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The influence of anticipation of word misrecognition on the likelihood of stuttering

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ABSTRACT

This study investigates whether the experience of stuttering can result from the speaker's anticipation of his words being misrecognized. Twelve adults who stutter (AWS) repeated single words into what appeared to be an automatic speech-recognition system. Following each iteration of each word, participants provided a self-rating of whether they stuttered on it and the computer then provided feedback implying its correct or incorrect recognition of it. Each word was repeated four times. Unbeknown to participants, 'Correct' and 'Incorrect' recognition of words by the system was pre-determined and bore no relation to the actual quality of participants' iterations of those words. For words uttered in the 'Correct recognition' condition, the likelihood of AWS self-reporting stuttering on a word diminished across iterations, whereas for words in the 'Incorrect recognition' condition it remained static. On the basis of the findings it is argued that: (a) in AWS, the anticipation that a word will be misrecognized increases the relative likelihood of stuttering on that word in the future; and (b) this effect is independent of the degree of difficulty inherent in the formulation and motor execution of the word itself, although it may interact with it. Mechanisms that can account for these findings and yet are also congruent with the wider range of evidence from psycholinguistic and speech motor control domains are discussed. It is concluded that stuttered disfluencies may best be explained as resulting from the inappropriate functioning of covert repair and/or variable release threshold mechanisms in response to the anticipation of communication failure.

Learning outcomes: This article informs readers about two different theoretical approaches to explaining developmental stuttering: (1) stuttering as an adaptation response to an underlying impairment; and (2) stuttering as an anticipatory struggle response. It describes how these approaches account for different symptoms of the disorder, and proposes that both theoretical approaches are needed in order to fully account for the range of symptoms and experimental findings associated with stuttering.

1. Introduction

People who stutter (PWS) do not stutter all the time. Rather, stuttering moments are more likely to occur on specific words, with specific conversation partners and in specific speaking situations, such as talking over the telephone, before groups, etc. (Bloodstein & Bernstein Ratner, 2008, chap. 10). The exact pattern of their occurrence may, however, vary considerably from one PWS to another, and a different pattern is found in young children who stutter compared to older

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children and adults (Bloodstein, 2001; Bloodstein & Grossman, 1981; Dworzynski, Howell, Au-Yeung, & Rommel, 2004; Howell, Au-Yeung, & Sackin, 1999).

In young children who stutter (CWS), stuttering is most likely to occur on utterances that are linguistically or motorically complex (Bernstein Ratner, 1997; Bloodstein & Grossman, 1981; Logan & Conture, 1997; Yairi & Ambrose, 2005), in line with the view that the language or speech production systems of young CWS are not yet sufficiently developed to enable them to fluently produce utterances with an age-appropriate level of complexity (e.g., Bernstein Ratner, 1997; Conture, Zackheim, Anderson, & Pellowski, 2004). In older children and adults who stutter (AWS) evidence of impaired language production or speech motor control is more equivocal. Although experimental studies have found that, compared to controls, AWS tend to have slower speech-onset latencies (e.g., Burger & Wijnen, 1999; Lieshout, Hulstijn, & Peters, 1996; Sasisekaran & De Nil, 2006; Tsiamtsiouris & Cairns, 2009), these could simply reflect speakers' attempts to adapt to the disorder. AWS have been found to make more phonological-encoding and word-order errors, in both inner and overt speech (Brocklehurst & Corley, 2011) and show more variability in fine motor coordination (e.g., Kleinow & Smith, 2000; Loucks, De Nil, & Sasisekaran, 2007; Max, Caruso, & Gracco, 2003). However, in all such studies there is a large degree of overlap between the stuttering and control participant groups. Thus, it seems likely that, in AWS, stuttering events may sometimes occur even in the absence of any significant ongoing underlying impairment in language formulation or speech motor control (Conture et al., 2004).

In the current study we explore the extent to which stuttering-like disfluencies can be precipitated on specific words independently of any formulation or articulation difficulty that production of those words might entail. We describe an experiment designed to test whether the likelihood of stuttering increases when participants produce specific words which they have been led to believe will be difficult (for a speech-recognition system) to recognize.

