L2 Proficiency Modulates Semantic Space in Korean-English Bilinguals: An ERP Study

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Background: How is semantic knowledge represented and accessed across languages in bilinguals, and how does second language (L2) proficiency modulate this process? While many models assume a largely shared semantic system across languages, growing evidence suggests that semantic representations may be partially shared yet language-specific. However, it remains unclear whether bilinguals rely more on first language (L1) or L2 semantic space during L2 processing, and how proficiency shapes this reliance. Existing bilingual models, such as the *Revised Hierarchical Model* (RHM)[1] and the *Bilingual Interactive Activation Plus* (BIA+) model[2] predict that increasing L2 proficiency strengthens direct access to L2 semantic representations. However, few studies have directly tested this prediction using explicitly language-specific semantic metrics. The present study addresses this gap by combining distributional semantic modeling with event-related potentials (ERPs) to examine whether Korean-English bilinguals rely on L1- or L2-based semantic space during L2 lexical processing as a function of proficiency. High L2-proficiency bilinguals are expected to show larger ERP differences between strong and weak semantic similarity when similarity is defined in L2 rather than in L1, whereas low-proficiency bilinguals are expected to show the opposite pattern.

Method: Thirty-four Korean-English bilinguals performed an L2-L2 semantic priming categorization task while EEG was recorded. Prime-target semantic similarity was manipulated using cosine similarity between *fastText* word vectors, computed separately within English (L2-based semantic space) and Korean translation equivalents (L1-defined semantic space; see Figure 1). Each target word belonged to a predefined semantic category (e.g., *relative*), and participants judged category membership following an L2 prime. Participants were divided into high- and low-L2 proficiency groups based on standardized test scores and/or self-ratings. ERP responses time-locked to target onset were analyzed using cluster-based permutation tests, separately for L1-based and L2-based similarity contrasts (strong vs. weak) within each proficiency group.

Results: Behavioral responses showed high accuracy overall, but no reliable priming effects as a function of semantic similarity or proficiency. In contrast, ERP results revealed a significant P600-like effect (522-666 ms) for L2-based semantic similarity, only in the high-proficiency group. Strong vs. weak L2 semantic similarity elicited significant amplitude differences over widespread fronto-central and parietal electrodes [Figure 2]. No significant ERP effects were observed for L1-based semantic similarity in either proficiency group, nor for L2-based similarity in low-proficiency bilinguals. Critically, only high-proficiency bilinguals showed neural sensitivity to L2-defined semantic similarity, suggesting that L2 proficiency selectively tunes the semantic space engaged during L2 lexical processing.

Discussion: The results demonstrate that highly proficient bilinguals preferentially engage L2-specific semantic space during L2 lexical processing, whereas low-proficiency bilinguals do not show clear neural sensitivity to either semantic space. The observed P600 effect without N400 effect suggests that semantic similarity modulates post-lexical integration or reanalysis processes rather than early automatic lexical access. These findings are consistent with both the RHM and BIA+ model, while providing direct empirical support for the idea that bilingual semantic representations are partially shared but dynamically weighted as a function of proficiency. The results generally suggest that proficiency shapes not only semantic access but also the geometry of lexico-semantic space engaged during L2 word processing.

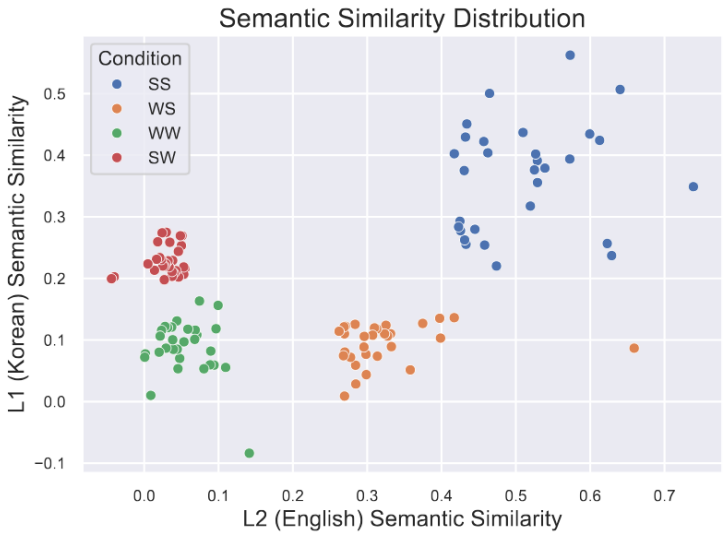

Figure 1: Scatter plot showing the relationship between semantic similarity in L2 (English) and L1 (Korean) across all exemplar prime–target pairs used in the experiment. Each point is a prime–target pair, colored by L1–L2 condition (SS: Strong–Strong; SW: Strong–Weak; WS: Weak–Strong; WW: Weak–Weak).

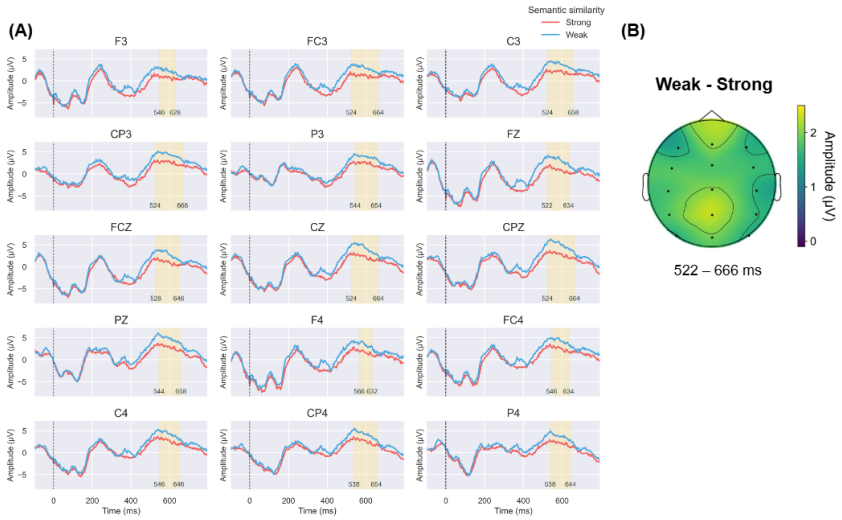

Figure 2: ERP results comparing Strong vs. Weak L2-based semantic similarity conditions in high L2 proficiency participants. (A) ERP waveforms from representative electrodes, time-locked to target onset (−100 to 800 ms). The significant P600 time window identified by the cluster-based permutation test is shaded for each channel, with the specific time range indicated within each plot. (B) Scalp topographies showing ERP amplitude differences between the Weak and Strong conditions (Weak – Strong), averaged over the time range encompassing all significant P600 windows across channels (522–666 ms).

References

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