RAPID NAMING ABILITY IN CHILDREN

WHO STUTTER

MS. JEMY SARA JOSE

PO1II22S123012

A Dissertation Submitted in Part of Fulfilment of the Degree of

Master of Science (Speech Language Pathology)

University of Mysore

Mysore

ALL INDIA INSTITUTE OF SPEECH AND HEARING,

MANSAGANGOTHRI,

MYSORE-570006

JULY, 2024

CERTIFICATE

This is to certify that this dissertation entitled "**RAPID NAMING ABILITY IN CHILDREN WHO STUTTER"** is a bonafide work submitted in Part of Fulfilment of the Degree of Master of Science (Speech Language Pathology) of the student Registration number: PO1II22S123012. This has been carried out under the guidance of the faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru

July, 2024

Dr. M. Pushpavathi

Director

AIISH, Manasagangothri

Mysore-570006

CERTIFICATE

This is to certify that this dissertation entitled **"RAPID NAMING ABILITY IN CHILDREN WHO STUTTER" is** a bonafide work submitted in Part of Fulfilment of The Degree of Master of Science (Speech Language Pathology) of the student Registration number: PO1II22S123012. This has been carried out under my supervision and guidance. It is also been certified that this dissertation has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru

July, 2024

Dr. Sangeetha Mahesh

Guide

Associate professor

AIISH, Manasagangothri

Mysore-570006

CERTIFICATE

This is to certify that this dissertation entitled **"RAPID NAMING ABILITY IN CHILDREN WHO STUTTER"** is the result of my own study under the guidance of Dr. Sangeetha Mahesh, Associate Professor, All India Institute of Speech and Hearing, Mysuru. This has not been submitted earlier to any other University for the award of any other Diploma or Degree.

Mysuru	**Registration No:**
July, 2024	**PO1II22S123012**

Acknowledgment

"Give thanks in all circumstances; for this is God's will for you in Christ Jesus" 1 Thessalonians 5:18

Thank you, ***LORD Jesus Christ****, for Your unending love towards me. From birth to this point in life, you have been faithfully leading, protecting, and molding me for your perfect plan.*

I sincerely convey my gratitude to our honorable Director ma'am, Dr. M Pushpavathi, AIISH for permitting me to carry out this study.

I sincerely extend my gratitude to my guide, ***Dr Sangeetha Mahesh****, for her constant guidance and support throughout the dissertation journey. Thank you for being so patient and kind. I will always be grateful for your calm, joyful, yet perfect approach to students.*

I am thankful to ***Dr Vasanthalakshmi*** *for the guidance for statistical works. I would also like to thank all the* ***faculties, staff and non-staff members*** *of AIISH who directly and indirectly helped me throughout this PG journey.*

Sincere thanks to the headmasters of JSS Public School, Saraswatipuram and Govt School, Kukkarahalli for allowing me to conduct my study on the students.

I thank you, dearest ***Pappa & Mummy****, for your constant love, patience, care and non-judgmental attitude. I am so grateful to God for you.*

I thank my dearest friends, ***Riya, Sheena, Jemy, Elza, and Ivy*** *for your prayerful support from different places of the world. Your prayers definitely strengthened me to become who I am today.*

*Thank you, **Laya**, for your constant love and mastermind wisdom. From the first day of college till today, thank you for being my homie.*

*I thank my dearest friends in AIISH, **Mizba, Chinnu, Devu, Sniktha, Asheena, Ani, Aadu, Kummi….** you guys were awesome; I can't imagine being in AIISH and hostel without you. Love you so much.*

*I thank my dearest **Priyu, Sharon, Siri, and Toto** for being my friends become family, for being so patiently staying with me, encouraging me, and lifting me with your prayers. Thank you **Nanni** for being my sweet younger sister. Thank you dear **Jasper akka and Shiva akka** for your love, support and prayers. I am so grateful for all our times of fellowship and love, "Heaven on Earth".*

*I thank you dear **Jocy Chechi, Jerome Achacha, and Judy Chechi** & families for your love, support and prayers in my life.*

*I thank all my family in Christ in **Thadiyoor, Vellore and Mysore** for your prayers, especially **Aby uncle and Princy aunty**, all my **MTBC friends** for cheering me up and supporting me.*

*I thank you dear **Kavitha chechi, Aparna chechi, Stephy akka** for continuously helping me with all my studies and works. Thank you **Nisha** for being there for me.*

*Thank you dear **Nivi and Harshinee**, my dissertation partners for your continuous support.*

*Thank you, dearest '**A' Section batch**, you guys were amazing,*

YES! WE DID IT!!

Table of Contents

List of Tables

List of Figures

CHAPTER I

Introduction

Stuttering is a communicative impairment that externally manifests as an interruption during speech initiation (Bloodstein et al., 2021). One of the most common outward signs of stuttering is the repetition of words or sounds in which the first sound occurs more than once, the prolongation of sounds in which the first sound occurs earlier than the word ends, or blocks in which the first sound of a word is difficult to initiate.

Numerous research has examined the relationship between phonology and stuttering, which has acquired adequate relevance (Wolk et al., 1993; Nippold, 2002). Phonological encoding is the ability to quickly and accurately retrieve phonological representations. According to several theories, persons with stuttering undergo a breakdown or delay in the phonological segment construction process (Perkins et al., 1991; Postma & Kolk, 1993; Howell & Au-Yeung, 2002). The ways in which phonological encoding may affect the normal fluency of speech were studied by several theorists. Wingate (1988) suggested the fault-line hypothesis. He ascribed stuttering as a lag in the retrieval and encoding of syllable rhyme during the production of speech, leading to a fault line occurring where the syllable onset integrates with its rhyme. Perkins et al. (1991) introduced the “neuropsycholinguistic theory” in which they identified two factors as essential elements contributing to stuttering: 1) lack of temporal synchrony among the linguistic (lexical and phonological, supra-linguistic planning) and 2) time pressure.

“EXPLAN” another theory suggests that interruptions in fluent speech arise from temporal mismatches between the planning(PLAN) and execution (EX) stages of speech production (Howell, 2004). It is difficult to distinguish phonological encoding in different linguistic processes because it is intertwined with the process of language formulation. Although several theories regarding stuttering suggest that it might be a contributing factor, it is still a challenging process to witness firsthand (Meyer, 1992; Coles et al.,1995).

The term "phonological processing" is broad and includes skills like rapid automatic naming, phonological memory, and phonological awareness (Wagner et al., 1999). Phonological awareness is the ability to recognize, isolate, and combine the various sounds that make up a word. Rapid automatic naming is the ability to quickly retrieve information that has been phonetically coded by converting written symbols and pictures into a series of phonemes. Phonological memory is the process of storing phonological and auditory information for short-term retrieval (Wijnen & Boers, 1994; Weber-Fox et al., 2004; Sasisekaran & de Nil, 2006; Sasisekaran et al., 2006; Acheson & MacDonald, 2009).

The process of calculating phonological encoding typically involves utilizing a range of spoken and written language tasks that assess an individual's ability to process sounds found in their native language (Wagner & Torgesen, 1987). A few of the frequently employed phonological encoding tasks for children who stutter are phoneme monitoring, accuracy of phoneme identification, and phonological encoding efficiency speed during passive picture naming and auditory priming paradigm with picture naming (Melnick et al., 2003; Sasisekaran et al., 2006; Byrd et al., 2007). In recent years, reading non-words while using eye tracking to measure phonological encoding in light of explicit and still circumstances has been performed (Pelczarski et al., 2019).

Rapid automatic naming is the ability to rapidly retrieve coded phonetic information by converting orthographic symbols and pictures into a meaningful string of phonemes that represent entries in the mental lexicon (Manis et al., 1999; de Jong & Vrielink, 2004; Anthony et al., 2007). Deficiency in one of the sub-processes or their integrated use can cause RAN's sub-performance. Tests like the Comprehensive Test of Phonological Processing (CTOPP) are used to evaluate rapid naming (Wagner et al., 1999) Rapid Automatized Naming and Rapid Alternating Stimulus-RAN/RAS (Wolf & Denckla, 2005) rapid naming subsections of assessment tests like Clinical Evaluation of Language Fundamentals-4 (Semel-Mintz et al., 2003) and Kaufman Test of Educational Achievement II (Singer et al., 2012). Wolf and Denckla (2005) claimed that seven processes—attentional, visual, visual discrimination and pattern identification, integration with orthographic representations, integration with stored phonological representations, phonological access and retrieval, semantic and conceptual information activation and integration, and finally, motoric activation that results in articulation—are associated with rapid naming.

