CHARACTERISTICS OF DISFLUENCY CLUSTERS

IN ADULTS WHO STUTTER

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Abstract

The phenomena of disfluency clusters have been examined in the speech of children who stutter (CWS) and children who do not stutter (CWNS). Little is known about disfluency clusters in the adult population. The purpose of this study was to examine the characteristics of disfluency clusters in adults who stutter (AWS). The participants were ten AWS ranging in age from 18 to 60 (mean age = 35), with a stuttering severity of 9 to 30% (mean = 19%). Each participant provided a conversational speech sample of at least 300 words. Analysis focused on disfluency type, utterance length, speaking rate, and perceptual measures. Findings indicated that utterances containing disfluency clusters were significantly longer than fluent utterances and the speaking rate of fluent utterances was found to be significantly faster than that of disfluent utterances. Collectively the results appear to support a linguistic interpretation of disfluency clusters. The clinical implications of the findings are discussed.

Introduction

Theories attempting to explain the phenomenon of stuttering exist in great diversity and span several life-times. One theory can be traced back as far as Aristotle, who believed that stuttering was due to an abnormality of the tongue (Bloodstein, 1995). Many theories can be seen to reflect beliefs of the time, including Freudian-like interpretations of stuttering with the emergence of psychoanalysis in the 19th century, behaviour-based interpretations with the advent of operant conditioning, psychological models, and genetic and neurological models with advanced technology. Bloodstein (1995) created three categories for the organization of theories; (1) those that attempt to define the etiology of stuttering, (2) those concerning the moment of stuttering and, (3) those which attempt to reformulate existing theories in either of the aforementioned areas. Although the symptom of stuttering is readily observable, the reason stuttering occurs is less than clear. Theories of stuttering are important as they represent different perspectives of the phenomenon and can ultimately affect how the disorder is evaluated and treated. It is indisputable that knowing the etiology of a disorder greatly increases the ability to accurately evaluate and treat the disorder. However, it is not certain that one will discover the etiology of a disorder without examining the symptoms. The purpose of this literature review is to briefly define some of the major theories as categorized by Bloodstein. Following this review, additional research regarding the moment of stuttering will be evaluated, with particular emphasis placed on the phenomena known as disfluency clusters.

Theories of Stuttering Etiology

Theories of the etiology of stuttering describe the conditions under which stuttering first develops (Bloodstein, 1995). Five well known theories are (1) Theory of Cerebral Dominance (2) Diagnosogenic Theory (3) Genetic Disorder Theory (4) Demands and Capacities Theory and (5) Covert Repair Hypothesis. Each is described in detail below.

Theory of Cerebral Dominance – This theory was proposed by Travis (1931). The theory explains stuttering as an inability to co-ordinate the messages sent from both cerebral hemispheres for the movement of speech musculature. One hemisphere was hypothesized to be dominant in controlling for the synchronization of messages. Therefore, if neither hemisphere exhibited dominance, the two halves would function independently leading to poorly coordinated timing of speech movements and the manifestation of stuttering. This theory is also sometimes referred to as the "handedness theory" as it makes a link between cerebral dominance, handedness and stuttering. The concept of handedness originated from an early belief that many children who stutter (CWS) were left-handed, ambidextrous or had been shifted to right-handedness early in life (Travis, 1931). Through observation of aphasic patients, it was believed that right-handed people had dominant left hemispheres and vice versa for left-handed people. It was further suggested that the language and motor hemispheres were one in the same and that ambidextrous children had no cerebral dominance. Travis (1931) believed that society's pressure for children to use the right hand in many activities, ultimately attempted to alter left-handed children's cerebral dominance, resulting in a predisposition for stuttering.

Diagnosogenic Theory – This is probably one of the most well known theories of stuttering and was presented by Wendell Johnson in 1942 (Bloodstein, 1995). This

theory follows the anticipatory-struggle principle in that it explains stuttering as the result of attempting to avoid stuttering (Bloodstein, 1984). Johnson (1959) further suggested that the result of this attempt at stuttering avoidance was caused by parent's misdiagnosing normal disfluencies as stutters. The parent's attempts to correct these disfluencies, or adverse reaction to disfluencies, created feelings of anxiety in the child leading to the child believing that he/she was indeed 'disfluent' and therefore became so. An important assertion by Johnson is his rejection of the concept of *primary stuttering*. Johnson believed that the disfluency noted in very young 'stuttering' children was no different to normal childhood disfluency (Bloodstein, 1984). This raised the question of differential diagnosis in very young children, which continues to receive research attention today (Ambrose & Yairi, 1995; Ambrose & Yairi, 1999; Meyers, 1986; Myers & Wall, 1981; Yaruss & LaSalle, 1998).

Genetic Disorder Theory - The notion that stuttering has a genetic basis was first generated by the observation that stuttering runs in families. It is generally accepted that stuttering does have a genetic factor, and that a person's inherited susceptibility along with environmental factors eventually leads to the development of stuttering (Felsenfeld et al., 2000; Kidd, 1984; Yairi & Ambrose, 1996). In addition, it has been suggested that genetics may also play a role in the persistence or recovery of stuttering (Ambrose, Cox, & Yairi., 1997).

Demands and Capacities Theory (DCT) – The premise of this theory is that stuttering is caused when a person's capacity for speech is inadequate to meet the demands placed on the person (Adams, 1990). This model was proposed by Starkweather (1987) and although he did not attempt to explain the theory in more detail it has received numerous interpretations over the years (Adams, 1990). Areas which people could have a reduced capacity included cognitive, linguistic, motoric

and/or emotional. There were also various interpretations of the source of demands, including environmental, communication partners and/or the stutterer's own demands (Adams, 1990). The DCT has also been used to develop therapy approaches for people who stutter (PWS). One such example is for parents to slow down their rate of speech when talking with their stuttering child in order to reduce the demands being placed on the child to reply with a similar rate of speech (Costello & Ingham, 1984).

Covert Repair Hypothesis (CRH) – This theory is based on the process of transforming thoughts into speech and suggests that stuttering is a reflection of disruptions in this process. This hypothesis states that instances of disfluency are self-repairs which reflect a person's impaired ability to phonologically encode, and their attempts to adapt for this (Postma & Kolk, 1993). Postma and Kolk suggest that people who stutter are slow in their ability to activate intended sounds. When they attempt to activate sounds at a faster rate than their phonological encoding system is capable of doing, there is a resultant increase in the chance of an error occurring in the sounds selected. If the speaker detects these errors they may attempt to correct it mid-speech which results in the perception of a stutter (Postma & Kolk, 1993).

Theories of the Moment of Stuttering

The Breakdown Hypothesis – Bloodstein (1981) defined a stuttering moment as the "momentary failure of the complicated co-ordinations involved in speech" (p. 40). These difficulties are exacerbated by environmental pressures which serve as triggers to the event of stuttering. Such environmental pressures include emotional/psychoemotional stress and speech anxiety. There are several theories of stuttering which are based around a description of stuttering moments. Researchers have also expanded on the idea of stuttering as a "momentary breakdown" through various explanations involving motor deficits (Adams, 1974; Perkins, Rudas, Johnson

& Bell, 1976), cerebral planning deficits (Travis, 1931), and language processing deficits (Moore & Haynes, 1980).

The Repressed Need Hypothesis – This theory explains stuttering as a symptom of unconscious anxious/obsessive thoughts. An early belief was that stuttering was the manifestation of an unconscious attempt to repress speech (Fenichel, 1945). The reason for this avoidance of speech has been given several explanations such as fear of expressing inappropriate words/thoughts or reflection on aggressive thoughts. Psychoanalytic theories such as the above largely rely on clinical observation and case studies with less scientific or objective data available. It has been noted that attempts at using psychotherapy to treat stuttering have been largely unsuccessful to date, explained by psychoanalysts as stutterer's increased resistance to therapy (Bloodstein, 1995).

The Anticipatory Struggle Hypothesis – This theory has probably received the most attention as a way of explaining the moment of stuttering. The premise of this theory is that people stutter because of their belief that speech is difficult. A similar effect is seen in many real life activities. For example, it is likely that when an individual concentrates on fear they are in fact increasing the chances of that fear occurring (Bloodstein, 1995). This theory has received numerous interpretations, such as stuttering being an attempt to exert voluntary control over individual speech movements rather than allowing the automatic process of speech production (West, Ansberry, & Carr, 1957). An additional interpretation was posited by Sheehan (1953) who described stuttering as the result of conflict between the desire to speak and the desire to remain silent. Yet another interpretation was Van Riper's (1971) suggestion that stuttering is triggered by anticipation of word difficulty, followed by three

physical reactions (tension in speech organs, focus on first sound rather than whole word, and unnatural positioning of speech organs) which leads to stuttering.

Reformulated Theories

Learning Interpretations are probably the most influential of the reformulated theories and look to understand how stuttering is learned and maintained by examining surrounding factors/variables. Notable theories within this include stuttering as an operant behaviour, where disfluency increases when children are attempting to gain attention and if they are rewarded for this it could reinforce the stuttering behaviour (Shames & Sherrick, 1963). On the other hand, it was also proposed by Shames and Sherrick (1963) that punishment of non-fluent responses may lead to the maladaption from simple repetition behaviours to characteristic stuttering responses. Stuttering has also been described as a conditioned behaviour, based on the observation that feelings of stress are capable of causing disfluent behaviour in normally fluent individuals. It was therefore suggested that if children are to repeatedly experience these stressful feelings in a given situation then the emotional response and subsequent stuttering is aroused with even neutral environmental cues (Brutten & Shoemaker, 1967).

Further Evaluation of the Stuttering Event

Among the vast number of existing theories, Wingate (1984) claims there is not one theory which has sufficient objective data to enable it to be classed as more than conjecture. Wingate (1984) goes on to quote from Hughlings Jackson, *"A study of the causes of things must be preceded by a study of the things caused"* (p. 215). This statement outlines the importance of studying the moments of stuttering in order to better understand the disorder and develop theories of etiology. In addition, many

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of the stuttering etiology theories involve factors that are not easily measured (e.g., cerebral dominance, biochemical), or even observed in the case of emotional stress or pressure. Stutterings are clearly the manifestation of the underlying cause of the speech disruption and they are observable and measurable. Therefore, when seeking to discover the etiology of stuttering it makes sense to examine the stuttering event.

Many researchers have adopted a similar viewpoint and have carried out examinations of different aspects of the 'stuttering event' (Kelly & Conture, 1992; Riley, 1980; Ryan, 2001; Throneburg & Yairi, 2001; Zebrowski, 1991; Zebrowski, 1994). One aspect is measurement of the frequency of disfluencies, which has been suggested as a potential predictive tool for the persistence or recovering of childhood stuttering. Throneburg and Yairi (2001) attempted to identify trends in the frequency of disfluencies in preschool children who recovered from stuttering and those who persisted. Results indicated that the overall frequency of disfluencies remained constant over time for the persistent group but dropped significantly for the recovered group. This finding is in agreement with Ryan (2001) who also found the frequency of disfluencies in preschool children to decrease in the recovered group and increase or remain stable in the persistent group.

Stuttering duration is another aspect of the stuttering event which has been shown to have relevance to assessment and monitoring of the disorder (Riley, 1980; Throneburg & Yairi, 2001; Zebrowski, 1994). Measures of duration have included duration of instances of repetitions and duration of sound prolongations (Zebrowski, 1994). Research has indicated no difference in the duration of stuttering between preschool CWS and preschool children who do not stutter (CWNS) (Kelly & Conture, 1992; Zebrowski, 1991). A longitudinal study by Throneburg and Yairi (2001)

suggested that stuttering duration was likely to decrease in recovering CWS and stay constant in persisting CWS.

Examining the moment of stuttering involves more than simply looking at frequency and duration of the disfluency. Research has also been carried out to describe the context of disfluencies. Brown (1945) reported six variables believed to hold predictive value in the likelihood of a stutter occurring. These were, (1) words beginning with a consonant other than /w, hw, h, t, th/, (2) words from the grammatical classes of nouns, verbs, adjectives, and adverbs, (3) long words (five or more letters), (4) words occurring early in a sentence, (5) the first sound of a word, and (6) stressed syllables. This notion of being able to predict the likelihood of a stutter based on the surrounding factors has continued to receive research attention. Kadi-Hanifi and Howell (1992) studied the surrounding language of disfluencies and concluded that stuttering frequency increases with more complex utterances. This finding supported the previous research of by Martin, Palour and Haroldson (1990). Location of speech disfluencies within utterances has also been examined. Kaasin and Bjerkan (1982) found that disfluencies occurred significantly more frequently on 'critical' words; that is words that are 'critical' to convey the meaning of an utterance. Other studies looking at disfluency location have focused on content versus function words, showing that children are more likely to stutter on function words whereas adults are more likely to stutter on content words (Au-Yeung, Howell, & Pilgrim, 1998; Haj-Tas, Park, & Logan, 2004; Howell, Au-Yeung, & Sackin, 1999; Natke, Sandrieser, Ark, Pietrowsky, & Kalveram, 2004; Wingate, 1984).

