L2 lexical development reshapes the L1 semantic network

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Background: Network science tools are increasingly valued in psycholinguistic research for their ability to capture latent organizational properties of the mental lexicon that traditional performance metrics cannot access [1]. Recent work applying these tools to semantic fluency data has shown that immersion in an L2-dominant environment degrades the structural organization of L1 semantic networks, even when behavioural performance shows no such effects [2]. However, bilingual experience is multidimensional, including L2 use, reduced L1 exposure, and vocabulary growth. Crucially, fluency tasks —in which speakers retrieve category exemplars under time pressure—are particularly sensitive to the organization of lexical-semantic memory, and performance in them has been shown to depend critically on vocabulary knowledge [3]. This raises a question: can the expansion of L2 vocabulary knowledge produce similar erosion of the L1 network as recently reported in Chaouch-Orozco and Martín-Villena [2]?

Method: We addressed this question by examining 134 Chinese-English bilinguals living in China—a non-immersed, L1-dominant context where L2 use is minimal. Participants were divided into three groups (small, intermediate, large) based on L2 vocabulary size (MINT) [4], while L1 vocabulary (MINT), L2 global proficiency (OQPT) [5], and L2 use (LHQ 3.0) [6] were controlled across groups. All participants completed a semantic fluency task responding to animals, the most common category in this paradigm [7], in both languages and within 60 seconds, across two sessions separated by one week. For each group and language, we constructed correlation-based semantic networks with the fluency data [8] and compared them on three global metrics: clustering coefficient (CC; the degree of local interconnectivity), average shortest-path length (ASPL; the efficiency of global communication across the network), and modularity (Q; the extent to which the network is partitioned into distinct subcommunities). Group differences were assessed using bootstrapped permutation analyses at multiple node-retention levels (50–90%), ensuring that effects were robust to network perturbation. We predicted more efficient L2 networks with larger L2 vocabulary. For the L1, if vocabulary expansion alone disrupts L1 organization, we expected degraded L1 networks with increasing L2 vocabulary size; if L1 erosion requires sustained activation shifts characteristic of immersion, L1 structure should remain unaffected.

Results: In the L2, larger vocabulary was linearly associated with more efficient networks (higher CC, lower ASPL and Q; all $ps < .001$) (Figure 1 and 2). In the L1 (Figure 3 and 4), however, organization followed a U-shaped trajectory: the intermediate-vocabulary group exhibited the worst L1 organization (lowest CC, highest ASPL and Q), while the large-vocabulary group showed the best—surpassing even the small-vocabulary group (all $ps < .001$). This pattern was robust across all node-retention levels—indicating a robust effect—yet was partially invisible in total response counts, which did not significantly differ between the small and mid groups.

Discussion: We interpret this trajectory through a three-stage developmental account. When the L2 lexicon is small, L2 words are accessed via L1 mediation and remain parasitically dependent on L1 structures, imposing minimal interference [9, 10]. At intermediate levels, the L2 is large enough to generate cross-linguistic co-activation but remains insufficiently autonomous—many L2 items still rely on L1 translation equivalents [10, 11]—producing maximal L1 disruption. Once the L2 lexicon reaches a sufficient size, direct L2-concept links are established, L1 mediation decreases, and L1 organization recovers. These findings show that L2 vocabulary size and immersion exert qualitatively different effects on L1 network structure—differences only visible through network science methods.

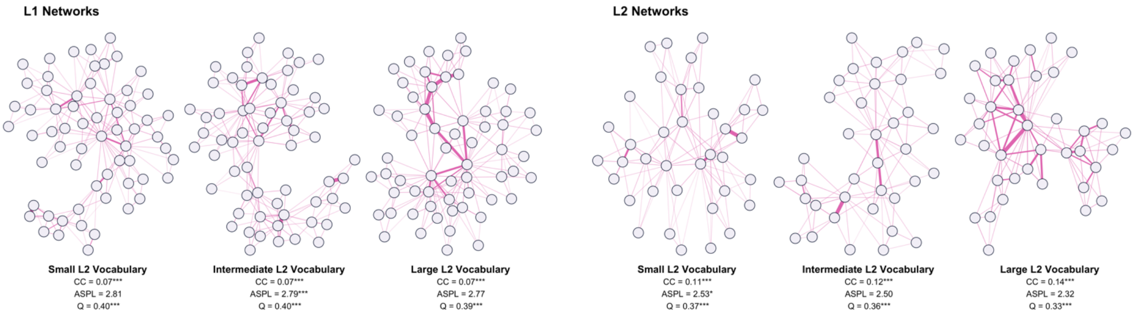

Figure 1: L1 and L2 semantic networks for the three vocabulary groups. Nodes represent animal names produced by all three groups; edges reflect co-occurrence patterns across participants, with thicker edges indicating stronger associations. Note that the metric values and significance levels displayed below each network are derived from the raw, unbootstrapped networks and are provided for descriptive purposes only; formal between-group comparisons are reported in the main text and are based on the bootstrapped permutation analyses (see Figures 3 and 4).

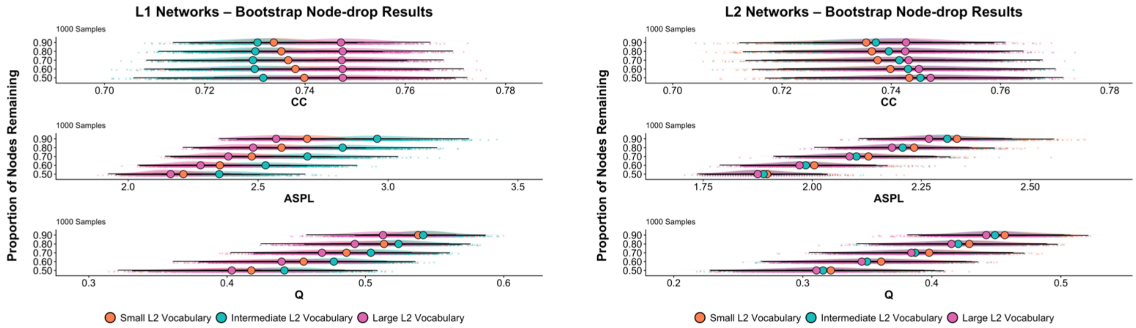

Figure 2: Bootstrap node-drop results for L1 and L2 semantic networks across the three groups. Panels display the distribution of the global network metrics obtained from 1,000 bootstrap iterations at five node-retention proportions (50%–90%). Coloured dots represent group means; shaded distributions reflect the variability across iterations.

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