Need of the Study

A research by Pelczarski (2011) in adults who stutter concluded that the ineffective phonological assembly system and diminished capacity to create phonological codes were the causes of low performance of Rapid Automatized Naming. The findings indicated that naming colours and objects required a longer completion time among all the RAN tasks. This was explained by a number of factors, such as articulatory variations and motor sequencing deficits. Rapid serial naming tests are more difficult than single item picture naming tasks, which are typically used to evaluate phonological encoding in stuttering populations. It will be interesting to investigate the differences between a child who stutter and a child who does not stutter as the cognitive demands during each one of the RAN and RAS sub-tasks (alphanumeric tasks of numbers and letters, non-alphanumeric tasks of colors and objects, and rapid alternating stimulus) vary.

Adults who stutter participated in a study by Pothen et al. (2020) on their rapid naming abilities in the Indian setting. The results showed that people who stutter performed lower than those who did not stutter on all rapid naming subtasks, taking longer to name items. The outcomes were attributed to the individuals' challenges with oral motor planning and sequencing. Forming phonological segments is delayed as a result of this difficulty. Future research on the rapid naming ability in stuttering depending on the degree of stuttering severity, bilingualism's influence, and different age groups (children, adults, and elderly) is necessary, according to the study.

In a study by Pelczarski and Yaruss (2008) rapid automatic naming, phonological awareness, and phonological memory were examined in children who stutter. The data pattern showed that some children who stutter scored extremely well on rapid automatic naming tasks while an equal number performed on the lower end of normal, resulting in varying conclusions. A normative for Rapid Automatic Naming in Kannada in 6–8-year-old typically developing children has been made by Ranjini (2011). But there is a lack of Indian studies on rapid naming ability in children with stuttering. Therefore, this paves the way to the need of the present study.

Aim of the Study

The aim of the study is to compare the rapid automatized naming in 6-8 year-old children with and without Stuttering.

Objectives of the Study

The objectives of the study are as follows:

- To analyse and compare the ***percentage of stuttered syllables*** across tasks (spontaneous speech, RAN and RAS) and severity of stuttering.
- To analyze and compare the total time taken in ***Rapid Automatized Naming*** of Letters, Digits, Objects and Colors (RAN-L, RAN-D, RAN-O and RAN-C) between groups (children who stutter & children who do not stutter, and 6-7 & 7-8 years).
- To analyze and compare the total time taken in ***Rapid Alternating Stimuli*** naming of Digits-Letters & Colors- Digits-Letters (RAS-DL & RAS-CDL) between groups (children who stutter & children who do not stutter, and 6-7 & 7-8 years).
- To analyze and compare the ***accuracy of responses*** between groups (children who stutter & children who do not stutter, and 6-7 & 7-8 years) in each of the following tasks:

1) RAN-L, RAN-D, RAN-O and RAN-C
2) RAS-DL & RAS-CDL

Hypotheses of the Study

The study assumes null hypothesis for each of the objective as follows:

- There is no significant difference in the ***percentage of stuttered syllables*** across tasks (spontaneous speech, RAN and RAS) and severity of stuttering.

- There is no significant difference in the total time taken in ***Rapid Automatized Naming*** of Letters, Digits, Objects, and Colors (RAN-L, RAN-D, RAN-O, and RAN-C) between groups (CWS & CWNS, and 6-7 & 7-8 years).
- There is no significant difference in the total time taken in ***Rapid Alternating Stimuli*** naming of Digits-Letters & Colors- Digits-Letters (RAS-DL & RAS-CDL) between groups (CWS & CWNS, and 6-7 & 7-8 years).
- There is no significant difference in the ***accuracy of responses*** between groups (CWS & CWNS, and 6-7 & 7-8 years) in each of the following tasks:

1) RAN-L, RAN-D, RAN-O and RAN-C
2) RAS-DL & RAS-CDL

CHAPTER II

Review of Literature

Yairi and Ambrose (2005) defined stuttering as marked by unintended interruptions in fluent and rhythmic speech despite the speaker having precise awareness of what he/ she wants to communicate. These involuntary disruptions in speaking consist of prolongation of sounds, repetition of syllables, and inaudible blocks, which last from fleeting to several seconds. Perkins et al. (1991) describe stuttering as "...disturbances of speech encountered by the speaker as lack of control." The International Classification of Diseases given by WHO specifies stuttering as a "disorder in the rhythm of speech, where the person is sure of what he wants to express, but while expressing, he has difficulty to articulate it due to uncontrolled repetitive prolongation or stoppage of a sound." (WHO, 1980).

The primary behaviors that are the leading indicators of stuttered speech are known as core behaviors (Van Riper, 1982). Darley et al. (1978) identified these core behaviors as repeating part of a word; repeating an entire word; repeating a phrase; prolongations, blocks, or incomplete words; hesitations; syllable, word, or phrase interjections; revisions; and unfinished or discontinued phrases. Repetition is classified as one of the fundamental core characteristics of stuttering. Prolongation is another primary trait that is presented when the voice or the airstream persists while the articulators cease to move (Van Riper, 1982). Block is viewed as an additional primary behavior of stuttering. This appears when an abrupt termination of airflow or sound and articulator motion occurs.

Other disfluencies than the core behaviors are also a feature of stuttering. Yairi and Ambrose (1993) tried to distinguish stuttering behavior into stuttering-like disfluencies (SLDs) and other disfluencies (ODs), aiming to recognize the individuals with stuttering. SLDs comprise of repetitions (syllable and at word level), prolongations and blocks/ oral fixations and ODs are polysyllabic word repetitions, repetition of phrases, inserted sounds/ words, and revisions. The extent to which SLDs take place corresponding to the ODs facilitates the identification of stuttering.

2.1. Stuttering as a disruption in language

Several researchers have viewed the chance that stuttering is associated with impaired language skills in certain young children who experience fluency disorders. Various psycholinguistic models aim at distinct phases of linguistic processing as the “core” facilitating action, which may lead to disfluencies. Bloodstein’s psycholinguistic model of the initiation of stuttering aimed at the development of syntax in children. According to this concept, stuttering can make us aware of how, lately, human beings have obtained this element of language, which helps us to differentiate ourselves from animal communication (Bloodstein et al., 2021).

Wingate (1988) proposed his “Fault-Line Hypothesis”; he suggested that stuttering arises from a phonological encoding issue, which makes it hard for speakers to move between the initial sounds and the rimes of syllables, leading to stuttering. Findings that PWS process phrases based on syllables rather than utterances and that disfluencies usually begin on a consonant occurring on the first stressed syllable are the basis for the Fault-Line hypothesis.

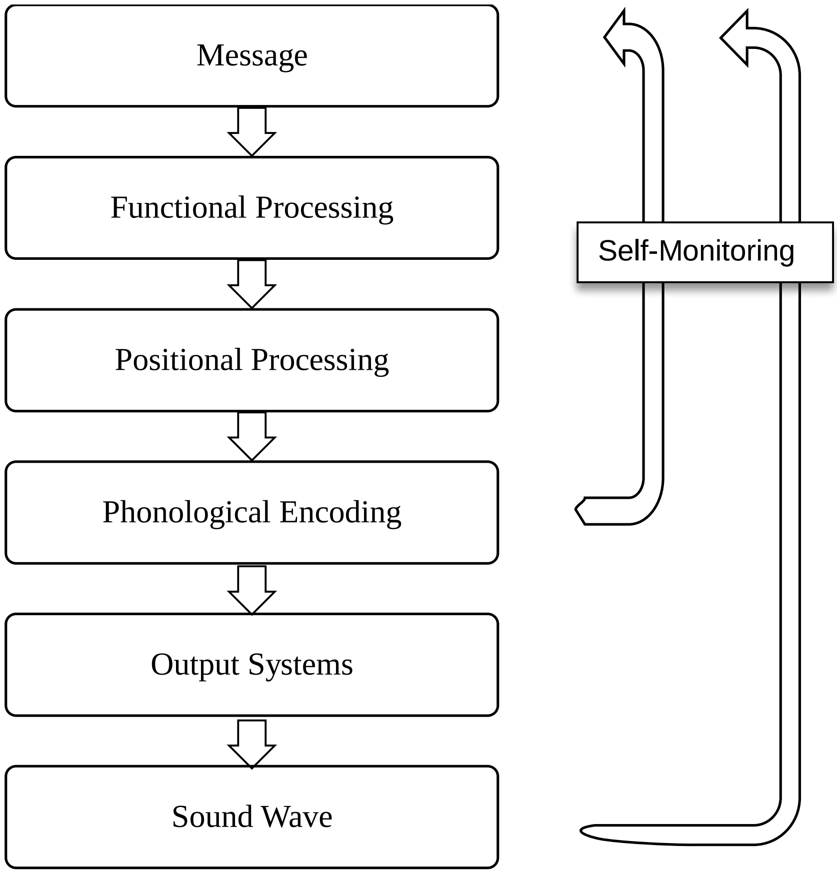
A neuropsycholinguistic function model (Perkins et al., 1991) the fully developed model of stuttering, was created by combining previously existing models of speech output with the brain substrates of segmental (linguistic) and paralinguistic (prosodic) aspects. They postulated that when segmental and supra-segmental information comes dyssynchronous, for example, when a syllable frame has been determined but its exact phonological contents are not yet known, fluency breakdowns of any type will occur. However, in this approach, the speaker's self-perception of time pressure and lack of control is necessary to differentiate between stuttering and normal fluency difficulties. According to the model, there is a greater chance of losing control when there is a lag in transmitting the prosodic/paralinguistic envelope that the speech segments need to be included into (Bloodstein et al., 2021).

