

Verbal and nonverbal cueing in olfactory categorisation: Are words unique?

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Are words special for category learning? Or can other cues in the environment help activate knowledge in similar ways? The enhancement of forming new categories with words, but less so with nonverbal cues, is known as the label advantage (Lupyan & Bergen, 2016). Previous studies in the visual domain suggest that verbal labels could indicate category membership more effectively than nonverbal sounds (Lupyan & Thompson-Schill, 2012). This study investigated the status of verbal labels in learning categories in the olfactory domain. We designed three experiments to investigate how successfully people learn odour categories with variations in cueing. In Experiment 1, we trained native Czech speakers ($n = 44$) to sort difficult-to-identify olfactory stimuli with Czech pseudowords (e.g., *fralíst*). In the CONCORD condition, participants were learning olfactory categories in the presence of consistently paired pseudowords (81%), and in the DISCORD condition, participants had equal exposure to the same, but inconsistently paired (25%), set of stimuli. Initial categorisation success was at chance level in both groups. After training, a test without labels showed that the concordant group increased their correct categorisation more successfully (MCON = 70.01%) than the discordant group (MDIS = 57.39%). To further examine the label advantage, in Experiment 2 we tested whether the nature of task-irrelevant verbal cues matters. We compared new CONCORD and DISCORD groups of Czech native speakers, whom we exposed to foreign-sounding labels that conformed to English phonotactics (e.g., *bitjeed*). Like in Exp.1, greater categorisation improvement emerged in the CONCORD group (MCON = 66.79%) than in the DISCORD group (MDIS = 61.74%). Word-like labels, irrespective of whether they follow the phonotactic principles of the native language, provided a greater boost to odour category formation than nonverbal cues. One explanation is that labels fine-tuned perception by channelling attention to category-relevant perceptual features (Smith et al., 2002). An alternative account is that participants became perceptually sensitised to odour distinctions through attribute differentiation (Goldstone & Steyvers, 2001). Categorisation abilities also improved without implicit odour-label associations, albeit to a lesser extent than in contexts where labels could serve as reliable categorical cues. In Experiment 3, we were interested in testing whether participant performance increases when odours are paired with nonverbal cues (structured noise devoid of speech-like qualities). After four days of intensive training, categorisation improvement was negligible when sound-odour pairing was consistent (MCON = 55.49%). Accuracy in the final test was unexpectedly higher for DISCORD (MDIS = 64.58%). The debriefs suggested that this result may be attributable to participants' deliberate inattentiveness to sounds, and enhanced focus purely on the odours, after they had realised the pairings were unreliable category indicators. An independent smell discrimination ability test (Hummel et al., 1997) helped to ensure that superior learning gains in the CONCORD groups with words were unrelated to participants' olfactory function because smell discrimination ability was comparable across experimental groups. In sum, our findings bring new evidence from the modality of olfaction, showing that words can achieve what nonverbal cues cannot, and they thus enjoy a special status in cross-modal associative learning.

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