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Autonomic arousal in adults who stutter prior to various reading tasks intended to elicit changes in stuttering frequency

Andrew Bowers [a], Tim Saltuklaroglu [a,*], Joseph Kalinowski [b]

[a] Department of Audiology and Speech Pathology, College of Allied Health Sciences, University of Tennessee, United States
[b] Department of Communication Sciences and Disorders, College of Allied Health Sciences, East Carolina University, United States

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ABSTRACT

This study examined relationships between anticipatory autonomic arousal and stuttering in four reading tasks. 13 adult persons who stutter (PWS) reported their 'feared' (expected to elicit more stuttering) sounds. They read phrases initiated by feared (F) and neutral (N) phonemes. Both stimuli sets were read solo (S) and with choral accompaniment (C), creating FS, FC, NS, and NC conditions. Skin conductance (SC) and heart rate (HR) measures were made during a 9 s window that followed stimulus presentation and preceded speaking. Only SC measures produced significant differences across conditions. Choral conditions produced decreases in SC measures and stuttered trials. Feared conditions produced increases in SC but not stuttering. HR measures were variable, undifferentiated by condition, but produced a gradually increasing triphasic response pattern. No differences in anticipatory SC or HR measures were found in stuttered versus fluent trial comparisons. However, the NC condition, which eliminated stuttering, produced significantly lower SC measures than the fluent utterances in the other conditions (FS, FC, NS). Furthermore, SC measures from the fluent and stuttered trials were similar in these three conditions. These findings suggest that anticipatory autonomic arousal is better differentiated by the possibility of stuttering than by a fluent/stuttered speech outcome. Trials that produced anticipatory SC responses showed greater final HR deceleration, suggesting autonomic coactivation, a response pattern that is associated with aversive stimuli and herein, likely indicative of speech-related state anxiety. However, these physiological markers of anxiety appear to be neither necessary nor sufficient to induce observable stuttering.

1. Introducton

Over the years and especially recently, anxiety has received substantial attention as an emotion that co-exists stuttering. There is strong evidence that adults who stutter display significant levels of social anxiety and social phobia (Kraaimaat et al., 2002; Messenger et al., 2004; Schneier et al., 1997; Stein et al., 1996) in addition to speech-related state anxiety (Iverach et al, 2011), such that these emotional symptoms are often treated alongside the disrupted speech patterns (e.g., Menzies et al., 2008). However, even in light of recent attention, the relationship between the multi-dimensional facets of anxiety and stuttering remains unclear (Ingham, 1984; Iverach et al., in press; Menzies et al., 1999). One issue that remains salient is whether or not anticipatory anxiety (i.e., anxiety prior to speaking) is sufficient to precipitate stuttering, as might be predicted by some orientations regarding the nature of the pathology (e.g., Brutten and Shoemaker, 1967; Miller and Watson, 1992; Sheehan, 1953; Wischner, 1952).

Anticipatory anxiety is described as a future-oriented cognitive state of negative affect and autonomic arousal (Barlow et al., 1996; Chua et al., 1999). Autonomic arousal related to anxiety in both men and women is commonly signaled by increases in skin conductance (SC; Ashcroft et al., 1991; Naveteur and Freixa-Baqué, 1987; Naveteur and Roy, 1990) and cardiovascular responses such as heart rate (HR; Lang et al., 1983; Matthews et al., 1986; Saab et al., 1989). SC is considered an electrodermal measure of sympathetic arousal and, when measured in anticipatory paradigms, can reflect reaction to an upcoming, potentially aversive event (Bach et al., 2010). Changes in HR are mediated by both sympathetic and parasympathetic branches of the autonomic nervous system (ANS). For the purposes of investigating relationships between anticipatory anxiety and stuttering, these psychophysiological measures have some advantages over self-report methods of collecting anxiety-related data. First, psychophysiological responses can be objectively measured across predetermined temporal domains prior to speaking. Second, there is often a lack of correspondence between autonomic reactivity

* Corresponding author at: UT Department of Audiology and Speech Pathology, College of Allied Health Sciences, 553 South Stadium Hall, UT, Knoxville, TN 37996-0740, United States. Tel.: +1 865 974 0355; fax: +1 865 974 1539.
E-mail address: tsaltukl@utk.edu (T. Saltuklaroglu).
URL: http://web.utk.edu/~aspweb/faculty/saltuklaroglu/ (T. Saltuklaroglu).