The execution and planning model [EXPLAN] (Howell, 2004), integrates theories regarding the dyssynchrony in the planning and execution of speech constituents with the likely "epicenter" of planning challenges (possibly the lexical or phonetic complexity) (Howell & Au-Yeung, 2002). The theory distinguishes between the motor execution of speech elements and language planning, which are believed to overlap in natural language production. This enables the planning of subsequent words or parts while the motor output of the previous part is being produced (Bloodstein et al., 2021).

Bloodstein (2021) describes the covert repair hypothesis among the most prevalent psycholinguistic models of stuttering in the past few years (Kolk & Postma, 1997; Postma & Kolk, 1993), which uses Levelt's (1999) established model of healthy speech production. Stuttering-like signs are probably caused by the "internal monitor" in this model, which is the CRH's primary focus. Figure 2.1

Figure 2.1

Model of Speech Production proposed by Levelt et al. (1999).



depicts the several serial and parallel processes occurring in normal speech production. The hyper-vigilant internal monitor, according to Kolk and Postma (1997), tries to correct utterances that include actual or possible mistakes before actual articulation. This leads to blockages and repetitions that characterize stuttering speech. There have been attempts to expand the prediction of the CRH model to children, even though it centres on adult speech and language performance. Baktiar et al. (2007) did not identify variations in error rates across a group of children who stuttered and those who did not. They used a non-word repetition test. It has been proposed that the onset of stuttering is caused by a high level of post-articulatory monitoring of typical disfluencies, which is made worse in young children who stutter due to challenges with linguistic encoding (Bloodstein et al.,2021).

According to these theories, stuttering behaviors are caused by linguistic encoding, organizing, executing, and/or surveillance issues. While some models pinpoint the exact locations of these language disturbances, others offer plausible explanations—like loss of control or variability—that could harm linguistic encoding and expression (Bloodstein et al., 2021).

2.2. Stuttering and Rate of Speech

Blomgren & Goberman, (2008**)** explains that stuttering individuals will stutter less frequently if they reduce their speech rate, according to a consensus regarding the temporal aspects of speech production (e.g., Andrews & Harris, 1964; Boberg, 1976; Boberg & Kully, 1985; Johnson & Rosen, 1937; Onslow et al., 1996; Runyan & Runyan, 1986; Webster, 1980). Additionally, it has long been known that stuttering usually increases with speech rate (e.g., Bloodstein, 1944; Howell et al., 2004).

2.3. Phonological Processing Skills

The use of a language's phonemes, or sounds, to process spoken and written language is known as phonological processing (Wagner & Torgesen, 1987). Phonological retrieval, working memory, and awareness fall under the wider domain of phonological processing. Each of the three elements of phonological processing are essential for the production of speech and for the acquisition of spoken and written language abilities. The *Comprehensive Test of Phonological Processing: 5-6-year-olds* (CTOPP; (Wagner et al., 1999) is one generally accepted test that quantifies these three skill sets. Using the CTOPP, Pelczarski & Yaruss, (2008) examined various phonological processing abilities in 5- and 6-year-old children who stutter and do not. This particular test was created with the explicit goal of evaluating preschoolers' developing phonological processing abilities. Phonological awareness (e.g., Elision, Word Blending, Sound Blending, and Sound Matching), phonological memory (e.g., Non-word Repetition and Memory for Digits), and rapid automatic naming (e.g., Rapid Color and Object Naming) were assessed using a range of subtests.

2.3.1. Phonological Awareness

Phonological awareness is the ability to actively evaluate and change the language's sound structure through various tasks, including speech sound segmentation and blending at the word, onset-rime, syllable, and phonemic levels. The tasks of elision, word- and sound-blending, segmentation, word reversal, and phoneme deletion all include alterations depending on the segment size, stimulus length, and phonological complexity. These task alterations reveal various aspects of the skill related to phonological awareness. The two variables used to assess performance on phonological awareness tasks are accuracy and response time. While verbal response time indicates how long it takes to finish a task, accuracy can be assessed by the number of accurate responses or productions. Lexical (i.e., true word) or non-lexical (i.e., non-word) stimuli can alter phonological awareness tasks and access other neural routes. The phonological route, as described in the model by Ramus et al. (2010), may be utilized for analysing the non-word tasks, whereas real-world stimuli will travel the lexical route.

Pelczarski et al. (2011) states that “a number of studies have reported evidence of significantly longer response times for adults who stutter on rhyme judgment and phoneme monitoring tasks.” These studies (Wijnen & Boers, 1994; Weber-Fox et al., 2008; Burger & Wijnen, 1999; Sasisekaran et al., 2006; Sasisekaran & de Nil, 2006) suggest that there could be an interruption in certain elements of phonological awareness processing. Researchers Weber-Fox and associates, (2004, 2008) studied stuttering individuals in both children and adults. While adults were reported to show slower response times with no differences in accuracy, stuttering children were found to be substantially less precise across conditions with comparable response times.

2.3.2. Phonological Working Memory

Phonological working memory involves preserving phoneme data within a short-term memory store (Wagner & Torgesen, 1987). According to Gupta and MacWhinney (1997) phonological memory helps create representations of new lexical elements, and lexical access in return helps preserve phonological memory. The support that lexical access offers could make it difficult to determine a person's actual capacity for phonological memory. Thus, phonological memory is usually assessed using non-words. Speech perception, phonological encoding (segmenting the auditory signal into segments of speech that may be retained in memory), phonological assembly (creating a motor plan that integrates the appropriate speech units), and articulation are all necessary for the successful repeating of a non-word. (Coady and Evans, 2008, p. 2)

The CTOPP analyzes phonological memory using non-word repetition and memory for digits. In the non-word repetition task, participants are asked to repeat the stimuli given aurally that follow the phonotactic principles of English but lack lexical or semantic meanings (nonsense words). Memory for digits checks the ability to listen to a sequence of numbers of increasing length and then recite them back in the precise sequence they were initially given. These two tasks have a strong correlation in normal populations (Baddeley & Wilson, 1993; Butterworth et al., 1986; Gathercole et al., 2008; Gupta, 2003) and are considered to depict phonological working memory ability (Baddeley et al., 1998; Hulme, 1996; Gathercole, 1995; Houghton et al., 1996).

According to Pelczarski and Yaruss (2008), children who stutter responded substantially differently on the CTOPP's non-word repetition and digit naming tasks; precisely, compared to the non-word repetition task, the performance was better on the digit recall task. These two tasks showed no association for children who stutter despite being strongly associated with the population without stuttering. Subsequent analysis of the data showed that digit naming did not statistically significantly contribute to the variation; rather, the significant finding was only attributed to performance on the non-word repetition task. Furthermore, Pelczarski et al. (2011) mention data from a few other research (Anderson et al., 2006; Hakim & Bernstein, 2004) indicating that children who stutter have different phonological memory than their generally fluent peers, as measured by non-word repetition.

2.4. Phonological Retrieval/ Rapid Automatic Naming

Phonological retrieval refers to the capability to recall phonemes corresponding to particular graphemes that are measured by rapid naming tests (e.g., rapid naming of letters and numbers). ASHA (1987).

