain the persistence of the verbal overshadowing effect even when participants consciously scrutinize their memories.

Irrelevance of description quality for odor recognition ability

The assertion that description quality may not significantly impact recognition abilities across different sensory modalities is supported by several lines of evidence (e.g., Schooler & Engstler Schooler, 1990; Fallshore & Schooler, 1995). Unlike visual stimuli, odors lack universally objective parameters for evaluation (Lundström et al., 2006). Factors such as odor intensity, pleasantness, and emotional associations exhibit significant variability among individuals (Bensafi & Rouby, 2007). This variability poses a challenge for establishing standardized criteria for assessing the quality of odor descriptions from lay people (with more success from neural networks such as the Principal Odor Map that was found to outperform trained human sensory panels (Lee et al., 2023)). Consequently, even if participants provide highly detailed or accurate verbal descriptions of an odor, the subjective nature of these descriptions may not necessarily translate into improved recognition performance. Participants were unable to accurately identify the source of the target odor (*leather*), and their descriptions substantially varied (e.g., "smells like medicine" or "smells like wood"). Some responses included references to various other sources, such as fossils, alcohol, paint, or cucumber. Inaccuracy and diversity in descriptions could explain why their verbal memories of the odor's description may not have enhanced their subsequent recognition performance either. When participants cannot accurately attribute the source of an odor based on their verbal memory, the quality of their description becomes less of an aide to recognition.

Cross-modal associations in the domain of olfaction

Another finding was that 26% of participants included non-olfactory sensory referents when describing the target odor. This observation, in line with previous findings on cross-modal associations (Halabi & Saleh, 2021; Courrèges et al., 2021; Crisinel et al., 2013; Demattè et al., 2006), which suggests that attempts to verbalize olfactory percepts are often assisted with cross-modal references. Participants frequently made connections between olfactory memories and taste memories, using terms related to taste when describing odors. This tendency could be linked to a more general overlap between smell and taste vocabularies (Winter, 2016). Research into memory recall processes has revealed the context in which information is encoded and retrieved can significantly influence memory (Tulving & Thomson, 1973; Nairne, 2002). Importantly, this contextual effect is not limited to the original sensory modality but can also encompass associations with other sensory cues present during encoding. These findings emphasize that memory retrieval is not solely determined by the sensory domain in which the information was initially acquired (Smith et al., 2014). This observation aligns with the concept of cross-modal associations and the amalgamation of sensory modalities during recall (Sakamoto & Watanabe, 2016; Demattè et al., 2006; Seo et al., 2010).

Challenges in coding olfactory memories with words

No participant accurately identified the source of the target odor (*leather*) in their verbal descriptions. In contrast, the control self-paced group demonstrated high accuracy, 90%, in target odor recognition. While it is plausible the difficulty in pinpointing the source of the target odor (*leather*) contributed to these outcomes, it is noteworthy that individuals' olfactory memory seemed more reliable than their verbal descriptions. We interpret the significant difference found between the verbal and control conditions as evidence supporting the core tenet of the Dual Coding Theory that the interplay of verbal and nonverbal codes can substantially impact memory and retrieval processes.

The observed between-group discrepancy can be attributed to several factors that make odor descriptions challenging. First, odor perception is subjective, varying among individuals due to genetic factors, past experiences, and cultural backgrounds (Ferdenzi et al., 2017; Keller, 2012). Unlike visual or auditory descriptions, which benefit from well-established and standardized vocabulary, the language used to describe odors is less developed in many cultures and languages (Majid, 2021).

In summary, odor descriptions are complex and multifaceted due to the intricacies of odor perception, the absence of a standardized vocabulary, cross-modal interactions, cognitive challenges in translating olfactory experiences into words, and environmental influences. These characteristics contribute to the rich and diverse tapestry of language used to describe the often elusive and subjective world of odors.

Conclusion

In conclusion, this study examined the verbal overshadowing effect in odor recognition. We found that describing odors hinders subsequent recognition performance under self-paced conditions. This verbal overshadowing effect diminishes during rapid recognition. Conscious awareness of the distinction between olfactory and verbal memory does not, however, modulate odor recognition.

