

# Schematic Diagrams and L2 Mental Simulation of English Prepositional Phrases

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Embodied simulation hypothesis supposes that language processing involves the activation of perceptual-motor systems to recreate the described scene (Bergen 2019). It has been found that mental simulation effects are modulated by factors such as the abstractness of meaning (literal vs. metaphorical) and visual stimulus presentation time (i.e., stimulus onset asynchrony (SOA))(Bergen et al. 2007). Previous mental simulation research primarily focused on L1 processing and reported compatibility and interference effects (Liu & Bergen 2016), while not enough attention has been paid to the mental simulation in L2 processing (Wheeler & Stojanovic 2006). In L2 pedagogy inspired by cognitive linguistics, schematic diagrams have been increasingly used as visual imagery tools with facilitative and inhibitory effects being found (Boers 2011; Tyler, Mueller & Ho 2011), but the examination of schematic diagrams still needs empirical psycholinguistic evidence from L2 learners.

The current study investigates L2 learners' mental simulation of English prepositional phrases cued by schematic diagrams and whether any observed mental simulation effect is modulated by prepositions (*over* vs. *in*), the abstractness of meaning (spatial vs. extended) and SOA (1040 milliseconds vs. 2040 milliseconds). 79 adult L2 English learners participated in the study. All of them were Chinese-L1 speakers with advanced English proficiency (IELTS > 6.5). The diagram configures the prototypical spatial sense of the preposition and a metaphorically motivated extended sense (Table 1). In the semantic priming task, participants saw a prime of a diagram embedded with a trajector word and judged the acceptability of a PP (Figure 1). Related and unrelated primes share the same trajector word but with different diagrams. Response times (RTs) of PP judgments were analysed using linear mixed-effects models with controlled covariates (L2 proficiency, frequency and event plausibility).

Results showed fixed effects of L2 proficiency, preposition and sense. Faster RTs were observed when L2 learners' English proficiency was higher. RTs for judging *over* phrases were longer than *in* phrases and RTs for judging extended senses were longer than spatial senses. Post-hoc analyses of the relatedness × preposition interaction showed interference effects of *over* diagrams on processing *over* phrases but no effect on processing *in* phrases (Figure 2). The relatedness × SOA interaction showed interference effects of diagrams on L2 phrasal judgement under 2040-millisecond but not 1040-millisecond SOA (Figure 3). No interaction was found between relatedness and sense. The interference effects on processing *over* phrases could be attributed to the mutual inhibition of diagram and language processing due to the simultaneous recruitment of the same perceptual neurons (Wheeler & Stojanovic 2006). Compared with the *in* diagram, the *over* diagram was more abstract and might yield more than one interpretation by L2 learners, such as *above* and *on*. The results indicated L2 mental simulation tended to be executed when SOA was relatively longer since it took time for schematic diagrams to be processed and comprehended. The findings suggested that L2 mental simulation effects were modulated by prepositions and SOA, and supported the psychological reality of schematic diagrams in L2 learners' processing of English prepositional phrases.

Table 1: Sample Stimuli of the Semantic Priming Task

Prep	Diagram	Sense (Based on Tyler & Evans 2003)		Prime word	Target phrase
over		Spatial	A TR is higher than the LM	sun	over the horizon
		Extended	A TR is more than the LM	score	over a hundred
in		Spatial	A TR is located within the LM	knife	in the drawer
		Extended	A TR experiences a state of the LM	animal	in great danger

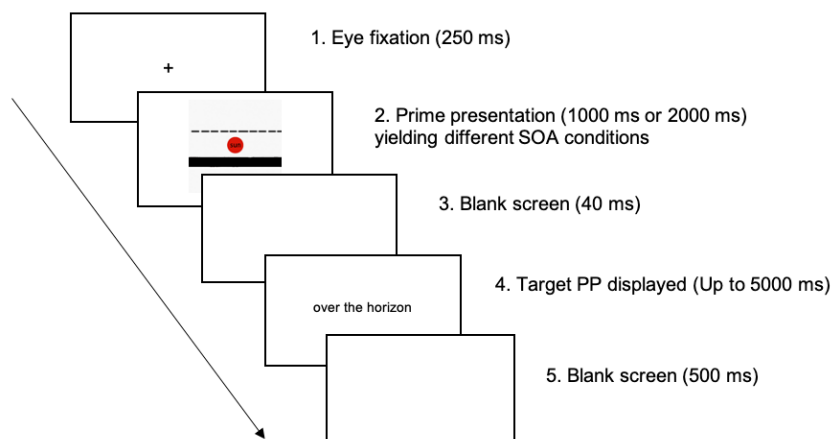


Figure 1: A Sample Trial of the Semantic Priming Task



Figure 2: Response Times of Related and Unrelated Trials by Preposition

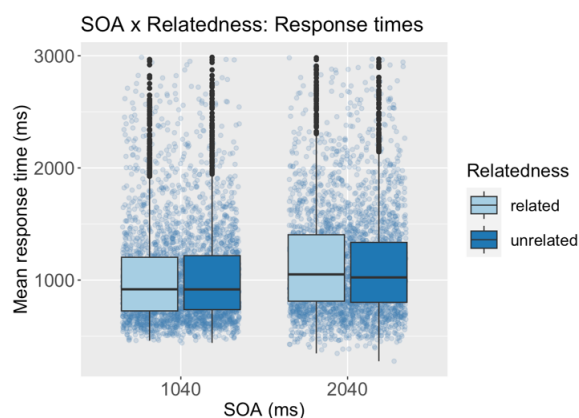


Figure 3: Response Times of Related and Unrelated Trials by SOA

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