Neural correlates of phonological awareness (PA) and rapid automatized naming (RAN) and implications for the double-deficit model

Neuroimaging studies of reading have mainly focused on neural circuits involved in phonological processing, while very few studies have examined rapid automatized naming (RAN). RAN refers to the ability to quickly name printed numbers, letters, colors, or objects that are arranged in rows. As discussed in previous summaries, it is a task that is closely related to reading fluency even though it is not a reading task, per se. Rather, it is hypothesized to rely on some of the cognitive skills that are building blocks for reading fluency. For this reason, neuroimaging studies of RAN are of great interest for understanding the neural circuits that support reading development.

In order to contextualize the neurobiological findings for RAN, it is important to review what is known about reading brain circuits more generally. The majority of studies on the neural circuits involved in reading have focused on phonological processing because it is one of the strongest predictors of reading abilities. These studies have consistently identified regions in the left hemisphere, in the frontal lobe and at the boundary of the temporal and parietal lobes of the brain, as being involved in phonological processing. In individuals with dyslexia, the general pattern is for these areas to show less brain activation during reading and phonological tasks.

In contrast to the large body of evidence documenting brain patterns associated with phonological awareness (PA), brain regions implicated in rapid naming have been the focus of much less research. Preliminary results have implicated the left frontal lobe and right cerebellum as being important for RAN. Most important for the central question of this review is the fact that phonological processing and RAN seem to show associations with at least a few different brain regions, which supports the behavioral evidence that these tasks are at least partly distinct.

Although neuroimaging studies are beginning to work out the neural correlates of PA and RAN, only one study has tested the double-deficit model of dyslexia using brain imaging data. This study asked whether children who meet criteria for different subtypes of the double-deficit model (i.e., RAN only, PA only, double-deficit) show different brain activation profiles. Results showed that predictions of the double-deficit model were generally supported by the brain imaging data. Children with a double-deficit showed the least activation in brain regions important for PA or RAN compared to children with the PA only profile, RAN only profile, or those who served as controls. This result suggests that the double-deficit children had the most severe neurological profile. Results also showed some distinction in brain regions associated with PA versus RAN. Overall, this study supported the idea that PA and RAN are at least partially distinct skills, and provided preliminary support for the double-deficit model. Nevertheless, a single study in the scientific literature is always accompanied by limitations, so further work is necessary to confirm this initial neurobiological pattern.