References

Alogna, V. K., Attaya, M. K., Aucoin, P., Bahník, Š., Birch, S., Birt, A. R., ... Zwaan, R. A. (2014). Registered Replication Report: Schooler and Engstler-Schooler (1990). *Perspectives on Psychological Science, 9*(5), 556-578. https://doi.org/10.1177/1745691614545653

Bensafi, M., & Rouby, C. (2007). Individual differences in odor imaging ability reflect differences in olfactory and emotional perception. *Chemical Senses, 32*(3), 237-244. https://doi.org/10.1093/chemse/bjl051

Boersma, P., & Weenink, D. (2014). Praat: doing phonetics by computer. Computer program. Version 5.3.64, retrieved 12 February 2014 from "http://www.praat.org/

Brown, C., & Lloyd-Jones, T. J. (2005). Verbal facilitation of face recognition. *Memory & Cognition, 33*(8), 1442-1456. https://doi.org/10.3758/BF03193377

Carey, S., & Diamond, R. (1977). From piecemeal to configurational representation of faces. *Science, 195*(4275), 312-314. https://doi.org/10.1126/science.831281

Courrèges, S., Aboulaasri, R., Bhatara, A., & Bardel, M. H. (2021). Crossmodal Interactions Between Olfaction and Touch Affecting Well-Being and Perception of Cosmetic Creams. *Frontiers in Psychology*, *12*, 703531. https://doi.org/10.3389/fpsyg.2021.703531

Crisinel, A., Jacquier, C., Deroy, O., & Spence, C. (2013). Composing with Cross-modal Correspondences: Music and Odors in Concert. Chemosensory Perception, *6*, 45-52. https://doi.org/10.1007/s12078-012-9138-4

Davids, M. S. C., Sporer, S. L., & McQuiston-Surrett, D. (2006). *The verbal facilitation effect: Person descriptions as a means to improve identification performance.* University of Giessen, Germany.

Demattè, M. L., Sanabria, D., & Spence, C. (2006). Cross-Modal Associations Between Odors and Colors. *Chemical Senses, 31*(6), 531-538. https://doi.org/10.1093/chemse/bjj057

Dodson, C. S., & Johnson, M. K. (1993). The rate of false source attributions depends on how questions are asked. *American Journal of Psychology, 106*(4), 541-557. https://doi.org/10.2307/1422968

Dodson, C. S., Johnson, M. K., & Schooler, J. W. (1997). The verbal overshadowing effect: Why descriptions impair face recognition. *Memory & Cognition, 25*(2), 129-139. https://doi.org/10.3758/BF03201107

Engen, T., & Ross, B. M. (1973). Long-term memory of odors with and without verbal descriptions. *Journal of Experimental Psychology, 100*(2), 221-227. https://doi.org/10.1037/h0035492

Ferdenzi, C., Joussain, P., Digard, B., Luneau, L., Djordjevic, J., & Bensafi, M. (2017). Individual Differences in Verbal and Non-Verbal Affective Responses to Smells: Influence of Odor Label Across Cultures. *Chemical Senses, 42*(1), 37-46. https://doi.org/10.1093/chemse/bjw098

Fiore, S. M., & Schooler, J. W. (2002). How did you get here from there? Verbal overshadowing of spatial mental models. *Applied Cognitive Psychology, 16*(8), 897-909. https://doi.org/10.1002/acp.921

Finger, K., & Pezdek, K. (1999). The effect of cognitive interview on face identification accuracy: Release from verbal overshadowing. *Journal of Applied Psychology, 84*(3), 340-348. https://doi.org/10.1037/0021-9010.84.3.340

Halabi, O., & Saleh, M. (2021). Augmented reality flavor: cross-modal mapping across gustation, olfaction, and vision. *Multimedia Tools and Applications*, *80*(30), 36423-36441. https://doi.org/10.1007/s11042-021-11321-0

Hummel, T., Sekinger, B., Wolf, S., Pauli, E., & Kobal, G. (1997). 'Sniffin Sticks': Olfactory performance assessed by the combined testing of odor identification, odor discrimination, and olfactory threshold. *Chemical Senses, 22*(1), 39-52. https://doi.org/10.1093/chemse/22.1.39

