Explaining the feedback effect in stuttering: A new thesis

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Suggested citation:

Abstract

Conditions such as choral reading, delayed or frequency altered auditory feedback, and masking with noise decrease the frequency of stuttering in people who stutter. This effect is known as the feedback effect. This paper proposes that the speech module mediates these effects. When speech stimuli -as feedback, actively engages the speech module in perceptual processes while the module is in the act of producing speech, the speech module enhances fluency in people who stutter. The characteristics of modules and their implications are considered and some suggestions for investigations are made.

Keywords: Stuttering, Feedback Effect, Speech Perception–Production Link
This paper introduces a new thesis to explain the feedback effect in stuttering. The feedback effect is elicited in people who stutter (PWS) when they listen to one or more of the various types of speech stimuli and simultaneously read or talk. Under these conditions, PWS show a remarkable decrease in the frequency of stuttering. The important reason for examining this effect is to understand the mechanisms that aid PWS in producing fluent speech. A clear knowledge of the way in which fluent speech may be elicited could help us develop an efficient and long-term treatment of stuttering. In addition, empirical follow-up of this thesis would bear upon the revised motor theory of speech perception and the construct of the speech module (Liberman & Mattingly, 1985).

Several conditions produce the feedback effect in PWS. These conditions include the choral reading (Barber, 1939) and shadowing (Cherry & Sayers, 1956) during which the PWS listen to and read or speak along with a normal speaker. Under these conditions, the speech of another normal speaker becomes the stimuli that appears to precipitate decreases the frequency of stuttering, producing the feedback effect. Other conditions that have been successful in producing fluency in PWS include reading or speaking with any one of these stimuli: stuttered speech (Kalinowski, Dayalu, Stuart, Rastatter, & Rami, 2000), filtered speech (Rami, Kalinowski, Rastatter, Holbert, & Allen, 2005), reversed speech (Rami & Diederich, 2005), vowel and consonant trains (Kalinowski et al., 2000), delayed auditory feedback (DAF) (Lee, 1950, 1951) and frequency altered feedback (FAF) (Howell, El-Yaniv, & Powell, 1987). Under these conditions, PWS listen to either an electronically modified speech of another speaker or their own speech that is electronically modified. In the case of DAF, the speech of PWS lag in
the time domain, and in FAF, their pitch is shifted either up or down a fraction of an octave and thus either lags or leads in the frequency domain. One study has documented fluency producing effects of visual choral speech (Kalinowski, Stuart, Rastatter, Snyder, & Dayalu, 2000). In this case, the PWS do not hear any speech stimuli, but they do see another person silently making the speech movements while they were producing speech. All of these conditions are known as feedback conditions, and they use either normal or modified speech as stimuli. Two other conditions that do not use speech as stimuli but also decrease the frequency of stuttering in PWS include noise (Shane, 1955) and a tone (Cherry, Sayers, & Marland, 1955). Under these conditions, the PWS listened to a noise or a tone while reading or speaking and might be affected by a change in the intensity domain. All of the above conditions, except the noise and the tone conditions, appear to involve the acts of speech perception and production simultaneously.

Some theories attempting to explain the feedback phenomenon include the correct feedback explanation (Lee, 1950), the distraction hypothesis (Barber, 1939; Bloodstein, 1995), external pace setting hypothesis (Pattie & Knight, 1944), and emphasized phonation and continuity of phonation (Wingate, 1969). However, none of these theories address the issue (1) of the instancy of the feedback effect, that the feedback effect is elicited instantaneous; (2) of the rate of speech of PWS, which is independent of the stimuli once the feedback effect is elicited; (3) the variety of stimuli that elicits the feedback effect, (4) the wide range of conditions under which the feedback effect exists, and finally, (5) the suggestions that not all PWS show feedback effect. Considering that the above speculations explaining the feedback
effect in a variety of conditions have found either no empirical support or inadequate support, further understanding of the feedback effect has remained elusive.

**A New Thesis**

Noting that speech stimuli are usually involved in the listening conditions with changes in either the frequency, intensity, or time domain, a new thesis is suggested. It is proposed that speech and speech-like stimuli, when used as feedback, engage the speech module in perceptual processes while the module is either engaged in producing speech or is about to produce speech. It is suggested that this dual activation of the speech module leads to a decrease in the frequency of stuttering in PWS. When the feedback is discontinued, the speech module disengages from the perceptual process, losing its state of dual activation and resulting in stuttering.

**Background**

The concept of a “speech module” was proposed to explain the processes of speech perception and production (Liberman & Mattingly, 1985). The speech module is conceived to be independent of the general auditory perception, free from cognitive bias, and is defined as “a piece of neural architecture that performs the special computations required to provide central cognitive processes with representations of objects or events belonging to a natural class that is ecologically significant for the organism.” (Liberman & Mattingly, 1985, p. 27). The speech module has privileged access to speech or speech-like events in the environment. Further, this module is adapted for the reciprocal processes of speech perception and speech production.
Specialized modules, such as the speech module above, are attributed to have a set of characteristics (Fodor, 1983). These characteristics, with reference to the speech module and their relevance to the proposed thesis, may be considered as follows.

