The role of semantic content of verbal categories in categorical perception: An ERP study

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Introduction

There is growing evidence that perception is cognitively penetrable (e.g., Lupyan, 2012). Specifically, concerning the relation between language and perception, categorical perception (CP) describes the phenomenon that two stimuli are discriminated faster when they belong to different linguistic categories than when they belong to the same linguistic category. Several studies have demonstrated CP effects for colors that were lateralized to the right visual field (VF; e.g., Gilbert, Regier, Kay, & Ivry, 2006; Winawer et al., 2007), but there is also evidence against the lateralization of CP (Witzel & Gegenfurtner, 2011), and CP has been demonstrated in non-lateralized designs (e.g., Thierry, Athanasopoulos, Wiggett, Dering, & Kuipers, 2009).

One issue that still awaits systematic investigation is the specific influence of semantic contents of verbal categories on CP. It is unclear to which extent CP depends on the semantic knowledge that is typically associated with verbal categories. We tackled this issue with a learning paradigm in which initially unfamiliar, yet realistic object stimuli were associated with either bare labels lacking explicit semantic content or labels that were accompanied by additional information as to their specific meaning. We used event-related brain potentials (ERPs) to investigate the effects of such bare and semantically enriched verbal labels on categorical perception in an oddball-task (e.g., Clifford et al., 2012; Mo, Xu, Kay, & Tan, 2011). Perceptual effects were expected to be reflected in ERP components associated with visual perception (P1, N1), and these effects should be enhanced if the semantic content of verbal categories has an influence on CP.

Method

In the learning phase 24 participants were familiarized with previously unfamiliar objects (see Figure 1). Each object was associated with a name (pseudoword), and additional semantic information about the object function was provided for half of the objects. Two days after learning, the EEG was recorded while participants performed a visual oddball task with a lateralized presentation of the newly learned objects (see Fig. 2 below). Object pairs could have the same or different labels (factor: within vs. between category), and were or were not associated with enriched semantic information (label only vs. semantically enriched label).

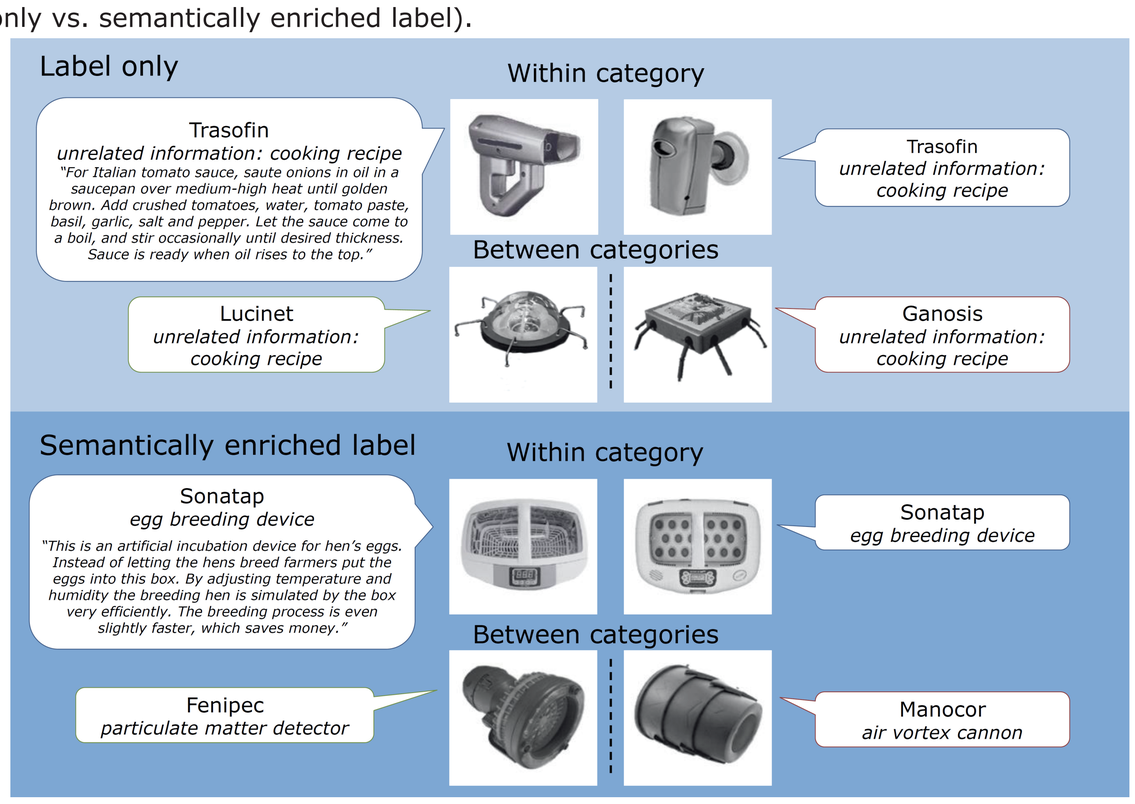

Figure 1. Illustration of the experimental conditions. The assignment of objects to experimental conditions was counterbalanced such that, across participants, each object was presented equally often in each condition.