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and self-reported states of stress (Croft et al., 2004; Feldman et al., 1999; Huwe et al., 1998; Schwerdtfeger, 2004). Reasons for this are thought to include lack of awareness of emotion (Wright and Kirby, 2001) and unwillingness to report anxiety-related thoughts (Egloff et al., 2002). Dietrich and Roaman (2001) reported evidence of a similar discrepancy in the field of stuttering, reporting a lack of association between subjective measures of predicted anxiety and SC responses on ensuing speaking tasks in PWS.

Psychophysiological measures have been used in attempts to distinguish PWS from persons who do not stutter (PWNS). Some between-group comparisons reported PWS to have increased resting cardiovascular activity compared to PWNS (Brunner and Frank, 1975; Palmer and Gillette, 1938, 1939), whereas others did not find significant differences (Ritzman, 1943; Golub, 1953; McCroskey, 1957; Walker and Walker, 1973). Studies reporting on speech-related cardiovascular activity have also produced inconsistent findings (Dabul and Perkins, 1973; Van Riper and Milsen, 1939; Ickes and Pierce, 1973). More contemporary and comprehensive studies have compared PWS to PWNS on measures of HR and SC, as well as other related autonomic measures prior to, during and after various speech and non-speech tasks (Peters and Hulstijn, 1984; Weber and Smith, 1990). Peters and Hulstijn (1984) used silent reading, reading, writing mirror-writing, and intelligence tests as their tasks. It should be noted that their measures were averaged across 30 s intervals, perhaps reducing sensitivity. Weber and Smith used jaw movement, reading, spontaneous speech and valsalva tasks measured across 10 s intervals. Both studies revealed increased autonomic activity related to speech but neither study revealed group significant differences.

Considering that stuttering is an intermittent and variable disorder, it seems appropriate to examine ANS arousal within PWS as it relates to speech fluency. To this end, there is evidence demonstrating increased autonomic activity within PWS associated with periods prior to stuttering or varying with fluency level (e.g., Brutten, 1963; Ickes and Pierce, 1973; Kline, 1959; Kraaimaat et al., 1988; Treon and Tamayo, 1975; Van Riper and Milsen, 1939), though others have not demonstrated such a relationship (Adams and Moore, 1972; Gray and Brutten, 1965; Gray and England, 1972; Reed and Lingwall, 1976, 1980). Baumgarnter and Brutten (1983) measured HR and cognitive expectancy of stuttering (i.e. predictions about individual stuttering events) prior to speaking in three participants. They found that in one participant only, HR was predictive of cognitive expectancy and speech performance.

To date, it appears that only the rigorously conducted Weber and Smith (1990) study has directly related autonomic responses to speech fluency (i.e., if a trial was stuttered or fluent) of the ensuing speech utterances within PWS. They found weak yet significant correlations between anticipatory autonomic responses and the ensuing utterances for reading ($R^2 = .11$) and spontaneous speech ($R^2 = .03$). These findings led the authors to conclude "stuttering is related to increased sympathetic activity, though the increase is not outside the ranges characteristic of normally fluent speakers (p. 703)". The significance of the Weber and Smith study cannot be understated. However, it has been suggested that more might be learned about the relationship between anxiety and stuttering if more than one speaking task is used and anxiety can be manipulated (Menzies et al., 1999). While Weber and Smith used two speaking tasks, they acknowledged that the use of covert avoidance strategies may have helped decrease stuttering events in the spontaneous speech task and therefore might have been responsible for the weaker predictive relationship between ANS activity and stuttering in this task. Since then, little data have been reported (Iverach et al., 2011), and perhaps there is more to learn about the relationship between the physiological components of anticipatory anxiety and stuttering. This might be accomplished by using reading tasks (to eliminate the possibility of covert avoidance strategies) that make a priori attempts to manipulate the difficulty of the ensuing speech act.

