

DISFLUENCY AND AGEING: A STUDY  
OF HEALTHY OLDER SPEAKERS OF  
NEW ZEALAND ENGLISH

---

A thesis submitted in partial fulfilment of the  
requirements for the Degree  
of Master of Science in Speech and Language  
Sciences

in the University of Canterbury

by Alexandra J. Weathersby

University of Canterbury

2016

---

## Table of Contents

<b>List of Figures.....</b>	<b>1</b>
<b>List of Tables.....</b>	<b>2</b>
<b>Acknowledgements.....</b>	<b>3</b>
<b>Abstract.....</b>	<b>4</b>
<b>1. Introduction.....</b>	<b>5</b>
<b>1.1 Fluency.....</b>	<b>6</b>
<b>1.2 Disfluency.....</b>	<b>6</b>
<i>1.2.1 Normal vs stuttering-like disfluency.....</i>	<i>7</i>
<i>1.2.2 Classification of disfluency.....</i>	<i>8</i>
<b>1.3 Assessment of Disfluencies.....</b>	<b>10</b>
<i>1.3.1 Speaking tasks.....</i>	<i>11</i>
<i>1.3.2 Disfluency count.....</i>	<i>13</i>
<b>1.4 Contributing Factors.....</b>	<b>14</b>
<i>1.4.1 Age.....</i>	<i>14</i>
<i>1.4.2 Sex.....</i>	<i>18</i>
<i>1.4.3 Years of education.....</i>	<i>20</i>
<i>1.4.4 Cognitive functioning.....</i>	<i>20</i>
<b>1.5 Statement of the Current Problem and the Aim of the Current Study.....</b>	<b>22</b>
<b>2. Method.....</b>	<b>25</b>
<b>2.1 Speech Data.....</b>	<b>25</b>
<b>2.2 Participants.....</b>	<b>25</b>
<b>2.3 Data Analysis.....</b>	<b>26</b>
<i>2.3.1 Disfluencies.....</i>	<i>26</i>
<i>2.3.2 Coding.....</i>	<i>27</i>
<i>2.3.3 Word and syllable counts.....</i>	<i>27</i>
<b>2.4 Reliability.....</b>	<b>28</b>

2.5 Statistical Analysis.....	28
<b>3. Results.....</b>	<b>30</b>
3.1 Age and Disfluencies.....	30
3.2 Stuttering-like and Normal Disfluencies.....	33
3.3 Sex and Disfluencies.....	34
3.4 Disfluencies and Additional Factors.....	36
3.5 Types of Disfluencies.....	38
3.6 Factors Associated with Stuttering-like Disfluencies in Conversation.....	39
3.7 Summary of Results.....	40
<b>4. Discussion.....</b>	<b>42</b>
4.1 Age and Disfluencies.....	42
4.2 Stuttering-like and Normal Disfluencies.....	44
4.3 Sex and Disfluencies.....	45
4.4 Disfluencies and Additional Factors.....	46
4.5 Types of Disfluencies.....	47
4.6 Factors Associated with Stuttering-like Disfluencies in Conversation.....	49
4.7 Limitations.....	50
4.8 Directions for Future Research.....	51
4.9 Conclusions.....	51
<b>Appendices.....</b>	<b>58</b>
<b>Appendix A: The Grandfather Passage</b>	
<b>Appendix B: Participant’s Biographical Information</b>	
<b>Appendix C: Coding Protocol</b>	
<b>Appendix D: Additional Disfluency Criteria</b>	

## List of Figures

Figure 1. Percentage of stuttering-like and normal disfluencies per 100 syllables in conversation by speakers over the age of 60 years.....	30
Figure 2. Percentage of stuttering-like and normal disfluencies per 100 syllables in reading by speakers over the age of 60 years.....	31
Figure 3. Percentage of stuttering-like and normal disfluencies per 100 syllables in conversational word count of 300 and 150.....	32
Figure 4. Percentage of stuttering-like and normal disfluencies per 100 syllables in conversation.....	33
Figure 5. Percentage of stuttering-like and normal disfluencies per 100 syllables in reading.....	34
Figure 6. Percentage of disfluencies per 100 syllables in conversation between male and female speakers.....	35
Figure 7. Percentage of disfluencies per 100 syllables in reading between male and female speakers.....	35
Figure 8. Percentage of disfluencies per 100 syllables in conversation and years of education.....	36
Figure 9. Percentage of disfluencies per 100 syllables in reading and years of education.....	37
Figure 10. Percentage of disfluencies per 100 syllables in conversation and MoCA scores.....	37
Figure 11. Percentage of disfluencies per 100 syllables in reading and MoCA scores.....	38

## List of Tables

Table 1. Conture's Within-word and Between-word Disfluencies (1982).....	9
Table 2. Results compared across studies.....	18
Table 3. The mean, standard deviation, and range of disfluencies per 100 syllables in conversation.....	39

### **Acknowledgements**

The author wishes to express sincere appreciation to Dr Catherine Theys and Associate Professor Megan McAuliffe for the assistance in the completion of this thesis. This study extracted textgrids of conversation and passage reading from the New Zealand Institute of Language, Brain and Behaviour's Language and Ageing Speech Corpus. We wish to also thank Robert Fromont for his contribution towards the process of data analysis using the corpus and coding disfluencies.

### **Abstract**

The current study examined 115 New Zealand English speakers aged 64-91 years to obtain normative data on fluency. Stuttering-like and normal disfluencies were analysed in speaking tasks of conversation and reading to determine the frequency of disfluencies. Variables of age, sex, years of education, and cognitive functioning were also examined to determine whether these influenced disfluencies. Results indicated no change in stuttering-like and normal disfluencies across age in conversation, yet a small significant increase was found in reading for normal disfluencies. Sex and years of education revealed no significant relationship with total disfluencies produced across age, however there was a significant relationship between cognitive scores and total disfluencies – speakers with higher cognitive scores produced less disfluencies. Age, sex, years of education, and cognitive scores were not significant predictors of stuttering-like disfluencies, though normal disfluencies were. Within the fluency literature, normative data is limited for the ageing population 60+. This study provides normative data for older New Zealand speakers and valuable additional information to assist clinicians in assessment/diagnosis of acquired communication disorders.

## 1. Introduction

Disfluent speech refers to disruptions in the production of speech (The American Speech-Language-Hearing Association [ASHA], 2015). It is commonly observed in people who stutter (PWS), but also occurs in our everyday communication. For diagnostic purposes, it is important to have a clear understanding of the types of disfluencies that occur in everyday speech—so a clear discrimination between normal and abnormal disfluency exists. While this information is well established in children, an understanding of the occurrence and characteristics of disfluency in later adulthood is lacking—both for PWS and people who do not stutter (PWDS).

Our ageing population is increasing —doubling since 1980 (Statistics New Zealand, 2013), therefore it is essential to expand our knowledge on characteristics of disorders presented in the elderly over the age of 70 years. This information will then enable health professionals to distinguish typical from disordered. Research on the types and number of disfluencies in healthy older adults can provide insight into normal fluency changes and provide comparative data for atypical characteristics (e.g., neurogenic stuttering or motor speech disorders). Furthermore, understanding potential contributing factors (i.e., age, sex, years of education, and differing speaking tasks) to the number and type of disfluencies can assist in identifying potential risk factors or red flags.

The topics covered in this introduction will offer background information and give an overview of existing knowledge presented in the literature. Discussion concerning fluency will define fluent versus disfluent speech and, within disfluent speech, characteristics of normal and stuttering-like disfluencies. Assessment procedures to measure disfluencies will also be discussed (i.e., speech tasks and



syllable versus word count). The review of the literature will consider previous studies that examined the influence of age, sex, and years, education, and cognitive functioning on fluency and discuss areas requiring further research.

### **1.1 Fluency**

The word *fluency* refers to our ability to be more or less fluent in speech and language (Starkweather, 1987). More specifically, fluency is “the ease and ongoing flow of speech muscular movement and the resultant speech sounds” (Yairi & Seery, 2011, p. 6). Dimensions of normal speech fluency consist of *rate* – timing within and between words, *continuity* – the flow within and between words, and *tension effort* – force regulation (Starkweather, 1987). Fluent speech requires effective coordination of the speech motor system – respiration, phonation, and articulation. Any disruptions to the speech motor system result in interruption of speech, leading to disfluencies.

### **1.2 Disfluency**

The term *disfluency* refers to any speech disruption, both stuttering and normal. Speech fluency is commonly associated with stuttering as it is a disorder characterised by the disturbances in the fluency (flow) of speech. Specific types of disfluencies associated with stuttering and non-stuttering have been established in the literature (Yairi & Seery, 2011). Disfluencies occurring in everyday speech are categorised into ‘normal disfluencies’ while disfluencies presented in stuttering are often considered ‘stuttering-like’ and usually occur more frequently (Yairi & Seery, 2011). Differentiating core behaviours in stuttering from those in normally fluent speakers has been a topic of discussion, thus scholars have made various modifications over the years. There is some agreement on core characteristics, however there has been controversy in determining which are normal and atypical.

Still it has been argued that neither type is exclusive to both populations (Ambrose & Yairi, 1999).

### *1.2.1 Normal vs stuttering-like disfluency*

*Typical disfluency, normal discontinuity* (Starkweather & Givens-Ackerman, 1997), and *normal disfluency* (Guitar, 1998; Yairi & Seery, 2011) are all terms used to describe normal disruptions that occur in normally fluent speech. These common disruptions derive from the theoretical basis of the planning and execution of speech and language proposed by Levelt (1998 as cited in Postma and Kolk, 1993).

Disfluencies in normal speech are often associated with disruptions in word-finding, formulating sentences, with revisions of content in a message, with distractions (Yairi & Seery, 2011) or with experiencing a cognitive overload (Bortfield, Bloom, Schober & Brennan, 2001). A moment of disfluency has also been argued to relate to pragmatic features such as the confidence of a speaker (Brennan & Williams, 1995) or to be an indication to the listener that the speaker wants to ‘hold the floor’ (Fox Tree & Clark, 1997; Shriberg 1996; Starkweather & Givens-Ackerman, 1997). Within the literature of PWDS, normal disfluencies occur more often than stuttering-like disfluencies in speech irrespective of age (Yairi & Seery, 2011).

Starkweather and Givens-Ackerman (1997) explain that there are many forms of *normal discontinuity* however four main types are generally recognized in everyday speech which includes those established by Kowal, O’Connell, and Sabin (1975):

- 1) repetition of phrases and words,
- 2) unfilled pauses shorter than 250 msec and filled pauses (e.g., “uh” or “um”),
- 3) false starts (e.g., “I went to the sh-, I went to the game”), and

- 4) parenthetical remarks also known as *fillers* or *interjections* (e.g., “*I mean*”, “*like*”, “*you know*”).

Stuttering-like disfluencies are often recognised as being abnormally high in frequency and long in duration (Starkweather, 1987), but may also occur less frequent and short in duration. Unlike normal disfluency of theories arising from planning and execution of speech, the source of stuttering is unknown (ASHA, 2015). Although the cause is unknown, characteristics of stuttering have been a major focus in studies. Core behaviours have been identified to describe basic characteristics present in stuttering: (1) repetitions (repetitive speech), (2) prolongations of voiced sounds, and (3) blocks (silent articulatory postures – *blockages*) (Van Riper, 1971).

### 1.2.2 Classification of disfluency

Various classification systems have been used to categorise disfluencies. Classifying types of disfluencies is useful in identifying speech of PWS and speakers who are normally fluent. Johnson (1961, as mentioned by Yairi & Seery, 2011) was an early classification system established. Conture (1982) provided another major classification system commonly used in studies examining disfluencies. Later, a third major classification was produced by the Illinois Stuttering Research Programme.

Johnson’s (1961) classification system consisted of disfluencies present in both stuttering and non-stuttering participants. It includes part-word repetitions (e.g., “*ba-baby*”), word repetitions (e.g., “*I-I*”), phrase repetitions (e.g., “*I want-I want*”), interjections (e.g., “*uh, well, like, you know*”), revisions (e.g., “*I said it at-just to try*”), tense pauses (e.g., “*can I have some----milk*”), prolongations (e.g., “*mmmmmy name is*” – any sounds prolonged longer than normal), and broken words (e.g., “*snow\_ball*”).

Another major classification system later established by Conture (1982), categorised disfluencies into two groups:

- (1) stuttering-like disfluency known as *within-word disfluency*, and
- (2) normal disfluency or other disfluencies known as *between-word disfluency*

These are presented in Table 1. This classification system has been modified by other studies examining older speakers (Manning & Monte, 1981; Mulligans et al., 2001; Searl, Gabel, & Fulks, 2002). Differences from Johnson's (1961) classification system exclude broken words, part-word repetitions and word repetitions with the addition of sound and syllable repetitions.

Table 1. Conture's within-word and between-word disfluencies (1982)

Type of Disfluency	Example
<u>Within-word Disfluency</u> sound repetitions syllable repetitions sound prolongations tense pause	<i>"f-five"</i> <i>"ba-baby"</i> <i>"mmmy"</i> (silent prolongation or block) <i>"—my"</i>
<u>Between-word Disfluency</u> Interjections revision-incomplete phrase word repetitions phrase repetitions	<i>"um"</i> <i>the baby is-let's do that"</i> <i>"and-and"</i> <i>"I want-I want"</i>

The Illinois Disfluency Classification devised by the Illinois Stuttering Research Programme distinguishes *stuttering-like disfluency* as not only exclusive to

stuttering. This disfluency classification retains the terms part-word repetitions from Johnson's classification, then adapts the term *single syllable word repetitions* (e.g., “*and-and-and*”) for repetitions and *disrhythmic phonation* (e.g., “*mo—mmy*”) for tense pause. *Other disfluencies* consisted of interjections – sound and word (e.g., “*uh*” “*er*”), phrase repetition and revision, and abandoned utterances (e.g., “*It was – I mean . . .*”). Multisyllabic word repetitions were also included to differentiate from monosyllabic word repetitions (Ambrose & Yairi, 1999; Yairi & Ambrose, 1992).

In the later literature, it is apparent that these disfluencies continue to be the fundamentals for differentiating various disfluency types (Duchin & Mysak, 1987; Roberts, Meltzer, & Wilding, 2009; Searl et al., 2002; Yairi & Clifton, 1972). Although there is close agreement regarding the basic characteristics of disfluencies, there is a variety of terminology used amongst the three major classifications. Adaptations made in classifying disfluencies such as removing, adding, and altering terminology creates conflicting results between studies and more so when methodology lacks detail (i.e., criteria and definitions of disfluencies).