Itoh, Y. (2005). The facilitating effect of verbalization on the recognition memory of incidentally learned faces. *Applied Cognitive Psychology, 19*(4), 421-433. https://doi.org/10.1002/acp.1069

Keller, A., Hempstead, M., Gomez, I. A., Gilbert, A. N., & Vosshall, L. B. (2012). An olfactory demography of a diverse metropolitan population. *BMC Neuroscience, 13*, 122. https://doi.org/10.1186/1471-2202-13-122

Kihlstrom, J. F. (2009). *Unconscious cognition.* In W. P. Banks (Ed.), *Encyclopedia of Consciousness* (pp. 411-421). Academic Press. https://doi.org/10.1016/B978-012373873-8.00080-3

Lawless, H. T., & Cain, W. S. (1975). Recognition memory for odors. *Chemical Senses and Flavor, 1*(3), 331-337. https://doi.org/10.1093/chemse/1.3.331

Lee, K. B.; Mayhew, E. J; Sanchez-Lengeling, B. […] & Wiltschko, A.B. (2023). A principal odor map unifies diverse tasks in olfactory perception. *Science*, 381(6661), 999-1006. https://www.science.org/doi/full/10.1126/science.ade4401

Levine, M. D. (2009). *Differences in learning and neurodevelopmental function in school-age children.* In W. B. Carey, A. C. Crocker, W. L. Coleman, E. R. Elias, & H. M. Feldman (Eds.), Developmental-Behavioral Pediatrics (4th ed., pp. 535-546). W.B. Saunders. https://doi.org/10.1016/B978-1-4160-3370-7.00055-9

Luisa Demattè, M., Sanabria, D., & Spence, C. (2006). Cross-modal associations between odors and colors. Chemical Senses, *31*(6), 531-538. https://doi.org/10.1093/chemse/bjj057

Lundström, J. N., Seven, S., Olsson, M. J., Schaal, B., & Hummel, T. (2006). Olfactory event-related potentials reflect individual differences in odor valence perception. *Chemical Senses, 31*(8), 705-711. https://doi.org/10.1093/chemse/bjl012

Manescu, S., Frasnelli, J., Lepore, F., & Djordjevic, J. (2013). Now You Like Me, Now You Don't: Impact of Labels on Odor Perception. *Chemical Senses, 39*(2), 167-175. https://doi.org/10.1093/chemse/bjt066

Majid, A. (2021). Human Olfaction at the Intersection of Language, Culture, and Biology. *Trends in Cognitive Sciences, 25*(2), 111-123. https://doi.org/10.1016/j.tics.2020.11.005

Melcher, J. M., & Schooler, J. W. (1996). The misremembrance of wines past: Verbal and perceptual expertise differentially mediate verbal overshadowing of taste memory. *Journal of Memory and Language, 35*(2), 231-245. https://doi.org/10.1006/jmla.1996.0013

Melcher, J. M., & Schooler, J. W. (2004). Perceptual and conceptual training mediate the verbal overshadowing effect in an unfamiliar domain. *Memory & Cognition, 32*(4), 618-631. https://doi.org/10.3758/BF03195853

Meissner, C. A., Brigham, J. C., & Kelley, C. M. (2001). The influence of retrieval processes in verbal overshadowing. *Memory & Cognition, 29*, 176-186. https://doi.org/10.3758/BF03195751

Moos, A., Smith, R., Miller, S. R., & Simmons, D. R. (2014). Cross-Modal Associations in Synaesthesia: Vowel Colours in the Ear of the Beholder. *I-Perception, 5*(2), 132-142. https://doi.org/10.1068/i0626

Nairne, J. S. (2002). The myth of the encoding-retrieval match. *Memory, 10*(5-6), 389-395. https://doi.org/10.1080/09658210244000216

Nordin, K. (2009). *Olfactory Memory and Verbal Overshadowing: Experts, Novices and the Effect of Objective Descriptions.* Department of Psychology, Lund University.

Paivio, A. (1971). *Imagery and verbal processes*. Holt, Rinehart & Winston.