Johnson's (1959) claim that there is no difference between disfluency exhibited by 'stuttering' children and normally fluent children has lead to a series of studies comparing normally fluent children to CWS (Howell et al., 1999; Kadi-Hanifi

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& Howell, 1992; Martin, Parlour, & Haroldson, 1990; Pellowski & Conture, 2002; Wexler & Mysak, 1982). One aspect which has received considerable attention is that of disfluency types. Commonly considered as the foremost figure in this area is Wendell Johnson, who in the late 1950's put forward the notion of a stutter being the reaction to a speech interruption (Johnson, 1959). That is, a stutter is the consequence of trying to avoid stuttering (Hubbard, 1998). Johnson asserted that stuttering should be viewed as individual moments of disfluency and that these moments should be the focus of investigation. Through analysis of language samples, Johnson created an eight-part classification system for categorizing types of disfluencies: they were 1) Interjections 2) Repetition of sounds or syllables 3) repetition of words 4) repetition of phrases 5) revisions 6) incomplete phrases 7) broken words 8) prolonged sounds (Johnson, 1959). In a study of 150 CWS and 150 CWNS, Johnson (1959) analysed speech samples in terms of disfluency counts and listener judgments of stuttering. From the results of this study, Johnson suggested that listener judgment of stuttering and objective measurement were not necessarily correlated. That is, a stutter could not be classed as such solely by looking at the type of stutter and a child could not be classified as stuttering by examining amounts and types of disfluencies alone (Johnson, 1959). Despite the tentative nature of these results, research looking at disfluency type measures has gained in popularity.

Several studies have examined the role of disfluency types in fluent and stuttered speech with varying results. Colburn (1985) examined the speech of CWNS and found the most frequently occurring disfluency types to be phrase repetition, word repetition and phrase revisions. On the other hand, Throneburg and Yairi (2001) compared disfluency type proportions between preschool CWS and CWNS and found no significantly different patterns between the two groups. In an earlier study

comparing disfluency types between CWS and CWNS, Yairi (1972) found part-word repetitions to be significantly more frequent in the speech of CWS than CWNS. This finding was later confirmed by Wexler and Mysak (1982) who found that the two most frequent disfluency types for CWNS were phrase revisions and interjections. The Wexler study also identified differences in disfluency types between severe and less severe CWS, therefore suggesting the importance of considering stuttering severity as another variable.

As discussed by Wingate (1984), one advantage of examining stuttering events is that they are readily identifiable and therefore measurable. In addition, as stuttering behaviour is a symptom of the problem, analysis of disfluencies may be able to provide information regarding the etiology of the disorder. Although disfluencies are more measurable than psychological functions, evaluating moments of stuttering is by no means a simple process. Indeed, considerable controversy exists among researchers pertaining to the manner in which stuttering is evaluated and measured. Particular controversy exists regarding the manner in which disfluencies are categorized. Einarsdottir and Ingham (2005) discuss the issue of using disfluency typology in stuttering research and identified one difficulty as the lack of consistency of categorization system used between studies. Johnson's eight disfluency categories have been subject to several adaptations including Throneburg and Yairi (2001) who used 7 disfluency types, Hubbard (1998) who used 8, and Natke et al. (2004) who used 5 categories.

Probably the most commonly used system to categorize types of disfluencies was proposed by Yairi and Ambrose (1992). The system uses two categories, reflecting either stuttering-like disfluencies (SLD) or other disfluencies (OD). This classification system works by reorganizing Johnson's 8 disfluency types into two

categories: SLD (i.e., part-word repetition, single-syllable word repetition, disrhythmic phonation, tense pause) and OD (polysyllabic word repetition, phrase repetition, interjection and revision-incomplete phrase). The premise for this classification is that SLDs are disfluencies related to stuttering and ODs are normal disfluencies. This system has also received criticism. Einarsdottir and Ingham (2005) argued that even within these two categories there has been variation in what is included within SLD and OD, and also state that the reliability of measuring disfluency types is poor. However, Hubbard (1998) examined the difference between using disfluency type measures and listener judgments in the differentiation of stuttering and found that neither method was significantly more reliable than another. Wingate (2001) presented a more specific criticism of SLDs when he questioned the inclusion of whole-word repetitions as a SLD, claiming that whole-word repetitions are widely regarded as aspects of normal speech. With this in mind, Graham, Conture and Camarata (2004) analyzed the speech samples of CWS with and without whole-word repetitions using the SLD categorization system. Graham et al. (2004) found that exclusion of whole-word repetitions within SLDs did not alter the results. However, one is still left wondering how best to categorize whole-word repetitions. Existing information illustrates that there are different viewpoints on the value of disfluency type measures in the area of stuttering. Concerns raised regarding the use of these measures, with particular reference to SLDs, do not justify the exclusion of this area of research but do suggest that caution should be taken when categorizing disfluencies.

Although there has been much interest in aspects such as the location, frequency, and form of disfluencies surrounding the stuttering event, there has been significantly less interest in disfluency clusters. A basic definition of a disfluency

cluster is, "the occurrence of two or more disfluencies on the same word and/or adjacent words" (Silverman, 1973). Interest in disfluency clusters arose through the observation that although previous studies have investigated many aspects of disfluencies one aspect that has escaped much attention is that of 'temporal influences'. That is, the significance of the time period in which disfluencies occur (Colburn, 1985). Colburn (1985) examined disfluency clusters in the early developing utterances of four CWNS. The study found that although clustering of disfluencies appeared to be a normal behaviour in young children, the assertion was made that the frequency of these disfluencies was not expected to increase over time. Colburn (1985) hypothesized that CWS would produce significantly more disfluency clusters and these would be of significantly longer length.

Despite having gained some potentially significant findings regarding disfluency clusters, there is not yet enough information in this area for any findings to be more than speculation. In addition, the great majority of studies that have looked at disfluency clusters thus far have used children. To investigate further the potential of clusters as holding diagnostic and/or predictive value it is necessary to develop an understanding of the role of disfluency clusters in the stuttering of both children and adults. The ensuing literature review provides a summary of the influences of (1) utterance length, (2) speaking rate, (3) motor and language, and (4) perception on the stuttering event in general, and disfluency clusters in particular.

Literature Review

<u>The Influence of Utterance Length</u>

Stuttering and utterance length in CWS

Previous research evaluating utterance length and syntactic complexity in CWS has proved fruitful. Ratner and Sih (1987) monitored the effect of gradually increasing the syntactic complexity of utterances on the disfluencies of CWS and CWNS. Findings indicated that as syntactic complexity increased, the number of disfluencies increased for both CWS and CWNS. Ratner and Sih also observed that neither group appeared to differ in their ability to replicate sentences of increasingly complex syntax, suggesting there was no difference in language ability of CWS and CWNS. However, no relationship was found between stuttering and utterance length (Ratner & Sih, 1987). In this study, imitated utterances were measured as opposed to spontaneous speech. It is possible the participants' lack of control over the utterance they produced could have impacted the results.

Several studies have found a relationship between stuttering and utterance length. Weiss and Zebrowski (1992) examined the utterance characteristics of CWS in an attempt to validate the commonly given advice for parents of children who stutter to reduce the number of questions they ask their children. Weiss and Zebrowski examined eight parent-child dyads and analysed the number of disfluencies in the childrens' responses to questions versus the number of disfluencies in the childrens' own assertions. Utterances which were longer and more syntactically complex were more likely to contain disfluencies. Whether the utterance was a response to a question or an assertion appeared to hold no predictive value in the occurrence of disfluencies. The above study supported earlier findings by Gaines, Runyan and Meyers (1991) who examined utterances more critically. Utterances which included

disfluencies in the first three words were longer and more syntactically complex than utterances which, were fluent or contained other types of disfluencies.

Logan and Conture (1995) examined the fluent and stuttered utterances of 15 boys who stuttered by comparing syllabic length, grammatical complexity and articulation rate between fluent and stuttered utterances. Stuttered utterances were found to contain significantly more syllables than fluent utterances. In addition, it was found that significantly more stuttered utterances were grammatically more complex. Interestingly, the results for articulation rate of both fluent and stuttered utterances were not found to differ significantly, and articulation rate was not correlated with either syllabic length or grammatical complexity. This finding suggests that articulation rate may not be a useful measure in the prediction of whether an utterance is likely to be stuttered or fluent.

The findings from Logan and Conture (1995) lend support to a previously held notion that disfluencies are more likely to occur when the demand of a speech task exceeds the individual's capacity to perform this task (Costello & Ingham, 1984). A later study by Logan and Conture (1997) investigated temporal, grammatical and phonological characteristics of conversational utterances in 14 CWS. Results indicated that the stuttered utterances of CWS contained more syllables than fluent utterances. Yaruss (1999) similarly found that stuttered utterances of CWS were significantly longer than the fluent utterances of CWS. Yaruss also found that utterance length held more predictive value than syntactic complexity as to whether a disfluency would occur. In a recent study, Haj-Tas et al. (2004) investigated the relationship between utterance length and disfluency frequency and found that preschool CWS exhibited more SLDs on words that initiated longer utterances than on words that initiated shorter utterances.

Researchers have had difficulty determining the relative importance of syntactic complexity over utterance length on the occurrence of disfluencies (Yaruss, 1999). Some studies have suggested that syntactic complexity is the most important parameter (Ratner, 1997; Ratner & Sih, 1987) and others have suggested that it is utterance length that is the most important indicator (Logan & Conture, 1995; Yaruss, 1999). Logan and Conture (1995) suggested that utterance length is a "macrovariable" and subsequently contains a number of variables within it, one of which includes syntactic complexity.

Results from previous research appear to support the notion that the frequency of disfluencies increases as utterance length increases. Logan and Conture (1997) presented two possible explanations for these findings. Firstly, it is possible that people who stutter have difficulty retrieving syllabic nuclei, therefore the more syllables that they are required to retrieve the greater the chance that an error will occur. Secondly, a more simplistic explanation could stem from Ratner and Sih (1987)'s clinical observation that people who stutter often insert additional syllables into their speech in an attempt to maintain fluent speech (Logan & Conture, 1997).

Findings such as above have had clinical implications. For example, the Lidcombe Program, an operant treatment approach for stuttering in children incorporates the principle of utterance length and syntactic complexity. In the early stages of the program, the child's verbal output is manipulated to ensure short, syntactically simple utterances are produced. Once the child achieves fluency at this level, the syntactic demand placed on the child is gradually increased (Onslow, Packman, & Harrison, 2003).

Stuttering and utterance length in AWS

Silverman and Ratner (1997) evaluated utterance characteristics of seven AWS and seven AWNS. Findings from this study indicated that normal disfluencies and repetition disfluencies increased as syntactic complexity increased, however disfluency types that are regarded as more reflective of stuttering were not positively correlated with syntactic complexity. Based on these findings, Silverman and Ratner (1997) suggested that syntactic complexity has less impact on the fluency of more mature speakers than it does for children. Following up from this study, Logan (2001) examined the fluency of 12 AWS in self-generated and prepared utterances. The data were analysed with regard to utterance length, complexity, stuttering frequency, and articulation rate. Findings indicated no difference in speech fluency between the various levels of syntactic complexity for the prepared utterances. However, the participants were found to stutter more frequently during the self-generated utterances than during the prepared utterances. This was thought to be due to the individuals being required to engage in their own linguistic formulation. Results from this study lead Logan to the tentative conclusion that adult stuttering is less affected by the syntactic complexity of utterances. This notion was later supported by Haj-Tas et al. (2004), where no difference was found between the observed and expected frequency of disfluencies in utterances of varying length.

Disfluency clusters and utterance length in CWS

Limited research has focused specifically on the relationship between utterance length and disfluency clusters. The greatest contributor to this area is a study by Logan and LaSalle (1999) who examined the grammatical characteristics of utterances containing disfluency clusters in both CWS and CWNS. Of particular interest are the results relating to utterance length and complexity. It was found that

fluent utterances were the shortest and less syntactically complex. Utterances containing single disfluencies were intermediate in terms of length and complexity, and clustered utterances were both the longest and the most syntactically complex. No significant differences in utterance length or complexity were found between CWS and CWNS. Logan and LaSalle (1999) suggested that these findings lend support to the notion that the occurrence of disfluency clusters is related to the linguistic demands of the utterance. Combined with the additional findings that disfluency clusters tend to occur at the beginning of a clausal constituent, and also tend to contain aspects of linguistic revision, this study lends strength to the argument of disfluency clusters being linguistically motivated and also indicates that utterance length may be a viable indicator of the same.

Disfluency clusters and utterance length in AWS

There are no studies to date examining the relationship between utterance length and disfluency clusters in AWS. Such research could be beneficial in further identifying the underlying cause of disfluency clusters. Normal linguistic development is viewed as being stable by the time a person reaches adulthood. Although there continues to be growth in vocabulary and social skills, the speed of development is significantly reduced (Peters & Starkweather, 1989). The effect of language development on stuttering behaviour is also considered to be stable by adulthood (Peters & Starkweather, 1989). Considering the stability of an adult's linguistic abilities, one might expect to see a decrease in the strength of the relationship between disfluency clusters and utterance length in AWS. Such a finding could reflect an adult's increased linguistic stability, and would also be consistent with findings regarding single disfluencies (Haj-Tas et al., 2004; Logan, 2001; Silverman & Ratner, 1997).

Summary

The existence of a relationship between utterance length and the occurrence of single disfluencies and disfluency clusters is well established. Studies to date have identified that disfluent utterances (including single disfluencies as well as disfluency clusters) in both CWS and CWNS tend to be longer in length and more syntactically complex (Gaines et al., 1991; Haj-Tas et al., 2004; Logan & Conture, 1995; Logan & LaSalle, 1999; Weiss & Zebrowski, 1992; Yaruss, 1999). Studies examining AWS have not found strong correlations between disfluencies and utterance length (Logan, 2001; Silverman & Ratner, 1997). The observed reduction in the relationship between utterance complexity and disfluencies in adults could be explained by the relative stability of an adult's linguistic development (Peters & Starkweather, 1989). Furthermore, there are no studies to date that have evaluated the relationship between utterance length and disfluency clusters in AWS. Such information could prove valuable in understanding the progression of stuttering and the supposed linguistic influence of disfluency clusters. Consequently, this study proposes the following hypothesis:

There will be no significant difference in the length of fluent, single stuttered and clustered utterances in AWS.

