INTRINSIC FACTORS OF ARTICULATORY SEQUENCING: ON HOW THE PERIPHERY SHAPES THE TIMING OF CENTRAL INFLUX TO MUSCLES

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Recent models of speech largely focus on the motor-sensory processes involved in producing and learning articulatory-acoustic features. Few models, however, deal with processes involved in the sequencing of articulatory motions. Those that do generally assume that speech gestures follow centrally represented strings of "phonemes". Our presentation aims to show how this dominant assumption misinterprets the role of central processing and overlooks intrinsic factors of articulatory sequencing at the periphery.

A series of findings partly summarized in Boucher (2008) support the view of Abbs (1996) that opening motions of close-open cycles in speech may not imply central influx to articulators. Instead, opening gestures can simply reflect elasticity effects of relaxing tissues. We present a synthesis of observations using electromyography (EMG) of lip and jaw openers and closers. First, we show that close-open cycles in speech may not involve activity for opener muscles. In fact, EMG activity in speech appears at the onset of closing motions and successive EMG bursts for closer and opener muscles may only occur for non-speech motions, such as chewing. On a second point, we present findings confirming Abbs' contention that spring-like properties of relaxing muscles govern opening motions. By Hooke's law, force applied in compressing a spring leads to an opposite elastic force that displaces a mass at a distance and speed that is proportional to system constants. We found that, in producing close-open cycles, force attributes of a closing motion are indeed proportional to the amplitude and velocity of a following opening gesture. Hence, neural influx that occurs at the onset of a close-open cycle specifies the kinematics of opening motions in the absence of neural influx to openers. Finally, the delay that occurs between "consonant"- and "vowel"-related gestures can relate to intrinsic effects of types of muscle fibers. Specifically, whereas numerous consonantal sounds involve fast twitch muscles, all vowel gestures involve slow twitch muscles (Stål et al., 2003 among others). The later can have relaxation times that are five times longer than those of fast twitch fibers. Thus, the delays may not reflect central commands for successive phonemes.

We discuss the implications of the above findings for current speech production models, Frame/Content theory, and research using brain-imaging techniques, where authors often assume centrally represented sequences of phonemes. In our discussion, we refer to a body of work where critics repeatedly point out that concepts of letter-like phonemes link to the tradition of analyzing speech via alphabetic symbols.

References

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