ERPs reveal that exemplar effects are driven by episodic memory instead of the mental lexicon

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Hybrid models of speech comprehension assume two types of lexical representations for the pronunciation of words: abstract representations and exemplars (e.g., Goldinger, 2007; Hawkins, 2003). Abstract representations are strings of sounds symbols that do not contain details about words’ exact pronunciations. Exemplars, in contrast, are highly detailed representations of word occurrences, which together form a word cloud. Accumulated evidence from auditory priming experiments supports the representation of words as clouds of exemplars (e.g., Craik & Kirsner, 1974; Palmeri, Goldinger & Pisoni, 1993). In these experiments, participants recognized the second occurrence of a word more quickly or more accurately when surface details (e.g., speaker voice) of the first (prime) and second (target) occurrence of a word matched compared to when they did not match.

However, not all priming studies found these exemplar effects. Evidence suggests that the occurrence of exemplar effects is related to whether participants rely on their episodic memories (rather than on their mental lexicons) in experiments, which is imposed by the task. Exemplar effects arose (when participants used their episodic memories) in old/new judgment tasks (e.g., Bradlow, Nygaard & Pisoni, 1999; Goh, 2005), while the effects were often not found (when participants relied on their mental lexicons) in lexical decision tasks (e.g., Hanique, Aalders & Ernestus, 2013; McLennan & Luce, 2005). These findings suggest that exemplar effects are driven by episodic memory rather than by the mental lexicon.

Contrary to this generalization, however, a few studies that used old/new judgment did not find exemplar effects under any circumstances (e.g., Church & Schacter, 1994; Theodore, Luthra & Blumstein, 2015). One possible account for these mixed results is that the method that was used (behavioral responses) was not sensitive enough to capture exemplar effects in all cases.

Despite its important implications for theories of speech comprehension, uncertainty thus still exists about the nature and role of exemplars. We therefore further investigated the hypothesis that exemplar effects are driven by episodic memory. We conducted two experiments, with 33 participants in each. Both experiments consisted of a study block (where 64 Dutch nouns appeared as primes, e.g., *oven* ‘oven’) and a test block (where the same words reappeared as targets, in addition to 64 fillers that were matched on length and frequency of occurrence, e.g., *ober* ‘waiter’). Primes were spoken by a male or a female speaker, while all targets were spoken by the male speaker, yielding a match (male - male) and mismatch condition (female - male). Primes and targets were on average separated by 50 intervening trials (which amounts to ~3 min.). Besides collecting response times and recognition accuracy like in previous work, we recorded participants’ electroencephalography (EEG) to investigate whether exemplar effects are better captured by a more sensitive method than behavioral measures.

In the study block of both experiments, participants made judgments about the words’ loudness. We selected this task because previous work has shown that directing participants’ attention to the speech signal during study increases the likelihood of observing exemplar effects during test. The critical difference between the two experiments was the task we used in the test block: in Experiment 1, participants performed old/new judgments (a task that relies on episodic memory) while in Experiment 2, they performed animacy judgments, a semantic task that relies on the mental lexicon. We used semantic judgment rather than lexical decision (like in a number of previous studies) because this enabled us to use the same real word stimuli in both experiments. If exemplar effects are driven by episodic memory, we anticipate greater exemplar effects in Experiment 1. In addition, if ERPs (event-related potentials: stimulus-locked brain potentials derived from the EEG signal) are more sensitive than behavioral measures to exemplar effects, we expect larger exemplar effects in our ERP data than in our behavioral data.

In the ERP results, we found that our two tasks elicited distinct ERP responses: an N400 effect arose in Experiment 1, but not in Experiment 2. This result is not unexpected, as previous research has identified the N400 as one of the ERP correlates of episodic recognition memory. More importantly, we found that participants in Experiment 1 and 2 were differentially affected by a match in speaker voice: In Experiment 1, the N400 peaked remarkably higher for matching compared to mismatching
targets, while in Experiment 2, brain responses did not clearly differ in the match vs. the mismatch condition. An exemplar effect thus arose in Experiment 1 only (see Figure 1).

Figure 1: Grand average ERP waveforms, time-locked to target word onset in the match and mismatch conditions in Experiments 1 and 2 at electrode C4. Negativity is plotted upwards.

In our behavioral results (RTs and accuracy), we found that responses were less accurate and slower in Experiment 1 (74% correct, 1179 ms on average) than in Experiment 2 (97% correct, 1128 ms). Words in the match condition received slightly more accurate responses (87% correct) than the mismatch condition (85%) in both experiments (no interaction arose). In RTs, there was no statistically significant difference between the two conditions in either of the experiments (Experiment 1: match 1153 ms and mismatch 1164 ms, Experiment 2 match 1128 ms, mismatch 1129 ms).

To conclude, we detected clear exemplar effects in our ERP data, while this was not the case for our behavioral data. Exemplar effects may thus well be present in cognitive processing even when they do not clearly surface in behavioral results. We therefore should be careful in disregarding (previous and future) null findings obtained with behavioral measures.

In addition, we found exemplar effects in the EEG data only when we used an old/new judgment task (in Experiment 1), but not the one in Experiment 2, required participants to use their episodic memories. Our exemplar effects were therefore likely driven by participants’ use of episodic memory. This implies that clouds of exemplars are represented in episodic memory rather than in the mental lexicon. As such, our results do not support a hybrid mental lexicon, in which abstract representations and clouds of exemplars are combined. Instead, they suggest that the mental lexicon, containing abstract representations, cooperates with domain-general episodic memory, in which clouds of exemplars are represented.

References