To put the study into perspective, we begin with an overview of two very different theoretical perspectives on the causes of moments of stuttering: Stuttering as a symptom of adaptation to underlying formulation or production impairment, as exemplified by the Covert Repair and EXPLAN Hypotheses (Howell & Au-Yeung, 2002; Kolk & Postma, 1997; Postma & Kolk, 1993), and stuttering as an anticipatory struggle response, as exemplified by the Anticipatory Struggle Hypothesis (Bloodstein, 1958, 1975).

1.1. Stuttering as a symptom of adaptation to underlying impairment

Findings from brain imaging research suggest that, as a group, PWS have both structural and functional weaknesses in areas of the brain associated with syllable planning and production (see Watkins, Smith, Davis, & Howell, 2008, for a review). The accumulation of such evidence has stimulated the development of a number of hypotheses that posit that PWS have underlying language or speech production deficits and that stuttered disfluencies arise as the unintended side-effects of their attempts to adapt to those deficits (Civier, Tasko, & Guenther, 2010; Howell & Au-Yeung, 2002; Max, Guenther, Gracco, Ghosh, & Wallace, 2004; Postma & Kolk, 1993; Vasić & Wijnen, 2005). Most commonly the adaptations that lead to stuttering are believed to involve overburdened 'covert error repair' or 'restart' mechanisms which, under more normal conditions, serve to regulate the flow of speech and ensure that it is relatively free of errors, thus helping the speaker to make himself understood and maintain his conversation turn during times of language-formulation difficulty.

Perhaps the best known of these hypotheses is the Covert Repair Hypothesis (CRH: Kolk & Postma, 1997; Postma & Kolk, 1993) which is predicated on the view that speakers audit their inner speech to check their planned utterances for encoding errors (Levelt, 1983, 1989). Because speech planning takes place somewhat in advance of motor execution, if an error is detected in inner speech, the speaker may have time to stop and reformulate the plan, and thus repair the error before starting to speak. The CRH accounts for the different symptoms of stuttering (whole and part-word repetitions, prolongations and blocks) by postulating that these are the overt symptoms of covert repairs that have been only partially successful because there was insufficient time to repair the error. Thus if cancellation of the erroneous speech plan occurs just as the first phoneme is about to be uttered, a silent pause, or 'block', may result while the speaker reformulates it, whereas if cancellation occurs after the first phoneme, syllable or word has already been uttered, a (phoneme, syllable or word) repetition may result, and if this happens several times in a row, then multiple repetitions may occur. More recently a similar mechanism, involving error detection and 'motor resets', has been postulated to operate at the level of speech motor control (Civier et al., 2010; Max et al., 2004), and an alternative, threshold-based mechanism whereby stuttered disfluencies arise in response to speakers' attempts to execute speech-plans which are simply incomplete or insufficiently activated, rather than containing actual errors, has been posited – in the EXPLAN hypothesis (Howell, 2003, 2011; Howell & Au-Yeung, 2002).

Such mechanisms provide plausible explanations for the variety of stuttering-like disfluencies that occur in both PWS as well as in normally fluent speakers. They also provide compelling explanations for why the likelihood of stuttering tends to decrease on subsequent iterations of previously spoken words (the 'adaptation effect'; Brutten & Dancer, 1980; Johnson & Knott, 1937);[1] why PWS are particularly likely to stutter on word onsets; why the likelihood of stuttering occurring on a word is strongly influenced by its grammatical function (Bloodstein, 2006; Howell & Sackin, 2001), length, position in the sentence, frequency and predictability (Brown, 1937, 1945; Newman & Bernstein Ratner, 2007); for why stuttering is more common on utterances that are longer and/or more complex (Logan & Conture, 1995, 1997; Newman & Bernstein Ratner,

[1] Nb. Brutten and Dancer's (1980) use of the term 'adaptation effect' is unrelated to the notion of stuttering as a 'symptom of adaptation' to underlying impairment.