### **1.3 Assessment of Disfluencies**

The importance of assessing disfluencies is to coherently express an understanding of the presenting characteristics. There are various ways to assess disfluencies which are dependent on the purpose of analysis and the classification system used. This section discusses various speech tasks used to elicit disfluencies and types of measurement methods to calculate the frequency of disfluencies.

### 1.3.1 Speaking tasks

In communication disorders, speech samples are used to observe deficits in speech and language for diagnosis and treatment. In regards to assessing stuttering in adults, speech samples commonly comprise of (a) conversation, (b) monologue, (c) oral reading, (Yairi & Seery, 2011) and (d) picture description (Johnson, 1961 as cited by Yairi & Seery, 2011) to denote disfluencies. Conversation involves the act of frequent turn-taking whereas a monologue provides a stream of continuous speech. Although monologues are more efficient in quickly obtaining a speech sample, it is not a common form of daily speaking context compared to conversation. Other speaking tasks such as oral reading and picture description provide additional contexts to examine possible differences in disfluencies (Yairi & Seery, 2011).

Formal assessments to assess stuttering, such as the *Stuttering Severity Instrument* (SSI-4) (Riley, 2009) and the *Lidcombe Programme* (Jones, Onslow, Harrison, & Packman, 2000), use speech tasks to measure the frequency and duration of disfluencies to determine the severity of the stutter. SSI-4 measures frequency of stuttering events, their duration, and the intensity of concomitant characteristics in picture description and conversation. These scores are then converted into a severity rating – very mild, mild, moderate, severe, and very severe. Like the SSI-4, the Lidcombe programme, for children who stutter, uses a severity rating system to assess how severe a stutter is in a conversational baseline. This parent training intervention programme uses a 1-10 rating scale – 1=no stuttering, 2=extremely mild stuttering, 10=extremely severe stuttering and percentage syllables stuttered to determine the severity (Stuttering Answers, 2008). These formal assessments to assess stuttering utilise speaking contexts that relate to everyday speech (i.e., conversation) and other

contexts of picture description and reading to observe fluency, disfluency, and associated factors for diagnosis and treatment.

Within the limited literature available on older speakers, conversational speech samples have been a central focus in examining disfluencies (Bortfield et al., 2001; Horton, Spieler, & Shriberg, 2010; Pindzola, 1990; Searl et al., 2002). In terms of conversational topics overall, some studies have followed the common themes of jobs, family, hobbies or interests (Bortfield et al., 2001; Duchin, & Mysak, 1987; Mulligans, Anderson, Jones, Williams, & Donaldson, 2001; Pindzola, 1990; Searl et al., 2002). Others have used pictures to elicit conversation such as photographs of children (familiar domain) and black and white tangrams (unfamiliar domain) (Bortfield et al., 2001) or choosing from 70 conversational topics (e.g., air pollution) (Horton et al., 2010). Yairi and Clifton (1972) used a picture description task to elicit spontaneous speech in nonstuttering preschool children, high school seniors, and geriatric persons while Spieler and Griffin (2006) used a picture naming task to also examine the relationship between age and normal disfluencies. Common conversational topics previously mentioned were also used in a study that examined disfluencies in monologues of the participants (Roberts et al., 2009).

Measuring disfluencies across speech sample tasks has been used in studies to demonstrate a comparison in different speaking situations (Duchin & Mysak, 1987; Mulligans et al., 2001). Comparisons have been made between disfluencies in passage reading and conversation in 16 PWS aged matched with 16 PWDS (age range 15-67 years). Results indicated the percentage of normal disfluencies being significantly greater in conversational speech than in reading (PWS: median 26.9 speech and 3.0 reading; PWDS: 13.1 speech and 1.8 reading). However no significance was shown for classic (stuttering-like) disfluencies (PWS: median 23.7

speech and 25.2 reading; PWDS: 1.6 speech and 0.8 reading) (Mulligans et al., 2001). Comparisons across the three main speaking contexts of conversation, picture description and oral reading were examined in 75 male participants; age 21-91 (15 in each of five age groups). Ten minute conversations regarding favourite summertime activities, three picture descriptions of Norman Rockwell pictures, and oral reading of the Rainbow Passage were examined. Results indicated more disfluencies presented in conversation (mean per 100 words 4.13) than in picture description (3.38). Due to a number of disfluencies non-existent in the age groups for the oral reading task, evaluation of disfluencies was not completed for this task (Duchin & Mysak, 1987).

### *1.3.2 Disfluency count*

In addition to type, the amount is another feature in measuring disfluencies in speech. Normative standard for total disfluencies in fluent speakers is considered to be  $\geq 10\%$  of words in speech samples (Guitar, 1998). The number in which disfluencies occur can be measured as percentage of disfluent words (a number of disfluencies occurring on one word is counted as only one disfluent instant) or frequency per 100 words (a number of disfluencies on one word are each counted as a disfluent event). Both measurements are subjective in that the clinician or researcher judges the occurrence of disfluencies. Yet the first measure only reveals the number of disfluencies produced on the word and nothing regarding the different types (Yairi & Seery, 2011). Counting disfluencies per 100 words allows for a more detailed measure in providing the specific types. This measurement is evident in the literature for the healthy ageing population (Duchin & Mysak, 1987; Mulligans et al., 2001; Pindzola, 1990; Searl et al., 2002; Yairi & Clifton, 1972).



Counting disfluencies per number of fluent syllables spoken is another recommended practice of assessing frequency of disfluencies (Guitar, 2006). Andrews & Ingham (1971) proposed alternative measurement of counting syllables seeing that multiple disfluencies can co-occur on multisyllabic words. Yairi (1997, as mentioned by Yairi & Seery, 2011) used this particular method of syllable count to measure disfluencies in older and younger children as it was likely that the older children would use more multisyllabic words. This method was used to maintain equitability between the results of the younger and older children. In relation to typical adults aged 20-51 years, syllable count has also been used to examine disfluencies (Roberts et al., 2009). In a clinical context a syllable count (percentage of syllables stuttered) is a metric frequently used to obtain a severity rating for stuttering such as using the *Stuttering Severity Instrument (SSI-4)* by Riley (2009).

## **1.4 Contributing Factors**

Age has been a major focus in examining disfluencies with the majority of studies focusing on the child population. Adults and the ageing population 50+ have had less focus when examining disfluencies and since there isn't a lot of research for this population results are inconsistent. This section will provide current data regarding the ageing population and the need for further research. Within this population, the influence of variables such as sex, years of education, and cognitive functioning have had little attention in relation to disfluencies.

### *1.4.1 Age*

Changes in cognition, motor abilities, perceptual functioning, and/or linguistic function may affect speech production due to age related factors (Ramig, 1986). Evidence suggest that older adults have more difficulty with word retrieval (Rastle &

Burke, 1996; Sandson, Obler, & Albert, 1987), thus affecting conversational speech. Such effects of age have been revealed in terms of fluency. Significantly higher rates of disfluencies per 100 words were demonstrated in conversation by older adults aged 63-72 years (6.65, with combined disfluencies of repeats, restarts, and fillers) compared to middle-aged, mean age 47;11, (5.69) and younger speakers, mean age 28;10, (5.55). It was suggested that as sentences present more “elaborate” in speakers aged 50 than those of younger speakers, more opportunity to generate more occurrences of disfluencies becomes apparent (Bortfield et al., 2001). These results were further supported in 300 speakers aged 17-68 where increasing age was associated with longer and more complex sentences and higher number of disfluencies such as fillers of “*uh*” and “*um*” (Horton et al., 2010).

Determining whether disfluencies increase in English speaking older adults 60+ has been examined in a small number of studies. An early study found normally speaking adults, 69-81 years of age, had an increase in disfluencies of Johnson’s (1961) classification (mean 6.29 per 100 words) compared to high school seniors (3.83) during a picture description task (Yairi & Clifton, 1972). Later, Manning and Monte (1981) reported an increase in formulative breaks – between-word disfluencies, particularly in fillers (hesitations of sounds “*uh*”, separate from interjections of additional words or phrases “*you know*”) in 40 nonstuttering participants 50-69 years of age (age 50-59, mean 0.93 per 100 words; age 60-69, mean 1.10 per 100 words), but reported a slight decrease in disfluencies in older speakers 70-80+ (age 70-79, 0.73; age 80+, 0.74) during conversation. Unfortunately, the specific age for older participants 80+ was not reported. Pindzola (1990) discussed the importance of understanding disfluencies in the ageing population and included older male participants aged 65-85 years in his study. Although, the relationship

between age and disfluencies was not investigated, it was found that the average percentage of disfluencies across speakers was 6.95, majority of disfluencies being interjections. In 2001, Bortfield and colleagues examined normal disfluencies of fillers, repeats, and restarts in three age groups of 16 pairs: young (mean age 28;10), middle-aged (mean age 47;11), and older (mean age 67;2). It was reported that older speakers produced more disfluencies per 100 words overall (6.63) than middle-aged (5.69) and young (5.55) speakers. These results were demonstrated in a linear trend,  $t(82) = 1.94, p = < .05$ , showing disfluencies to increase with age.

In contrast, another study argued that disfluency rate does not change over the age of 65 years (Duchin & Mysak, 1987). Duchin and Mysak reported no significant difference in within-word and between-word disfluencies in five age groups of young (21-30 years), two of middle-aged (45-54 and 55-64), and two of older (65-74 and 75-91) participants. Results for each type of disfluency were provided rather than a total for each age group.

Regarding the most frequently occurring disfluency within this older population of 60+, interjections/fillers were found to have the highest rates overall (Bortfield et al., 2001), followed by revisions (Caruso, McClowry, & Max, 1997; Duchin & Mysak, 1987; Leeper & Culatta, 1995; Manning & Monte, 1981; Pindzola, 1990; Roberts et al., 2009; Searl et al., 2002; Yairi & Clifton, 1972). Various studies have made suggestions as to why such normal disfluencies are frequently occurring in speech. Filled pauses or interjections have been suggested as planning difficulties (Bortfield et al., 2001), while another suggests the influence of turn-taking in conversation results in the need to *hold the floor* (Fox Tree & Clark, 1997; Shriberg, 1996; Starkweather & Givens-Ackerman, 1997). A possible explanation for revisions frequently occurring has been suggested by Fox Tree and Clark (1997) as an outcome

of planning deficits in language (i.e., word retrieval and planning/formulation an utterance).

Only a small number of studies have examined disfluencies in participants over the age of 100+ (Caruso et al., 1997; Searl et al., 2002). Unlike previous studies with older adults 65-91 years of age, there has been a consensus among studies examining disfluencies in participants over the age of 100. Caruso et al. (1997) conducted a single case study on a 105 year old female and compared these results with participants 20 years younger in previous studies (Duchin & Mysak, 1987; Leeper & Culatta, 1995; Yairi & Clifton, 1972). Results were similar to Yairi and Clifton (1972) in that the number and type of disfluencies, within-word and between word, were comparable to adults with a mean age of 78.1 years (Yairi and Clifton (1972): 87.4% and 12.5%; Caruso (1997): 83.3% and 16.7%).

Searl et al. (2002) found similar results in seven participants aged 100-103 as they presented with disfluencies comparable to younger elderly speakers aged 70-90 from the same previous studies (Duchin & Mysak, 1897; Leeper & Culatta, 1995; Yairi & Clifton, 1972) presented in Table 1. The two studies including participants over the age of 100 argue that disfluencies, as we age, do not increase. Although these studies provide preliminary information regarding disfluency characteristics over the age of 100, small sample sizes and the exclusion of younger elderly speakers to compare age related changes affect the validity of results.

In summary, the literature for the ageing population between the ages of 50 and 100+ has shown contrasting results. Generally an increase in normal disfluencies (interjections and revisions) from ages 60-69 compared to younger adults

Table 1. Results compared across studies. The table represents no change in fluency between ages 70-90 years of age compared to 100+ across six studies.

(Searl et al., 2002)

Comparisons of current results to previously reported data

	Yairi and Clifton (1972)	Manning and Monte (1981)	Duchin and Mysak (1987)	Leeper and Culatta (1995)	Caruso et al. (1997)	Searl et al. (2002)
Number of speakers	15	10	15	20	1	7
Mean age (years)	78.1	80+ <sup>a</sup>	80.0	88.5	105	100.6
Percent disfluency	6.29	7.83	7.83	5.75	6.55	6.20
Speaking rate	-- <sup>b</sup>	-- <sup>b</sup>	133.3	-- <sup>c</sup>	105	111.6

Mean age of elderly subjects in the oldest group of each study, mean percent disfluent words, and mean speaking rate (words per minute) are listed per study.

<sup>a</sup> The age group was labelled as 80+, but the group mean age was not reported.

<sup>b</sup> Did not measure speaking rate.

<sup>c</sup> Measured speaking rate, but did not report values for spontaneous speech

occur and when reaching 70+ disfluencies are comparable to younger speakers. In contrast, Duchin and Mysak (1987) indicated no change in disfluencies across age. Limitations of small sample sizes and comparing across studies rather than including younger age groups to compare data needs to be considered. Limited information within the methodology of measuring disfluencies in terms of describing disfluency type, measuring frequency and metric system used also adds to the limitation of results. It is also worth noting that other contributing factors such as cognition and years of education have yet to be considered which may have an effect on determining whether a person is perceived as more or less fluent.

#### 1.4.2 Sex

Sex differences in stuttering is well known in terms of prevalence. Stuttering is shown to be substantially more prevalent in males than in females overall.

Depending on the age of participants in studies, the ratio can vary. For developmental stuttering, sex ratio in children starts at 3:1 (Yairi & Seery, 2011), increases with age, 4:1, and begins to decline postadolescence, 2.2:1, continuing to decline with age 1.4.1 (Craig & Tran, 2005).

Sex differences in disfluencies produced by PWDS is not as well defined as PWS. Studies examining a relationship between sex and disfluencies in normally fluent people have provided conflicting results. Manning and Monte (1981) reported no differences in the number of formulative breaks/normal disfluencies in PWDS, however results were not provided to support this statement. Shriberg's (1996) "Disfluencies in Switchboard" study found that although there wasn't a difference in the rate of disfluencies between men and woman, men showed more normal disfluencies (fillers) than woman, measured as rate of fillers per word. Bortfield et al. (2001) also questioned the effect of sex on disfluency. Their results showed that men produced a higher rate of disfluencies overall per 100 words (6.80) than woman (5.12) and too found that fillers (e.g., "uh") were produced more frequently in men, measured by frequency of fillers per word.