The Influence of Speaking Rate

Stuttering and speaking rate in CWS

It is widely accepted that there appears to be a relationship between stuttering and speech rate, although the nature of the relationship is not yet well understood. Much attention has been given to the speech rate of CWS, and one commonly used therapy approach is to advise parents of CWS to slow their own speaking rate while

conversing with CWS (Meyers & Freeman, 1985). Theories surrounding the speech rate of CWS include the suggestion that they may speak faster than they are able to co-ordinate their articulators (Conture, Louko, & Edwards, 1993), a notion supported by some researchers (Kloth, Janssen, Kraaimaat, & Brutten, 1995). However, Meyers and Freeman (1985) found that CWS spoke slower than their fluent counterparts and multiple studies have also been unable to find any difference between the speech rate of CWS or CWNS (Kelly & Conture, 1992; Yaruss, Logan, & Conture, 1995). Further still, Sargent, Robb and Zebrowski (2006) examined the speaking rate of five CWS and five CWNS and found that CWS spoke slower than their fluent counterparts. In summary, there is no unified view that CWS speak at a significantly different rate to CWNS.

Stuttering and speaking rate in AWS

It is generally accepted that reducing the speech rate of AWS leads to an increase in fluency (Adams, Lewis, & Besozzi, 1973; Onslow & Ingham, 1987; Van Riper, 1973; Zebrowski & Kelly, 2002). Consequently, a significant number of studies have been carried out examining the effects of altered speaking rate on the disfluencies of AWS (Hutchinson & Navarre, 1977; Kalinowski, Armson, & Stuart, 1995; Ramig, 1984; Sparks, Granta, Millaya, Walker-Batsona, & Hynanb, 2002). Fewer studies have been carried out comparing the speech rate of AWS and AWNS. One example is a study by Gronhovd (1977), who found no difference in the fluent articulation rate of AWS and AWNS. However, Gronhovd examined oral reading rates and, therefore, estimates of speaking rate are not necessarily reflective of a natural speaking context. In summary, there is little research available surrounding the relationship between speaking rate and stuttering in adults. It is also unknown as to whether the speaking rate of AWS is different to AWNS.

Disfluency clusters and speaking rate in CWS

Logan and LaSalle (1999) suggested that examining the relationship between speaking rate and utterance length and complexity on the occurrence of disfluency clusters may provide additional information regarding the nature and context of disfluency clusters. To highlight the potential usefulness of such research, Logan and LaSalle (1999) discuss one participant in their study who had the most disfluency clusters of the CWNS group. It was noted that the conversation this child was participating in was of a particularly quick pace and also included frequent interruptions between speakers, resulting in increased competition for speaking turn. In a similar vein, Kelly and Conture (1992) examined speaking rates, response time latencies and interrupting behaviours of CWS, CWNS and their mothers. Findings showed no significant difference in the interrupting behaviours or response time latencies of mothers of children who stutter (MCWS) versus (MCWNS). Logan and Conture (1995) evaluated articulatory speaking rate in CWS and found no difference in rate between fluent and stuttered utterances. In addition, no correlation was found between articulation rate and syllabic length or complexity of utterances. The collective findings from above suggest that articulation rate may not be useful in the prediction of whether an utterance will be fluent or stuttered, nor do they provide any information on a possible relationship between articulation rate and disfluency clusters.

Disfluency clusters and speaking rate in AWS

There have been no studies to date examining the relationship between disfluency clusters and speaking rate in AWS. While it is known that a reduction in speaking rate results in an increase in fluency (Adams et al., 1973; Onslow & Ingham,

1987; Van Riper, 1973; Zebrowski & Kelly, 2002), the relationship between speaking rate and moments of disfluency is less clear.

Summary

The relationship between stuttering and speech rate has long been a focus of research evaluating the moment of stuttering. Not only have researchers examined the speech rate of people who stutter, they have also examined the speech rate of conversational partners, particularly parents. Some of the many explanations surrounding the relationship between speaking rate and stuttering include: (1) that CWS attempt to speak faster than they are physically capable of (Conture et al., 1993) and (2) that PCWS put CWS under unnecessary pressure by talking to them at a rate that is too rapid (Costello & Ingham, 1984). However, no conclusive findings have been discovered regarding whether CWS or PCWS speak at a rate significantly different to their fluent counterparts. Speaking rate has also been examined in AWS, indicating that fluency increases as speaking rate decreases (Adams et al., 1973; Onslow & Ingham, 1987; Van Riper, 1973; Zebrowski & Kelly, 2002). No research to date has examined the relationship between speech rate and disfluency clusters in either children or adults. In keeping with the findings from children, it might be expected that AWS will show no difference in speech rate between fluent and stuttered utterances. Alternatively, considering the suggestion by Logan and LaSalle (1999) it may be expected that the adults with the fastest speech rates will be likely to demonstrate a higher occurrence of disfluency clusters. Consequently this study proposes the following two hypotheses:

1. *The speaking rate and articulation rate of AWS will differ significantly between fluent and stuttered utterances.*

2.   There will be a significant correlation between speaking rate and articulation rate and number of disfluency clusters.

Motor and Linguistic Aspects of Disfluency Clusters

Disfluency clusters have received a range of interpretations. Still and Griggs (1979) suggested that the occurrence of disfluency clusters are likely a result of heightened anxiety and feedback. Still and Griggs suggested that the anxiety and physical tension created when a stutter occurs serves to increase the likelihood of another stutter occurring. Furthermore they claimed that when a person is anxious about their speech they are likely to focus undue attention to their voice and this monitoring also leads to an increased chance of stuttering.

Hubbard and Yairi (1988) provide a motor interpretation of clusters on a model of disfluency presented by Zimmermann (1980). This model describes a stutter as occurring due to an overload on the speech musculature. This overload causes the brain to "get stuck" in this repetitive action, and unless the system is quickly restored, subsequent stuttering will develop (Zimmermann, 1980). It was noted by Hubbard and Yairi (1988) that this interpretation could readily explain the stuttering behaviours of dysrhythmic phonations and part-word repetitions but was more difficult to relate to revisions and interjections. As noted by earlier studies, revisions and interjections have been associated with disfluency behaviours of fluent individuals (Colburn, 1985; Wexler & Mysak, 1982), whereas behaviours associated with stuttering include part-word repetitions and dysrhythmic phonations (Yairi & Ambrose, 1992). Therefore, if these certain stuttering behaviours are characteristic of stuttering, and stuttering is a motor disorder, it is likely that normal disfluencies do not reflect a motor breakdown.

Rather, normal disfluencies are likely to result from influences related to the organization of speech and language.

Logan and LaSalle (1999) agreed that the occurrence of disfluency clusters is not due to chance alone, however they suggested that disfluency clusters were most likely attributed to linguistic factors. In a study which looked at the characteristics of utterances containing disfluency clusters in CWS and CWNS, Logan and LaSalle (1999) observed that disfluency clusters occurred more often in syntactically complex utterances. In addition, it was also found that clusters often included instances of linguistic revision, which could be a reflection of syntactic monitoring/formulation. A linguistic influence on clusters is further supported by the finding that disfluency clusters often occur at the beginning of utterances or clauses.

Both the motor and linguistic interpretation of disfluency clusters are attempts to identify the underlying cause of the stuttering event. An alternative interpretation of disfluency clusters was proposed by Wexler and Mysak (1982). Analysis was carried out among a group of CWNS to identify correlations between various types of disfluencies which were observed to occur in clusters. Findings indicated strong correlations between phrase revisions and interjections, revision-incomplete phrase and word repetitions, and between phrase repetitions and disrhythmic phonations. Lowest correlations were noted between interjections and phrase repetitions, tense pause and word repetitions, and tense pause and interjections. The authors interpreted the high correlations found between phrase revisions and interjections; and phrase revisions and word repetitions as supporting a linguistic hypothesis, due to these types of disfluencies being "intuitively" linguistic related (Wexler & Mysak, 1982). On the other hand, a motor hypothesis was supported by relatively low frequencies observed for types of disfluencies such as part-word repetitions and dysrhythmic phonations.

These types of disfluencies have an intuitively 'motor' element and have been reported as occurring more frequently in the speech of CWS (Johnson, 1959).

The findings by Wexler and Mysak (1982) introduce an alternative method for analysing and interpreting disfluency clusters, which can be combined with recent findings regarding disfluency clusters as categorized by the SLD-OD system of Yairi and Ambrose (1992). Sawyer and Yairi (2005) used the SLD-OD system to analyse the disfluency clusters of persistent and recovering CWS and CWNS. Essentially three types of clusters can occur using this system. The first cluster is SLD-SLD, which would involve two motor-based disfluencies. The second type of cluster is OD-OD, which would involve two linguistic-based disfluencies. The third cluster is mixed and would involve both SLD and OD type disfluencies. Results indicated that near the onset of stuttering, CWS had similar frequencies of SLD and mixed clusters but significantly less OD clusters in their speech. A speech sample collected six months later showed that recovering CWS displayed a significant drop in the number of SLD and mixed clusters and no change in OD. On the other hand, persisting CWS had a significant decrease in SLD only, although the frequency of SLD in this group continued to be significantly more than CWNS. Further investigation of the composition of mixed clusters identified that for all groups of children, 80% of mixed clusters began with an OD and were usually followed by an SLD. Considering the findings from Wexler and Mysak (1982), it could be hypothesized that OD's reflect linguistic disfluencies and SLD's reflect motor disfluencies.

Summary

Disfluency clusters have received numerous interpretations. Two of the most notable being the linguistic hypothesis which suggests that disfluency clusters reflect difficulties formulating and/or expressing syntactically complex utterances (Logan &

LaSalle, 1999), and the motor hypothesis which explains clusters purely as disruptions to the neurotransmissions of the motor planning process caused by exceeding the limits of the speech musculature (Hubbard & Yairi, 1988). An interesting interpretation of clusters was proposed by Wexler and Mysak (1982) who considered both linguistic and motor influences on disfluency clusters with reference to particular disfluency types. Wexler and Mysak (1982) suggested that certain types of disfluencies represented both motor and linguistic components. Interestingly, the disfluencies identified as linguistically-related by Wexler and Mysak (1982) relate to the disfluency types categorized as ODs by Yairi and Ambrose (1992), and those identified as motor-related correlate with the types of disfluencies categorized by SLDs. Previous findings and observations are taken to suggest that the motor and linguistic influence on disfluency clusters may be analysed using the SLD-OD classification system. In addition, the majority of studies attempting to determine motor and linguistic influences have used child participants, hence no picture of the progression of stuttering (i.e. adulthood), with regard to these influences, has been formulated. Consequently this study proposes the following hypothesis:

Is there a specific type of disfluency cluster that is characteristic of adult stuttering?

Perceptual Impressions of the Stuttering Event

Stereotypes

A significant amount of research has focused on the perceptions of listeners to the speech of people who stutter (PWS). Previous research examining listener perceptions has found that many people make personality judgments based on the speech of PWS. Such personality judgments include an assumption that PWS are

quiet, introverted, anxious, and tense (Bloodstein, 1981; Susca & Healey, 2002; Turnbaugh, Guitar, & Hoffman, 1979; Woods & Williams, 1976). Such stereotypes have not been supported scientifically (Snyder, 2001), however they continue to be a commonly accepted view. Such negative attitudes towards PWS can have a profound impact on the person's quality of life. Often PWS will let their stuttering influence their career choice (Peters & Starkweather, 1989), and although employers do not typically believe that stuttering interferes with job performance, it does appear to impact on an employer's choice of employee, as well as the employees potential promotion opportunities (Hurst & Cooper, 1983). Negative stereotypes of PWS also exist in the wider community. Doody, Kalinowski, Armson and Stuart (1993) examined 106 individuals perspectives of AWS and AWNS and found largely negative perceptions of AWS, including a belief that they are more guarded, nervous, shy, self-conscious, tense, sensitive and anxious than AWNS. Interestingly, 85% of the participants reported having had contact with PWS and 39% of the participants reported being related to PWS. This study illustrates the strength of stereotypes surrounding stuttering, a finding also observed by Snyder (2001). Snyder examined the ability to change graduate speech therapy clinicians' perceptions of stuttering using an emotive documentary depicting the life of a PWS. Results indicated that clinicians' perceptions towards stuttering etiology, stuttering therapy and attitudes to PWS in general were reasonably preset and resistant to change.

Negative perceptions of PWS are far reaching, even to the point where PWS come to believe these stereotypes about themselves (Kalinowski, Lerman, & Watt, 1987). White and Collins (1984) proposed a possible explanation for the persistence of these negative stereotypes, despite a lack of evidence to support them. They

suggest that the negative characteristics people attribute to PWS, are in fact reflections of the listener's own emotional response to the speech of PWS.

Communication ability

In addition to making personality judgments, listeners also make judgments on the communication ability of PWS based on the fluency of their speech (Susca & Healey, 2001). Susca and Healey (2001) simulated speech samples with 0%, 5%, 10% and 15% disfluency and asked naïve listeners to judge various aspects of the speech. Findings indicated that as the level of disfluency increased, listeners assigned lower ratings to speaker competence, speech fluency, ease of reading the story and comfort listening to the story. Listener comfort when listening to PWS has also been investigated as a potential indicator of the successfulness of a therapy program (O'Brian, Packman, Onslow, Cream, & O'Brian, 2003). O'Brian et al. (2003) suggested that listener comfort could be a useful tool in helping determine the social validity of therapy outcomes. Susca and Healey (2002) examined perceptions of stuttered speech along a fluency-disfluency continuum and found that a listener's judgments were based on more attributes than simply the degree of disfluency. Listeners perceive a range of information from the speech signal which impacts their overall impression of a speaker's communicative ability and personality.