Successful rapid automatic naming is based on the assumption that a person can interpret visuals or orthographic symbols and convert them into a series of phonological representations. The quick translation of orthographic symbols into phonological coding allows one to obtain representations rapidly and effectively.

2.4.1. Core Mechanisms Involved in Rapid Automatized Naming

Rapid automatized naming tests the child's capability to name common visual stimuli in sequence as quickly as possible. A few familiar visual stimuli are chosen for the task. Since rapid automatic naming tasks aim to target the automatic process of converting visual stimuli into spoken words, known stimuli are usually employed. Picture stimuli are utilized instead of numbers and letters because they are often not yet automatic in the learning process of young children. Nevertheless, in addition to exhibiting greater phonological complexity and articulatory spans, the images can also trigger extra semantic and phonological representations. Therefore, in most groups, it takes more time to finish tasks involving rapid automatic naming of picture stimuli (Coltheart et al., 2001; Wagner et al., 1999).

According to Pelczarski et al. (2011), lexical access may impact timed rapid automated naming. Individuals tend to identify tasks requiring them to name objects and colors—words with lexical connections—faster than they do numerals and digits, which have less lexical connections. Information that has collected over time is integrated with lexical processes, such as semantic, phonological, and retrieval processes. An articulated name is created by motor commands from this phonological information. The whole action takes place in 500 ms. When undertaking any phonological processing study, it is important to take into account factors like phonotactic frequency, articulatory duration, and phonological complexity, which also affect precision and speed of performance for all three phonological processing tasks.

Using a visual naming model, Waber et al. (2000) highlight the several processes that underlie RAN. According to their model, RAN necessitates the coordinated and integrated use of lexical (semantic and phonological access as well as motoric sub-processes), attentional, perceptual, conceptual, and memory functions. A limitation in any of the sub-processes or their combined use may be the cause of low performance on RAN tasks. All the components in the naming process have accompanying processing speed requirements (PSRs). The authors suggest that the extra requirements of rapidity and serial processing to the standard PSRs found in each sub process are added to the visual naming model by use of continuous naming speed tasks.

Narhi et al. (2005) studied the relationship between different stimuli and how several neuropsychological factors may affect the rapid serial naming. The authors included alphanumeric and non-alphanumeric RSN as well as single RSN and alternate RSN. The study was performed on 605 children from 8-11 years from typical schools in Finland. RSN single categories of colors, letters, digits and objects and RSN alternate categories of digits-letters and colors-digits-letters were performed. Authors quotes that the executive functions are also connected to rapid naming (Denckla & Cutting, 1999). An assumption suggests that the extent to which various RSN tasks assess executive functions varies. It has been suggested that naming objects (Carte et al., 1996) and colors (Tannock et al., 2000) requires more executive function than naming numbers and letters. According to Wolf (1984, 1986), in order to support processing, RSN-AC tasks call for the integration of lower level skills needed for RSN-SC tasks with higher level strategic functions, like paying attention to patterns and the larger context.

2.4.2. Rapid Automatized Naming Measurement

Denckla and Rudel (1974, 1976a, 1976b) originally created the Rapid Automatized Naming (RAN) tasks to assess continuous, serial naming-speed performance on standard visual stimuli. Older children and adults are typically presented with letters and numbers, while children under the age of six are typically presented with non-orthographic stimuli like colors, pictures of objects, or large vs. small size discriminations (Anthony et al., 2007; Badian, 1993; Bowers et al., 1999; de Jong & Vrielink, 2004; Manis et al., 1999; Meyer et al., 1998; Savage & Frederickson, 2005; Torgesen et al., 1997). Since rapid automatic naming tasks aim to target the automatic process of converting the visual input into spoken words, well-known stimuli are typically employed. Picture stimuli are utilized instead of numbers and letters because they are not yet automatic in young children's learning.

The Rapid Alternating Stimuli (RAS) task was first presented by Wolf (1984, 1986). It is a continuous rapid alternating visual stimulus task that uses stimuli from various categories. For example, the stimuli alternate between digits and letters and between digits, letters, and colors. This task, which is completely automated in experienced readers, needs knowing and generating names that reflect many semantic fields (letters, numbers, and colors).

2.4.3. Rapid Automatized Naming in Typically Developing Children

Denckla & Rudel (1974) studied 180 typically developing subjects (90 girls and 90 boys) in six age groups from 5 to 11 years. Nine naming charts were presented to each child, including colors, numerals, capital letters (high frequency of occurrence), animals, lower-case letters (low-frequency letters), use objects, capital letters (low frequency of occurrence), random objects, lower-case letters (high frequency of occurrence). The children were instructed to name the things as quickly as possible without making errors. The first five items were made to name as a practice trial, which was untimed, during which they were not given the name or any correction to avoid practice effect. The subjects were encouraged by phrases like “Keep going!”. The mean time in all nine tasks was significantly low in older children. For instance, the response time for RAN colors was 109.5 secs in 5.0-5.11-year-old boys, while it was 42.3 secs in 10-10.11-year-old boys. The rapid object and color naming were performed separately in males and females because of the significant gender difference present in those. The mean scores for RAN Objects were 90.2 sec for boys and 76.0 for boys in 6.0-6.11 years, and for colors, it was 68.5 and 66.7 secs, respectively. Few younger age groups were excluded from the letter and number tasks because they did not know few of the items. All age groups except seven and eight year olds revealed significant age differences. Mistakes for children above age six were negligible, maximum two per fifty items in one picture chart. When it came to the various categories of names, "letters and numbers" were named relatively faster than "colors and objects" as early as age six. This "automatization" of naming was not reflected in the developmental order of acquisition of these names, as evaluated by speed, accuracy, and consistency on these tasks. Word frequency, response competition, operativity, overlearning, and stimulus discriminability are all taken into account when analyzing children's "automatization" of naming various semantic categories; only the last two seem to be explanatory elements.

Avall et al. (2019) studied the rapid automatized naming in its developmental perspective from 4 to 10 years of age. In the literature review, the authors describe that, although digits and letters are learned later than objects and colors, numerous studies have shown that they can be recalled more quickly and precisely (e.g., Denckla & Rudel, 1974; Meyer et al., 1998b; Rodriguez et al., 2015; Spring & Capps, 1974; Van den Bos et al., 2002). The fact that letters and numbers appear significantly more frequently than images of well-known objects could be one factor contributing to the difference in speed between alphanumeric and non-alphanumeric RAN (Bowey et al., 2005). The fact that digits and letters are known to promote serial processing in RAN tasks, such as those in which the stimuli are presented in an array from left to right, could further account for the faster execution times of alphanumeric RAN (Cummine et al., 2014). On the other hand, items are seldom displayed and handled in a sequential manner; instead, they are handled as discrete units. 222 kids (111 girls and 111 boys) were tracked from the age of 4 to the age of 10 in this longitudinal study. Three distinct RAN stimuli—objects, numbers, and letters—were measured. After being expanded for use with older kids, the RAN objects was renamed as school objects. Students had to name five different, well-known one-syllable objects out loud. The items are arranged randomly on an A4 sheet, with five items in each row and four rows totalling twenty items. It was noted how long it took to name every item. Between the ages of 4 and 6, there was a sharp increase in the performance of object naming, and there was less variance in performance. Additionally, there was a significant correlation between children's performance on RAN objects at the age of 4 and 8 years old. By the time they were 4 years old, the kids were familiar with the RAN objects.

Response time and standard deviation rapidly declined during years that follow, suggesting a rise in automatization (Seglowitz & Seglowitz, 1993).

In school, children learn letters and numbers unless they already know them. There are solid grounds for learning the 10 numbers occurs much earlier than learning the 26 (or 29 in Sweden) letters. Thus, at eight years old (Grade 2), letters are less fluent than digits. In fact, they observed that RAN letters were slower than RAN digits. At the age of eight, performance on RAN digits was marginally faster than on RAN letters; however, at the age of ten, there was no difference, suggesting that RAN digits plateau earlier than RAN letters.

Ranjini (2018) developed a rapid automatized naming (RAN-K) in 6-8-year old normal children. The study aimed to construct standardized data for normally developing Kannada-speaking children in the age range of 6 to 8 years. They were divided into four age groups: 6-6.6 years, 6.6-7 years, 7-7.6 years and7.6-8 years. It included 120 TDC in the age range of 6-8 years, 60 male and 60 female children. Initially, the RAN-K test material was developed and standardized, which included six picture charts, including four single-category items and two alternate-category tasks. The single category tasks contained the alphanumeric tasks of RAN- Letters (RAN-L), RAN-Digits (RAN-D), and Non-alphanumeric tasks of RAN- Objects (RAN-O) and RAN-Colors (RAN-C). The RAN alternate category tasks comprise of RAN-Digit-Letter (RAN-DL), and RAN-Color-Digit-Letter (RAN-CDL).