Within the ageing population some studies have included male and female participants, but either failed to analyse a possible effect (Mulligans, et al., 2001; Searl, et al., 2002), failed to include female participants for comparisons (Roberts et al., 2009), or sex differences were not the focus of the study (Duchin & Mysak, 1987; Pindzola, 1990). Larger sample sizes and equal numbers of male and female participants are required to determine a significant difference in disfluencies between sexes.

### *1.4.3 Years of Education*

Most studies investigating normal disfluencies in PWDS have yet to consider years of education as an influential factor. Years of education/education level is usually reported as biographical information, but not statistically analysed against disfluency (Duchin & Mysak, 1987; Pindzola, 1990; Roberts, 2009).

So far, findings from the literature reveal no clear results on the potential effect of age, sex, and years of education on type and frequency of disfluencies.

### *1.4.4 Cognitive Functioning*

Cognitive screening tools are used to assess cognitive functioning and detect deficits. The Montreal Cognitive Assessment (MoCA) is a screening tool to identify mild cognitive impairment which often progresses into dementia. This particular screening tool assess eight cognitive domains and a score of 26 or higher is considered normal cognitive functioning (Naasreddine et al., 2005). Cognitive functions such as intelligence and executive functioning in relation to disfluencies has been questioned in individuals who stutter and typically fluent individuals.

In PWS, those with cognitive deficits (particularly severe) have a high frequency of stuttering (Van Riper, 1982). Typical language and speech production is complex as it depends on full functioning of cognitive abilities. A breakdown in cognitive functioning is likely to result in deficits in typical speech and language (Guitar, 2006). In relation to intellectual abilities, PWS are perceived by those who do not stutter as less intelligent. This has been found in 75 school-aged children (9-11 years old) when listening to speech samples of fluent adults and adults who stutter (mild and moderate). Ratings were made between adjective pairs related to

personality (outgoing – shy) and intelligence (intelligent – stupid). More negative perceptions were associated with the adult who stuttered compared to the adult who did not stutter (Franck, Jackson, Pimentel, & Greenwood, 2003).

Engelhardt, et al. (2013) studied the relationship between intelligence and executive functioning and how they relate to types of disfluencies in 106 PWDS, aged between 14 and 35 years old. Structural equation models were run which included intelligence and executive functioning of inhibition (ability to suppress competing responses or distractions) and set shifting (ability to shift back and forth between tasks) with each disfluency type separately. Disfluency types included filled pauses (fillers), repairs, unfilled pauses of more than 1 second, repetitions, and repairs. A significant finding between inhibition and repairs was found with a -.33 factor loading suggesting 1/3 of the variance in repairs can be accounted for by individual differences of inhibition. A non-significant finding worth mentioning was a trend found between unfilled pauses and intelligence with a factor loading of -.22 suggesting 1/4 of the variance in filled pauses is due to individual differences in intelligence. These findings are more related to disfluency types associated with cognitive abilities rather than indicating an increase or decrease in disfluencies relating to scores of intelligence.

Individuals who stutter are often perceived as unintelligent, but this is considered a myth (The Stuttering Foundation, 2016). Based on findings indicating a potential influence from cognitive abilities (Engelhardt et al., 2013), it would be interesting to compare cognitive scores such as MoCA scores used clinically with disfluencies to identify a potential relationship.



### **1.5 Statement of the Problem and the Aim of the Current Study**

In the literature there is a large focus on the development of fluency in children, leaving the ageing population largely unaddressed (Pindzola, 1990). As a result, there is limited data for both stuttering and non-stuttering older adults (Smith, Wasowicz & Preston, 1987). Due to limited information regarding speech characteristics such as fluency, comparisons for older persons are often made with normative data of younger adults and even children (Smith et al., 1987). It is important to examine fluency within the entire life cycle to understand disruptions in fluency such as stuttering, both developmental and acquired. Likewise, data regarding normal disfluencies is required as it is relevant to aspects of assessment and treatment (Roberts et al., 2009). This information would aid clinical decision making to differentiate normal changes in ageing from those that may be indicative of an acquired disorder such as neurogenic stuttering, aphasia, and apraxia of speech.

The majority of studies that have examined disfluencies in older speakers over 70+ acquired a limited sample size with uneven numbers of female and male participants. Older age groups tend to range from 50s to 70s with fewer participants included when reaching 65 years of age and over. Discrepancies have been recognised within the literature concerning the relationship between age and disfluencies with majority reporting older adults comparable to younger or no change (Caruso, 1997; Duchin & Mysak, 1987; Leeper & Culatta, 1995; Searl et al., 2002), while others reporting an increase (Yairi & Clifton, 1972). Other factors such as years of education have yet to be analysed against age and disfluencies which may be a feature in whether or not more or less disfluencies are presented in older adults. Although there is some agreement on the types of stuttering-like and normal disfluencies presented in speech, methodology across studies make it difficult to

compare data (Robert, 2009). As stated by Roberts (2009) a consensus is required concerning types of disfluencies to be counted and the methodology of counting disfluencies as this is often differing across studies or absent.

The purpose of this study was to investigate the speech of the ageing population 60+, specifically looking at disfluencies. This study sought to analyse the types of disfluencies exhibited, the number of disfluencies, both stuttering-like and normal, and the proportion of disfluencies in contexts of conversation and reading. It is anticipated that the findings would provide specific information regarding relationships of disfluency, ageing, sex, years of education, cognitive functioning, and speaking tasks. Within a clinical context, the profession will gain normative data for the New Zealand ageing population and comparative data for assessing/diagnosing acquired communication disorders. The outcomes from this current study will further extend our knowledge on the type of normal and stuttering-like disfluencies in addition to providing agreement of measurement outcomes. The following hypotheses were proposed for the healthy ageing population:

- 1) Based on Duchin and Mysak (1987), there will be no change in disfluencies in relation to age in speakers 60+ across conversation and reading contexts.
- 2) Based on the literature of the nonstuttering adults, normal disfluencies will occur more often than stuttering-like disfluencies in the population 60+.
- 3) More overall disfluencies will occur in men than in woman shown by Bortfield et al. (2001) and Manning and Monte (1981).
- 4) We hypothesis that more disfluencies will occur in speakers with less years of education (Searl et al., 2002) and speakers with lower MoCA scores (Engelhardt et al., 2013).

- 5) We hypothesise that interjections and revisions will occur the most in conversation within the population 60+.
- 6) We hypothesise age, sex, years of education, cognitive scores, and normal disfluencies to be predictors of stuttering like disfluencies.

## 2. Method

### 2.1 Speech Data

For the current study, the New Zealand Institute of Language, Brain and Behaviour's Language and Ageing Speech Corpus was used to analyse speech samples. The corpus entails an extensive amount of conversational speech and oral reading transcripts. The process of obtaining speech samples was part of a larger study. Participants attended a single, individual recording session lasting approximately 15 minutes. This took place in a quiet room with an interviewer present. Each speaker was asked to participate in conversation regarding a childhood memory and read the 'the Grandfather passage' (see Appendix A). Speakers were asked to speak in their normal speaking voice during conversation and when reading the passage aloud. Participants were asked first to familiarise themselves with the content within the passage before reading aloud. Participants were seated at a table with a ZoomH4n recorder placed in front of them, approximately 30 centimetres away. Digital audio recordings of the speaker were made at 22.05 kHz with 16 bits of quantization.

### 2.2 Participants

Participants for this study included 115 New Zealand English speakers aged between 64 and 91 years (average 71.9, range 64 – 91, standard deviation (SD) 5.36). There were 85 female and 30 male participants. Selection criteria used to obtain the participants from the 1,038 speaker corpus included speakers: (1) 60+ years of age, (2) New Zealand English speaking determined by living in New Zealand from the age of 7 years, (3) to have reported no previous history of cognitive impairment or speech and language disorders, and (4) to have scored within normal limits (>26) on the

Montreal Cognitive Assessment (MoCA) – a screening assessment for identifying individuals with mild cognitive impairment (Nasreddine et al., 2005). Of the selected participants, the average MoCA score among participants was 27.7 (range 26.0 – 30.0, *SD* 1.3) and the average years of education was 13.4 (range 7.0 – 21.0, *SD* 2.8). For further participant biographical information see Appendix B.

## **2.3 Data Analysis**

Recorded reading passages and conversation were transcribed by investigators from a previous study (Fletcher, McAuliffe, Lansford, & Liss, 2015), and then automatically segmented at phoneme level with the Hidden Markov Model Toolkit (Young et al., 2002). With the use of Praat (Boersma & Weenink, 2001) phoneme segments were labelled. For the current study, the accuracy of all phoneme boundaries were manually checked and corrected where necessary for both speaking contexts following standard segmentation criteria (Peterson & Lehiste, 1960). Manual checking entailed examining the wave-form and wide-band spectrogram with the audio recording.

### *2.3.1 Disfluencies*

Perceptual analysis of each speech sample was completed by two investigators. On the transcript, the following disfluencies were counted: (1) sound repetition, (2) syllable repetition, (3) mono-syllabic word repetition, (4) prolongations, (5) blocks, (6) multisyllabic word repetition, (7) interjection/filler of sounds, words, and phrases, (8) pause longer than 1 second (Engelhardt, Nigg, & Ferriera, 2013), (9) revisions, (10) broken words, (11) part-sentence repetitions, and (12) unfinished sentences. The first five disfluencies were categorised as stuttering-like and the remaining seven as normal disfluencies.

### 2.3.2 Coding

Automatic coding was completed for the following disfluencies: monosyllabic word repetition, multisyllabic-word repetition, prolongations, interjections/filler of sounds, and pauses. Manual checking was required for sound, syllable, and part-sentence repetitions. The remaining disfluencies were manually coded: sound and syllable repetitions, blocks, revisions, broken words, and unfinished sentences. Refer to Appendix C for the coding protocol.

When multiple disfluencies occurred on a word each one was counted. Fricatives and affricates such as ‘f, s, sh, th, ch’ that were prolonged for more than 0.30 seconds were counted as prolongations. Prolongations on vowels were only counted if they exceeded 0.50 seconds. The measurement for prolongations was determined by the researches of the current study as this was perceived as an abnormally long prolongation of a sound. Interjections/fillers that were prolonged were not counted as prolongations. A phrase interjection was counted if the participant used a phrase without meaning continuously (e.g., “*you know what I mean*”). Tongue clicking, sighing and breathing were counted as a pause excluding laughter and coughing. Pauses were counted if exceeding 1 second (Engelhardt et al., 2014) and occurred within the speaker’s own utterances – not before or following the interviewee’s utterances. Refer to Appendix D for additional criteria for counting disfluencies adapted from Manning and Monte (1981) and Roberts et al. (2009).

### 2.3.3 Word and syllable counts

Speech sample transcripts (115) consisted of the middle 150 words of a sample. Speech samples with a 300 word count (22) were also coded to compare any differences between the two speech samples of differing lengths. The ‘Grandfather

Passage' transcript (115) consisted of 116 words, however the count for the passage was dependant on deletion or addition of words spoken by the participant. Disfluent words were not included within the intended word count. A conversational speech sample of 150 words allowed for direct comparisons with the reading task.

Intended syllables were counted in each 150 and 300 word count as well as the reading passage, thus excluding disfluent words/syllables. Syllable counts for each context was then calculated to divide by the average number of disfluencies – stuttering-like, normal and total – to obtain the percentage of disfluencies per 100 syllables resembling the Robert et al. (2009) study.

## **2.4 Reliability**

Inter-rater reliability of measures was determined through random selection of 20% of speech samples of the original analyser. Re-analysis involved the second investigator independently listening to the speech samples and coding transcripts. Inter-rater reliability revealed a high agreement of 99.7%, with a Cohen's Kappa of 0.93. The two investigators were Speech and Language Pathologists who trained together in disfluency analysis and consulted with each other throughout coding, contributing to the high agreement. Intra-rater reliability was determined by the investigator coding the same 20% of speech samples two months following coding. Intra-rater reliability showed high agreement of 99.8%, with a Cohen's Kappa of 0.96.

## **2.5 Statistical Analysis**

Pearson's correlation was used for correlational analyses relating to disfluencies. Correlations were calculated to determine the strength of a linear association between disfluencies in conversation and reading, and variables of age,

years of education, and MoCA scores. Welch's *t*-test was calculated to compare two independent populations of male and female speakers on occurrence of stuttering-like and normal disfluencies. A paired sample *t* test measurement was used to compare participants (22) with a 300 and 150 word speech sample to identify any significant differences in disfluencies with differing speaking lengths. Further statistical analyses using a regression model were completed to see whether additional factors of age, sex, years of education, cognitive scores, and normal disfluencies predicted stuttering-like disfluencies.

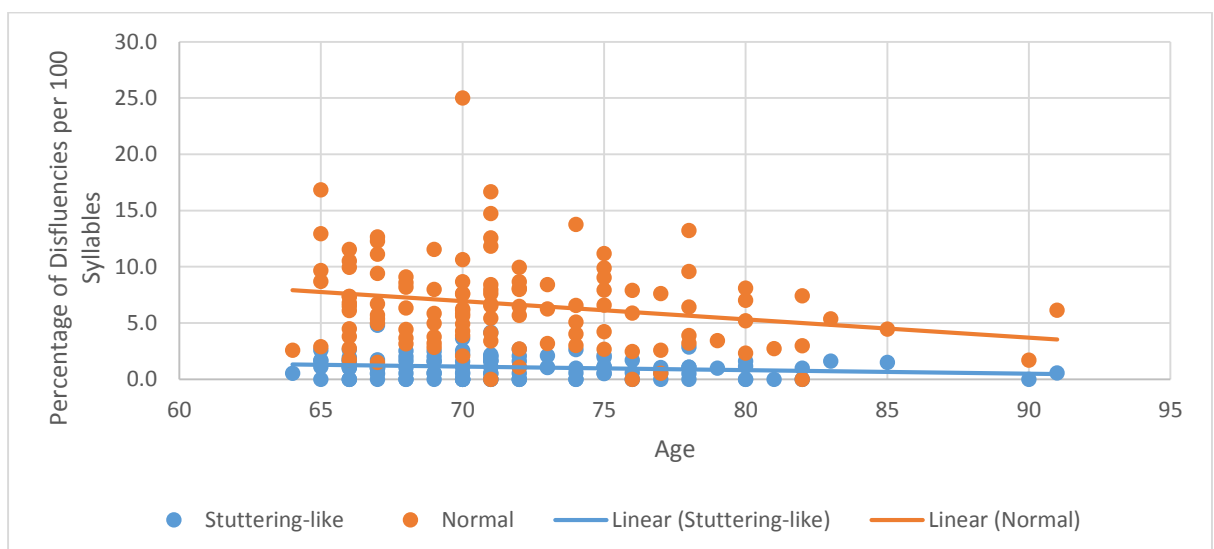


### 3. Results

Speech samples of conversation and reading from 115 participants were used to measure normal and stuttering-like disfluencies in the ageing population. The percentages of stuttering-like and normal disfluencies in conversation and reading were calculated to determine the relationship between disfluencies and variables of age, sex, years of education and cognitive scores. A comparison between 150 and 300 word count was also analysed to ensure compatibility of disfluency results. Results also include the frequency of occurrence for each disfluency type. Correlation and *t*-test measures were used to compare the relationship between disfluencies and variables previously mentioned. A multiple regression model was then used to examine variables influencing stuttering-like disfluencies.