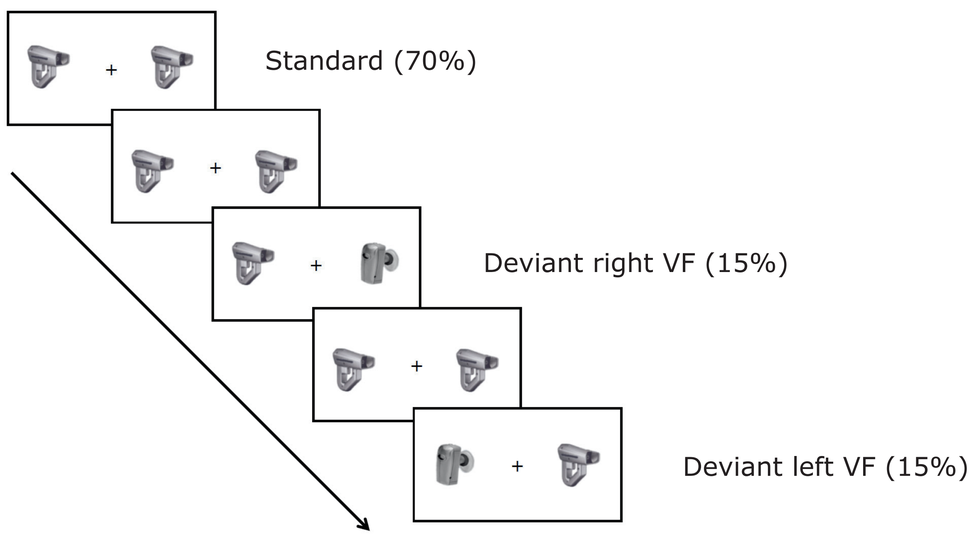

Figure 2. Sequence example of the oddball-task. 70% of the trials were standard trials. In 15% of the trials the deviant object was presented in the left visual field, and in 15% on the right. Manual reactions (button press) were required in deviant trials only.

Results

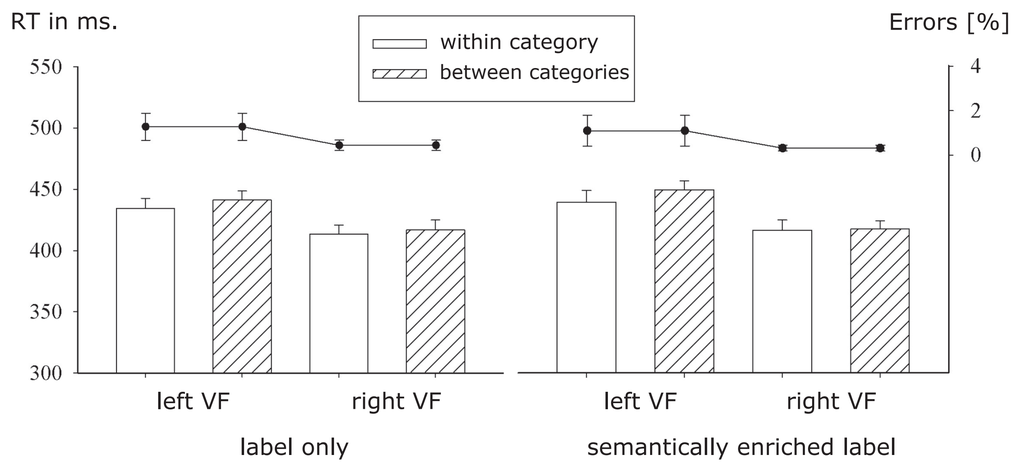

Figure 3. Reaction times (RTs; bars) and error rates (dots) in the oddball task. RTs were shorter for deviants in the right VF. There was no CP effect (i.e. main effect of *category*, interaction of *category* × *VF*, or three-way interaction of *category* × *semantic information* × *VF*) in RTs. In contrast, there was a numerically small but significant inhibitory effect of *semantic information* (426 and 430 ms in the label only vs. semantically enriched label condition).

