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Rhythmic auditory cues shape neural network recruitment in Parkinson's disease during repetitive motor behavior

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QUICK DEFINITIONS

Rhythmic Auditory Stimulation (RAS)

> Synchronization of body movements to tones played at consistent intervals (like a metronome or in music). Improves walking, coordination, and even thinking in people with Parkinson's Disease.

INTRA-Network Connectivity

> Connections **within** brain regions. Like the local roads that connect buildings within a city to one another.

INTER-Network Connectivity

> Connections **between** brain regions. Like large highways that link cities together (e.g. I-25 that connects Fort Collins to Denver).

Correlation

> In this context, refers to things that change together. For example: the longer you sit in traffic, the more annoyed you become.

The study that each of you participated in was accepted for publication at an academic journal. We wanted (and promised to some) to provide you with a summary of what we found, because without you this wouldn't have been possible.

Parkinson's Disease (PD) is the second most common neurodegenerative disease, affecting 1-2% of the adult population over the age of 65. In the United States alone, there are 500,000 to 1,000,000 people living with Parkinson's. As the world's population ages, the number of people with PD is only expected to increase.

Although there is currently no cure for PD, there is intensive focus devoted to developing therapies that will improve the quality of life for those living with the disease. One promising therapy, known as RAS, has the potential to help thousands of people. However, before we are able to expand its clinical use, **we have to understand how RAS works in the brain - which is the goal of our research.**

The 4 tasks in the MRI looked like this:

"No RAS - " referred to trials that you continued to tap along to the beat after the tone stopped playing.

"RAS - " referred to trials that you tapped along to the tone played the whole time.

PRIMARY RESEARCH GOAL:

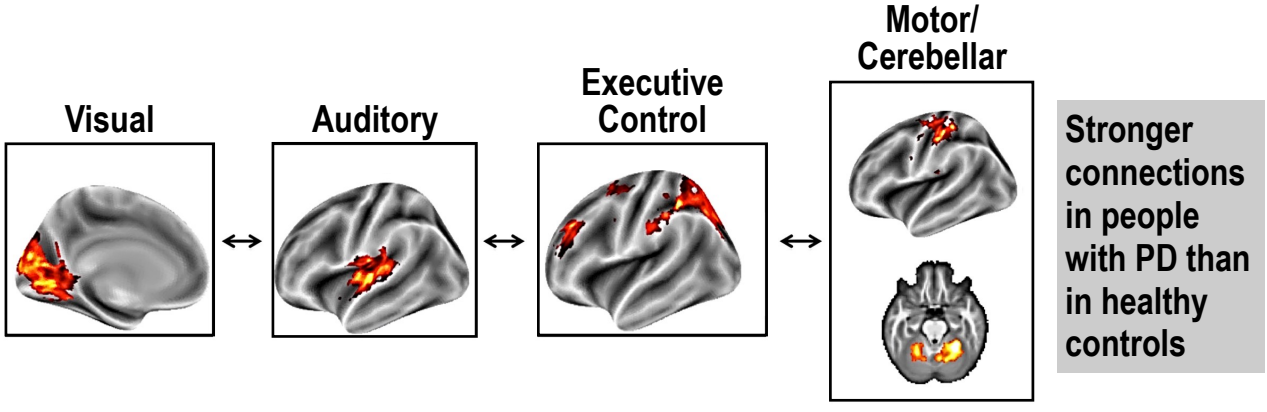
To identify differences in tapping performance and in brain connections between people with PD and healthy controls in "RAS" trials versus "No RAS" trials.

In general, **we found that Rhythmic Auditory Stimulation** (tapping along to a consistent tone)**, benefited both the healthy older adult controls as well as people with Parkinson's Disease**. Both groups tapped earlier compared to the tone in "RAS" trials as opposed to "No RAS" trials. Also, both groups tapped with a more consistent rhythm for the RAS trials. There was no difference between "fast" and "slow" tapping for either "RAS" or "No RAS" trials.

This finding suggests that RAS can help all people to start movements (tapping earlier) and to coordinate their movements (consistent tapping) to a rhythm, like starting to dance **and** being able to dance to the beat of your favorite song. This is especially important for people with PD, since they tend to have deficits in coordinated and rhythmic movements - like walking. RAS can help them start walking, walk faster and with longer strides, and to synchronize their steps. Taken together, RAS has the potential to increase their independence and quality of life.

We also wanted to identify the brain networks that underlay RAS, and to see if those networks differed between healthy older adults and people with Parkinson's Disease.

We found that there were **stronger INTRA-network connections ("local roads") in brain areas that correlate with the demands of RAS in healthy controls compared to people with PD**. These brain regions are responsible for processing auditory information (like the tones heard in RAS) and controlling movement (like tapping along with a rhythm).



We also found that **people with PD have stronger INTER-network connectivity (highways) between many regions of the brain (see the above figure).** These include regions that coordinate different types of thought (Executive Control), parts that process Auditory and Visual information, and areas that control muscle movement compared to healthy controls (Motor/Cerebellar).

WHAT DOES THIS MEAN?

To sum up: healthy adult controls had more intra-network connectivity while people with Parkinson's Disease had more inter-network connectivity. This means that while people with PD had different brain activity than people without PD, the people with PD could perform just as well as people without PD by using other parts of their brains to compensate.

We think that this shift from intra-network connectivity to inter-network connectivity in people with Parkinson's Disease during RAS may help them to use brain regions that haven't been affected by PD. By stimulating these intact brain regions with RAS, they are able to partially overcome movement-related shortfalls and improve their walking and other affected movements.

Although RAS is already successfully in use to improve mobility in people with PD, the underlying brain regions involved in RAS have yet to be understood. This study will facilitate the expansion of its use by showing that RAS not only helps movement, but also encourages different brain regions to communicate with each other more effectively.

Thank you,

- the authors

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