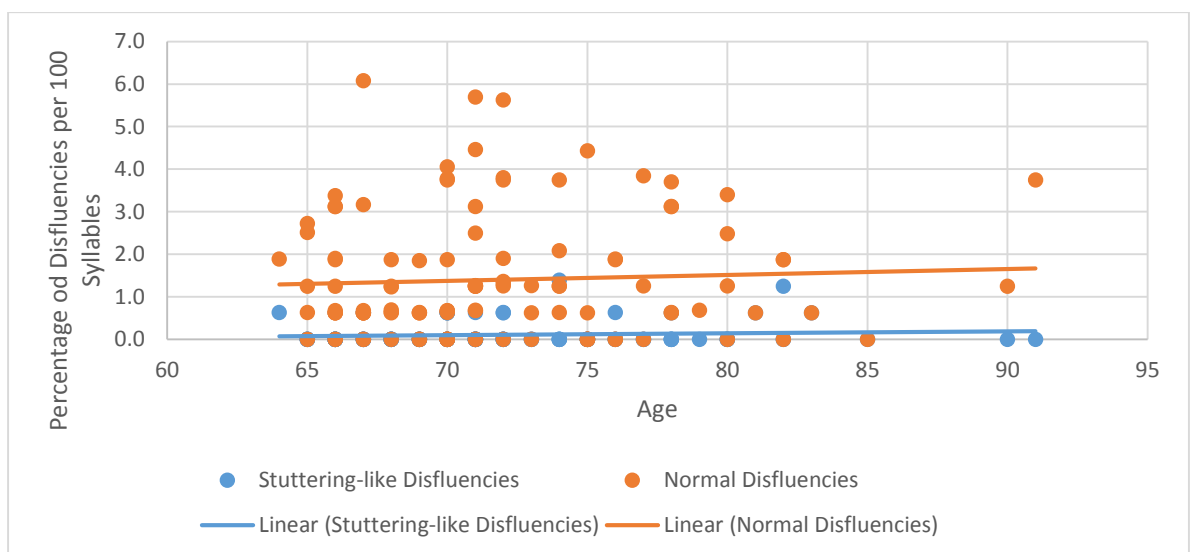
#### 3.1 Age and Disfluencies

*Hypothesis 1: Based on Duchin and Mysak's (1987) study, there will be no change in disfluencies in relation to age 60+ across conversation and reading contexts.*



*Figure 1.* Percentage of stuttering-like and normal disfluencies per 100 syllables in conversation by speakers over the age of 60 years.

To calculate the frequency of disfluencies in conversation, all disfluency occurrences were counted, multiplied by 100, and divided by the total number of fluent syllables spoken within the sample. This resulted in the percentage of disfluencies per 100 syllables spoken. Figure 1 shows the relationship between age and disfluencies – stuttering-like and normal – in conversation. The average percentage of stuttering-like disfluencies in conversation was  $M = 1.1$  (range: 0.0 – 4.8) with a standard deviation ( $SD$ ) of 1.0. Figure 1 also displays two outliers producing over 3% stuttering-like disfluencies, 4.2 and 4.8. For normal disfluencies in conversation the average was  $M = 6.7$  (range: 0.0 – 25.0 and  $SD = 3.9$ ). In conversation, Pearson's correlation indicated no significant relationship between stuttering-like (SLD) and normal disfluencies (ND) in conversation and age,  $r_{SLD} = -0.17, p = .92$  ( $p < .05$ );  $r_{ND} = -0.02, p = .81$ .

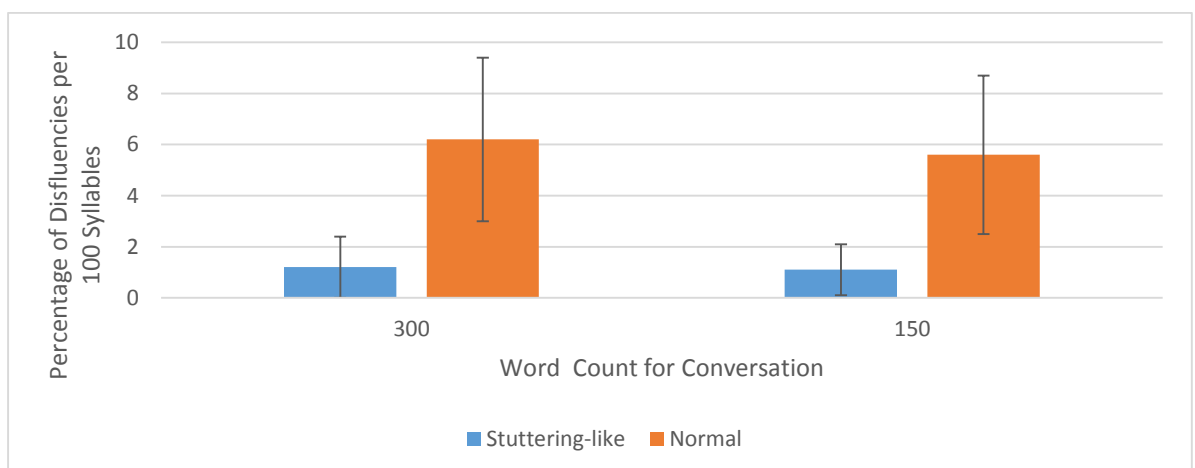


*Figure 2.* Percentage of stuttering-like and normal disfluencies per 100 syllables in reading by speakers over the age of 60 years.

Figure 2 shows the relationship between age and disfluencies in reading. The average percentage of stuttering-like disfluencies in reading was  $M = 0.1$  (range: 0.0 – 1.4) and  $SD = 0.3$ . For normal disfluencies in reading the average was  $M = 1.4$  (range:

0.0 – 6.1) and  $SD = 1.4$ . No significant relationship was found between stuttering-like disfluencies in reading and age ( $r = -0.08, p = .39$ ). A small, yet significant positive correlation was found between normal disfluencies in reading and age ( $r = 0.08, p = .02$ ), indicating that as speakers get older, normal disfluencies occur less when reading.

Twenty-two participants had a 150 and 300 word conversational speech sample. These two speech samples were compared to see whether the different lengths influenced the amount of disfluencies. Figure 3 indicates a comparable occurrence of disfluencies in the two word counts for conversation.



*Figure 3.* Percentage of stuttering-like and normal disfluencies per 100 syllables in conversational word count of 300 and 150 samples.

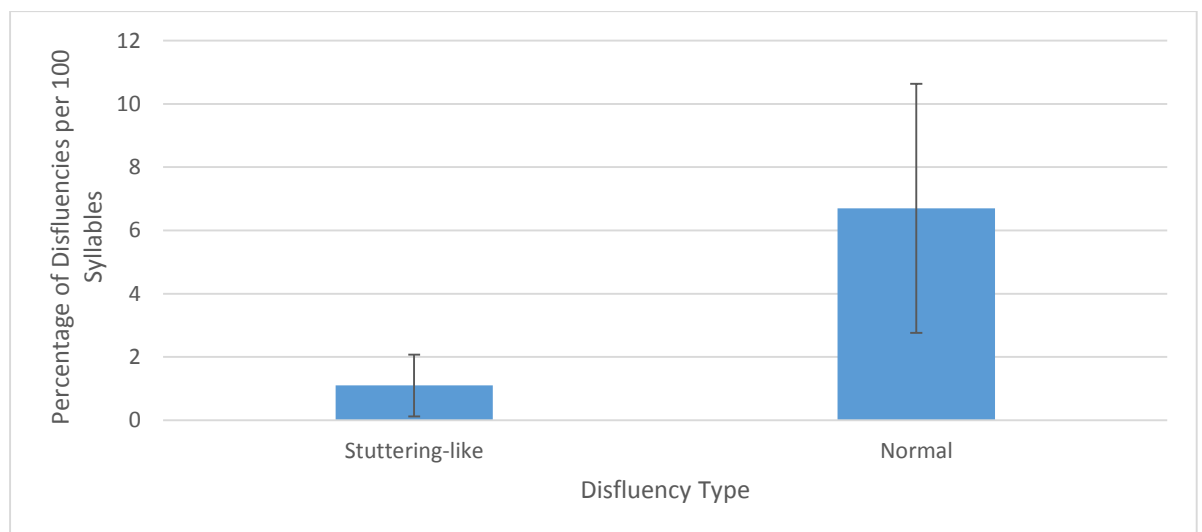
The average percentage of stuttering-like disfluencies in the 300 word count was  $M = 1.2$  (range: 0.0 – 4.2) and  $SD = 1.2$ . For normal disfluencies the average was  $M = 6.2$  (range: 2.1 – 12.0) and  $SD = 3.2$ . For the 150 word count, the average percentage of stuttering-like disfluencies was  $M = 1.1$  (range: 0.0 – 2.9), and  $SD = 1.0$ . For normal disfluencies  $M = 5.6$  (range: 0.5 – 13.2) and  $SD = 3.1$ . A paired sample  $t$ -test indicated no significant difference in the percentage of stuttering-like and normal disfluencies

between the 300 and 150 word conversational speech samples,  $t_{SLD}(21) = 0.98$ ,  $p_{SLD} = .34$ ; ,  $t_{ND}(21) = 1.43$ ,  $p_{ND} = .17$ .

### 3.2 Stuttering-like and Normal Disfluencies

*Hypothesis 2: Based on the literature of the nonstuttering adults, normal disfluencies will occur more often than stuttering-like disfluencies in the population 60+.*

The difference between stuttering-like and normal disfluencies in conversation is displayed in Figure 4. The average percentage of stuttering-like disfluencies was  $M = 1.1$  (range: 0.0 – 4.8) and  $SD = 1.0$ , and for normal disfluencies  $M = 6.7$  (range: 0.0 – 25.0) and  $SD = 3.9$ . Welch's  $t$ -test measurement indicated a significant difference between stuttering-like and normal disfluencies in conversation,  $t(128.08) = 15.11$ ,  $p = < .001$ .



*Figure 4.* Percentage of stuttering-like and normal disfluencies per 100 syllables in conversation.

The relationship between stuttering-like and normal disfluencies was also examined in reading (Figure 5). The average percentage of stuttering-like disfluencies was  $M = 0.1$  (range: 0.0 – 1.4) and  $SD = 0.3$ , and the average for normal disfluencies was  $M = 1.4$  (range: 0.0 – 6.1) and  $SD = 1.4$ . Welch's  $t$ -test measurement indicated a

significant difference in the percentage of disfluencies in reading between stuttering-like and normal,  $t(121.52) = 9.68, p = < .001$ .

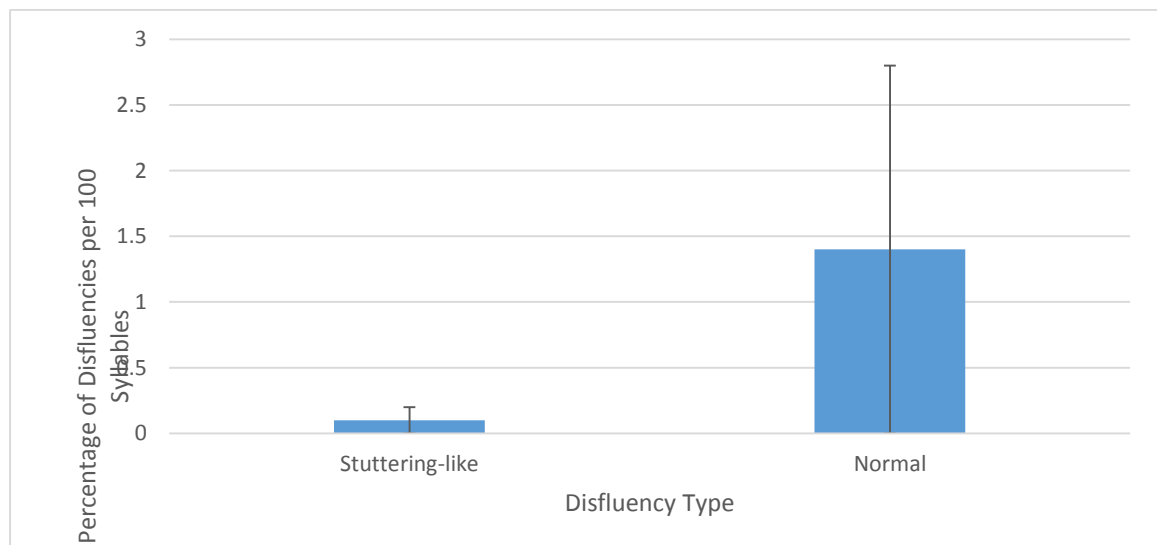
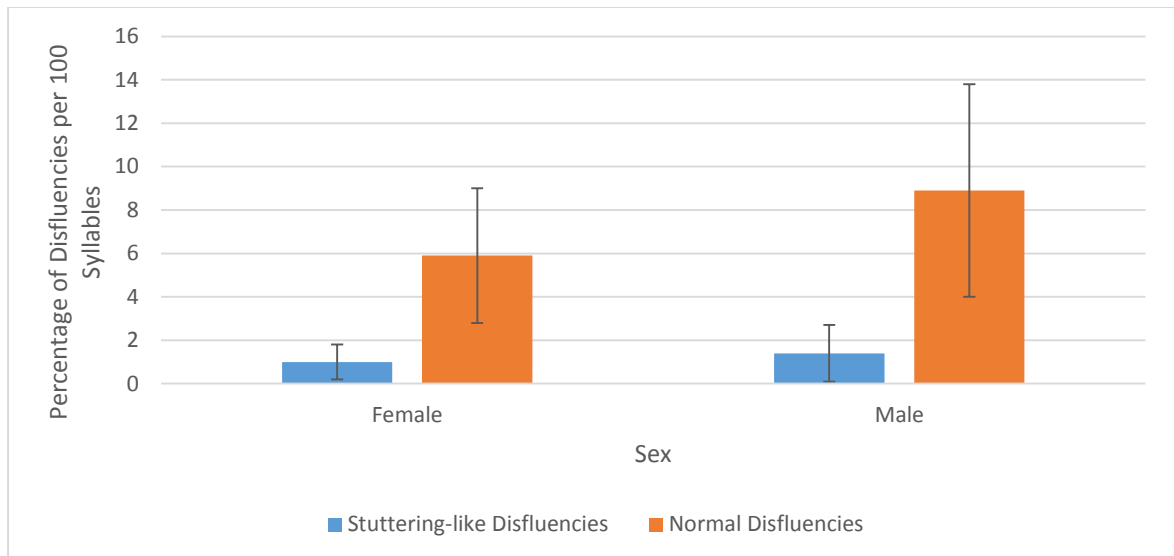


Figure 5. Percentage of stuttering-like and normal disfluencies per 100 syllables in reading.