**Domain Specificity**

This characteristic specifies the domain in which the module operates. The domain of the speech module is speech, regardless of whether speech is presented auditorily or visually. The speech module is engaged only in the cases when the incoming stimuli are speech. If the stimulus is non-speech, the speech module does not come into play (Liberman, Cooper, Shankweiler, Studdert-Kennedy, 1967). This characteristic could explain the feedback effect seen in PWS with delayed auditory stimuli (Lee, 1950, 1951), frequency altered stimuli (Howell, El-Yaniv, & Powell, 1987), and other speech stimuli such as filtered speech (Rami et al., 2005) and reversed speech (Rami & Diederich, 2005). Further, this specialty of dealing with speech regardless of the mode of presentation of the stimuli could explain the effects of visual choral speech (Kalinowski, Stuart, et al., 2000). It is suggested that, because all of these stimuli consist of speech, the speech module should be dually engaged. That is, the speech module is engaged in perceiving these speech stimuli at the same time when it is engaged in the process of speech production, a condition that is suggested to lead to fluent speech in PWS.

**Mandatory Operation**

This characteristic specifies that the modules are operational at all times. This implies that the speech module is operational at all times. However, it must be noted that it is actively engaged in processing the incoming stimuli only if the incoming stimuli are speech.
Consequently, if the incoming stimuli are not speech, the speech module, though operational, is not actively engaged in processing the incoming stimuli. This characteristic could explain the instancy with which the feedback effect appears in PWS. As soon as the speech stimuli are received, the speech module is actively engaged and the feedback effect may be elicited in PWS while they speak.

The only way to disengage the speech module while it is receiving speech stimuli is to not attend to the incoming speech stimuli but to attend to some other stimuli. This characteristic could explain the suggestions that the feedback effect, though present in many PWS, is not found to decrease the frequency of stuttering in everyone who stutters (Ingham, Moglia, Frank, Ingham, & Cordes, 1997). It is suggested that for the feedback effect to happen, the PWS must attend to the incoming speech stimuli. In the absence of attention, the effect may be either inconsistent or absent (Fodor, 1983)

**Speed**

The specialized modules, since they are mandatorily operational and automatic, are fast. The automatic operation saves time. Such a characteristic in the speech module would support the fact that the feedback effect is instantaneous. As soon as the incoming stimuli are detected to be speech, the speech module is actively engaged. This characteristic could also explain the immediate recurrence of stuttering in PWS while they are speaking, once the feedback is paused.
Information Encapsulation

The specialized modules are assumed to deal with a specific task on its own. The module does not have an access to any additional information even if that information may have some bearing on the task in which the module specializes. The speech module is assumed to deal only with incoming speech stimuli and does not have access to any other information that might be present. This property allows the speech module to operate fast, almost instantly. This property could explain the fact that it is only speech stimuli that elicits the feedback effect and that this effect is not colored by any knowledge in the PWS about the feedback effect itself or that they are under the feedback effect or that they are under an experimental condition under which they usually have increased instances of stuttering such as talking in front of an audience (Kalinowski, Stuart, Wamsley, & Rastatter, 1999). Such knowledge has no bearing on the presence of the feedback effect.

Breakdown Patterns

The speech module is assumed to have a specific breakdown pattern that may not be easily explained by global capacities like memory and attention. This property supports the suggestions that the disorder of stuttering develops in phases. Various accounts of a pattern of development of the characteristics of stuttering are available (Bloodstein, 1960; Van Riper, 1992).

Issues Explained

Several known aspects of the phenomenon of stuttering and the feedback effect may be accounted for with the new thesis. Among them are the instancy of the feedback effect, the
variety of auditory and visual speech stimuli that elicit the feedback effect, the breadth of conditions under which the feedback effect exists, and the differences among PWS in their individual responses to the various speech stimuli.

In addition to the above, the present thesis also accommodates and explains the effect of noise, or the masking effect, in decreasing the frequency of stuttering in PWS. It has been suggested, while explaining the various properties of input modules such as the speech module, that since these modules are operating fast and informationally encapsulated, they are “prepared to trade false positives for speed” (Fodor, 1983, p. 71). It may then be inferred that the speech module perhaps adopts a heightened state of alert and activates itself as it has difficulty separating any speech information that may be present in the noise or a tone and hence performs better (D. H. Whalen, personal communication, February 10, 2003). However, a possibility that a different mechanism might be responsible for the masking effect cannot be ruled out.

**Producing Empirical Evidence**

From the proposed thesis, it may be predicted that speech and speech-like stimuli, as feedback, would elicit the feedback effect in PWS. Non-speech stimuli, it may be predicted, will not engage the speech module in the perceptual process and hence they would not be as efficient in eliciting the feedback effect in PWS. Further, it may predict that there should be a continuum, from speech to speech-like to non-speech, of these stimuli in their ability to elicit the feedback effect in PWS. For prospective studies, it is suggested that various types of speech stimuli such as non-native languages and non-native vowel and consonant trains; speech-like
stimuli such as sine wave speech or glides; and non-speech stimuli such as frequency modulated tones and clicks, should be used.

Additionally, and importantly, the data produced by pursuing the experiments suggested may speak to the revised motor theory of speech perception and the presence of a single speech module (Liberman & Mattingly, 1985). Such a line of investigation could lead to new areas of research with a significant impact on the discipline of stuttering as well as speech perception and production.
Acknowledgement

The thanks Dr. Doug Whalen, Haskins Laboratories, New Haven, CT for his comments on an earlier draft of this paper.
References