Each of the picture charts will be presented in A3 sized charts and the subjects were asked to name as rapidly as possible. The response time for each task were calculated separately as well as the accuracy of naming. The child correcting themselves was considered correct, with the time being extended. The results demonstrated a developmental trend in the response times, with longer response time for the lower age group and faster for the higher age group. This was consistent across all four single-category tasks and two alternate-category tasks. RAN L obtained a mean time of 41.67 secs, RAN D was 46.46 sec, RAN O was 60.23 and RAN C was 72.40 secs. RAS DL was observed to be 49.73 secs and RAS CDL was 66.96. The response time of RAN presented significant gender effects between males and females in few of the tasks like RAN Objects and RAN Color in the age range of 7 to 7.6 years. The subjects took the longest time for RAN-CDL out of all the six tasks. The accuracy scores were nearing 100% in all the tasks. The scores were comparatively better in the single-category tasks than the alternate-category tasks and alphanumeric tasks of letters and digits than in non-alphanumeric categories. The accuracy scores did not reveal any age, gender or age and gender interaction effect on the scores.

2.4.4. Rapid Automatized Naming in Persons Who Stutter

The ability of children who stutter to undertake rapid automatic tasks, as well as their phonological awareness and phonological memory, were all examined in a study by Pelczarski and Yaruss (2008).

The results showed no changes in this regard when compared to their peers who are typically developing. The data pattern, which showed that some stuttering children scored outstandingly on rapid automatic naming tasks while many others scored at a lower level of normal, may cast doubt on the conclusions. It's likely that these two patterns of response neutralized a noteworthy result in the collected data. Rapid automatic naming performance also develops over time as a phonological processing ability since it is intimately related to phonological awareness and phonological memory. Pelczarski & Yaruss's ambiguous results imply that more research is necessary to determine whether individuals who stutter have different rapid automatic naming skills. In order to ascertain whether this component of phonological processing in persons who stutter remains the same as they get older.

Pothen et al. (2020) carried out an investigation of rapid naming ability in adults with stuttering with the purpose of comparing adults who stutter and those who do not in terms of their capacity to name words quickly utilizing RAN/RAS. Thirty-two individuals of stuttered individuals and 32 of whom did not, were chosen as study participants. RAN Objects, letters, numbers and colors and RAS-3 set and RAS-2 set were the tasks which were performed on each of the participants. The total in seconds to complete each of the subtasks were calculated with a stopwatch to compare across groups. The results of the study showed that individuals with stuttering performed poorer than those without stuttering, taking longer time to name things on each of the six rapid naming subdivisions. The current study discovered that there were differences in the four subtasks (numbers, letters, colors, and object naming). Compared to the rapid naming of numbers, both objects and colors were slower to finish the tasks. In the study, it was shown that both groups took longer to complete the rapid alternating stimulus subtask (RAS-3 set>RAS-2 set) than the rapid automatized naming subtask. This suggested that the cognitive loads associated with quickly naming items that are presented alternately are higher when it comes to attentional switching and switching between various sets of stimuli. Overall, the study's conclusions showed that stutterers' rapid naming skills are worse when compared to those who do not stutter. The study's conclusions made it obvious that rapid naming abilities must be taken into account when evaluating and treating stutterers.

To summarize, the literature depicting the phonological processing abilities in children who stutter, the phonological awareness deficits in children who stutter, the reviewed studies revealed that they may have a reduced accuracy in awareness tasks with response times remaining same. The phonological working memory skills were comparatively affected in children who stutter with non-word repetition being the major test which correlated with the ability.

Rapid Naming Ability in typical developing children were looked into in the research, there was developmental pattern which was observed in the response time, i.e., higher age group showed reduced response times while lower age group showed longer response times. Accuracy was observed to be consistently near to 100% in all the age group above 6 years. Across the tasks, the RAN colors and objects revealed longer response time compared to the tasks of letters and digits. The final observation was regarding the complexity of the tasks, where in which the alternate category tasks required longer response times and reduced accuracy scores. Even though the literature shows a consistent pattern in the dependent variables of response time and accuracy measured across the tasks and age groups, Indian literature is lacking where RAN and RAS measures were taken into consideration in children who stutter. This is the thread of connection to the current study being undertaken aiming to understand the rapid naming abilities in 6 to 8-year old children who stutter.

CHAPTER III

Method

3.1. Research Design

A Standard group comparison was used to compare the performance between children who do not stutter (CWNS or the control group) and children who stutter (CWS or the clinical group).

3.2. Informed consent and ethical guidelines

The study followed the ethical guidelines prescribed by the Board of Institutional Review. All participants and/or caregivers were asked for their informed consent before the testing, by writing.

3.3. Participants

20 children who stutter, within the age range of 6 to 8 years, 10 from each 6-7 and 7-8 years respectively, were part of the clinical group. Similarly, 20 age and gender and matched normally developing children who do not stutter, within the same age range and age groups were involved in the control group. The participants were divided into 2 groups according to their age range as follows:

Table 3.1

Details of different participants group

Group	Age Range	No. of Participants	
		CWS	CWNS
I	6-7 years	10	10
II	7-8 years	10	10

**CWS-children who stutter, CWNS-children who do not stutter*

The following were the inclusion criteria that were being used to choose study participants:

- The participants were from the age range of 6 to 8 years old.
- The children exhibited adequate language and phonological ability.
- The children were diagnosed with stuttering and no other comorbid disorders.
- The children had normal hearing sensitivity and normal/ corrected vision.
- The children were all native speakers of Kannada.
- The children were physically fit at the time of examination.
- The children had normal hearing and normal/ corrected vision.
- The children did not have any history of psychological or neurological disorders.

Comprehensive data regarding the child's stuttering onset, rehabilitation history, sibling history, and other demographic information were gathered during the time of evaluation from the parent/ caregiver.

Participants in the clinical group were recruited once,

- a certified speech-language pathologist's confirmed diagnosis of stuttering using the SSI-4 (Riley, 2009),
- with a minimum of very mild degree of stuttering at the least,
- displaying three or more dysfluencies resembling stuttering for every 100 words in conversation (Yairi & Ambrose, 1992),
- at least one adult who knows the child, had expressed worries about their stuttering.

3.4. Materials

The stimulus that was used in the study included six sized printed charts of RAN Letters, Digits, Objects, Colors and RAS Digits, Letters and RAS Colors, Digits, Letters which was developed by Ranjini (2011) based on the Measure Model by Narhi et al (2005). The RAN material was originally in English by Denckla and Rudel (1974). The model includes both single-category tasks designed by Denckla and Rudel (1974, 1976a, 1976b) and relatively complex alternate-category tasks given by Wolf (1984, 1986). The RAN-SC (Single Category) consists of four task: RAN-C, RAN-O, RAN-L and RAN-D; in which, RAN-objects and RAN-colors are termed as non-alphanumeric tasks and RAN-letters and RAN-digits are called alphanumeric tasks. The RAN-AC (Alternate Category) consists of two tasks, RAN-DL (digits, letters) and RAN-CDL (colors, digits, letters) in which the stimuli are selected alternatively from two and three categories respectively.

Table 3.2

Details of Rapid Naming Tasks

S. No.	TASKS		
1.	RAN-Single Category (RAN-SC)	Non-alphanumeric tasks	RAN- objects (RAN-O)
2.			RAN- colors (RAN-C)
3.		Alphanumeric tasks	RAN-letters (RAN-L)
4.			RAN-digits (RAN-D)
5.	RAN- Alternate Category (RAN-AC)		RAN-digit-letter (RAN-DL)
6.			RAN-color-digit-letter(RAN-CDL)

* *RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming-Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli-Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

An additional chart was added for the familiarity check/ practice trial of the items. The practice items were printed on an A4 sheet, and the test items will be printed on A3 sized sheet.