### 3.3 Sex and Disfluencies

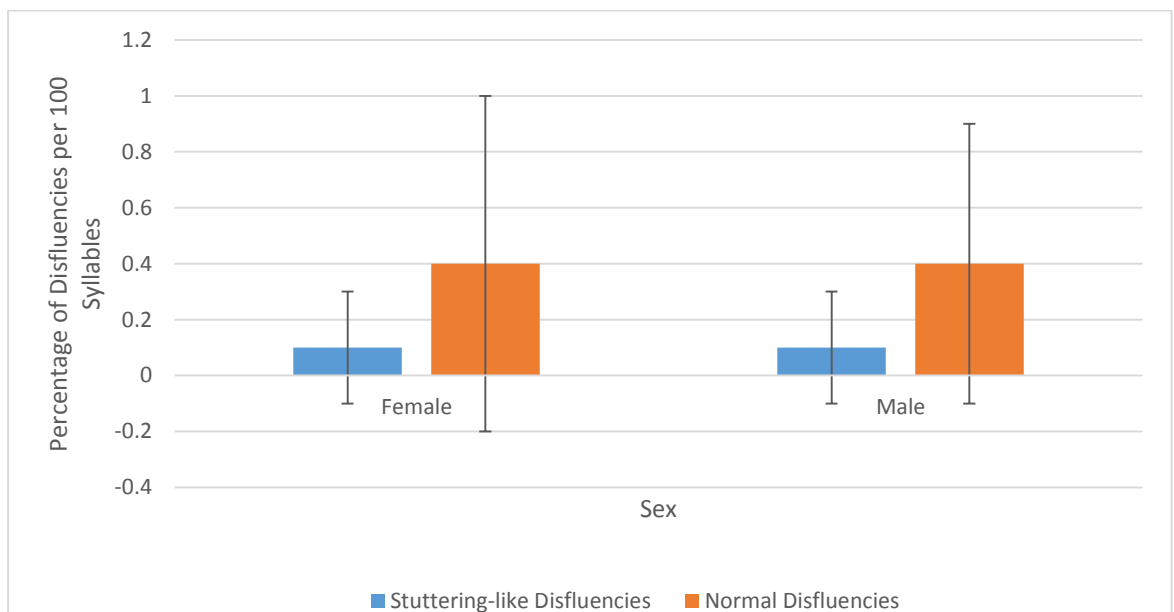
*Hypothesis 3: More overall disfluencies will occur in men than in woman shown by Bortfield et al. (2001) and Manning and Monte (1981).*

Sex differences regarding disfluencies were investigated and are presented in Figure 6. For female speakers the average percentage of stuttering-like disfluencies was  $M = 1.0$  (range: 0.0 – 2.9) and  $SD = 0.8$ , and the average for normal disfluencies was  $M = 5.9$  (range: 0.0 – 16.9) and  $SD = 0.8$ . Male speakers had an average percentage of stuttering-like disfluencies of 1.4 (range: 0.0 – 4.8) and  $SD$  of 1.3 and the average for normal disfluencies was  $M = 9.0$  (range: 2.3 – 25.5) and  $SD$  of 4.9. Although male speakers produce more disfluencies than female speakers, Welch's  $t$ -test measurement indicated no significant difference in the percentage of disfluencies between female and male speakers in conversation,  $t(37.71) = 1.64, p = .11$ .



*Figure 6.* Percentage of disfluencies per 100 syllables in conversation between male and female speakers.

Sex differences were also examined in reading (Figure 7). For female speakers the average percentage of stuttering-like disfluencies was  $M = 0.1$  (range: 0.0 – 0.6) and  $SD$  of 0.2, and the average for normal disfluencies was  $M = 0.4$  (range: 0.0 – 3.7)



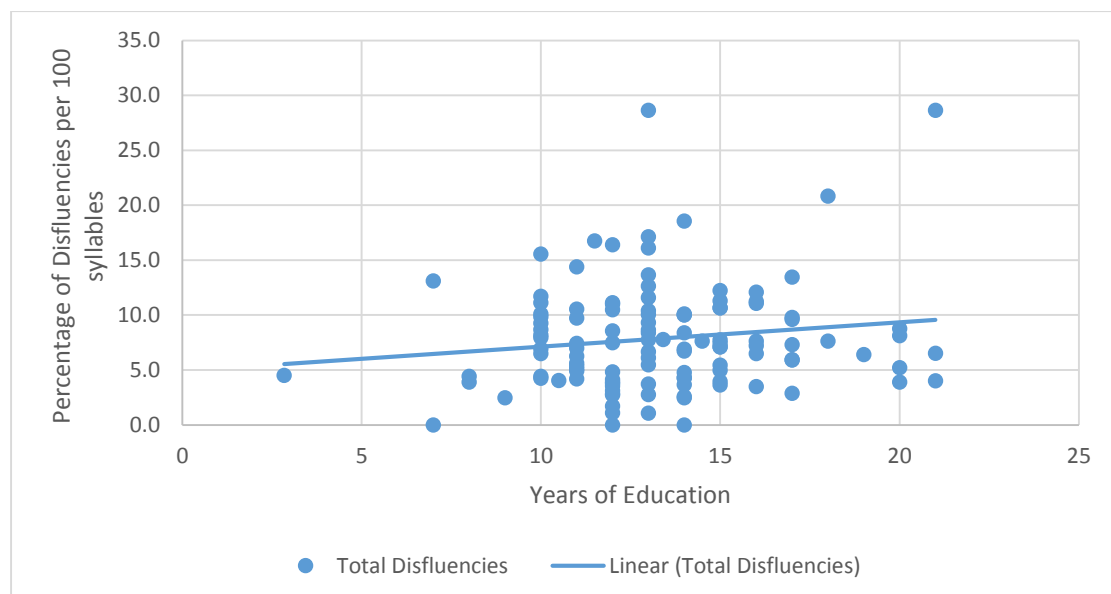
*Figure 7.* Percentage of disfluencies per 100 syllables in reading between male and female speakers.

and  $SD$  of 0.6. Male speakers had an average percentage of stuttering-like disfluencies of  $M = 0.1$  (range: 0.0 – 0.6) and  $SD$  of 0.1 and the average for normal disfluencies

was  $M = 0.4$  (range: 0.0 – 1.8) and  $SD$  of 0.5. Like conversation, male speakers produced more disfluencies than female speakers, however Welch's  $t$ -test measurement indicated no significant difference in disfluencies between female and male speakers in reading,  $t(43.28) = 0.11, p = .91$ .

### 3.4 Disfluencies and Additional Factors

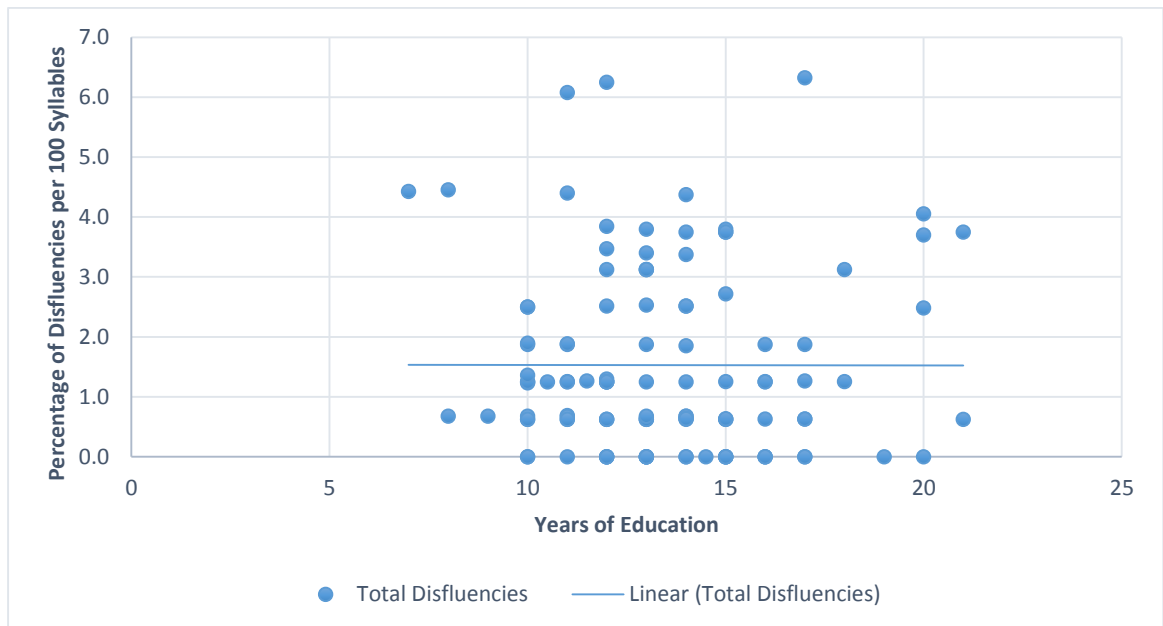
*Hypothesis 4: We hypothesis that more disfluencies will occur in speakers with less years of education (Searl et al., 2002) and speakers with lower MoCA scores (Engelhardt et al., 2013).*



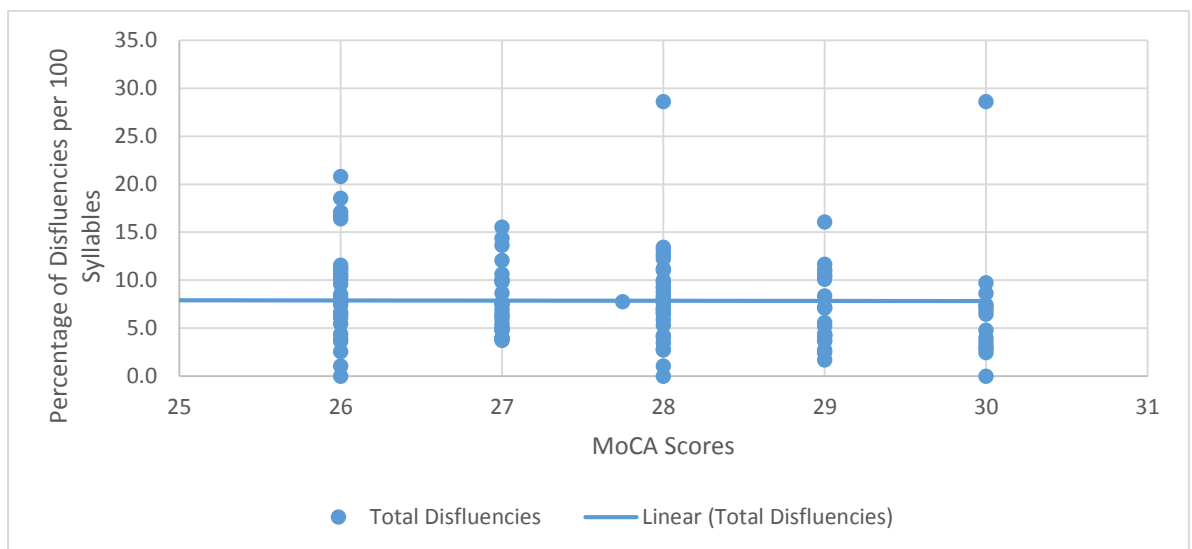
*Figure 8. Percentage of total disfluencies per 100 syllables in conversation and years of education*

Years of education against percentage of total disfluencies in conversation is displayed in Figure 8. The average years of education were 13.4 (range: 7.0 – 21.0) and  $SD$  of 2.8. For total percentage of disfluencies in conversation the average was 7.8 (range: 0.0 – 28.6) and  $SD$  of 4.5. The relationship between years of education and total percentage of disfluencies in reading is shown in Figure 9 –  $M = 1.5$  (range: 0.0 – 6.3) and  $SD$  1.5. Pearson's correlation indicated no significant difference in total

disfluencies and years of education; conversation:  $r = < 0.001$ ,  $p = 0.97$  and reading:  $r = < 0.001$ ,  $p = 0.98$ .



*Figure 9.* Percentage of total disfluencies per 100 syllables in reading and years of education.



*Figure 10.* Percentage of total disfluencies per 100 syllables in conversation and MoCA scores.

Measurements previously stated for total disfluencies in conversation and reading were used to show a relationship with normal cognitive functioning shown in MoCA



scores. The average MoCA scores among participants was  $M = 27.7$  (range: 26.0 – 30.0) and  $SD$  of 1.3. Pearson’s correlation revealed a significant negative correlation between total disfluencies and MoCA scores in conversation,  $r = -0.23$ ,  $p = < 0.01$  meaning as MoCA scores increase the number of disfluencies decrease. No significant correlation in the context of reading was shown,  $r = -0.01$ ,  $p = .90$ .