One way to increase anxiety associated with reading tasks is to use target stimuli initiated by 'feared' speech-sounds. These sounds are those that are perceived by PWS as being more 'difficult' (i.e., inducing higher frequencies of stuttering when they occur in word-initial positions). A recent contemporary example can be found in news anchorman, John Stossel, who "when asked to step in front of the camera made sure to edit his own clips and tried to avoid all words that started with "b" and "d" — his problem sounds…" (Triggs, 2011, p. 110). Though the scope of feared phonemes may vary across PWS, Bloodstein (1960) noted that recognition of these patterns may develop as early as 8 years. This recognition appears to be related to the tendency for a PWS to 'scan ahead' while speaking, in anticipation of upcoming sounds or words likely to evoke stuttering (Brutten and Jansen, 1979). Therefore, they appear to be associated with increased anticipatory anxiety and arousal, though there is a lack of evidence to suggest that PWS actually stutter more frequently on these words (Bloodstein and Bernstein-Ratner, 2008; Wingate, 1988). Thus, if an important relationship between anxiety and stuttering exists, then increases in ANS arousal might be expected when a PWS anticipates having to produce utterances that are initiated by phonemes that are feared.

Conversely, an effective and efficient means of immediately reducing or even eliminating the possibility of stuttering is to use choral speech (i.e., speaking in unison), which is well documented to be among the most powerful of fluency enhancers. Reduction of stuttering via choral speech is immediate, requiring no training or volitional changes in speech production and sufficiently powerful to normalize aberrant patterns of neural activity associated with stuttering (Fox et al., 1996). If this is the case and a relationship between anticipatory arousal and stuttering exists, then anticipatory anxiety and arousal should be lowest when the PWS know that the ensuing speech will be produced chorally and the possibility of stuttering is minimized.

According to accounts of 'autonomic space' (Berntson et al., 1991) multiple relationships can exist between SC and HR, reflecting various relative contributions from the two branches of the ANS. One pattern of simultaneous ANS activity that has received attention in the field of stuttering is autonomic coactivation, which is observed when electrodermal responses are increased and HR is decreased, reflecting activity from both sympathetic and parasympathetic branches of the ANS. Alm (2004) re-examined data from Caruso et al. (1994), Weber and Smith (1990) and Peters and Hulstijn (1984). From his analyses, he suggested that this ANS coactivation might be displayed in PWS as 'freezing response' related to anticipatory anxiety. However, Alm's analyses were retrospective and based on between-group differences. Evidence of autonomic coactivation does not appear to have been examined differentially within a group of PWS to see if might be related to speaking and/or occurrences of stuttering.

The aim of the present study is to simultaneously measure anticipatory SCR and HR, in addition to the frequency of ensuing stuttered trials in four tasks that attempt to manipulate anticipatory anxiety by changing linguistic content (i.e., phrases initiated by feared versus neutral phonemes) and auditory condition (i.e., solo versus choral). The anticipation of reading phrases initiated by feared sounds might be sufficient to induce increased levels of anxiety-related autonomic arousal relative to non-feared (i.e., neutral) sounds, though it is unclear how it might influence stuttering frequency. In contrast, the anticipation of choral speech might be expected to produce significant reductions in both anticipatory anxiety and stuttering frequency. Perhaps most importantly, it will be possible to examine the effects of combining feared sound initiations with choral speech on both the psychophysiological and behavioral measures. In addition, a post hoc analysis of ANS responses preceding stuttered versus fluent trials is expected to shed further light on the relationship between these anticipatory ANS responses and occurrences of stuttering events. Lastly, these data will provide an opportunity to examine the possibility of anticipatory autonomic coactivation in PWS.