Severity of stuttering

Previous research has also examined a listener's ability to identify moments of stuttering (Hedge & Hartman, 1979) and to rate levels of stuttering severity (Leach, Wolfolk, Fucci, & Gonzales, 1995). Findings indicated that listeners were reliable in their identification of mild to moderate disfluencies but reliability decreased when rating more severe-type disfluencies (Hedge & Hartman, 1979). Prosek, Walden,

Montgomery and Schwartz (1979) presented speech-language pathologists with pairs of sentences recorded by 13 male AWS and required them to identify the most severe stutterer from each pair. Results indicated that reading rate and number of intra-sentence pauses were the most important factors in determining the severity of a stutter. On the other hand, frequency of disfluencies or type of disfluencies appeared less related to overall stuttering severity. O'Brian, Packman, Onslow and O'Brian (2004) compared two forms of stuttering measurement, (1) percentage of syllables stuttered and (2) a 9-point severity scale. They found that the two forms of measurement were largely interchangeable. Exceptions included when the speech sample contained either a small number of significant fixed postures or a large number of repeated movements. In these cases, O'Brian et al. (2004) recommended that both a percentage score and severity rating be used. Results from the above studies suggest that frequency and type of disfluency alone are not sufficient in establishing a reliable measure of severity.

Severity of disfluency clusters

Logan and LaSalle (1999) commented that it is unclear as to whether the presence of disfluency clusters has more of a negative impact on the speech of PWS than single disfluencies. Previous studies examining the duration of utterances that contain single disfluencies and clustered disfluencies have found that clustered utterances are more than three times as long as single utterances in terms of the time spent speaking (Logan & LaSalle, 1996). This would suggest that listeners would be more likely to react adversely to utterances containing disfluency clusters, which may in turn provide more information regarding listener perceptions.

Disfluency clusters have been shown to be positively correlated to stuttering severity (LaSalle & Conture, 1995; Sawyer & Yairi, 2004), suggesting that disfluency

clusters would indeed be detrimental to the speech of PWS. However, no studies have been carried out to examine listener perceptions of disfluency clusters. It could be expected that if disfluency clusters and stuttering severity are correlated, then listeners may perceive disfluency clusters as being more reflective of the severity of a person's stutter. Furthermore, it could be anticipated that the types of disfluency clusters that PWS exhibit most frequently will be the most closely correlated with that persons severity of stutter.

Summary

An extensive amount of research has been carried out looking at listener perceptions of stuttering. Research has examined both listener impressions of PWS in general and also impressions of moments of stuttering. Findings indicate strongly that people often attribute negative personality characteristics with PWS (Bloodstein, 1981; Turnbaugh et al., 1979; Woods & Williams, 1976), despite no factual evidence (Snyder, 2001). In addition, it has been found that these negative stereotypes can persist even when people have contact with, or are related to, a person who stutters (Doody et al., 1993). Such negative stereotypes can have a dramatic effect on the life of a PWS, including impacting their self-esteem (Kalinowski et al., 1987) and career choice (Peters & Starkweather, 1989). Research examining listener perception of the moment of stuttering has included looking at aspects such as a listener's ability to rate the severity of stuttering (Leach et al., 1995), ability to identify stuttering behaviour (Hedge & Hartman, 1979), and how speech fluency can impact on a listener's impression of overall communication ability (Susca & Healey, 2002).

No research has taken place to date examining listener impressions of disfluency clusters, therefore it is not known whether the presence of disfluency clusters is viewed as particularly disruptive to the speech of someone who stutters

(Logan & LaSalle, 1999). It has been found that utterances containing disfluency clusters are significantly longer in duration than utterances with single disfluencies (Logan & LaSalle, 1996). In addition, it is known that disfluency clusters are positively correlated with stuttering severity (LaSalle & Conture, 1995; Sawyer & Yairi, 2004). Considering the collective findings, it could be expected that listeners will correlate disfluency clusters with a person's overall stuttering severity. Consequently, the study proposes the following hypothesis:

Listeners will perceive most commonly occurring clusters to be more reflective of overall stuttering severity.

Statement of the Problem

Past research evaluating the nature of disfluency clusters has revealed that they occur in the speech of both CWS and CWNS; however proportionally more disfluency clusters occur in the speech of CWS (Hubbard & Yairi, 1988; LaSalle & Conture, 1995; Sawyer & Yairi, 2004). In addition, disfluency clusters have been found to have a positive correlation with stuttering severity (LaSalle & Conture, 1995; Sawyer & Yairi, 2004). Disfluency clusters have received both motor (Hubbard & Yairi, 1988) and linguistic (Logan & LaSalle, 1999) interpretations. There is a paucity of research evaluating the characteristics of disfluency clusters in an adult population. The purpose of this present study was to examine the relationship between disfluency clusters and utterance length, speaking rate and perceptual impressions in the speech of AWS. The following hypotheses were proposed:

1. *There will be no significant difference in the length of fluent, single stuttered and clustered utterances in AWS.*

2. *The speaking rate and articulation rate of AWS will differ significantly between fluent and stuttered utterances.*

3. *There will be a significant correlation between speaking rate and articulation rate and number of disfluency clusters*

4. *Is there a specific type of disfluency cluster that is characteristic of adult stuttering?*

5. *Listeners will perceive most commonly occurring clusters to be more reflective of overall stuttering severity.*

Method

<u>Participants</u>

A group of ten adults who stutter participated in the study. The age range of the adults was 18 to 60 years with a mean age of 35 years. The participants for this study were obtained from a pool of 20 individuals originally evaluated at the Australian Stuttering Research Centre in Sydney, Australia. No attempt was made to control for sex and all participants were free of known or reported hearing, neurological, developmental, intellectual or emotional problems. The ten participants chosen from among the pool of 20 were those who provided the largest speech sample based on an informal conversation with a Speech-Language Therapist. The percentage of disfluencies demonstrated by the participants ranged from 9% to 31% with a mean disfluency of 19%. Identification of stuttering was based on the number of disfluencies per 100 words of conversation based on a 300-word sample. Use of a 300-word sample is generally deemed sufficient for the differentiation between stuttering and non-stuttering populations (Hubbard & Yairi, 1988; LaSalle & Conture, 1995; Logan & LaSalle, 1999; Throneburg & Yairi, 2001). The general characteristics of the participants are listed in Table 1.

<u>Data Collection</u>

Each participant was audio- and video recorded while interacting with a Speech-Language Therapist for approximately 15 minutes. The participant and therapist engaged in informal conversation. No attempt was made to control for the topic of conversation nor was instruction given to alter manner of speaking. Participants were seated at a table directly in front of a camera and asked to face upwards while speaking to allow better view of facial movements. The speech samples were taken to

Table 1. General characteristics of individual participants including age (years), gender, percentage of disfluencies (%) and history of stuttering therapy (Y = yes, N = no).

Participant	Age (yrs)	Gender	% Disfluent	Previous treatment
1	51	M	9	Y
2	51	M	20	Y
3	23	M	22	Y
4	32	F	9	N
5	23	F	24	Y
6	45	F	26	N
7	18	M	31	N
8	20	M	20	N
9	37	M	16	Y
10	45	M	12	Y
Group Mean	**35**		**19**	

establish a baseline measure of the participants stuttering prior to entry into a stuttering therapy program. The final selection of ten adults was made based on conversation speech samples which contained more than 300 words.

Data Transcription

The researcher listened to the speech sample recordings and orthographically transcribed each participant's utterances verbatim. An utterance was defined as a string of words or clauses that a) communicate an idea, b) are set apart by pauses and c) are bound by a single intonational contour (Meyers & Freeman, 1985). Unintelligible utterances, single-word utterances, and one-syllable utterances were deleted from the samples. Each moment of disfluency was identified. Individual disfluencies were coded as either stuttering-like disfluencies (SLD) or other disfluencies (OD). A SLD was defined as any of the following disfluencies: disrhythmic phonations, part-word repetitions, tense pauses and single word repetitions (Ambrose & Yairi, 1999; Sawyer & Yairi, 2004; Throneburg & Yairi, 2001). An OD was defined as an interjection, revision-incomplete phrase, multisyllabic word repetition or phrase repetition (Ambrose & Yairi, 1999; Sawyer & Yairi, 2004; Throneburg & Yairi, 2001).

Disfluency Clusters

Each moment of disfluency was evaluated to determine whether it comprised a disfluency cluster. A disfluency cluster was defined as the occurrence of two or more disfluencies on the same word and/or adjacent words (Colburn, 1985). As per Sawyer and Yairi (2005), the clusters were classified as 1) SLD-type; which involved the occurrence of two or more SLDs (e.g., a part-word repetition followed by a disrhythmic phonation, "The b-b-boy wwent", 2) OD-type; which involved the

occurrence of two or more ODs (e.g., an interjection followed by a phrase revision "The man um -the boy went", or 3) mixed-type; which involved the occurrence of both OD and SLD types (e.g., an interjection followed by a part-word repetition "He um w-w-wants").

Disfluency Cluster Analysis

Using the three categories of cluster types, each participant's spontaneous speech sample was analyzed in the following way:

a. Percentage of OD clusters. Defined as the proportional occurrence of disfluency clusters containing only OD type disfluencies within each 300-word sample.

b. Percentage of SLD clusters. Defined as the proportional occurrence of disfluency clusters containing only SLD type disfluencies within each 300-word sample.

c. Percentage of mixed clusters. Defined as the proportional occurrence of disfluency clusters containing both OD and SLD type disfluencies within each 300-word sample.

d. Percentage of total disfluency clusters. Defined as the proportional occurrence of all OD, SLD and mixed disfluency clusters within each 300-word sample.

Acoustic Analysis

Ten utterances were chosen from each participant's speech sample and submitted to acoustic analysis. The utterances were analyzed acoustically using a commercially available speech analysis system (Kay CSL-4300B). Utterances that were four syllables in length or longer were included in the acoustic analysis. In

addition, for each participant an attempt was made to include utterances that were either (1) fluent, (2) contained a single disfluency, or (3) contained a disfluency cluster. Across the 100 utterances analyzed (ten participants x ten utterances per participant) 28 utterances were fluent, 35 utterances contained clustered disfluencies and 37 utterances contained single disfluencies. Each of the participants contributed utterances from the three above categories. Each utterance was measured for speaking rate and articulation rate and defined as follows:

Speaking Rate is a measure of the overall rate of speech including pause times. Using the protocols from Robb, Gilbert, Reed and Bisson (2003), each utterance was displayed on a computer screen as an amplitude-by-time waveform. Using the display, vertical cursors were placed at the onset and offset of the first and last syllables of the utterance, respectively. Syllable onset was identified as the point where acoustic energy first became visible and syllable offset was identified as the point where acoustic energy ceased (i.e. returned to baseline). The time interval between the first and second cursor was measured. Speaking rate was calculated by taking this measurement and dividing it by the number of syllables in the utterance. An average measure of speaking rate was determined for each individual.

Articulation Rate involves calculating the number of syllables produced in a timed sample with silent periods (or 'pauses') removed (Robb et al., 2003). Due to the removal of these pauses articulation rate is seen as a more sensitive measure of speech execution time (Hall, Amir, & Yairi, 1999). Using the protocols from Robb et al. (2003), each utterance was displayed on a computer screen and silent pauses exceeding 150ms were deleted. This was done by placing two cursors at the onset and offset of the pause and deleting that section. The remaining waveform represented a continuous speech sample and was used to calculate articulation rate. An average

measure of articulation rate was taken for each individual. An example of a typical waveform measured for speaking rate and articulation rate is displayed in Figure 1. All audible disfluencies were included in the measurements of articulation rate. The rationale for including audible disfluencies was to provide an unbiased assessment of the speed of articulatory movement. By including audible disfluencies in this measure, all articulatory behaviour was assessed.