3.5. Procedure

The subjects who satisfy the inclusion requirements will be chosen and undergo individual testing. The examiner made the child sit in a quiet and well-lit room. A spontaneous speech sample will be collected from the children who stutter to measure the % of dysfluencies using SSI-4 during initial assessment. The spontaneous speech sample, as well as the RAN & RAS task responses, were audio recorded for further data analysis of severity, % of disfluencies, and accuracy scores. Five items from each category were provided for practice trial at first, and the examiner modeled the task. Before the actual test, the printed picture charts of all the six categories were provided to the child. The participants were instructed to name the pictures from left to right on each line as rapidly and accurately as possible. The total response time taken for each RAN and RAS task was calculated separately using a stopwatch in seconds. The measurement of time begins once the child starts the first word and ends as they finish naming the last item. The raw scores were recorded in the examiner record sheet. To determine the accuracy, the number of errors were recorded. Precise self-corrections will be taken as appropriate answers. Accuracy in % was calculated by the following formula:

$$\text{Accuracy of a task} = \frac{\text{No. of correct responses}}{\text{Total no. of responses}} \times 100$$

While testing RAN and RAS naming and spontaneous speech(SS), stuttered syllables were noted to measure the % of stuttered syllables.

$$\text{\% of stuttered syllables in SS} = \frac{\text{No. of stuttered syllables in SS}}{\text{Total no. of syllables in SS}} \times 100$$

$$\text{\% of stuttered syllables in RAN} = \frac{\text{No.of stuttered syllables in RAN}}{\text{Total no. of syllables in RAN}} \times 100$$

$$\text{\% of stuttered syllables in RAS} = \frac{\text{No.of stuttered syllables in RAS}}{\text{Total no. of syllables in RAS}} \times 100$$

3.6. Data Analysis

The total time taken for the participant to complete each of the tasks of Rapid Automatized Naming of the single non-alphanumeric categories of colours and objects (RAN-C, RAN-O), alphanumeric categories of digits and letters (RAN-D, RAN-L) as well as Rapid

Alternating Stimuli naming for the alternate categories of digits, letters and colours, digits and letters (RAS- DL & RAS-CDL) tasks were tabulated for the clinical and control group in both 6-7 years old and 7-8 years old children. The percentage of dysfluencies of children who stutter was calculated for spontaneous speech, RAN, and RAS separately for analysis. The scores were analyzed and compared between clinical and control groups and across age groups.

3.7. Statistical Analysis

The group data were further subjected to statistical analysis using the Statistical Package for Social Sciences version 26.0. The descriptive statistical measures such as mean, median, and standard deviation were calculated for all the dependent variables.

The percentage of severity scores across the severity of stuttering was calculated by using descriptive statistics since the no. of participants in each severity of stuttering was negligible, and comparison by any parametric or non-parametric test was not appropriate.

The response time measures of RAN L, RAN D, RAN O, RAN C, RAS DL, and RAS CDL followed the normal distribution. Therefore, a Two-way MANOVA parametric test was performed to determine if there is a significant effect of age, group, and age & group interaction effect on the dependent variables.

The accuracy measures RAN L, RAN D, RAN O, RAN C, RAS DL, and RAS CDL did not follow a normal distribution, and the standard deviation was high. Therefore, a non-parametric Mann-Whitney U Test was conducted to find the significant effect between CWS and CWNS groups.

Chapter IV

Results & Discussion

The present study aimed to analyze and compare the rapid automatized naming abilities in 6-8-year-old children with and without stuttering. Twenty children who stutter and twenty who do not stutter participated in rapid automatized and rapid alternating stimuli naming tasks. A normality test was performed on the obtained data using the Shapiro-Wilk test of Normality. The results of normality tests revealed that some dependent measures were normally distributed while others were non-normally distributed. Two-way MANOVA and Mann Whitney U Test were carried out to statistically analyze normal and non-normally distributed data results, respectively. The results of the study are elaborated as follows:

4.1. The effect of severity of stuttering on the percentage of stuttered syllables across spontaneous speech, RAN & RAS tasks

4.1.2 Descriptive Measures of the percentage of stuttered syllables

The percentage of stuttered syllables calculated in the spontaneous speech, RAN, and RAS tasks across various stuttering severity were analyzed using descriptive statistic measures of mean and standard deviation. Table 4.1 and Figure 4.1 reveal the mean scores and standard deviation of the percentage of stuttered syllables in spontaneous speech, RAN, and RAS tasks. The mean percentage of stuttered syllables in spontaneous speech showed an increasing pattern consistently from very mild to severe stuttering, after which it decreased little in very severe stuttering.

In RAN tasks, which included the RAN Letters, Digits, Numbers, and Colors, the percentage of stuttered syllables increased from very mild to very severe. In RAS tasks, including the RAS Digits, Letters (DL) and RAS Colors, Digits, Letters (CDL), the percentage of stuttered syllables demonstrated the same pattern as that in RAN tasks. The percentage of stuttered syllables were considerably reduced in RAN and RAS tasks compared to spontaneous speech tasks.

Table 4.1

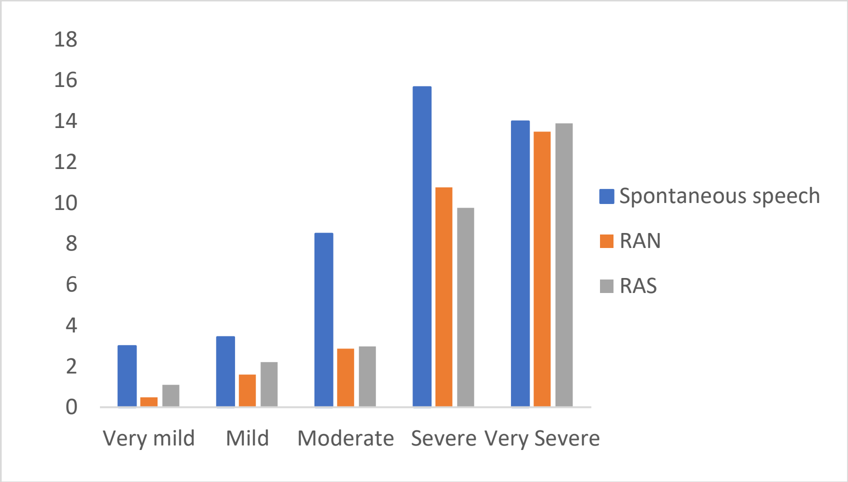
Mean scores and standard deviation of percentage of stuttered syllables in spontaneous speech (SS), RAN & RAS tasks across severity of stuttering

Severity	No. of subjects	Spontaneous speech		RAN		RAS	
		Mean	SD	Mean	SD	Mean	SD
Very mild	3	3.00	0.00	0.50	0.62	1.11	1.96
Mild	6	3.43	0.63	1.60	0.82	2.22	1.92
Moderate	6	8.50	0.54	2.88	1.3	2.98	14.28
Severe	3	15.67	4.50	10.76	0.68	9.76	1.96
Very Severe	2	14.0	0.70	13.5	0.70	13.90	0.14

**RAN- Rapid Automatized Naming, RAS- Rapid Alternating Stimuli*

Figure 4.1

Mean percentage of stuttered syllables in spontaneous speech, RAN, and RAS across severity of stuttering



**RAN- Rapid Automatized Naming, RAS- Rapid Alternating Stimuli*

The previous literature by Blomgren and Goberman (2008) states that the frequency of stuttering increases with an increased rate of speech, which doesn't support this particular study. The existing literature has used spontaneous speech or reading as the tasks, while RAN and RAS use automatized naming. Automatized naming incorporates visual input of printed letters, numbers, objects, and colors as the stimuli, which could have helped easily encode the names. Any other speaking task, such as picture description or spontaneous speech, requires more thought processing, cognitive skills, and complex language skills. Even though the added load of time pressure was given on the rapid naming tasks, this didn't result in increased percentage of stuttered syllables in these tasks compared to the spontaneous speech. The number of subjects were relatively few in very mild, severe, and very severe stuttering, i.e., 3,3 and 2, respectively. Therefore, further analysis by the tests of normality were not performed.

4.2. Response time of Rapid Automatized Naming (RAN) and Rapid Alternating Stimuli (RAS) across 6-7-years and 7-8-years

4.2.1. Comparison of Descriptive measures of the response time across age groups

The response time measures underwent Shapiro Wilk test of normality and were found to come under normality. The standard deviation scores were also observed to be within the acceptable limits. The descriptive statistical measures of the response time taken for each task of the RAN, across age groups are provided in Table 4.2. The response time decreased from 6-7 years to 7-8 years in CWS in all the RAN tasks except RAN Colors, where the total time taken to complete the task increased.

