Language switching in the bilingual brain: What’s next?

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Separate neural systems for each language during picture naming


A number of published studies have found evidence of differences in neural activity across a bilingual's two languages (due to differences in age of acquisition, language proficiency and computational demands of each language)

Increased activity in the Dorsolateral Prefrontal Cortex (DLPFC)
- Picture naming paradigm
- increased activity in the DLPFC and the superior parietal lobule during language switching
- neural bases of bilingualism
- early bilinguals’ representation of the two languages may be mediated by neural systems not typically associated with language.
• Study by Price et al. (1999)
• Increased activity for translation in areas involved in articulation (including the Anterior Insula and the supplementary motor area) and in attentional control including the Anterior Cingulate Gyrus.
• Increased activity in the Broca’s area and the Supramarginal Gyrus.
• The task, involved picture naming not translation. (Hernandez et al., 2000, 2001)
• Translation may involve a sufficiently strong executive component on its own.
• Increased activity of brain areas involved in cognitive control when bilinguals are switching between languages.
• In previous studies: the almost complete lack of discussion about differences between each single language condition
The current study uses the same picture naming task.

Dorsolateral Prefrontal Cortex suggests that switching must rely, at least in part, on more executive processing.

Early Spanish–English bilinguals.

Their least proficient language is Spanish, their L1.

Whether the less dominant L1 will reveal increased activity in areas devoted to attentional control and/or those devoted to articulation and visual word form processing?
• The order of presentation of the four blocks (two mixed, one Spanish and one English) was counterbalanced across subjects.

• Mixed vs. blocked comparisons revealed increased activity in a network of areas including the left Superior Parietal Lobule, as well as the right Precentral Gyrus, Supplementary Motor Area, and the Dorsolateral Prefrontal Cortex. These results confirm and extend those seen in previous studies on language switching.
- English vs. Spanish comparison, there was increased activity in the right Postcentral Gyrus (BA 3), Superior Temporal Gyrus, the Hippocampus, the Insula and the Pre-supplementary motor area.
- Spanish vs. English comparison there was increased activity in the left Hippocampus, Thalamus, Amygdala, Inferior Frontal Gyrus and the right Anterior Insula.
• early bilinguals recruit a set of neural areas that are involved in executive function and motor processing, articulation and phonological retrieval when naming pictures in a condition which involves language switching

• alternating between languages leads to activation in brain structures which play a role in executive control and articulatory and motor planning

• activity in the Precentral Gyrus, an area involved in phonological retrieval, suggests that it may be interference during phonological retrieval that is the main source of interference during the mixed condition

• one of the limitations of the current study is that it leaves unclear whether the need for increased executive function in early bilinguals is due to language switching and/or language mixing.
• The nature of this higher level of processing is also present in subject’s awareness of their bodies and suggest that picture naming, in an early L2 even when it is the dominant language, is a more conscious process than that seen in Spanish the L1.

• Picture naming in English revealed increased activity in the right hippocampus whereas picture naming in Spanish revealed increased activity in the left hippocampus.

• The naming of pictures in Spanish the first language would be associated with more robust word meaning retrieval. In English, the naming of pictures in early bilinguals is associated faster picture naming times but also with increased reliance on recognition memory.

• Picture naming in Spanish revealed an increase in activity in bilaterally in the amygdala relative to naming of pictures in English.
• differences in activity in brain areas traditionally associated with language
• also differences in brain areas associated with more general cognitive functions. This included areas devoted to memory (i.e. Hippocampus), somatosensory processing, emotion (e.g. Amygdala), and self-awareness (i.e. Posterior Cingulate)
• later learning as involving higher level conscious processing whereas early learning is conceptualized as involving more lower-level processing. In this view, items in L1 may be more closely linked to emotional content as well as word knowledge. L2 items are linked to faster picture naming speeds but seem to involve a more “detached” mode of processing.
What’s next?

• Future studies are needed to extend these results using language tasks which have differences in the emotional valence of items in each language.
• The link between additional inhibitory control and its possible “strengthening” in bilinguals.
• Uncovering of the underlying mechanisms that create better inhibitory control in bilingual speakers.