Understanding Parkinson's Disease: Basal ganglia Dysfunction's Role in the Visual Adaptation of Speech

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Parkinson’s Disease (PD) is a degenerative neurological disorder caused by loss of dopamine cells in the basal ganglia region of the brain. Not only does the loss of motor control affect limbic movements, it also causes speech and voice disorders as well. Effective treatments for voice disorders exist, but are lacking for more complex speech disorders. PD typically has comorbidities such as depression and anxiety. This research proposes a new paradigm of using visual information to influence speech production. Vowel stimuli were chosen based on distinct tongue movements that could be easily observed. PD speakers were asked to say a set of words [“hid”, “head”, “had”] while watching corresponding tongue avatar movements. After the baseline frequencies were recorded, participants were asked to say “head” in synchronization with each visual cue. As the tongue avatar morphed from “head” to “had”, the speakers’ F1 frequencies steadily increased. On seeing a tongue avatar movement of “had”, speakers significantly shifted production to match the F1 frequency of “had” (ANOVA on F1 frequencies indicating [$F(3,39)$] = 7.48, $p < 0.001$).Lobanov z-transformation of F1 frequencies between the healthy control group and PD speakers indicated similar levels of adaptation ($T<\alpha=0.05$). These research results establish that PD speakers respond to visual feedback in real-time. Based on this, an engineering solution provided on mobile platforms can allow patients to have more fluent communication, helping minimize the effect of comorbidities such as depression. In future, novel speech therapy utilizing visual cueing to improve articulation and fluency can be designed.