Journal Club

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"Il piccolo principe est allé": Processing of Language Switches in Auditory Sentence Comprehension

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Review of Abutalebi et al. (http://www.jneurosci.org/cgi/content/full/27/50/13762)

There is an ongoing debate surrounding the possible mechanisms that enable bilinguals to switch between languages. Studies on bilingual language production consistently find that switching from a weaker (often second) language to a stronger (often first) language incurs a greater processing cost than producing switches in the opposite direction. The main account for these asymmetrical switch costs holds that the stronger language is inhibited to a larger extent during production in the weaker language than vice versa. Switching from a weaker to a stronger language thus requires greater disinhibition than the reverse.

Cognitive control mechanisms are often assumed to be involved in switching between languages. Indeed, a number of functional imaging studies on productive language switching (e.g., Hernandez et al., 2001) have found activation in areas linked to cognitive control (among others the anterior cingulate cortex, dorsolateral prefrontal cortex, and basal ganglia). The study by Abutalebi et al. (2007), which was published recently in *The Journal of Neuroscience*, is one of few studies to have investigated the comprehension of language switches that occurred in spoken sentences. Despite the value of this study, its explanation of the difference between regular and irregular language switches is debatable. In the following, we will specify why this is the case.

In an event-related functional magnetic resonance imaging paradigm, 12 highly proficient Italian-French bilinguals living in Switzerland listened to narratives in French (FR) and Italian (ITA) that unpredictably switched language at certain points during the presentation. These language switches could be regular (that is, they respect the constituent structure of the sentence, e.g., "Il piccolo principe_est allé": ITA-"The little prince"_FR-"was going") or irregular (that is, contain switches within a verb phrase or noun phrase, e.g., "J'ai_risposto": FR-"I have"_ITA-"answered").

Regular language switches activated the left Brodmann's area 37 more than irregular language switches, and irregular switches activated the opercular portion of Broca's area and the left inferior parietal lobule more than regular switches. The authors believe that these findings suggest that regular switches are interpreted as translation equivalents and thus activate brain areas associated with lexical-semantic processing, whereas irregular switches are initially perceived as violations and thus activate brain areas related to phonological and syntactic processing.

Although behaviorally there were no differences in relative language proficiency in the participants' first or second languages, results revealed that perceiving language switches from French (second language) to Italian (first) resulted in less activation of the left caudate and bilateral anterior cingulate cortices than perceiving language switches from Italian to French [Abutalebi et al. (2007), their Fig. 4 (http://www.jneurosci.org/cgi/content/full/27/50/13762/F4)]. The authors argue that, given that this particular group of bilinguals reported being more exposed to their second language than to their first, this asymmetry effectively represents a greater neural cost of perceiving switches from the dominant (French) to weak (Italian) language compared with perceiving switches from the weak to dominant language.

The study by Abutalebi et al. (2007) represents an important step forward in bilingual research and may prove to have long-lasting implications for models of bilingual language switching and bilingual language comprehension. In particular, the finding that perception of language switches activates areas related to cognitive control suggests the existence of an "input switch" between a bilingual's languages, a concept that has hitherto received little support. One should note, however, that other studies that involved

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language switching in comprehension did not find switch-specific cortical activation (Klein et al., 2006). Therefore, we feel that the authors' claim that the anterior cingulate cortex and the caudate nucleus host a dedicated language control mechanism for language switching in bilinguals may be slightly premature. Reported control-related areas may, alternatively, be involved in lexical-semantic control in both monolinguals and multilinguals (Crinion et al., 2006), or may simply reflect less automatic processing of a weaker language (cf. Friederici, 2006).

As the authors note, the finding that switching from the weak to dominant language incurs a greater processing cost than the reverse is contrary to results from productive bilingual language switching studies. It would be interesting to know whether the reported asymmetry mirrors the directionality in which this population of bilinguals usually hears and produces language switches. If so, this fact may also account for the differential processing costs, given that language switches in an unfamiliar direction may be relatively difficult to process.

Despite the significance of this research, the comparison between regular and irregular language switches is problematic, in our view. As is clear from the extensive body of research on code-switching (for review, see Muysken, 2000), bilinguals regularly produce language switches both within (e.g., between the verb and auxiliary) and between sentence constituents (e.g., between noun phrase and verb phrase). Therefore, it is by no means certain that between-constituent switches would be perceived as more "regular" than within-constituent switches. Thus, any conclusions drawn from this comparison must be interpreted with caution. Furthermore, the hypothesis that irregular language switching may require a greater amount of phonological and syntactic processing is never sufficiently justified by the authors, and neither is the supposedly greater involvement of lexical-semantic processing for the regular switches. In fact, in addition to lexical-semantic and phonological/syntactic processing, the areas reported in Abutalebi et al. (2007) have been found to be activated by numerous other cognitive processes (e.g., inferior frontal regions have been connected to almost all aspects of language processing as well as various non-language-related tasks (cf. Poldrack, 2006). Thus, we argue that the reported activation patterns are insufficient to warrant conclusions regarding processing differences between "regular" and "irregular" switches by reverse inference (cf. Poldrack, 2006). Regardless, any such interpretation should be supported by a direct comparison between the two conditions rather than the simple contrasts for each type of switch that were reported in the article.

Future studies will have to elucidate the exact role of control processes in perceiving language switches, as well as reconcile the possible existence of a switching mechanism with the volume of studies that show concurrent activation of more than one language in bilinguals (cf. Dijkstra, 2005). We would, however, urge caution in interpreting the reported differences between processing of regular and irregular language switches. As a side comment, although the active brain areas reported are consistent with previous findings, it would be interesting to see which clusters of activation would survive a more conservative thresholding level.

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