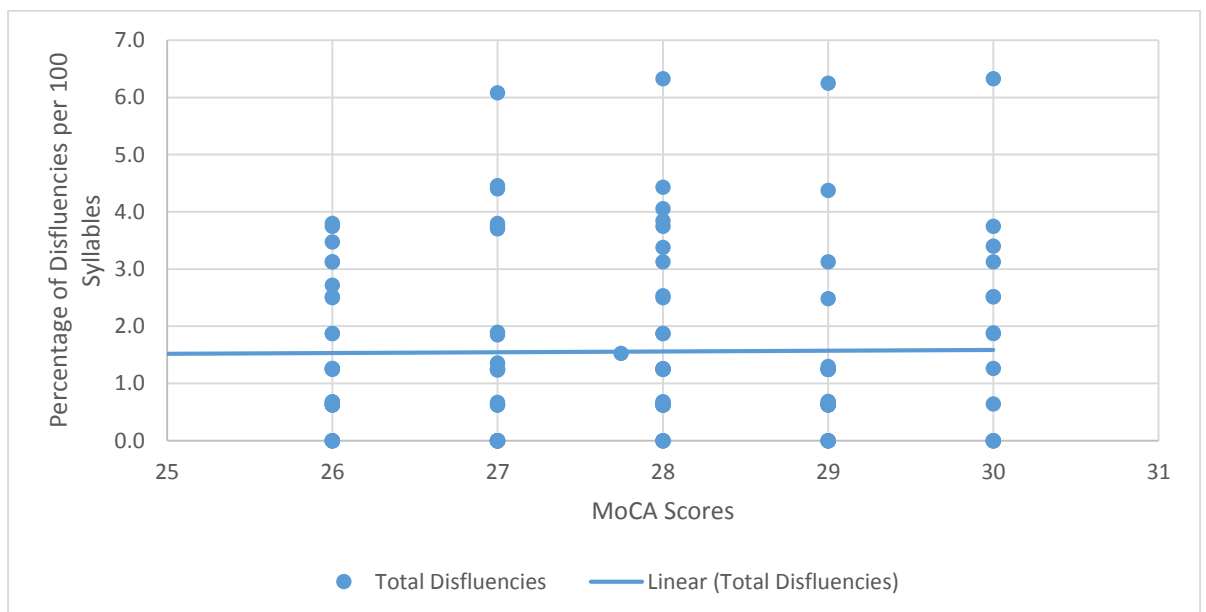


Figure 11. Percentage of total disfluencies per 100 syllables in reading and MoCA scores.

### 3.5 Types of Disfluencies

*Hypothesis 5: We hypothesise that interjections and revisions will occur the most in conversation within the population 60+.*

The current study reported the frequency of each disfluency type. Table 1 presents the frequency of disfluencies in conversation in measures of mean, standard deviation, and range. The results show that interjections are most frequently occurring disfluency (6.5) followed by pauses (3.1); mean length of 1.5 seconds (range: 0.0 – 12.5 seconds) and  $SD = 1.5$ . Previous studies have not included pauses within their

disfluency count, therefore the removal of pauses would show revisions to follow interjections (2.0) which coincides with previous studies for normal disfluencies.

Table 1.

The mean, standard deviation, and range of disfluencies per 100 syllables in conversation.

<b>Disfluencies</b>	<b>Mean</b>	<b>SD</b>	<b>Min</b>	<b>Max</b>
Word repetition	1.0	1.4	0.0	8.0
Sound repetition	0.3	0.7	0.0	3.0
Syllable repetition	0.1	0.4	0.0	2.0
Block	0.1	0.3	0.0	2.0
Prolongation	0.5	0.9	0.0	5.0
Multisyllabic word repetition	0.1	0.3	0.0	1.0
Part sentence repetition	0.5	0.9	0.0	4.0
Interjection	6.5	5.7	0.0	42.0
Revision	2.0	1.5	0.0	7.0
Unfinished sentence	0.3	0.6	0.0	2.0
Broken word	0.0	0.1	0.0	1.0
Pause	3.1	2.9	0.0	17.0

### **3.6 Factors Associated with Stuttering-like Disfluencies in Conversation**

*Hypothesis 6: We hypothesise age, sex, years of education, cognitive scores, and normal disfluencies to be predictors of stuttering like disfluencies.*

A multiple regression analysis was used to determine whether variables of age, sex, years of education, cognitive scores, and normal disfluencies, in combination, influence stuttering-like disfluencies. Two models for conversation and reading began with analysing a full model including the effects of age, sex, years of education, and

normal disfluencies. Further models were then evaluated to eliminate factors with no significance ( $p = < .05$ ). For conversation, the final model resulted in the effects that normal disfluencies were highly significant predictors of stuttering-like disfluencies in conversation,  $F(1, 113) = 52.48, p = < .001, R^2 = .31$ . For reading, the final model also revealed that normal disfluencies significantly influence stuttering-like disfluencies in reading,  $F(1, 113) = 5.24, p = .02, R^2 = .04$ .

### 3.7 Summary of Results

The findings of the current study are as follows:

- 1) The percentage of stuttering-like and normal disfluencies demonstrated no significant change with age in conversation. A small, yet significant change was found in reading where speakers showed more normal disfluencies with age, however this did not apply to stuttering-like disfluencies in reading.
- 2) The percentage of normal disfluencies was significantly higher than stuttering-like disfluencies in conversation and reading.
- 3) Male speakers produced more disfluencies in conversation and reading compared to female speakers, however this difference was not significant.
- 4) No significant correlation was found between percentage of total disfluencies in conversation and years of education. A significant finding was found between percentage of total disfluencies in both speaking contexts and MoCA scores in that as MoCA scores increased, percentage of total disfluencies decreased.
- 5) Interjections, followed by pauses and revisions were most frequently occurring in conversation.

- 6) Results from the multiple regression models indicated normal disfluencies as highly significant predictors of stuttering-like disfluencies in conversation and reading.

## 4. Discussion

The purpose of the current study was to examine characteristics of disfluencies in the healthy ageing population aged 60 to 91 years. The literature on disfluencies in the ageing population to date is limited and lacks consistency, thus this study's focus was to further examine disfluency characteristics and possible contributing factors. The current study therefore investigates the occurrence of stuttering-like and normal disfluencies across contexts of conversation and reading in addition to factors of age, sex, years of education, and cognitive scores. A major finding from this study regarding the relationship between age and disfluencies revealed no significant difference in conversation. For reading however, a small increase in normal disfluencies with age was found. With regard to sex and years of education, no significant differences were found with disfluency scores. In contrast, the number of total disfluencies was found to be significantly negatively correlated with cognitive scores – as MoCA scores increased, the total number of disfluencies decreased. A multiple regression model revealed that normal disfluencies are strong predictors of stuttering-like disfluencies in conversation and reading. This section will discuss these results in reference to the literature and clinical implications. Limitations to the current study and the direction for future research will also be discussed.

### 4.1 Age and Disfluencies

*Hypothesis 1: Based on Duchin and Mysak's (1987) study, there will be no change in disfluencies in relation to age 60+ across conversation and reading contexts.*

Speech samples of older NZE speakers (64-91 years of age) in conversation and reading were analysed to determine whether a relationship exists between disfluencies and age. A small, but significant positive correlation was found between

normal disfluencies in reading and age, suggesting that as people get older, more normal disfluencies may be present in reading. Previous studies have included conversation and reading to compare the frequency of disfluencies between the two contexts (Duchin & Mysak, 1987; Mulligans et al., 2001). Duchin and Mysak (1987) sought to compare disfluencies in each context, however the oral reading task presented with little to no disfluencies and therefore was not reported on. The current study is the first to report on a relationship between age and disfluencies in the context of reading. This increase in normal disfluencies during reading with age is interesting as conversations are known to have more disfluencies than reading (Mulligans et al., 2001). Possible explanations may be that as speakers get older, reading becomes more challenging due to increasing problems with visual acuity. It is worth noting that pauses were an additional disfluency type included in the current study which may have influenced results in reading. These findings are important as previous studies have failed to report on how fluency changes with age during reading and the inclusion of pauses within the disfluency count. Clinically, if normal disfluencies increase with age when reading, clinicians may require norms for different age groups when assessing patients/clients in a speech reading task.

When looking at the relationship between disfluencies in conversation and age, results indicated no significant relationship for stuttering-like and normal disfluencies. This lack of change in disfluencies in conversation across age supports previous findings of Duchin and Mysak (1987) for two older male age groups (65-74 and 75-91) which showed no change in the frequency of disfluencies in conversation. Although outcomes were alike, the current study included male and female speakers while Duchin and Mysak (1987) only included male participants, thus restricting generalisation of their results. Studies that included participants over 100 years of age

also supports findings of no change in disfluencies as their results were comparable to younger older participants aged 70-90 years (Caruso et al., 1997; Duchin & Mysak, 1987; Leeper & Culatta, 1995; Sear et al., 2002). Findings from the current study indicate that clinicians would not require different norms to assess different age groups for older clients/patients when assessing conversation.

As previously mentioned, two outliers were identified in our study. Both produced more than 3% of stuttering-like disfluencies in conversation. Participant 1478SCN produced 4.2% stuttering-like disfluencies per 100 syllables and participant 1506SCN produced 4.8% stuttering-like disfluencies per 100 syllables. Scores exceeding 3% in stuttering-like disfluencies are considered a characteristic of stuttering (Yairi & Seery, 2011). The types of stuttering-like disfluencies produced by these participants are also common in PWS: mono-syllabic word and sound repetitions. Although participants were asked of any previous history of speech and language disorders prior to participating in the study, specific questions related to stuttering may not have been addressed. Although presence of speech problems was considered an exclusion criteria for the corpus, these two speakers may have been missed.

#### **4.2 Stuttering-like and Normal Disfluencies**

*Hypothesis 2: Based on the literature of the nonstuttering adults, normal disfluencies will occur more often than stuttering-like disfluencies in the population 60+.*

Previous studies have shown that PWDS produce more normal disfluencies than stuttering-like disfluencies (Yairi & Seery, 2011). Within the ageing population this too has been well established in conversation (Duchin & Mysak, 1987; Manning & Monte, 1981; Roberts et al. 2009; Yairi & Clifton, 1972) and reading (Mulligans,

2001). Findings from this study of the ageing population presenting with significantly more normal disfluencies (ND) than stuttering-like disfluencies (SLD) in conversation (ND:  $M = 6.7$ ; SLD:  $M = 1.1$ ) and reading (ND:  $M = 1.4$ ; SLD:  $M = 0.1$ ) are consistent with the literature. A substantially large contrast between the two speaking contexts in general is also clearly depicted in Figures 4 and 5. A possible explanation for this major difference in speaking contexts may be due to additional demands generating language for speech and interactional demands with a conversational partner (Mulligans et al., 2001). Although it has been well established in the literature that normal disfluencies occur more frequently than stuttering-like, clinically it is worth analysing both disfluencies types to detect cases of stuttering (Cordes & Ingham, 1995).

### **4.3 Sex and Disfluencies**

*Hypothesis 3: More overall disfluencies will occur in men than in woman shown by Bortfield et al. (2001) and Manning and Monte (1981).*

Sex differences are well recognised in stuttering where males produce more disfluencies overall than females (Yairi & Seery, 2011), yet this is less prominent in normally fluent speakers. Although a difference between male and female speakers were non-significant, male speakers produced more disfluencies than female speakers in conversation (male SLD:  $M = 1.4$ , ND: 9.0; female SLD:  $M = 1.0$ , ND: 5.9). Such findings coincide with Bortfield et al. (2001) of males producing higher rates of disfluencies during conversation compared to females.

When considering sex differences in types of disfluencies, previous researchers such as Bortfield and colleagues (2001) found “fillers” (interjections) to be more prevalent in male than female speakers. Shriberg (1996) also reported men to



correlate with “fillers” more so than women. The current results for male and female groups in conversation showed that interjections had the highest percentage of disfluencies per 100 syllables in both groups and even more so for males (males,  $M = 4.9$ ; females,  $M = 3.0$ ), but this was not evident in the context of reading.

Interestingly, sex difference were not found for stuttering-like and normal disfluencies in reading. This is shown in identical measures of disfluency percentages for male and female speakers (SLD: 0.1, ND: 0.4) and is clearly illustrated in Figure 7. In the assessment of developmental stuttering, sex differences are considered red flags (Yairi & Seery, 2011). Having an understanding of sex and fluency in the healthy ageing population would be beneficial in identifying those with an increased risk of deficits in their speech. Currently, the literature indicates no significant difference between sexes and disfluencies produced by normally fluent older speakers. From the current findings represented in percentage of disfluencies, it appears that there may be a sex difference in conversation, males presenting with more disfluencies than females, but lacks statistical significance. For clinical purposes such as assessing stuttering, sex appears to not be an influential factor on disfluencies presented in older New Zealand speakers.

#### **4.4 Disfluencies and Contributing Factors**

*Hypothesis 4: We hypothesis that more disfluencies will occur in speakers with less years of education (Searl et al., 2002) and speakers with lower MoCA scores (Engelhardt et al., 2013).*

To our knowledge, no previous studies have investigated the relationship between disfluencies and years of education. Education levels/years of education are often reported on, but not considered as a potential predictor of disfluencies.

Therefore the current study sought to investigate a possible relationship. No significant findings were shown between disfluencies and years of education for conversation and reading, thus may not be an influential factor to consider when assessing disfluency.

Cognitive functioning was assessed using MoCA scores and was used as an inclusion criteria for the current study (normal < 26). These scores of normal cognitive functioning ranging from 26 to 30 were then considered as a potential influential factor on disfluency, thus was examined. From the literature, Engelhardt, et al. (2013) indicated relationships between disfluency types and cognitive functions of inhibition and intelligence. Alike, this study found a significant connection between disfluencies in conversation and MoCA scores, cognitive functioning of 8 domains. The relationship showed that as MoCA scores increased, disfluencies in conversation decreased. These findings suggest that older people who are higher in cognitive functioning produce less disfluencies than those with lower cognitive scores. This was found to be exclusive to conversation as no significant relationship between disfluencies and MoCA scores was shown in reading. The literature states that severely low cognitive functioning is associated with high levels of stuttering (Van Riper, 1982). Our findings indicate that this trend may also be relevant to cognitively intact PWDS in that cognitive decline, moving towards a mild cognitive impairment, may lead to an increase in normal disfluencies.