Table 4.2

Mean response time (in secs) and standard deviation of RAN and RAS tasks across groups (age groups; CWS & CWNS)

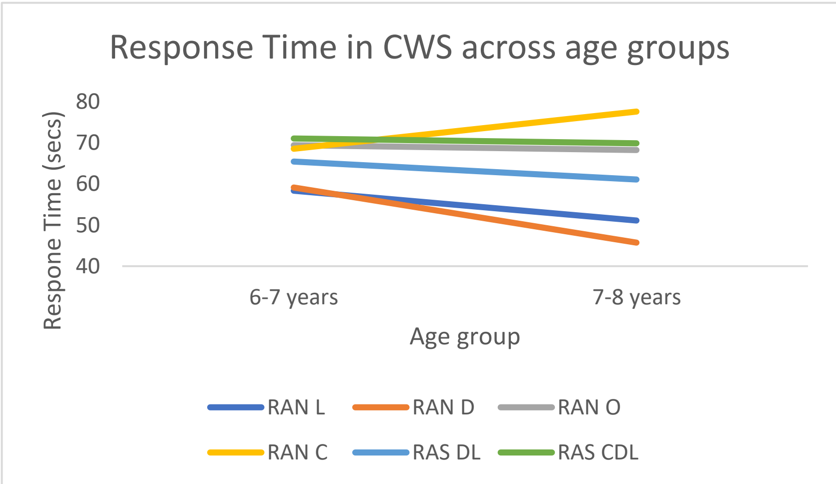
Group	CWS				CWNS			
Age	6-7 years		7-8 years		6-7 years		7-8 years	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
RAN Letters	54.85	10.90	51.13	10.90	58.37	16.18	50.99	12.56
RAN Digits	48.25	4.86	45.76	12.19	59.16	20.71	46.81	10.45
RAN Objects	74.82	13.17	68.24	12.42	69.45	11.83	66.78	12.89
RAN Colors	75.63	13.11	77.59	20.43	68.55	17.75	70.04	14.45
RAN DL	61.20	9.17	61.08	16.15	65.50	14.26	56.32	12.23
RAN CDL	74.61	9.86	69.90	20.67	71.04	15.39	66.81	15.47

**CWS- Children who stutter, CWNS- Children who do not stutter, RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C-Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli-Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

In figure 4.2, the mean response time taken to complete each task decreased from 54.85 to 51.13 seconds for RAN Letters, 48.25 to 45.76 seconds for RAN Digits, 74.82 to 68.24 seconds for RAN Objects and increased from 75.63 to 77.59 for RAN colors for CWS. The RAS tasks exhibited a reduction in the response time in RAS DL from 61.20 to 61.08 seconds in 6-7 years to 7-8-year-old children who stutter. Likewise, RAS CDL also demonstrated a drop in the response time from 74.61 to 69.90 seconds.

Figure 4.2

Response Time for CWS across age groups



**CWS-Children who stutter, RAN L- Rapid Automatized Naming-Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C- Rapid Automatized Naming-Colors, RAS DL-Rapid Alternating Stimuli-Digits, Letters, RAS CDL-Rapid Alternating Stimuli- Colors, Digits, Letters*

The response times for letters and digits were the least when compared to the objects, and colors, as observed in the original RAN study by Denckla and Rudel, (1974) as well as the Indian study done by

Ranjini (2018) in which RAN-Kannada was developed. A longitudinal study of RAN by Avall et al. (2019) supports the finding that the alphanumeric which are learnt later than the non-alphanumeric of objects and colors, takes lesser time to encode. The possible causes which they suggest are that the alphanumeric are usually learned in serial order, therefore serial processing of these in RAN tasks are way easier. But the objects and colors even though these are achieved earlier in age, these are usually processed in single items, and line drawings of such objects are rarely exposed to children.

Similarly, the complexity of the tasks also played a role in the response time, i.e.; the single-category tasks were completed at a faster rate than the alternate-category tasks except RAN colors, which showed the largest response time among all the tasks. This observation was also in accordance with the existing literature (Denckla & Rudel, 1974; Ranjini, 2018).

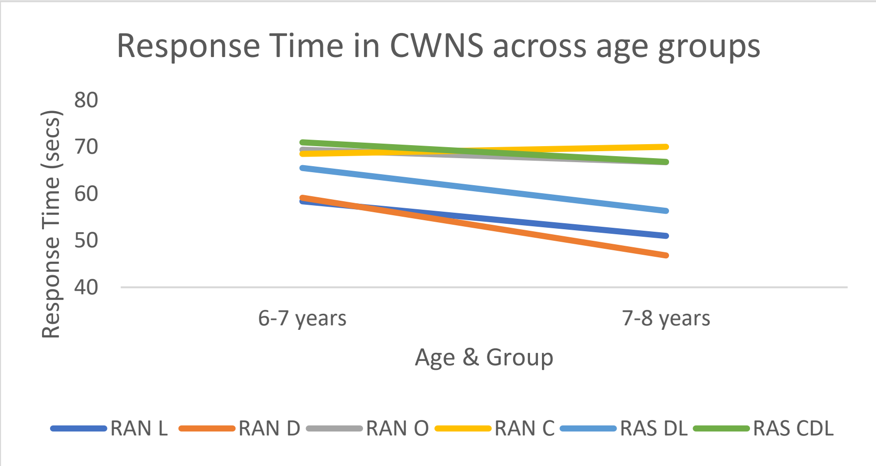
The CWNS followed a similar pattern of mean response time as that in CWS across 6-7 and 7-8-year-old children. Table 4.2 and figure 4.3 depicts the same results. There was a decrease in total time taken to finish RAN Letters, from 58.37 to 50.99 seconds, 59.16 to 46.81 seconds for RAN Digits, 69.45 to 66.78 for RAN Objects, and an increase from 68.55 to 70.04 seconds for RAN Colors. Children who do not stutter (CWNS), similar to CWS, manifested a fall in response time of RAS DL from 65.50 to 56.32 seconds and from 71.04 to 66.81 seconds for RAS CDL from 6-7-year-old to 7-8-year-old children.

In all the groups except for 6-7-year-old CWNS, RAN Colors showed the largest response time out of all the six tasks. This observation was in support of the study carried out by Ranjini (2018). The response time from the above cited normative study were comparatively shorter in all the tasks of the current study. This might convey a notion that the sample for the present study was not adequately representing the normative population of the age range. Also, in the current study undertaken, most subjects were males since stuttering is more prevalent in males than females. According to the study by Ranjini (2018), there was a significant gender effect on RAN objects and colors in the age range of 7 to 7.6 years. This finding can probably explain the disparity of response time in the current study.

Out of all six subtasks, RAN digits revealed the least response time in all the groups except for 7 to 8-year-old CWS. According to Aval et al. (2019), the first 10 digits of the numbers are easier and more easily achieved in young children than the 26 alphabets. This pattern was seen till the age of 8 years after which a plateau was seen for digits.

Figure 4.3

Response Time for CWNS across age groups



**CWNS- Children who do not stutter, RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli-Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

4.2.2. Two-way MANOVA to analyze the effect of age on response time measures

The total time taken to complete the RAN Letters, Digits, Objects, Colors, RAS DL, and RAS CDL was subjected to a Parametric test of Two-way MANOVA since the data followed a normal distribution.

Table 4.3

Two-way MANOVA Results for the effect of age (6-7 vs 7-8 years) on Response time

Task	d.f	F value	Significance
RAN L	1	1.87	0.18
RAN D	1	3.09	0.09
RAN O	1	1.35	0.25
RAN C	1	0.11	0.74
RAN DL	1	1.24	0.27
RAN CDL	1	0.80	0.38

**RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming-Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli-Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

Table 4.3 displays the effect of age on the response time of RAN and RAS. The two-way MANOVA did not reveal any significant main effect of age on RAN L ($F (1) = 1.87$, $p > 0.05$), RAN D ($F (1) = 3.09$, $p > 0.05$), RAN O ($F (1) = 1.35$, $p > 0.05$), RAN C ($F (1) = 0.11$, $p > 0.05$), RAS DL ($F (1) = 1.24$, $p > 0.05$) and RAS CDL ($F (1) = 0.80$, $p > 0.05$).