R Core Team (2020). R: *A language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Read, D. J., & Schooler, J. W. (1994, July). *Verbalization decrements in long-term person identification.* Paper presented at the Practical Aspects of Memory Conference, Baltimore County, MD.

Ryan, R. S., & Schooler, J. W. (1998). Whom do words hurt? Individual differences in susceptibility to verbal overshadowing. *Applied Cognitive Psychology, 12*(Spec Issue), S105-S125. https://doi.org/10.1002/(SICI)1099-0720(199812)12:7S105::AID-ACP5973.0.CO;2-V

Sakamoto, M., & Watanabe, J. (2016). Cross-Modal Associations between Sounds and Drink Tastes/Textures: A Study with Spontaneous Production of Sound-Symbolic Words. *Chemical Senses, 41*(3), 197-203. https://doi.org/10.1093/chemse/bjv078

Sauerland, M., Holub, F. E., & Sporer, S. L. (2008). Person descriptions and person identifications: Verbal overshadowing or recognition criterion shift? European *Journal of Cognitive Psychology, 20*(3), 497-528. https://doi.org/10.1080/09541440701728417

Schab, F. R. (1991). Odor Memory: Taking Stock. *Psychological Bulletin, 109*(2), 242-251. https://doi.org/10.1037/0033-2909.109.2.242

Schooler, J. W., & Engstler-Schooler, T. Y. (1990). Verbal overshadowing of visual memories: Some things are better left unsaid. *Cognitive Psychology, 22*(1), 36-71. https://doi.org/10.1016/0010-0285(90)90003-M

Seo, H. S., Arshamian, A., Schemmer, K., Scheer, I., Sander, T., Ritter, G., & Hummel, T. (2010). Cross-modal integration between odors and abstract symbols. *Neuroscience Letters, 478*(3), 175-178. https://doi.org/10.1016/j.neulet.2010.05.011

Sikström, S., Hellman, J., Dahl, M., Stenberg, G., & Johansson, M. (2018). The role of sparsely distributed representations in familiarity recognition of verbal and olfactory materials. *Cognitive Processing, 19*(4), 481-494. https://doi.org/10.1007/s10339-018-0862-9

Speed, L. J., & Majid, A. (2020). Grounding language in the neglected senses of touch, taste, and smell. *Cognitive Neuropsychology*, *37*(5-6), 363–392. https://doi.org/10.1080/02643294.2019.1623188

Sporer, S. L., Kaminski, K. S., Davids, M. C., & McQuiston, D. (2016). The verbal facilitation effect: re-reading person descriptions as a system variable to improve identification performance. *Memory, 24*(10), 1329-1344. https://doi.org/10.1080/09658211.2015.1106561

Stern, L. B., & Dunning, D. (1994). Distinguishing accurate from inaccurate eyewitness identifications: A reality monitoring approach. In D. F. Ross, J. D. Read, & M. P. Toglia (Eds.), *Adult eyewitness testimony: Current trends and developments* (pp. 273-299). Cambridge University Press. https://doi.org/10.1017/CBO9780511759192.014

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*(5), 352-373. https://doi.org/10.1037/h0020071

Vanek, N., Sóskuthy, M., & Majid, A. (2021). Consistent verbal labels promote odor category learning. *Cognition, 206*, 104485. https://doi.org/10.1016/j.cognition.2020.104485

Wickham, L. H. V., & Lander, K. (2008). The effect of verbal description and processing type on face identification. *European Journal of Cognitive Psychology, 20*(3), 577-586. https://doi.org/10.1080/09541440701728433

Winter, B. (2016). Taste and smell words form an affectively loaded and emotionally flexible part of the English lexicon. *Language, Cognition and Neuroscience, 31*(8), 975-988. https://doi.org/10.1080/23273798.2016.1193619

Yu, C. J., & Geiselman, R. E. (1993). Effects of Constructing Identi-Kit Composites on Photospread Identification Performance. *Criminal Justice and Behavior, 20*(3), 280-292. https://doi.org/10.1177/0093854893020003005

Zaragoza, M. S., & Lane, S. M. (1994). Source misattributions and the suggestibility of eyewitness memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(4), 934-945. https://doi.org/10.1037/0278-7393.20.4.934