#### **4.5 Types of Disfluencies**

*Hypothesis 5: We hypothesise that interjections and revisions will occur the most in conversation within the population 60+.*

As confirmed in the literature, normal disfluencies generally occur more frequently than stuttering-like disfluencies. For types of normal disfluency in normally fluent older speakers, interjections/fillers demonstrate the highest rates (Bortfield et al., 2001), followed by revisions (Caruso, McClowry, & Max, 1997; Duchin & Mysak, 1987; Leeper & Culatta, 1995; Manning & Monte, 1981; Pindzola, 1990; Roberts et al., 2009; Searl et al., 2002; Yairi & Clifton, 1972). Interjections for this study included words (e.g., “like” “well”), phrases (e.g., “I mean”) and sounds (e.g., “uh” and “um”) which falls under similar categorisation in previous studies, but may be considered as fillers and interjections (Manning & Monte, 1981) or fillers alone (Bortfield et al., 2001; Yairi & Clifton, 1972). Revisions were identified as an interruption with a change in a word or phrase (e.g., “There is a ball, **a snowball**”).

Following the examination of disfluency types among the current older participants, results confirmed interjections to occur most frequently in conversation which corresponds with previous research with older speakers. Interjections may be the most frequently occurring disfluency in conversation due to pragmatic functions of turn-taking and the need to *hold the floor* (Fox Tree & Clark, 1997). Unlike previous studies, the analysis on disfluency type included pauses (a silent period longer than 1 second) between words of the speaker. Pauses were the second most frequent disfluency produced by speakers, followed by revisions. Agreement with previous studies on revisions following interjections in frequency of occurrence can be achieved with the removal of pauses in the current study. Pauses and repetitions have been suggested to be the result of processing difficulties such as word retrieval or planning (Fox Tree & Clark, 2007) which may be relevant to the older population or the possibility of cognitive scores at the lower end of normal. The additional normal disfluency of pauses provides the literature with further information on

fluency in the healthy ageing population which previous studies have failed to include. This study also provides detailed descriptions for coding different types of disfluencies with high inter/intra rater reliability agreement, making it easier and more reliable for future use of disfluencies coded.

Clinicians assessing patients/clients investigate which disfluencies are the most frequent to determine typical and atypical speech characteristics. In reference to the literature of disfluency types, it is commonly known that high rates of interjections and revisions occur in PWDS regardless of age. The current results provides additional descriptive information on pauses frequently occurring in the healthy ageing population and may be considered in the clinical field when assessing all possible disfluencies affecting an older persons speech.

#### **4.6 Factors Associated with Stuttering-like Disfluencies in Conversation**

*Hypothesis 6: We hypothesise age, sex, years of education, cognitive scores, and normal disfluencies to be predictors of stuttering like disfluencies.*

To discover whether variables of age, sex, years of education, MoCA scores, and normal disfluencies were predictors of stuttering-like disfluencies, a multiple regression analysis was run. Clinically, this information would be beneficial in identifying which variables should be considered when a patient/client presents with disfluent speech. It was found that for both conversation and reading, normal disfluencies were the only significant predictors of stuttering-like disfluencies. This information may assist the clinician confronted with a patient/client whose speech may appear typical, due to normal disfluencies produced, but may in fact have an acquired communication disorder. The clinician may then predict stuttering-like disfluencies to occur and investigate further to establish whether this is indicative of

atypical speech. No significance relationship demonstrated between disfluencies and age, sex, years of education, and cognitive scores allows for less variation in an older person's speech, and therefore would make assessment more straight-forward.

Findings obtained from the older New Zealand English speakers 60+ indicated no change in stuttering-like and normal disfluencies across age in conversation, yet a small significant increase was found in reading for normal disfluencies. Variables of sex and years of education showed no significant relationship with total disfluencies produced across age, yet a significant relationship between cognitive scores and total disfluencies was revealed, indicating that speakers with higher cognitive scores produced less disfluencies. Factors of age, sex, years of education, and cognitive scores were not significant predictors of stuttering-like disfluencies, however normal disfluencies were highly significant predictors. Normative data is limited for the ageing population 60+, therefore this study is a valuable addition to the literature as the current study offers normative data for older New Zealand speakers and information regarding factors that may influence disfluencies.

#### **4.7 Limitations**

This study included a large sample size of 115 participants aged 60-91. Normative data for older New Zealand speakers was established which provides an important starting point for New Zealand literature. Limitations to the current study do however impact the generalisation of results. Participants over the age of 80 years was limited to 11 participants and the male to female ratio was unequal (30 male and 85 female participants).

Limitations to the methodology, specifically automatic calculation completed from computer software, should be considered. As this study calculated percentage of

disfluencies per 100 syllables, following Robert et al. (2009), syllables were automatically counted on LaBBCAT software. Currently the database does not entail all words spoken by participants such as New Zealand places (e.g., Whangarei) or certain names of people (e.g., McCracken), consequently these were excluded from the syllable count. When reviewed manually the difference was not substantial (e.g., 1-4 syllables per participant) but may have an effect on the accuracy of disfluency percentages.

#### **4.8 Directions for Future Research**

The focus of the current study was to investigate the presence of normal and stuttering-like disfluencies in participants between 60 and 91 years of age. Further investigation is required regarding older participants over the age of 80 years as the majority of participants in this study were between 60 and 80 years of age. Future research should also consider comparative data between normally fluent older speakers and older speakers who stutter. Analysis between healthy and cognitively impaired older speakers may also be conducted as the current study excluded participants with cognitive deficits.

#### **4.9 Conclusions**

The current study provides further confirmation regarding frequency and types of disfluencies produced in older PWDS in addition to data regarding pauses as this type of disfluencies is not commonly considered. As 115 participants were examined in this study, the large sample size consolidates findings for older adults 60+. Information for relationships between factors of age, sex, years of education, and cognitive functioning is now provided due to the analysis of the current study. Factors previously mentioned as well as normal disfluencies were also further analysed to

determine potential predictors of stuttering-like disfluencies for clinical purposes of assessment. It was found that normal disfluencies were considered a strong predictor. The large sample size encourages generalisation of results between ages 60-80 years. The findings from this study are valuable to the literature due to additional analysis and normative data provided for older New Zealand speakers.

Disfluencies in conversation across age showed no significant difference, but showed a slight significant increase in normal disfluencies when reading with age. No change in disfluencies across age clinically would not require norms when assessing, however may be required for reading. Although male speakers produced more disfluencies than female speakers in conversation, these findings showed no significant difference between male and female speakers, possibly due to unequal male to female ratio. In the context of reading, it was interesting to find that male and female speakers had equal percentage of disfluencies. It appears a sex difference is still unclear in older healthy speakers for normal and stuttering-like disfluencies. No significant difference was found for years of education, yet a significant relationship was observed in cognitive functioning which showed that as MoCA scores increased, normal disfluencies decreased. Information on cognitive scores may assist in our understanding in the cause/onset of these disfluencies. In terms of predictors of stuttering-like disfluencies, normal disfluencies were highly significant in conversation and reading as is worth considering clinically. Findings from this study provide further information on disfluency characteristics and variables of age, sex, years of education, and cognitive scores in older New Zealand speakers 60+ for clinical practice.

## References

- Ambrose, N., & Yairi, E. (1999). Normative disfluency data for early childhood stuttering. *Journal of Speech, Language, and Hearing Research, 42*, 895-909.
- American Speech-Language-Hearing Association. (2015). Stuttering. Retrieved from <http://www.asha.org/public/speech/disorders/stuttering/>
- Andrew, G., & Ingham, R.J. (1971). Stuttering: Considerations in the evaluation of treatment. *British Journal of Communication, 6*, 129-138.
- Baayen, R.H., Piepenbrock, R., & Gulikers, L. (1996). CELEX2 [cd-rom] (Linguistic Data Consortium, Philadelphia, PA)
- Bortfield, H., Leon, S.D., Bloom, J.E., Schober, M.F., & Brennan, S.E. (2001). Disfluency rate in conversation: Effects of age, relationship, topic, role, and gender. *Journal of Language and Speech, 44*(2), 123-147.
- Boersma, P., & Weenink, D. (2012). "Praat: doing phonetics by computer," Version 5.3.04, <http://www.praat.org/> (date last viewed: 10/08/15).
- Caruso, A.J., McClowry, M.A., & Max, L. (1997). Age-related effects on speech fluency. *Seminars in Speech, Language and Hearing, 18*, 171-180.
- Conture, E.G. (1982). *Stuttering* (1<sup>st</sup> ed.). Englewood Cliffs, NJ: Prentice Hall.
- Craig, A., Hancock, K., Tran, Y., Craig, M., & Peters, K. (2002). Epidemiology of stuttering in the communication across the entire life span. *Journal of Speech, Language and Hearing Research, 45*, 1097–1105



- Duchin, S.W., & Mysak, E.D. (1987). Disfluency and rate characteristics of young adult, middle-aged, and older males. *Journal of Communication Disorders, 20*, 245-257.
- Engelhardt, P.E., Nigg, J.T., & Ferreira, F. (2013). Is the fluency of language outputs related to individual differences in intelligence and executive function? *Acta Psychologica Amsterdam, 144*(2), 424-432.
- Fletcher, A.R., McAuliffe, M.J., Lansford, K.L., & Liss, J.M. (2015). The relationship between speech segment duration and vowel centralization in a group of older speakers. *Journal of the Acoustical Society of America, 138*(4), 2132-2139.
- Fox Tree, J.E., & Clark, H.H. (1997). Pronouncing “the” and “thee” to signal problems in speaking. *Cognition, 62*, 151-167.
- Franck, A.L., Jackson, R. A., Pimentel, J.T., & Greenwood, G.S. (2003). School-age children’s perceptions of a person who stutters. *Journal of Fluency Disorders, 28*, 1-15.
- Fromont, R., & Hay, J. (2008). “ONZE Miner: the development of a browser-based research tool,” *Corpora, 3*, 173–193.
- Guitar, B. (1998). *Stuttering: An integrated approach to its nature and treatment* (2nd ed.). Baltimore, MD: Lippincott Williams & Wilkins.
- Horton, W.S., Spieler, D.H., & Shriberg, E. (2010). A corpus analysis of patterns of age-related change in conversational speech. *Psychology of aging, 25*(3), 708-713.
- Johnson, W. (1961). Measurements of oral reading and speaking rate and disfluency of adult male and female stutterers and nonstutterers.

*Journal of Speech and Hearing Disorders, Manograph Supplement, 7,*  
1-20.

Jones, M., Onslow, M., Harrison, E., & Packman, A. (2000). Treating stuttering in young children: Predicting treatment time in the lidcombe program. *Journal of Speech, Language, and Hearing Research, 43*(6), 1440-1450.

Leeper, L.H., & Culatta, R. (1995). Speech fluency: effect of age, gender and context. *Folia Phoniatica et Logopedia, 47*, 1-14.

Manning, W.H., & Monte, K.L. (1981). Fluency breaks in older speakers: Implications for a model of stuttering throughout the life cycle. *Journal of Fluency Disorders, 6*, 35-48.

Mulligans, H.F., Anderson, T.J., Jones, R.D., Williams, M.J., & Donaldson, I.M. (2001). Dysfluency and involuntary movements: A new look at developmental stuttering. *International Journal of Neuroscience, 109*, 23-46.

Nasreddine, Z.S., Phillips, N.A., Bédirian, V., Charbonneau, S., Whitehead, V., Collin, I., Cummings, J.L., & Chertkow, H. (2005). The Montreal Cognitive Assessment, MoCA: A brief screening tool for mild cognitive impairment. *Journal of American Geriatric Society, 53*(4), 695-699.

Pindzola, R.H. (1990). Dysfluency characteristics of aged normal-speaking black and white males. *Journal of Fluency Disorders, 15*, 235-243.

Postma, A., & Kolk, H. (1993). The covert repair hypothesis. *Journal of Speech, Language, and Hearing Research, 36*, 472-487.

- Peterson, G.E., & Lehiste, I. (1960). Duration of syllable nuclei in English. *Journal of the Acoustical Society of America*, 32, 693-703.
- Ramig, L.A. (1986). Aging speech: Physiological and sociological aspects. *Journal of Speech, Language and Hearing Research*, 16, 118-123.
- Rastle, K.G., & Burke, D.M. (1996). Priming the tip of the tongue: Effects of prior processing on word retrieval in young and older adults. *Journal of Memory and Language*, 35, 586-605.
- Riley, G. (2009). *The stuttering severity instrument for adults and children (SSI-4)* (4th ed.). Austin, TX: PRO-ED.
- Roberts, P.M., Meltzer, A., & Wilding, J. (2009). Disfluencies in non-stuttering adults across sample lengths and topics. *Journal of Communication Disorders*, 42, 414-427.
- Sandson, J., Obler, L.K., & Albert, M.L. (1987). Language changes in healthy aging and dementia. In Rosenberg, S. (ed.). *Advances in applied psycholinguistic* (pp. 264-292). New York, NY: Oxford University Press.
- Searl, J.P., Gabel, R.M., & Fulks, J.S. (2002). Speech disfluency in centenarians. *Journal of Communication Disorders*, 35, 383-392.
- Shriberg, E. (1996). Disfluencies in Switchboard. Speech Technology and Research Laboratory, SRI International. Menlo Park, CA
- Smith, B.L., Wasowicz, J., & Preston, J. (1987). Temporal characteristics of the speech of normal elderly adults. *Journal of Speech and Hearing Research*, 30, 522-529.
- Starkweather, C. (1987) *Fluency and Stuttering*. Englewood Cliffs, NJ: Prentice Hall, Inc.