Perceptual Analysis

An analysis was undertaken to determine whether the disfluency clusters produced by the participants could be differentiated according to perceived severity. For each participant, two utterances containing instances of disfluency clusters were chosen for inclusion in the perceptual analysis task. In total, 20 samples were evaluated (two disfluency clusters per participant x ten participants). The two disfluency clusters chosen from each participant's respective speech sample represented one example of the most frequently occurring type of cluster and one example of the least frequently occurring type of cluster. For example, Participant 1 was found to produce OD-type clusters most frequently, and the least occurring cluster was mixed (see Table 1). Several authors have suggested that the occurrence of disfluency clusters is positively correlated with stuttering severity (LaSalle & Conture, 1995; Sawyer & Yairi, 2004). Therefore, it was assumed that the most commonly occurring type of cluster produced by each participant would likely be perceived by listeners as more representative of the speakers overall stuttering severity. The utterances containing the least and most commonly occurring clusters were trimmed to an overall length ranging from 3 to 6 secs. In all cases, the clusters were surrounded by fluent words. The utterances were trimmed so as to provide maximum emphasis on the stuttering event. Once the utterances were trimmed, they

Figure 1. Waveform display of utterance "The b-b-boy went to the shop". The top display is unedited and used for measurement of speaking rate. The bottom display is edited, with pauses greater than 150ms removed, and is used for measurement of articulation rate. Disfluencies are included in the measurement of articulation rate.
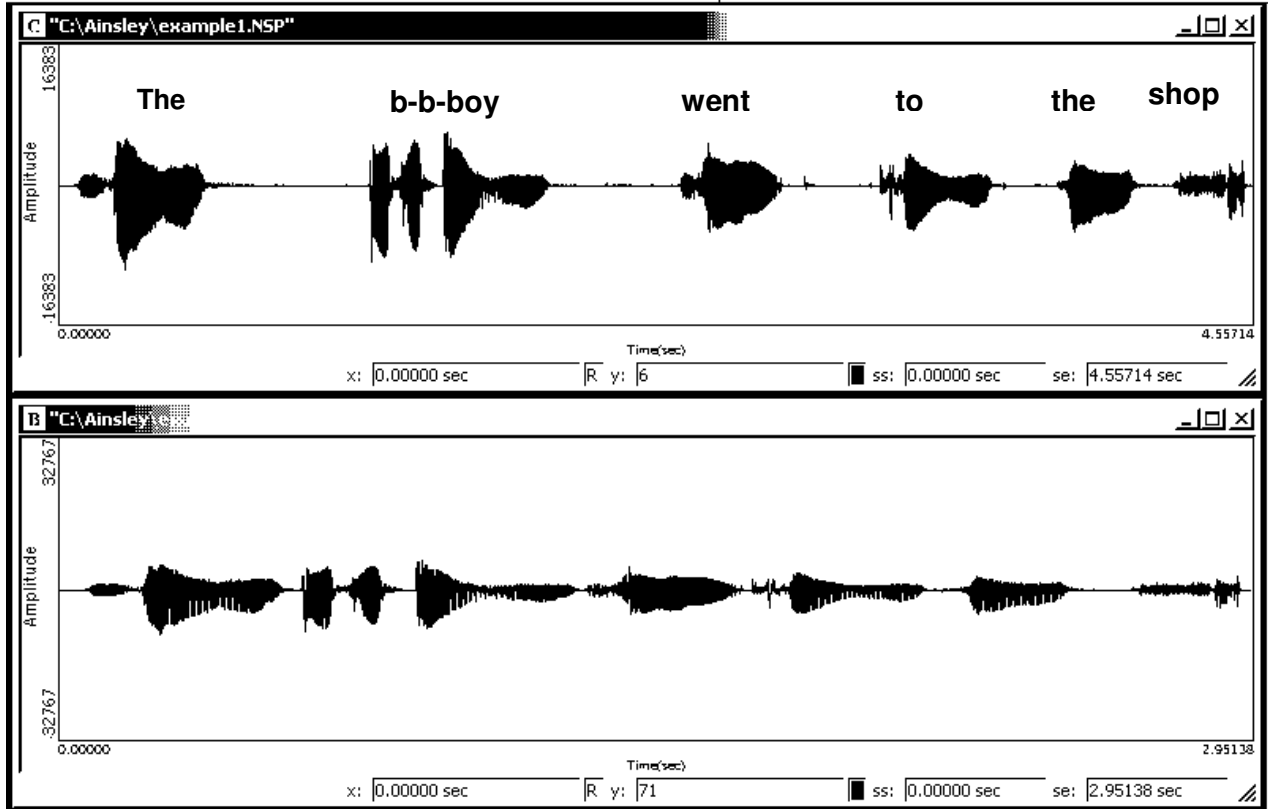
were saved as individual "wav" files. The resulting 20 "wav" files were transferred to a compact disc.

Twenty naïve listeners, with no previous training in speech-language therapy, served as perceptual judges. The naïve listener group contained 12 females and 8 males, aged between 19 and 58 years, with a mean age of 35 years. All of the judges reported normal hearing. Each judge received the same verbal instructions (see Appendix 1). Using earphones, each listener was first allowed to listen to the entire sample of disfluency clusters played in random order, during which time they were asked to concentrate on the severity of the stutter exhibited. Following this rehearsal task, each disfluency cluster was played individually, again in randomized order, and the judge was asked to rate the severity of the speaker's stutter using a visual analogue sliding scale of zero (no stutter) to 10 (worst stutter imaginable). Similar scales have been used in previous perceptual research evaluating the severity of speech disorders (Dromey, 2003). Five disfluency cluster samples were repeated at the end of the perceptual task, which served to assess the intra-reliability of each judge's severity ratings. Judges could repeat each sample as many times as they wished prior to assigning a severity score. In addition, the judges were able to modify the volume of the speech samples throughout the task, to ensure an adequate loudness level.

Reliability Assessment

Intra-judge and inter-judge assessments were performed for the identification of disfluency clusters, and measurement of speaking rate and articulation rate. Reliability for identification of disfluency clusters was performed randomly by choosing the speech samples of two participants. The samples were then listened to by the researcher and another listener, both of whom are Speech-Language Therapists, the occurrence of all disfluencies and disfluency clusters were noted. The results

obtained by the researcher and another listener were then compared with the original results in terms of presence/absence of a cluster and type of cluster. The agreement for the presence/absence of a disfluency cluster for intra-judge reliability and inter-judge reliability was 96% and 81% respectively. The level of agreement for the type of disfluency cluster identified (SLD, OD or mixed) was 100% for both intra- and inter-judge reliability.

Reliability for measurement of speaking rate and articulation rate was performed by choosing 26 utterances at random for re-measurement. The utterances were chosen to ensure a representation of utterances containing no disfluencies, single disfluencies, and clustered disfluencies. Each of these utterances was then re-measured for both speaking rate and articulation rate by the researcher. The results of this analysis were compared to the original measurements obtained by the researcher using a Pearson product-moment correlation test. For speaking rate, the correlation between the original measures and the researcher's second measurements was 0.99. A t-test was performed to examine the difference between the original mean speaking rate (of the 26 utterances) and the re-measured speaking rate. The test was not significant [$t(.101)=.92$, $p<.05$]. For articulation rate, the correlation between the original measures and the researcher's second measurements was 0.82. A t-test was performed to examine the difference between the original mean articulation rate (of the 26 utterances) and the re-measured articulation rate. The test was not significant [$t(.388)=.70$, $p<.05$].

In addition, intra-judge reliability was assessed for the perceptual task by having each listener re-rate 5 randomly chosen disfluency clusters at the end of the task. The correlation between the listener's initial ratings and second ratings were 0.79 as a group. A t-test was performed to determine whether the two groups of data

differed significantly. The *t*-test was not significant [$t(38)=.650$, $p >.05$], indicating that the difference was not great enough to reject the possibility of chance.

Statistical Analysis

The data were analysed using a combination of correlation and inferential statistics to describe relationships and differences between the data, respectively. A series of one-way analysis of variance (*ANOVA*) tests were used to compare 1) the types of disfluency clusters, 2) the number of elements per cluster and 3) the length of utterances containing no disfluencies, single disfluencies and clustered disfluencies. Any significant differences identified in the *ANOVA* test were further evaluated using follow-up (post-hoc) *t*-tests. In addition, *t*-tests were used to compare the speaking rate and articulation rate of fluent and disfluent utterances. When significant differences were found, *p*-values were adjusted using the Bonferoni procedure to reduce to possibility of making a Type I error (Schiavetti & Metz, 2002). In addition, a series of correlational analyses were performed to evaluate the relationship between 1) stuttering severity and number of disfluency clusters, 2) stuttering severity and percentage of clusters/total disfluencies, 3) stuttering severity and speaking rate, 4) stuttering severity and articulation rate, and 5) stuttering severity and perceptual ratings. All of the analyses were carried out using SigmaStat Statistical Software (Scientific, 1997).

Disfluency Clusters

Cluster type. The distribution of disfluency cluster types for each individual is displayed in Table 2. The total number of disfluency clusters across all participants was 144 and ranged from 6 to 23. The total number of SLD, OD and mixed disfluency clusters were 23, 28 and 93 respectively. The mean number of SLD, OD and mixed clusters for the group was tabulated and submitted to a series of alpha-adjusted *t*-tests ($p=$ .05/3 = .016). The results indicated that there were significantly more mixed clusters than OD-type [$t(18)=3.31$, $p<.01$] or SLD-type [$t(18)=3.67$, $p<.01$] clusters. There was no difference between the number of OD and SLD clusters [$t(18)=.55$, $p>.01$].

Cluster elements. The number and percentage of elements per cluster for each participant is displayed in Table 3. The total number of clusters across all participants with two elements, three elements and four (or more) elements was 108, 25 and 11 respectively. A one-way repeated measures ANOVA was performed to determine if the proportional occurrence of disfluency clusters differed according to the number of elements. Prior to performing the test, all percentage values were transformed to arcsine values (Schiavetti & Metz, 2002). The test was significant [$F(2,29) = 44.25$, $p<0.001$]. Post-hoc Tukey tests were then performed to identify the source of the significant difference. The alpha level was adjusted to account for multiple *t*-test comparisons. Results indicated there were significantly more two-element clusters than three-element clusters ($q=9.27$, $p<0.001$) or four-element clusters ($q=12.89$, $p<0.001$) clusters. There was no significant difference between the number of three-element clusters and four-element clusters.

Table 2. Total number of clusters per participant and distribution of clusters based on type (SLD-type = two or more SLDs, OD-type= two or more ODs, and mixed-type = both SLDs & ODs). Standard deviations are shown in parentheses.

	Participant	Total # Clusters	SLD-type clusters	OD-type Clusters	Mixed-type clusters
	1	9	0	8	1
	2	18	5	4	9
	3	12	4	2	6
	4	9	1	3	5
	5	21	4	4	13
	6	23	4	0	19
	7	18	2	0	16
	8	15	1	2	12
	9	13	1	3	9
	10	6	1	2	3
	Total	**144**	**23**	**28**	**93**
Group	**Mean**	**14.4 (5.58)**	**2.3 (1.77)**	**2.8 (2.30)**	**9.3 (5.76)**

Table 3. Number (#) and percentage (%) of disfluency clusters made up of 2, 3 and 4+ elements produced by each participant. Standard deviations are shown in parentheses.

Participant	2 elements		3 elements		4+ elements	
	#	%	#	%	#	%
1	9	100	0	0	0	0
2	15	83.3	1	5.6	2	11.1
3	8	66.7	3	25	1	8.3
4	8	88.9	1	11.1	0	0
5	15	71.4	3	14.3	3	14.3
6	17	74	2	8.7	4	17.4
7	10	55.6	7	38.9	1	5.6
8	12	80	3	20	0	0
9	10	76.9	3	23	0	0
10	4	60	2	40	0	0
Total	108	N/A	25	N/A	11	N/A
Group						
Mean	10.8 (3.97)	75.7 (13.3)	2.50 (1.90)	18.7 (13.4)	1.10 (1.45)	5.67 (6.74)

<u>Utterance Length</u>

The results regarding number and length of utterances for each participant are displayed in Tables 4 and 5. The mean syllable length of fluent utterances was 8.5 syllables with a range from 5.8 to 12.8 syllables. The mean syllable length of utterances containing single disfluencies was 11.0 syllables with a range from 8.4 to 12.7 syllables. The mean syllable length of utterances containing disfluency clusters was 12.9 syllables with a range from 9.7 to 17.2 syllables. A one-way repeated measures ANOVA was used to determine if utterance length significantly differed between fluent, single disfluencies and disfluency clusters. Results indicated there was a significant difference among the means [$F(2,29) = 18.68$, $p<.001$]. A series of alpha-adjusted post-hoc Tukey tests ($p=.05/3 = .016$) were performed to identify the source of the significant difference. Results indicated that fluent utterances were significantly shorter than utterances with clustered disfluencies ($q=8.62$, $p<0.001$). There were no significant differences between fluent utterances and utterances with single disfluencies ($q=4.86$, $p<0.05$). Utterances with single disfluencies did not significantly differ in length compared to utterances with disfluency clusters ($q=3.76$, $p<0.05$). The utterance lengths for each participant are displayed in Figure 2. Examination of the figure indicates that, in nine out of ten participants, fluent utterances were the shortest in length. In eight out of ten participants, fluent utterances were the shortest in length, followed by single disfluency utterances. Of the two participants that did not follow this trend, both continued to demonstrate shorter fluent utterances than clustered utterances.

Table 4. Total number (#) of utterances calculated for each participant. The number of utterances containing no disfluency, single disfluencies and clustered disfluencies are reported.

Participant	Total # of utterances	# of Fluent utterances	# of Single disfluency utterances	# of Clustered disfluency utterances
1	58	28	21	9
2	49	18	16	15
3	41	8	22	11
4	51	29	13	9
5	42	10	15	17
6	28	8	7	13
7	26	5	7	14
8	34	8	11	15
9	31	6	15	10
10	42	24	13	5
Group	**402**	**136**	**140**	**118**

Table 5. The mean (M) number (#) of syllables comprising fluent utterances, utterances with single disfluencies, and utterances with disfluency clusters per participant. The corresponding standard deviations are shown in parentheses.

