General organizing principles governing the amount of functional overlap between languages in the bilingual brain

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Does the same brain area subserve two different languages, or are two languages organized separately in bilinguals? There is a vast literature that has identified multiple important factors affecting the extent to which languages rely on the same neural populations in the specific brain region (Supizio et al. 2020). The factors include, e.g., the age of acquisition of the second language (L2), proficiency level of the first language (L1) and L2, the amount of exposure to each language, the manner of L2 acquisition (formal vs. informal), the linguistic similarity between L1 and L2, and the modality of acquisition of L1 and L2 (oral versus signed) (Emmorey et al. 2016; Hirosh & Degani 2018; Hull & Vaid 2007; Liu & Cao 2016; Perani et al. 1998; Rahmani et al. 2017). We will refer to these factors as language modifiers (LMs). These LMs have been generally studied one or – less frequently – two at a time. What is lacking is a set of general principles that explains why and how these factors modify divergent versus convergent language organization in the bilingual brain. We are offering a hypothesis that integrates and organizes previous findings into broad guiding principles. The principles relate to (1) the complex interplay between multiple diverse LMs that can each modulate the degree to which L1 and L2 can overlap functionally, (2) the requirement of cognitive control, and (3) the similarity of LMs in L1 and L2. The first principle suggests that there are two main types of LMs: primary and secondary. The primary LMs directly modulate the amount of functional convergence between L1 and L2. They subdivide into acquisition modifiers (the age of L1 acquisition, the level of proficiency in L1 and L2, the amount of exposure to each language, and the manner of language acquisition), and linguistic modifiers (the linguistic distance between L1 and L2, and the modality of L1 and L2). The primary LMs can explain independent regions of language specialization versus functional overlap (e.g., a late versus early age of L2 acquisition). The secondary LMs may modify the degree of functional overlap between languages in an indirect manner. They include metalinguistic awareness and individual factors (e.g., motivation). The second principle differentiates between cognitive control abilities (superior performance on executive function tests) versus those involved in the cognitive effort. The principle explains how LMs modulate cognitive control. The third principle suggests that the more similar the LMs in L1 and L2 are, the more functional co-localization is to be expected between the languages. For example, if both L1 and L2 were acquired early in life, they are both spoken with a high degree of proficiency, they are linguistically close, they are both used daily, and share the same modality, a high degree of neural overlap is more likely to occur. Referencing the broad characteristics of language organization in bilinguals, as presented in the hypothesis, can provide a roadmap for future clinical and basic science research.

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