Lexical access in comprehension vs. production: Spatiotemporal localization of semantic facilitation and interference

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Humans understand words faster when they are preceded by semantically related primes. This facilitation is usually thought to result from the automatic activation of the prime that spreads to the representation of the target word. Interestingly, in language production, semantic relatedness often has the opposite effect: in object naming for example, a semantically related prime delays the naming time of the current object. While the semantic facilitation effect is most commonly thought to originate at the lexical level, the locus of semantic interference in production is highly debated, with some hypotheses placing it at the lexical level and others at later, post-lexical stages. On the lexical account, the effect is caused by competition for selection between the activated representations of the prime and target, and consequently, lexical selection is achieved via competition (Bloem & La Heij, 2003; Levelt, Roelofs, & Meyer, 1999). However, more recent studies have proposed that the interference effect is post-lexical, at the level of articulatory programs. For instance, the Response Exclusion Hypothesis (Janssen, Schirm, Mahon, & Caramazza, 2008; Mahon, Costa, Peterson, Vargas, & Caramazza, 2007) assumes that language production involves a single-channel output buffer to which visually presented words have privileged access over names of images. Before the name of the image can be produced, this buffer would have to be cleared of the representation of the prime; a process regulated by semantic information, giving rise to the interference effect.

The present work took advantage of the high temporal resolution of magnetoencephalography (MEG) to address the spatio-temporal localization of the semantic interference effect in production and the facilitation effect in comprehension. The challenge was designing maximally parallel comprehension and production tasks to allow adequate comparison across them. Specifically, production includes a motor component which is absent in comprehension. We resolved this by using overt Word Reading for the comprehension task and Object Naming for production. We also manipulated prime type at three levels: identical primes, that were the repetition of the target for Overt Reading, and the name of the objects for Object Naming. We also used semantically related primes, which were words that belonged to the same semantic category of the targets. Finally, unrelated primes were words that differed from the target in their visual, phonological, and semantic aspects. Further, since previous studies have shown that stimulus onset asynchrony (SOA) can modulate the direction and strength of priming effects (Bloem & La Heij, 2003), we also manipulated SOA at 4 levels.

The behavioral results replicated the interference effect in object naming and the facilitation effect in word reading. Further, within each task, reaction times decreased with longer SOAs. The MEG data showed an early facilitatory priming pattern in the Superior Temporal Gyrus (STG) at 180-335ms, in line with spatial (Hillis, Rorden, & Fridriksson, 2017) and temporal (Pylkkänen & Marantz, 2003; Hauk & Pulvermüller, 2004) localizations of lexical selection. In contrast, we found a much later interference effect at 395-485ms, centered in and around the left insular cortex, which has been linked to motor planning of articulation (Ackermann & Riecker, 2004). Crucially, in classic models of object naming, the timing of this effect coincides with estimated timings of phonetic encoding and articulatory planning, and occur much later than lexical selection (Indefrey, 2011).

We thus confirmed that semantic facilitation in comprehension localizes at the early lexical level and presented neuroimaging evidence in support of the Response Exclusion Hypothesis, pointing to a late, post-lexical locus of semantic interference.

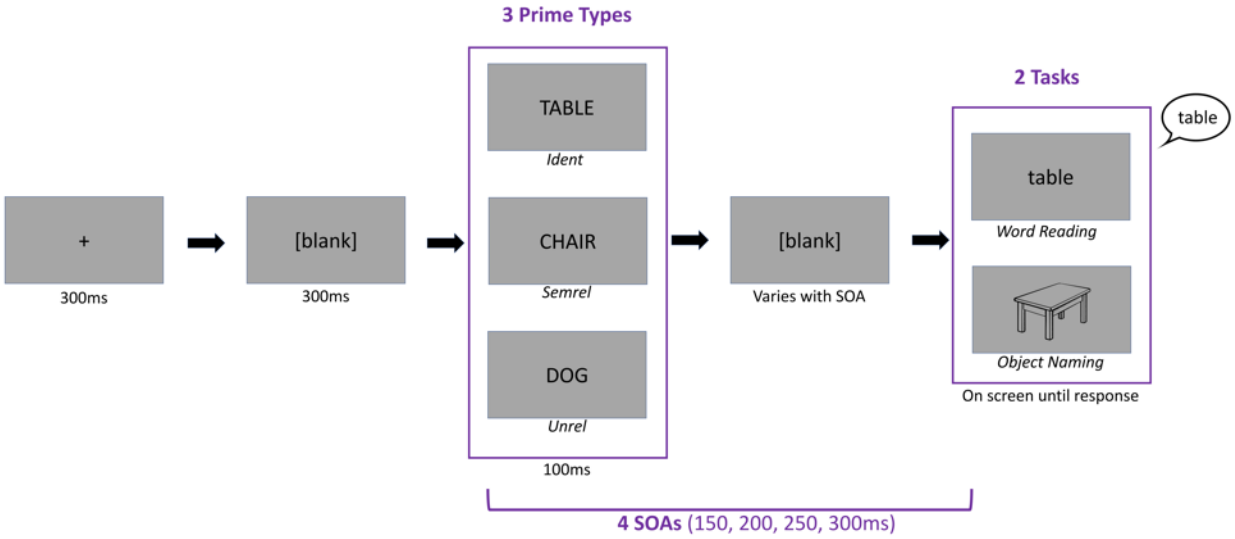

Figure 1: Stimulus presentation and design

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