Participant	Fluent utterance M # Syllables	Single disfluency M # Syllables	Clustered disfluency M # Syllables
1	9.8	10.9	11.2
2	7.5	8.4	9.7
3	6.5	11.6	13.2
4	9.2	10	10.8
5	6.4	9.1	12
6	9.6	11.6	17.2
7	5.8	12	13.4
8	9	12.7	11
9	12.8	11.7	16.6
10	8.1	11.5	13.6
Group	**8.47 (2.08)**	**10.95 (1.36)**	**12.87 (2.47)**

Figure 2. Mean utterance length (in syllables) containing no disfluencies, utterances with single disfluencies, and utterances with clustered disfluencies.
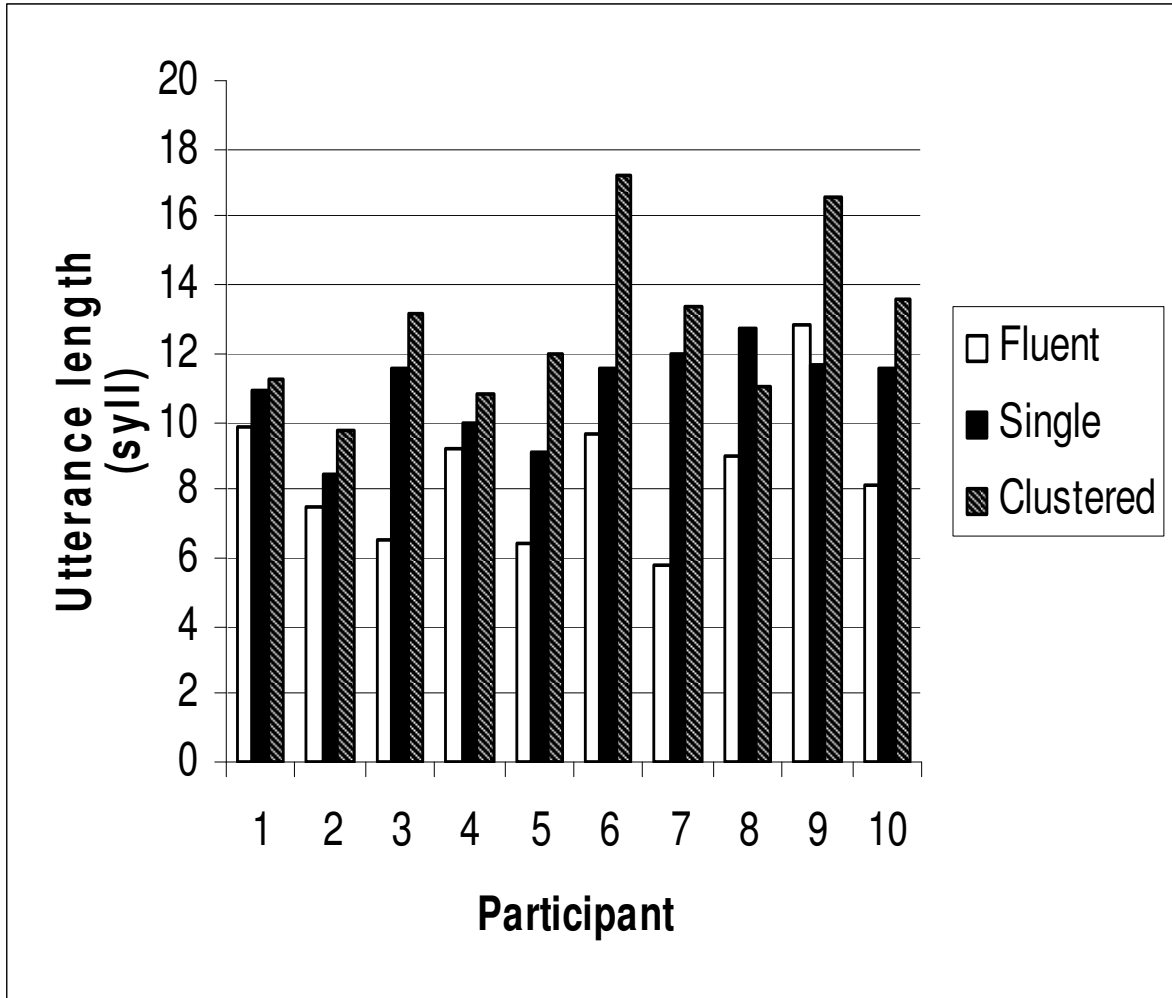
Stuttering Severity and Disfluency Clusters

A Pearson product-moment correlation was computed to examine the relationship between each participant's stuttering severity and corresponding number of disfluency clusters. Results indicated a significant positive relationship ($r = 0.76$, $p<.05$), suggesting that as stuttering severity increased the number of disfluency clusters also increased. The relationship between stuttering severity and number of clusters is displayed in Figure 3. A Pearson correlation was also computed to examine the relationship between stuttering severity and the proportional occurrence of disfluency clusters (the number of disfluency clusters divided by the total number of disfluencies). Results indicated no significant relationship ($r = 0.12$, $p>.05$) between these two variables.

Speech Rate

Speaking rate. The results obtained for each participant are displayed in Table 6. The mean speaking rate for fluent utterances was 5.43 sps with a range of 4.06 to 7.66 sps. The mean speaking rate for disfluent utterances was 3.69 sps with a range of 2.49 to 5.36 sps. A *t*-test was performed to determine whether average speaking rate differed between fluent and disfluent utterances. The *t*-test was significant [$t(18) = 3.91$, $p <.05$], indicating that fluent utterances were spoken at a faster rate than disfluent utterances. The mean speaking rates calculated for each participant's fluent and disfluent utterances are displayed in Figure 4. Examination of the figure indicates that each participant spoke faster in their fluent utterances compared to disfluent utterances. In addition, a correlational analysis was completed to evaluate the relationship between speaking rate and number of clusters and stuttering severity. No significant relationship was found.

Figure 3. The relationship between stuttering severity and total number of clusters produced by each participant. A line of best fit is superimposed on the data and the corresponding correlations coefficient (r) is reported.

Table 6. Average speaking rate (syllables/second) of fluent, disfluent and combined utterances for participants. Standard deviations are shown in parentheses.

	Speaking Rate		
Participant	**Fluent**	**Disfluent**	**Combined**
1	7.66 (1.58)	5.36 (1.08)	6.05 (1.60)
2	4.10 (0.42)	3.37 (1.17)	3.59 (1.04)
3	5.33 (1.90)	3.76 (1.03)	4.23 (1.44)
4	4.17 (0.57)	3.80 (1.79)	3.91 (1.44)
5	5.61 (0.07)	3.61 (0.62)	4.01 (1.00)
6	6.95 (0.77)	4.03 (1.29)	4.91 (1.80)
7	4.06 (0.69)	3.19 (0.79)	3.36 (0.82)
8	5.52 (0.13)	2.49 (1.14)	3.10 (1.63)
9	5.05 (1.52)	3.34 (1.19)	3.85 (1.46)
10	5.80 (1.63)	3.91 (1.24)	4.67 (1.64)
Group	**5.43 (1.19)**	**3.69 (0.74)**	**4.17 (0.86)**

Figure 4. Mean speaking rate (syllables/second) of fluent and disfluent utterances for each participant
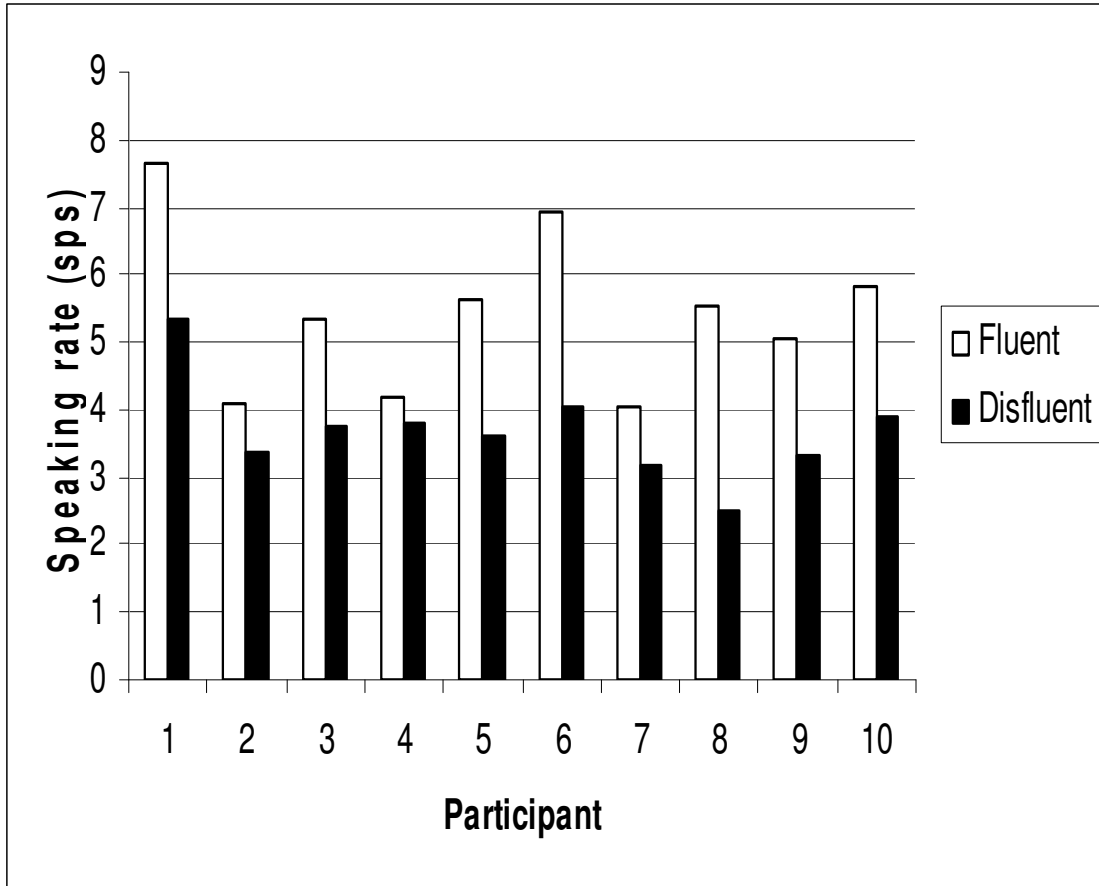
between speaking rate and either the number of clusters (r = .30, p=.40) or stuttering severity (r = .39, p=.26).

   Articulation rate. The results obtained for each participant are displayed in Table 7. The mean articulation rate for fluent utterances was 5.75 sps with a range of 4.06 to 7.81 sps. The mean articulation rate for disfluent utterances was 4.56 sps with a range of 3.73 to 6.03 sps. A *t*-test was performed to determine whether articulation rate differed between fluent and disfluent utterances. The *t*-test was significant [$t(18)$ = 2.63, p <.05], indicating that the articulation rate of fluent utterances was faster than disfluent utterances. The mean articulation rates calculated for each participant's fluent and disfluent utterances are displayed in Figure 5. Examination of the figure indicates that nine of the ten participants had a faster articulation during fluent utterances compared to disfluent utterances. In addition, a correlational analysis was completed to evaluate the relationship between articulation rate and number of clusters and stuttering severity. No relationship was found between articulation rate and either the number of clusters (r = .12, p=.74) or stuttering severity (r = .23, p=.52).

Perceptual Analysis

   The results obtained for the perceptual task are displayed in Table 8. Across the 20 judges, the most commonly occurring disfluency clusters were given a mean severity score of 3.11, with a range of 1.03 to 6.29. The mean rating for the least commonly occurring disfluency cluster was 3.28, with a range of 1.61 to 7.26. A *t*-test was performed to determine if the severity ratings differed between the most common and least commonly occurring disfluency clusters. The test was not significant [$t(18)$ = .210, p >.05], indicating that listeners were unable to perceive a difference in severity between
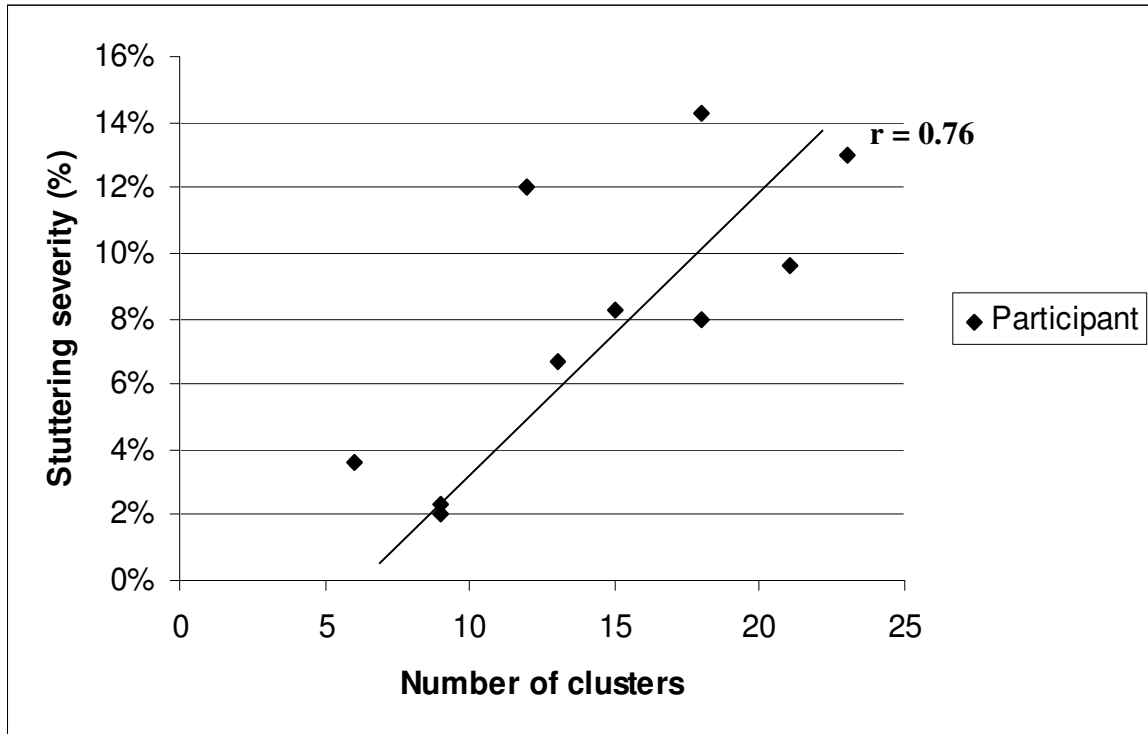
Table 7. Average articulation rate (syllables/second) of fluent, disfluent and combined utterances for each participant. Standard deviations are shown in parentheses.

