Introductory Notes as Motor Preparatory Motor Gestures Underlying Zebra Finch Song

Humans produce complex and learned behaviors like speech, playing musical instruments, and sports through exceptional motor abilities. These learned actions need specific motor planning and preparation. Researchers use songbirds in part because they produce a stereotyped motor sequence whenever they engage in singing behavior. Further, Zebra Finches learn their song through vocal production learning, similar to human speech acquisition; they mimic their adult male tutor's song and reproduce a similar version in adulthood. This motor learning process leads to the generation and execution of a highly skilled and stereotyped motor program production. Before the song, Zebra finches sing a sequence of introductory notes that are short-duration, non-stereotyped sounds. Previous work has speculated that these introductory notes are a form of motor preparation, but an experimental test of this hypothesis has not been conducted. This study casually examines the role of introductory notes as a motor preparation phase to help transition to executing the main song motor sequence. To distinguish motor preparation from song execution, we reasoned that presenting an external stimulus would delay preparation but not execution. We used air pressure recording to identify introductory notes and triggered white-noise playback during the introductory note performance in six birds and found that the external stimulus led to a delay, which can lead to interruption of the typical song motor pattern (e.g., abnormal pauses). Whereas the same stimulus presented during the song either caused an abnormal early termination of the motor program or did not affect the song (continuation), but it did not delay the execution of the song's motor gestures. Our findings suggest that introductory notes are flexible and modifiable by external stimuli, which is consistent with the hypothesis that they function as a preparatory motor gesture for the upcoming stereotyped song.

Understanding motor planning can provide insight into neurological, behavioral, speech, and motor disorders that are characterized by deficits in neuromuscular preparation.