- Starkweather, C.W., & Givens-Ackerman, J. (1997). *Stuttering: Pro-ed studies in communicative disorders*. Shoal Creek Boulevard, TX: Austin.
- Statistics New Zealand. (2013). How will New Zealand's ageing population affect the property market. Retrieved from [http://www.stats.govt.nz/browse\\_for\\_stats/population/estimates\\_and\\_projections/ageing-population-property-market.aspx](http://www.stats.govt.nz/browse_for_stats/population/estimates_and_projections/ageing-population-property-market.aspx)
- The Stuttering Foundation. (2016). Five myths about stuttering. Retrieved from <http://www.stutteringhelp.org/five-myths-about-stuttering>
- Van Riper, C. (1971). *The nature of stuttering*. Englewood Cliffs, NJ: Prentice-Hall.
- Yairi, E., & Clifton, N.F. (1972). Disfluency rates and patterns of stutters and nonstutters. *Journal of Communication Disorders*, 5, 225-231.
- Yairi, E., & Ambrose, N. (1992). Onset of stuttering in preschool children: Selected factors. *Journal of Speech and Hearing research*, 35, 755-760.
- Yairi, E., & Seery, C.H. (2011). *Stuttering: Foundations and clinical applications*. Upper Saddle River, NJ: Pearson.
- Stuttering Answers. (2008). Manual for the Lidcombe program of early stuttering intervention. Retrieved from <http://www.stuttering-answers.com/Lidcombe-Program-for-Childhood-Stuttering.html>

## Appendices

### Appendix A. The Grandfather Passage

You wished to know all about my grandfather. Well, he is nearly ninety-three years old yet he still thinks as swiftly as ever. He dresses himself in an old black frock coat, usually with several buttons missing. A long, beard clings to his chin, giving those who observe him a pronounced feeling of the utmost respect. Twice each day he plays skilfully and with zest upon a small organ. Except in the winter when the snow or ice prevents, he slowly takes a short walk in the open air each day. We have often urged him to walk more and smoke less, but he always answers, "Banana Oil!" Grandfather likes to be modern in his language.

## Appendix B. Participant's Biographical Information

Participant	Sex	Age	Language	Occupation	Highest Qualification Rating	Years of Education	MOCA
1000SCN	F	76	English (NZ)	Typist	None	10	26
1004SCN	F	68	English (NZ)	Clerical work	Sixth form	12	29
1005SCN	F	72	English (NZ)	Dental nurse	Dental nurse training	14	28
1007SCN	F	66	English (NZ)	Research supervisor	School certificate	13	29
1010SCN	M	66	English (NZ)	Accountant	B. Comm	14	29
1013SCN	F	68	English (NZ)	Hotel worker	None	7	28
1015SCN	F	75	English (NZ)	Secretary	B.A (Hons)	15	26
1018SCN	F	77	English (NZ)	Nurse	None	10	29
1022SCN	F	68	English (NZ)	Manager	High School qualification	14	30
1025SCN	F	76	English (NZ)	Physiotherapist	Undergraduate certificate	14	26
1028SCN	F	70	English (NZ)	Cytotechnologist	Undergraduate diploma	12	27
1029SCN	F	69	English (NZ)	Biochemist	B.Sc	17	27
1030SCN	M	85	English (NZ)	Business owner	None	12	26
1035SCN	F	71	English (NZ)	Grocer	Certificate in social work	15	26
1040SCN	F	69	English (NZ)	Accountant	High school qualification	12	30
1045SCN	F	64	English (NZ)	Housewife	High school qualification	13	26
1046SCN	F	66	English (NZ)	Phlebotomist	Nursing training	13	26
1064SCN	F	67	English (NZ)	Primary school teacher	Undergraduate certificate	14	29
1070SCN	F	69	English (NZ)	Lawyer	LLB	17	30
1090SCN	F	73	English (NZ)	Acupuncturist	None	9	29
1093SCN	M	67	English (NZ)	Agricultural researcher	B.Sc	17	26
1094SCN	F	76	English (NZ)	Office accounts clerk	None	11	30
1097SCN	F	82	English (NZ)	Teacher	Teacher's college certificate	12	28
1098SCN	M	77	English (NZ)	Business owner	Trade certificate	10	27
1105SCN	F	68	English (NZ)	New Zealand post counter staff	None	11	29

1106SCN	F	70	English (NZ)	House wife	High school qualification	12	26
1111SCN	M	70	English (NZ)	Electronics technician	Certificate in electronics	16	28
1127SCN	F	80	English (NZ)	Teacher	B.A	13	30
1128SCN	M	80	English (NZ)	Minister of religion	PHD	21	30
1130SCN	F	74	English (NZ)	Administrator	School certificate	10	28
1141SCN	F	73	English (NZ)	Professional actress	B.A	14	29
1145SCN	F	70	English (NZ)	Architectural draftsmen	School certificate	12	30
1149SCN	F	66	English (NZ)	Office worker	None	10	29
1152SCN	F	66	English (NZ)	Medical laboratory technician	Diploma	15	28
1155SCN	M	67	English (NZ)	Farmer	Sixth form	13	28
1161SCN	M	70	English (NZ)	Aircraft engineer	Vocational qualification	20	28
1162SCN	F	70	English (NZ)	Lawyer	Undergraduate degree	19	26
1163SCN	F	70	English (NZ)	Dietician, market researcher	Undergraduate diploma	13	27
1164SCN	F	71	English (NZ)	Accounts clerk	None	10	26
1165SCN	F	71	English (NZ)	Typist	High School qualification	10	28
1168SCN	F	71	English (NZ)	Housewife, counsellor	Counselling certs	16	28
1175SCN	M	70	English (NZ)	Travel agent	High School qualification	12	29
1197SCN	M	90	English (NZ)	Pilot, air traffic controller	High School qualification	13	26
1240SCN	F	67	English (NZ)	Physiotherapist	Undergraduate diploma	12	29
1252SCN	M	81	English (NZ)	Cabinet maker	Apprenticeship	12	26
1256SCN	F	74	English (NZ)	Teacher	Teaching degree	15	29
1273SCN	F	75	English (NZ)	Librarian	Librarian diploma	13	27
1278SCN	M	75	English (NZ)	Farming and agriculture	High School qualification	16	28
1283SCN	M	75	English (NZ) Maori	Aircraft engineer	High School qualification	12	29
1292SCN	F	72	English (NZ)	Homemaker	School certificate	10	27
1304SCN	M	78	English (NZ)	Farmer	High School qualification	10	27
1306SCN	F	65	English (NZ)	Nurse aide	High School qualification	11	29
1310SCN	M	68	English (NZ)	Bank work	University degree	17	28
1344SCN	F	71	English (NZ)	Housewife	None	11	30

1346SCN	F	72	English (NZ)	Nurse	Nursing diploma	14	28
1347SCN	F	71	English (NZ)	Pharmacist	BSc	16	29
1360SCN	F	71	English (NZ)	Nurse	Nursing diploma	13	27
1374SCN	F	75	English (NZ)	Journalist	University qualification	14	27
1376SCN	M	75	English (NZ)	Accounting	Undergraduate degree	20	28
1377SCN	F	80	English (NZ)	Librarian	University degree	11	27
1384SCN	F	74	English (NZ)	Secretary	Diploma commercial teaching	13	29
1385SCN	M	78	English (NZ)	Railway engine driver	None	11	27
1386SCN	F	67	English (NZ)	Retail assistant	None	11	29
1387SCN	M	73	English (NZ)	Teacher	University degree	15	26
1391SCN	F	78	English (NZ)	Teacher	Teacher's college certificate	15	26
1395SCN	F	65	English (NZ)	IT technician	BSc (Hons)	17	30
1396SCN	F	65	English (NZ)	Broadcaster, post grad coordinator	Higher qualification	15	27
1398SCN	F	66	English (NZ)	School teacher	Teacher's college certificate	14	29
1403SCN	F	75	English (NZ)	Lab assistant	None	8	27
1407SCN	M	71	English (NZ)	Boiler operator	Vocational qualification	12	28
1409SCN	F	69	English (NZ)	Physiotherapist	Diploma	16	30
1413SCN	F	76	English (NZ)	Nurse	Nursing qualification	13	28
1425SCN	F	66	English (NZ)	Teacher	Higher qualification	12	29
1430SCN	M	66	English (NZ)	High school counsellor	MA x 2	21	28
1435SCN	F	66	English (NZ)	Registered nurse	B.A	17	28
1440SCN	F	67	English (NZ)	Adult educator	Higher qualification	15	28
1442SCN	F	74	English (NZ)	Teacher	Teacher's college certificate	13	28
1451SCN	F	66	English (NZ)	Physiotherapist	Physio training	14	30
1453SCN	M	68	English (NZ)	Teacher	University degree	20	29
1456SCN	F	80	English (NZ)	Teacher	PHD	20	27
1459SCN	F	78	English (NZ)	Homemaker	High school qualification	12	29
1461SCN	F	68	English (NZ)	Teacher	Higher dip. Teaching	15	27
1463SCN	M	67	English (NZ)	Photographer	School certificate	10	27



1466SCN	F	72	English (NZ)	Homemaker	High school qualification	12	30
1472SCN	F	82	English (NZ)	Homemaker	Nursing training	13	26
1474SCN	M	72	English (NZ)	Veterinary surgeon	University qualification	16	27
1478SCN	M	69	English (NZ)	Engineer	Undergraduate degree	18	26
1483SCN	M	71	English (NZ)	Minister of religion	University	13	26
1492SCN	F	72	English (NZ)	Midwife	Nursing qualification	12	30
1494SCN	F	69	English (NZ)	Nurse	University degree	17	28
1506SCN	M	65	English (NZ)	Wool industry	Higher qualification	13	26
1507SCN	F	67	English (NZ)	Homemaker	High school qualification	15	28
1524SCN	M	70	English (NZ)	Farmer	Vocational qualification	11	27
1525SCN	F	70	English (NZ)	Real estate agent	High school qualification	12	28
1528SCN	F	71	English (NZ)	Author, lace spinner/weaver	B.A (fine arts)	15	27
1538SCN	F	82	English (NZ)	Homemaker	None	8	26
1543SCN	F	79	English (NZ)	Manger/Business owner	None	10	27
1547SCN	M	72	English (NZ)	Computer industry	Highest school qualification	13	26
1551SCN	F	67	English (NZ)	Physiotherapist	Vocational qualification	14.5	27
1555SCN	F	77	English (NZ)	Teacher aide	None	10	28
1558SCN	M	71	English (NZ)	Consultant	Vocational qualification	11.5	26
1559SCN	F	71	English (NZ)	Teacher	Vocational qualification	13	26
1564SCN	F	66	English (NZ)	Office administrator	Highest school qualification	11	28
1565SCN	M	70	English (NZ)	Property investor	B.A	13	28
1573SCN	F	66	English (NZ)	Teacher	MA (Hons)	18	28
1578SCN	F	70	English (NZ)	Clerk	Vocational qualification	11	28
1583SCN	F	83	English (NZ)	Teacher	Vocational qualification	14	29
1586SCN	F	78	English (NZ)	Teacher	Vocational qualification	14	26
1590SCN	F	65	English (NZ)	Retail	Vocational qualification	10.5	27
1595SCN	F	74	English (NZ) Maori	University lecturer	University degree	16	27
1597SCN	F	71	English (NZ)	Social worker	Teaching certificate	14	27
1606SCN	F	69	English (NZ)	Office worker/dress designer	School certificate	11	27

1620SCN	F	70	English (NZ)	Teacher	Higher qualification	15	27
1625SCN	F	72	English (NZ)	Clerk	Higher qualification	14	28
1630SCN	F	91	English (NZ)	Homemaker	None	10	26

### Appendix C. Coding Protocol

TYPE OF DISFLUENCIES	CODE	EXAMPLE
<b>STUTTERING-LIKE DISFLUENCIES</b>		
Sound Repetition*	SoR	<p>Where is the <b>c-c-c-cup</b>?</p> <p>The first sound of a word occurs twice or more.</p>
Syllable Repetition*	SyR	<p>Where is the <b>cu-cu-cu-cup</b>?</p> <p>The first syllable of a word occurs twice or more.</p>
Mono-syllabic Word Repetition	WR	<p>Where <b>is is</b> the cup? It was <b>a a a a</b> bear.</p> <p>Single syllable word occurs twice or more.</p>
Prolongations*	Pro	<p><b>(Sssss)omething</b> is prolonged.</p> <p>Sound or airflow continues, but movement of articulators is stopped.</p> <p>An audible extension of a sound. Most common on fricatives /f/ /s/ 'sh'.</p> <p>Does not include interjections that have sounds prolonged e.g., "uhhhhhh".</p>
Blocks*	B	<p>...Something is blocked. (there is a build-up of pressure/tension, no sound is coming out or the sound that comes out is unrelated to the word)</p> <p>And abrupt stopping of the flow of air or voice usually at the beginning of words.</p>
<b>NORMAL DISFLUENCIES</b>		
multi-syllabic word repetition	MSR	<p>Bring me the <b>guitar guitar</b>.</p> <p>A word with more than one syllable occurs twice or more.</p>

Interjection/filler	Int	Bring me the <b>um</b> guitar.  Sounds: “um, uh, ah, er, mmm”  Words: “like, well, so”  Phrases: “You know” “I mean”
Disfluent Pause	P	It is ...\$300.  A silent period longer than 1 second.
Articulation Rate Pause <sup>a</sup>	ARP	A silent period equal to or greater than 50ms
Revision*	R	There is a ball, <b>a snowball</b> .  A sentence is interrupted with a change in a word or phrase.
Broken Words*	BW	There is a <b>snow_ball</b> . (usually happens when the person is thinking or wants to stress about something; no tension build up)  A silent gap or stopping within a word equal to or greater than 250ms
Part-sentence Repetition	PSR	He is coming, <b>he is coming</b> , home.  Phrase repeated once or more.
Unfinished Sentence*	US	<b>I went to...</b> It was fun.  Abandoned sentence.

\* Manually coded disfluencies

<sup>a</sup> Not used in the current study

## Appendix D. Additional Disfluency Criteria

Criteria adapted from Manning and Monte (1981) and Roberts, Meltzer and Wilding (2009) were used to determine disfluencies.

- 1) A word revision was counted if the speaker began to say a word and then changed it to another word before completing the initial word.
- 2) If the speaker paused and repeated part of the phrase following a filler, it was counted as a phrase revision: “it is uh, . . . it is really enjoyable.”
- 3) If the speaker interjected a phrase it was not counted as a disfluency: “I’d sit in the water about, it’s a heated pool, stay in the water about five minutes.”
- 4) Questions asked by the speaker were counted as part of the speech sample.
- 5) If the experimenter’s questions or prompt caused the speaker to pause and repeat a phrase it was not counted as a fluency break.
- 6) “Um” and “uh” were counted as fillers when the speaker could not immediately remember something.
- 7) If the speaker changes a word which seemed to be a cause of lapse of memory it was not counted as a fluency break: “She is eighty, eighty-two years old.”
- 8) If a word was repeated for emphasis it was not counted as a disfluency: “it was really really nice.”
- 9) If a word was repeated as part of a response to the experimenter’s question it was not counted as a disfluency: “yes, yes.”
- 10) Instances in which the speaker corrects an error (pronunciation or grammar) or begins an utterance but does not complete it was counted as a revision.