Participant	Articulation Rate		
	Fluent	**Disfluent**	**Combined**
1	7.81 (1.35)	6.03 (1.06)	6.56 (1.38)
2	4.70 (0.47)	3.95 (1.02)	4.17 (0.94)
3	5.33 (1.90)	4.79 (0.89)	4.95 (1.18)
4	4.58 (0.96)	3.97 (1.56)	4.15 (1.38)
5	6.82 (1.63)	4.81 (1.20)	5.21 (1.46)
6	7.31 (1.17)	5.21 (1.99)	5.84 (2.00)
7	4.06 (0.69)	4.01 (0.86)	4.02 (0.79)
8	5.52 (0.13)	3.73 (1.30)	4.09 (1.37)
9	5.19 (1.31)	4.16 (0.82)	4.47 (1.04)
10	6.20 (1.19)	4.91 (0.81)	5.42 (1.13)
Group	**5.75 (1.24)**	**4.56 (0.72)**	**4.89 (0.86)**

Figure 5. Mean articulation rate (syllables/second) of fluent and disfluent utterances for each participant
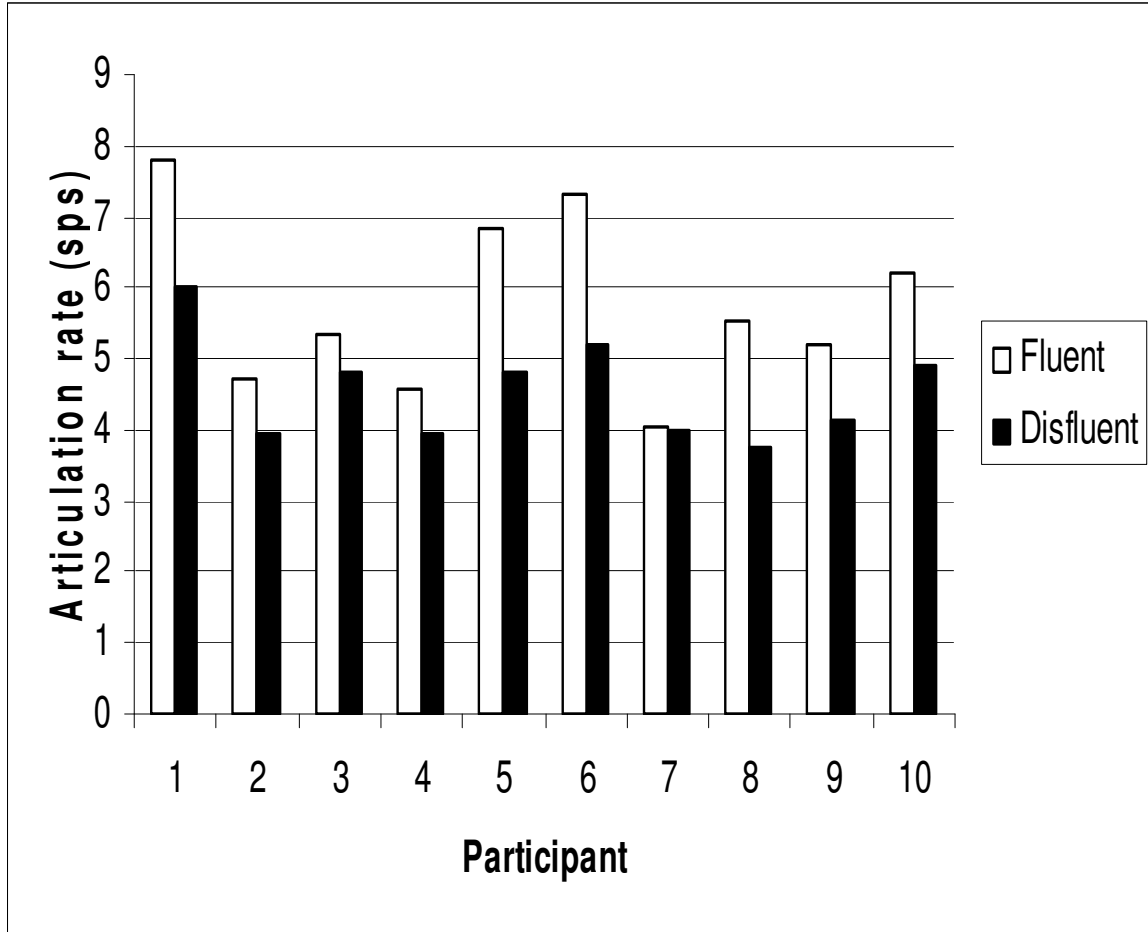
Table 8. Means and standard deviations of combined perceptual ratings (n=20 judges) of the most commonly (MC) occurring disfluency cluster and the least commonly (LC) occurring disfluency cluster. Perceptual ratings were based on a scale of 0 (no stutter) to 10 (worst stutter).

	MC		LC	
Participant	**M**	**SD**	**M**	**SD**
1	1.36	1.15	2.68	1.68
2	3.30	1.65	2.83	1.87
3	2.88	1.63	2.67	1.65
4	2.34	1.81	1.72	1.53
5	1.03	1.21	3.01	1.61
6	6.07	2.08	1.61	1.45
7	3.92	1.89	7.26	1.26
8	6.29	1.55	4.56	2.14
9	1.85	1.57	2.06	1.67
10	2.06	1.96	4.37	1.92
Group	**3.11**	**1.83**	**3.28**	**1.71**

the most and least commonly occurring disfluency clusters. In addition, a series of correlational analyses were completed to examine the relationship between the perceptual ratings of the most and least commonly occurring disfluency clusters and a range of variables. No significant correlation was found between the severity judgments of the most commonly occurring disfluency cluster and overall stuttering severity (based on the 300-word sample) ($r = .52$, $p=.12$). Furthermore, no significant correlation was found between the severity judgments of the most commonly occurring disfluency cluster and speaking rate ($r = .34$, $p=.33$) or articulation rate ($r = .25$, $p=.48$). No significant correlation was found between the severity judgments of the least frequently occurring disfluency cluster and overall stuttering severity (based on the 300-word sample) ($r = .35$, $p=.32$). Furthermore, no significant correlation was found between the severity judgments of the least frequently occurring disfluency cluster and speaking rate ($r = .40$, $p=.25$) or articulation rate ($r = .37$, $p=.30$).

Previous Treatment

Finally, a cursory analysis was performed in regard to each participant's speaking behaviours and their history of stuttering therapy. Among the ten participants, six had received some form of therapy as an adult. The remaining four participants had not received any formal therapy for stuttering (see Table 1). Tables 9 and 10 contain a summary of the results obtained for cluster type/occurrence, speech rate and perceptual evaluation for each participant, organized according to treatment status. Two observations can be made from this analysis. First, the group that had received prior treatment for stuttering, had a lower overall disfluency level (17.2%) compared to the non-treatment group (21.5%). Secondly, the perceptual ratings for severity of disfluency

clusters was lower among the treatment group (5.02) compared to the non-treatment group (8.46).

Table 9. Summary of speech characteristics for participants who have been involved in stuttering therapy as an adult. Characteristics include total percentage of disfluencies (%), number of SLD-, OD- and mixed-type disfluency clusters, articulation rate (AR), speaking rate (SR), and combined perceptual ratings (MC+LC). Standard deviations are shown in parentheses.

Participant	% Disfluent	# SLD	# OD	# Mixed	AR	SR	Perceptual Rating
1	9	0	8	1	6.56	6.05	4.04
2	20	5	4	9	4.17	3.59	6.13
3	22	4	2	6	4.95	4.23	5.55
5	24	4	4	13	5.21	4.01	4.04
9	16	1	3	9	4.16	3.85	3.91
10	12	1	2	3	4.91	4.67	6.43
Group	**17.2 (5.88)**	**2.5 (2.07)**	**3.83 (2.23)**	**6.83 (4.40)**	**4.99 (0.88)**	**4.4 (0.89)**	**5.02 (1.15)**

Table 10. Summary of speech characteristics for participants who have never been involved in stuttering therapy. Characteristics include total percentage of disfluencies (%), number of SLD-, OD- and mixed-type disfluency clusters, articulation rate (AR), speaking rate (SR), and combined perceptual ratings (MC+LC). Standard deviations are shown in parentheses.

Participant	% Disfluent	# SLD	# OD	# Mixed	AR	SR	Perceptual Rating
4	9	1	3	5	4.15	3.91	4.06
6	26	4	0	19	5.84	4.91	7.68
7	31	2	0	16	4.02	3.36	11.2
8	20	1	2	12	4.09	3.10	10.9
Group	21.5 (9.47)	2.0 (1.41)	1.25 (1.50)	13 (6.06)	4.53 (0.89)	3.82 (0.80)	8.46 (3.34)

Discussion

The aim of the present study was to examine characteristics of disfluency clusters in the speech of AWS. At present little research has been completed focusing on adults, therefore this study sought to investigate whether previous findings regarding disfluency clusters in children were consistent with an adult population. A number of hypotheses were posed to evaluate various aspects of disfluency clusters in AWS. The outcome of each hypothesis is discussed below. Following this discussion, a series of limitations to the present research are presented. In addition, the clinical implications of the present results are presented, along with directions for future research.

Hypothesis 1: There will be no significant difference in the length of fluent, single stuttered and clustered utterances in AWS.

Results from the present study indicated that fluent utterances were significantly shorter in length than utterances containing disfluency clusters for AWS. The length of utterances containing single disfluencies was longer than fluent utterances but shorter than utterances with disfluency clusters. Consequently, Hypothesis 1 was rejected.

The observed differences in utterance length according to fluency are consistent with past studies for CWS (e.g., Haj-Tas et al., 2004; Logan & Conture, 1995; Yaruss, 1999). More importantly, the findings from this study are also in agreement with Logan and LaSalle (1999) who found children's utterances that contain disfluency clusters to be significantly longer than fluent utterances. Past explanations for the relationship between

utterance length and fluency in CWS have been offered by Logan and Conture (1997) and Ratner and Sih (1987). Logan and Conture suggested that it is possible that CWS have difficulties retrieving or elaborating syllabic nuclei, therefore the more syllables that they are required to retrieve the greater the chance that an error will occur. A more simplistic explanation was offered by Ratner and Sih, whereby people who stutter often insert additional syllables into their speech in an attempt to maintain fluent speech. Although both of these interpretations may be valid it is important to note that these interpretations are based on the speech of CWS. Although the present findings fit nicely with results from those for CWS, they are not compatible with the available data for AWS. Findings from both Silverman and Ratner (1997) and Logan (2001) suggested that the relationship between language complexity and disfluencies is less strong among AWS compared to CWS.

A likely explanation for the differences obtained in the present study for AWS compared to past studies may be due to methodological differences. Past studies evaluating language complexity and fluency in AWS have not specifically examined utterance length. Rather, the focus has been on syntactic complexity. A specific analysis of syntactic complexity was not performed in the present study. Rather, a simple measure of utterance length according to number of syllables was calculated. It is possible that no difference may have been found in the current study, had an alternative measure of utterance complexity been employed. However, assuming a relationship between utterance length and type of stuttering exists for AWS, it is important to recognize that the relationship between disfluency clusters and utterance length that is prevalent in the speech of CWS also appears to be prevalent in the speech of AWS. Such a finding could

have implications for the management of stuttering in adults. Currently, the Lidcombe Program, a therapy approach for stuttering in children, takes into account the impact of utterance length/complexity on stuttering by structuring therapy to control for utterance length (Onslow et al., 2003). Perhaps the same type of consideration should be employed when providing therapy for adults.

Hypothesis 2: The speaking rate and articulation rate of AWS will differ significantly between fluent and stuttered utterances.

Results indicated that speaking rate and articulation rate were significantly faster for fluent utterances compared to disfluent utterances; consequently Hypothesis 2 was accepted. In general there is no unified view in regard to rate differences in the fluent and disfluent speech of CWS and AWS. Most of these studies have focused on CWS and have not specifically evaluated fluent versus disfluent utterances. Rather, the approach has been to evaluate the fluent speech of CWS compared to CWNS. Meyers and Freeman (1985) found that CWS spoke slower than their fluent counterparts. On the other hand, Sargent et al. (2006) found that CWS spoke faster than their fluent counterparts. Further still, there are a number of studies that have found no difference between the speech rate of CWS versus CWNS or AWS versus AWNS (Gronhovd, 1977; Kelly & Conture, 1992; Yaruss et al., 1995). Only Logan and Conture (1995) directly evaluated the articulation rate of fluent and disfluent utterances in CWS. The results of their study found no significant differences in the rate of the two types of utterances.