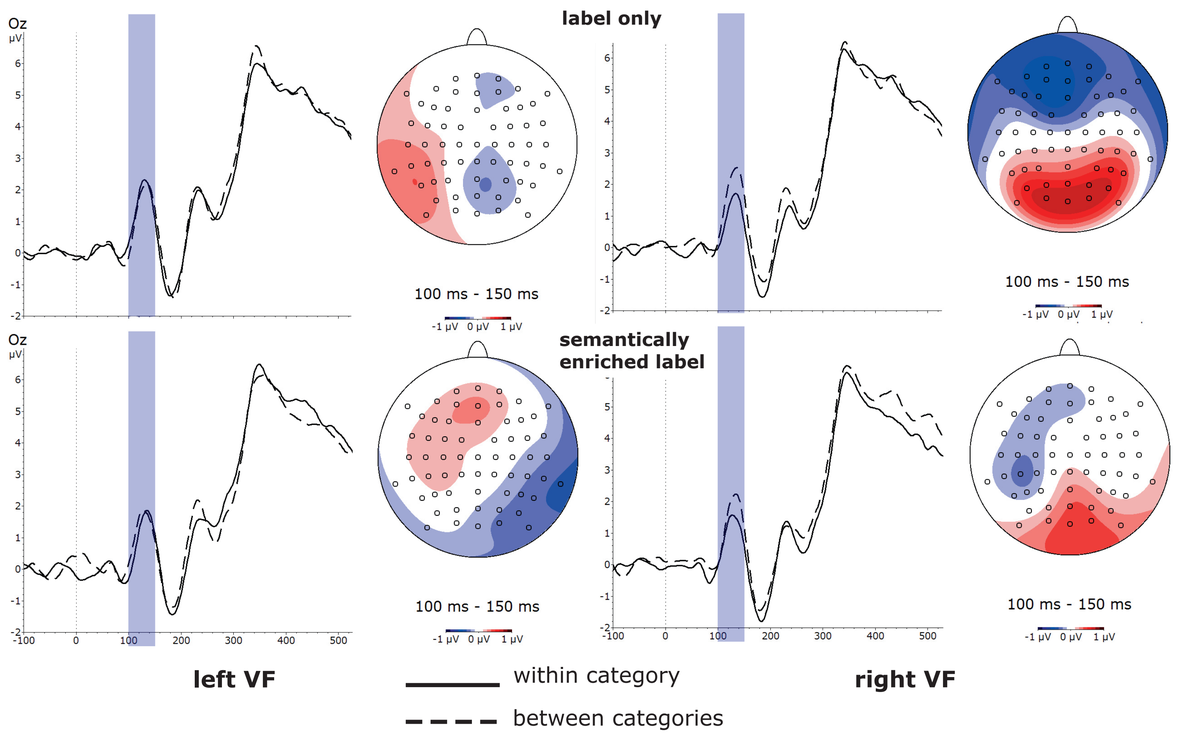

Figure 4. In the P1 time window (100-150 ms) there was an interaction of *category* and *VF*, reflecting CP effects restricted to the right VF, and this effect was unaffected by *semantic information*.

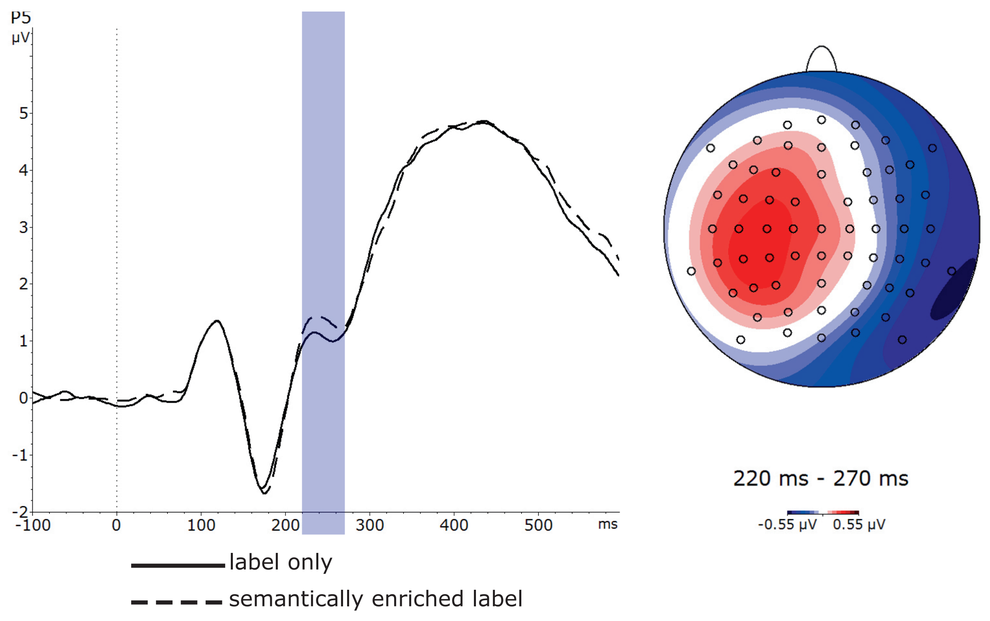

Figure 5. A significant main effect of *semantic information* was found at about 200 ms in the P2 time-window.

Summary and discussion

In line with recent evidence (see above), our data support the idea that CP effects are located at early visual processing stages, and that they are lateralized to the right VF. However, CP was only observed in ERPs, not in RTs. Importantly, CP effects were not influenced by enriched semantic category information, suggesting that basic labels and the associated minimal perceptual-semantic information are sufficient for CP. Semantic knowledge had a main effect on RTs and later ERP components, starting at about 200 ms. This might reflect object-based attention to semantically meaningful visual features. Thus, although not directly interacting with CP, semantic knowledge appears to be an important factor shaping the relation between cognition and perception.

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