Keynote

The Stuttering Brain: Scanning and Stimulation Studies

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Developmental stuttering (also known as stammering in the UK) affects one in twenty children and persists to adulthood in one in a hundred. Fluency can be achieved temporarily by people who stutter by changing the way speech is produced, for example by singing, speaking with a different accent or in time with an external stimulus, such as a metronome or another speaker. Altering the auditory feedback associated with speech production can also be effective; for example, feedback that is noisy, or altered in pitch or time (delayed) can result in almost complete fluency in some people (as portrayed in the film The King's Speech). The effectiveness of altering auditory feedback in enhancing fluency suggests that stuttering may be caused by a problem in combining motor and auditory information.

In our research, we aim to understand the brain abnormalities that cause stuttering. We use MRI brain scans to measure how brain areas involved in producing speech (motor areas) and in monitoring speech (auditory areas) communicate with each other both functionally and structurally. Our findings of white matter disruptions (Watkins et al., 2009) and changes in coordinated motor and auditory activity during speech production in people who stutter (Watkins 2011) are consistent with the idea that sensorimotor integration is abnormal. MRI can also be used to see what is happening inside our mouths when we are speaking. We have developed new ways of using MRI to scan the vocal tract during fluent speech and during stuttering to show that movement of the articulators is more variable during speech production in people who stutter.

Recently, we used transcranial direct current stimulation (tDCS) in a double-blind randomised sham-controlled trial alongside fluency training in people who stutter. We found that 5-days of 1-mA anodal tDCS over the left inferior frontal cortex successfully reduced disfluency by about one third and that these effects were still present 6 weeks after the end of the intervention (Chesters et al., 2018). MRI scans of brain activity during speech production before and after the intervention showed a significant increase in subcortical areas in the group that had anodal tDCS and successfully reduced their disfluency relative to the group that had sham stimulation and showed no change in their fluency.

These studies suggest that developmental stuttering is caused by neural disruptions to systems involved in speech motor control. Brain stimulation coupled with speech fluency training now offers a realistic opportunity for improving fluency in adults who stutter for whom therapy options may be more limited or less effective than those available in childhood.

References

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