The results obtained in the present study differ from past studies according to the manner in which articulation rate was measured. While past studies have tended to

exclude audible disfluencies from the measure of articulation rate, the present study included all portions of audible speech. Instead, the measurement of articulation rate entailed deleting all silent (non audible) portions of the acoustic waveform in excess of 150 ms. The inclusion of all audible portions of the acoustic signal (i.e., audible disfluencies) was thought to provide a more objective measurement of actual speed of articulator movement during moments of disfluency. By including these moments, a clear difference in articulation rate between fluent and disfluent utterances was identified. It is perhaps not surprising to find that during utterances where stuttering is occurring the individual may start concentrating their resources on trying to maintain fluency. Consequently, this could have the effect of naturally slowing down the speed with which they move their articulators. This suggestion fits nicely with the Anticipatory Struggle Hypothesis (West et al., 1957) regarding the moment of stuttering, whereby the AWS attempts to exert voluntary control over individual speech movements rather than allowing the automatic process of speech production. Consequently, disfluent utterances are articulated more slowly, while fluent (i.e., automatic) utterances are articulated more rapidly.

Hypothesis 3: There will be a significant correlation between speaking rate and articulation rate and number of disfluency clusters

This hypothesis was prompted by the results of Logan and LaSalle (1999), who recommended examining the relationship between speaking rate and the occurrence of disfluency clusters as a means of better understanding the nature and context of disfluency clusters. Based on data obtained in one of their child participants, Logan and

LaSalle suggested that fast paced conversations may be linked to a higher occurrence of disfluency clusters. The results of the present study found no strong correlation between speaking rate (or articulation rate) and the number of disfluency clusters, therefore Hypothesis 3 was rejected.

The present study did not evaluate the relationship between conversational speaking rate (between speaker & listener) and the occurrence of disfluency clusters. Subsequently, the present findings cannot be directly compared to those of Logan and LaSalle (1999). Still, it is interesting to consider that although disfluency clusters appear to occur more often in long utterances (compared to short utterances), the rate at which utterances are spoken does not appear to influence disfluency clusters. Assuming measures of speaking rate and articulation rate provide inferential estimates of speech motor control (Robb et al..), it seems the occurrence of disfluency clusters is more dependent upon linguistic factors (e.g., utterance length) rather than motor factors (e.g., speaking rate).

Hypothesis 4: Is there a specific type of disfluency cluster that is characteristic of adult stuttering?

Findings from this study indicated that there were significantly more mixed clusters than SLD-type or OD-type clusters. Some of the participants were found to produce all three cluster types, while some produced only two of the cluster types. However, across each of the participants, mixed clusters were the most commonly produced disfluency cluster. The production of significantly more mixed clusters compared to the remaining clusters, provides clear support for Hypothesis 4.

The current results also parallel those obtained by Sawyer and Yairi (2004, 2005). These authors found that mixed-type clusters were the most frequently occurring cluster for CWS. Further, the general composition of mixed clusters was primarily an OD followed by SLD. A similar pattern was observed for the present group of AWS. Previously, disfluency clusters have been considered with both linguistic (Logan & LaSalle, 1999) and motor interpretations (Hubbard & Yairi, 1988). It is possible that the composition of clusters may provide information regarding the underlying cause of disfluency clusters. Findings from Wexler and Mysak (1982) lead to the suggestion that both motor and linguistic processes may be involved in the presentation of disfluency clusters, with ODs representing a linguistic breakdown and SLDs representing a motor breakdown. Considering this notion with the results from the present study it is possible to theorize about the process by which disfluency clusters emerge. Results from this study indicated that the majority of disfluency clusters were mixed and began with an OD, followed by an SLD. Using the theory developed through the work of Wexler and Mysak (1982) a possible explanation is as follows. The initial OD may reflect that an individual has exceeded their linguistic capabilities therefore resulting in a linguistic-based breakdown in fluency. This linguistic breakdown then serves to "trigger" a motor-based stuttering event (i.e., an SLD). Comparative data on the composition of disfluency clusters in AWNS would need to be examined to determine whether the pattern of an OD followed by an SLD is characteristic of true stuttering or whether it is also observed in the non-stuttering population. It could be hypothesised that although both AWS and AWNS may exceed their linguistic abilities, reflected by the initial OD in a disfluency

cluster, an AWS is more likely to trigger a stuttering event, resulting in a subsequent SLD than an AWNS.

The results obtained for the present group of AWS, are in agreement with the previous studies among CWS. For example, Sawyer and Yairi (2004) and LaSalle and Conture (1995) have shown that the occurrence of disfluency clusters is correlated with stuttering severity. A similar pattern was found in the present group of PWS, with a strong correlation ($r = 0.76$) between the number of clusters and overall stuttering severity. On the one hand, the relationship between overall stuttering severity and occurrence of disfluency clusters is not surprising. The calculation of stuttering severity is based on overall occurrence of disfluencies. Therefore, the fact that severe stutterers produce a large number of disfluencies increases the likelihood of disfluency clusters. Yet, it is worthwhile to consider that disfluency clusters are more indicative of a severe stuttering condition rather than a mild condition. The longitudinal work of Yairi and his colleagues (Sawyer & Yairi, 2004, 2005) indicated that those children who persisted in childhood stuttering were also those who produced a larger number of disfluency clusters. Thus, the occurrence of disfluency clusters in AWS may reflect the obvious – that AWS are persistent stutterers.

Hypothesis 5: Listeners will perceive most commonly occurring clusters to be more reflective of overall stuttering severity.

Considering the extensive research that has been carried out evaluating listeners' perception of the stuttering event, it is surprising that disfluency clusters have not been critically examined. Based on the premise that the occurrence of clusters is correlated

with overall stuttering severity (LaSalle & Conture, 1995; Sawyer & Yairi, 2004), it was assumed that listeners would perceive most commonly occurring (MC) clusters to be more reflective of overall stuttering severity compared to the least commonly (LC) occurring clusters. Results from this study found no clear correlation between listener perceptions of MC occurring disfluency clusters and stuttering severity, consequently Hypothesis 5 was rejected. In addition, listeners were unable to perceive any significant difference in severity between MC and LC occurring clusters.

Three possible explanations are offered for the apparent lack of relationship between the perception of disfluency clusters and overall stuttering severity. Two of these explanations are related to the methodology employed. First, the design of the perceptual task may not have included enough salient information concerning the stuttering event to obtain revealing results. A study by Susca and Healey (2002) found that listeners respond to a much wider range of factors as opposed to simply disfluency when making judgments surrounding the speech of PWS. That is, a wide range of segmental and suprasegmental variables are likely to influence judgments of the stuttering event. In the current study, speech samples provided to the listeners in this perceptual task were brief (i.e., lasting no longer than 6 sec) and were primarily isolated to incidents of disfluency clusters. Therefore, it could be that listeners were unable to make accurate judgments regarding the severity of a disfluency cluster resulting from an insufficient speech sample.

A second possible explanation for the lack of significant relationship between stuttering severity and perceived ratings concerns the composition of disfluency clusters. No attempt was made to control for the type of cluster (i.e. OD, SLD, Mixed), aside from

the criteria of being either a MC or LC occurring cluster. Due to the wide range of possible disfluency clusters, it is likely that the listeners were attending to the types of disfluencies within the clusters, rather than the overall stuttering event. An alternative approach to equating stuttering severity with listener perception of disfluency clusters would have been to target only one type of cluster produced by each participant (e.g., SLD), and present this cluster to the 20 listeners.

Finally, it is not unreasonable to assume that, regardless of possible methodological issues, disfluency clusters are not perceptually related to stuttering severity. The disfluency clusters presented to the listeners in the perceptual task ranged between SLD-type, OD-type and mixed-type, with the most frequent falling into the latter category. Subsequently the listeners were potentially exposed to all types of disfluencies which fit within the SLD and OD system. It could be that there are too many possible types of disfluencies for any clear pattern to surface. A second influencing factor may be due to the nature of OD-type disfluencies. As these disfluencies are generally viewed as normally occurring in the speech of fluent individuals, listeners may not consider these disfluencies as 'stutters' per se. Therefore, when a listener is exposed to a disfluency cluster that includes both OD and SLD elements, they may base their severity judgments on the SLD portion alone.

Clinical Implications

It is interesting to consider the generally accepted view that reducing the speech rate of AWS leads to an increase in fluency (Adams et al., 1973; Onslow & Ingham, 1987; Van Riper, 1973; Zebrowski & Kelly, 2002). Consequently, a significant number of

studies have been carried out examining the effects of altered speaking rate on the disfluencies of AWS (Hutchinson & Navarre, 1977; Kalinowski et al., 1995; Ramig, 1984; Sparks et al., 2002). However, the present study identified two important aspects related to speaking rate and fluency. First, the articulation rate of disfluent utterances is actually slower compared to fluent utterances. This would suggest that during moments of disfluency, an AWS may be volitionally reducing the rate of movement of their articulators in an attempt to maintain fluency. Secondly, the occurrence of disfluency clusters does not appear to be dependent upon speaking rate. As such, direct attempts to reduce speaking rate may not necessarily have a direct impact on the reduction of disfluency clusters. Rather, disfluency clusters are more likely to be dependent upon utterance length. Any treatment program specifically targeted at the reduction of disfluency clusters should include a component related to linguistic complexity.

An individual's prior treatment for stuttering may also be a consideration in the treatment of disfluency clusters. Results of a cursory analysis of the data according to a participant's prior treatment history (see Tables 9 & 10) were revealing of various trends. First, those participants that had received prior treatment for stuttering, had a lower overall disfluency level (17.2%) compared to the non-treatment group (21.5%). Secondly, the combined MC/LC perceptual ratings for severity of disfluency clusters was lower among the participants who had received treatment (5.02) compared to the non-treatment group (8.46). Granted, these trends were not tested statistically, and should accordingly be viewed as preliminary. Still, the possible relationship between prior treatment and the severity of disfluency clusters would suggest a possible hierarchy of stuttering behaviour. Assuming disfluency clusters reflect a more severe type of stuttering compared to

singleton disfluencies, one would predict that disfluency clusters would either be (1) most amenable to change/reduction across a treatment programme or (2) be most resistant to change/reduction.

Finally, Conture (1990) proposed that the type of disfluency rather than the frequency of disfluencies, is a more valid clinical measure as it holds more value in the identification of severity of stuttering. Findings from this study appear to support this notion. Considering disfluency clusters as a type of disfluency (as opposed to single disfluencies) it was found that the presence of clusters does indicate a more severe stutter. However, the presence or frequency of disfluency clusters alone does not appear to provide information over and above already existing measures of stuttering severity. Therefore, it is important to consider other aspects such as the composition of the disfluency clusters, duration of disfluencies, and listener perceptions to better understand the overall severity or impact of a person's stutter.

Limitations

This study used ten participants and although parametric statistics were used the low sample size resulted in a lack of statistical power. Future research, with larger samples sizes, would increase the statistical power of the results, therefore allowing for greater generalization of the findings.

Limitations in the design of the perceptual task for this study may have resulted in the non significant findings. Informal comments from the perceptual judges indicated that many individuals believed the samples were too short to enable accurate judgments. A perceptual task which includes longer speech samples may enable judges to more

accurately rate the severity of the stuttering. In addition, the perceptual task did not take into account the individual types of disfluencies that made up the disfluency clusters. It is possible that listeners were responding to the individual disfluencies rather than the disfluency clusters as a whole. Future research may take into account controlling for the types of disfluencies listeners are exposed to.

The present study focused on a limited number of associated speech variables. A wider range of variables could have been examined. One of the most obvious being utterance complexity. This study analysed utterances in terms of length in syllables, however previous studies have also included a measure of utterance complexity. As the results from this study differed from previous findings, using such a measure in this study would have allowed for better comparison between studies.

Lastly, the analysis was confined to an existing classification scheme of SLD and OD. This system has been used frequently in previous stuttering research; however it does eliminate the ability to examine specific types of disfluencies. Findings from the present study, particularly with regard to the perceptual task, suggest that analysis of disfluency clusters may need to be more specific than a classification system of SLD and OD.

Directions for Future Research

One possible area of research relates to the relationship between disfluency clusters and stuttering therapy outcomes. Examination of data from the present study suggests that there may be a relationship between the type/frequency of disfluency clusters and whether an individual has received formal stuttering therapy. In particular, it

was noted that the participants who had been involved in stuttering therapy received lower severity scores in the perceptual task. Future research comparing disfluency cluster measures pre- and post therapy could help further explain the relationship between stuttering severity and disfluency clusters.

The present study is one of the first to date, that has examined disfluency clusters in AWS. There is still no research available looking at AWNS, subsequently there is no normative data regarding the nature of disfluency clusters in an adult population. Research examining the characteristics of disfluency clusters in AWNS would allow for direct comparisons between the stuttering and non-stuttering adult population.

In addition, there is scope for large scale longitudinal studies to track the progression of disfluency clusters from childhood to adulthood. One longitudinal study has been carried out looking at disfluency clusters in children (Sawyer & Yairi, 2004, 2005), however the time frame for this study was relatively short and did not span into adulthood. Yairi's findings do suggest, however that changes occur in the presentation of disfluency clusters over time. The potential clinical value of such changes is yet unknown, therefore a longitudinal study may help determine whether disfluency clusters hold any value in the diagnosis, treatment or prediction of stuttering.

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Appendix 1. Verbal instructions read out to each judge for the perceptual task.

You are going to hear a number of short speech samples of people who stutter. You will be asked to rate them on their severity of stuttering. First, you will hear all the samples played in random order. You do not need to do anything. Just listen to the samples and concentrate on the severity of the stutter. Next, you will be played each sample individually. Listen to each sample and rate how severely you think that person stutters, on a scale of 0-10. A 0 would mean that you think the person sounds completely fluent and 10 would be the worst stutter that you can imagine. You can repeat each sample as many times as you want. You may hear some of the samples more than once. Do you have any questions?