The results suggest that all the dependent variables of response time are not significantly different across ages in both groups. This contradicts the studies of Denckla and Rudel (1974), and Ranjini (2018). The small sample size of twenty children who stutter and twenty children who do not stutter may not be sufficient to provide a significant difference across the 6-7 and 7-8 years' age groups. Moreover, the narrow age range of two years from 6 to 8 years wouldn't be enough for an appropriate comparison because both the age groups performed equally well on all the attempted tasks.

4.3. Response time of Rapid Automatized Naming (RAN) and Rapid Alternating Stimuli (RAS) between CWS and CWNS

4.3.1. Comparison of Descriptive measures of the response time between CWS and CWNS

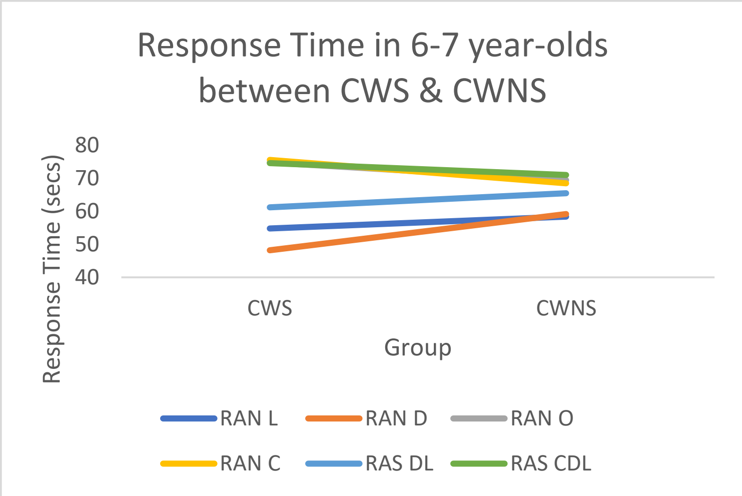
Table 4.2 and Figure 4.4 describe the response time taken for RAN in 6-7-year-old children across CWS and CWNS, which showed a mixed pattern. The results for RAN Letters and RAN Digits indicated a longer response time in CWNS than in CWS. The response time increased from 54.85 to 58.37 and 48.25 to 59.16 seconds in 6-7-year-olds. Meanwhile, RAN Objects and Colors showed a decreased response time from 74.82 to 69.45 and 75.63 to 68.55 seconds, respectively, in CWNS, in contrast to the CWS. Among the alternate categories, RAS DL was faster in CWS with a mean of 61.2 sec than CWNS with a mean of 65.5 secs, and RAS CDL was faster in CWNS with a mean of 71.04 secs than CWS with a mean of 74.61 secs.

The overall results did not follow any pattern and did not show any significant difference across clinical and control groups. A lack of existing studies makes it difficult to compare with the literature. Pelczarski and Yaruss (2008) explain that few of the children who stutter performed extremely well compared with the typically developing children, which could be the reason for the lack of significant difference between the CWS and CWNS. The same observation was made in the present study in CWS. Other factors, such as attention span, could have negatively impacted the performance of typically developing children.

The single categories of letters and numbers and alternate categories of DL showed faster response times in CWS than in CWNS. A probable reason could be the factors that affect the "automatization," according to Denckla and Rudel (1974) such as 'overlearning and stimulus discriminability'. Even though children who were taken into the study excluded those with any intellectual deficits, factors like parent motivation and other subjective factors like training and learning environment at home could have affected the response time. The children who were taken in the clinical group could be those with high motivation and literacy levels of parents. However, the control group who were taken largely from typical schools (government and private) had a mixed group of children whose parents may or may not play a significant role in their learning. Such subjective factors could have led to mixed results.

Figure 4.4

Response Time in 6-7-year-old children across CWS & CWNS



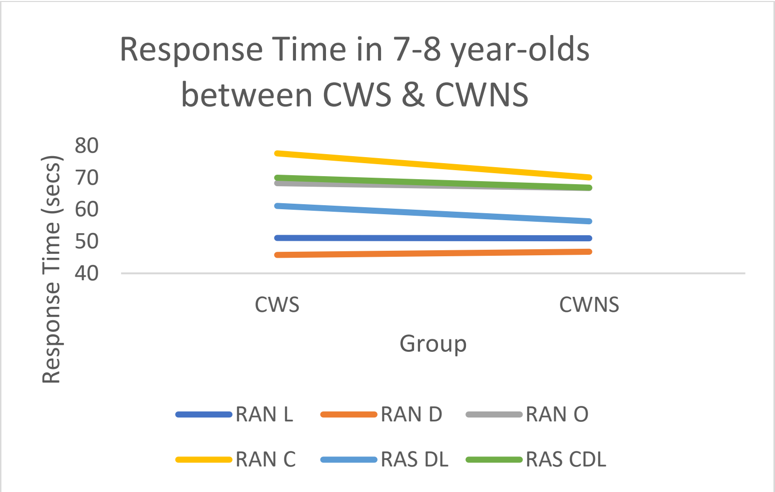
**CWS- Children who stutter, CWNS- Children who do not stutter, RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C-Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli-Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

Table 4.2 and figure 4.5 depicts the response time taken in 7-8-year-old children across CWS and CWNS. The response time in 7-8-year-old children demonstrated a decreasing pattern in CWNS compared to CWS, except for RAN D. The mean time taken to complete the task reduced from 51.13 to 50.99 seconds for RAN L, 68.24 to 66.78 seconds for RAN O, and 77.59 to 70.04 seconds for RAN C in CWS to CWNS. The response time for RAN Digits increased from 45.76 to 46.81 seconds in CWS relative to the CWNS. The RAS DL and RAS CDL were observed to be longer in CWS, 61.08 and 69.9 sec, respectively. Meanwhile, in CWNS, the mean was 56.32 and 66.81 sec, respectively.

Majorly, all the tasks obtained longer response times in CWS except for RAN digits in 7-8-year-old children. The longer response time could result from the ineffective phonological assembly system and diminished capacity to create phonological codes, as concluded by Pelczarski (2011). This finding can be comparable with the rapid naming abilities of adults who stutter, which was studied in the Indian context by Pothen et al. (2020) where all six tasks obtained longer response times for adults who stutter than adults who do not stutter. This can be supported by the covert repair hypothesis, according to which people who stutter employ disfluencies like repetitions, restarts, and revisions as a means of correcting phonological encoding mistakes. People who stutter have trouble with oral motor planning and sequencing when they have to name picture stimuli quickly. Producing phonological segments could be delayed as a result of this difficulty (Postma & Kolk, 1993).

Figure 4.5

Response Time in 7-8-year-old children across CWS & CWNS



**CWS- Children who stutter, CWNS- Children who do not stutter, RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli- Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

4.3.2. Two-way MANOVA to analyze the effect of group on response time measures

Table 4.4 displays the two-way MANOVA results of the effect of the group on response time measures. The two-way MANOVA didn't reveal any significant main effect of group (CWS vs CWNS) on RAN L (F (1) =0.17, p>0.68), RAN D (F (1) =2.01, p>0.16), RAN O (F (1) =0.73, p>0.40), RAN C (F (1) =1.92, p>0.17), RAS DL (F (1) = 0.00, p>0.05) and RAS CDL (F (1) =0.44, p>0.05) in both the age ranges of 6-7-years and 7-8-years.

The presence of stuttering, even though it lengthened the mean response time in most of the tasks, the difference was not statistically significant. This observation might be because of the outstanding performance of a portion of the CWS over the others in the same group, which goes along with the study by Pelczarski and Yaruss, (2008).

Table 4.4

Two-way MANOVA Results for effect of group (CWS vs CWNS) on Response time

Task	d.f	F value	Significance
RAN L	1	0.17	0.68
RAN D	1	2.01	0.16
RAN O	1	0.73	0.40
RAN C	1	1.92	0.17
RAN DL	1	0	0.95
RAN CDL	1	0.44	0.51

**CWS- Children who stutter, CWNS- Children who do not stutter, RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli- Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

4.4. Accuracy of Rapid Automatized Naming (RAN) & Rapid Alternating Stimuli (RAS) across age groups

4.4.1. Comparison of Descriptive measures of the accuracy scores across age groups

The accuracy measures underwent Shapiro Wilk test of normality and were found not to fall under normality. The standard deviation scores were observed to be outside the acceptable limits. The descriptive statistical measures of the accuracy scores obtained for each task of the RAN tasks across age groups are provided in Table 4.5.

Table 4.5

Mean and standard deviation of accuracy of correct responses of RAN and RAS tasks across age groups

Group	CWS				CWNS			
Age	6-7 years		7-8 years		6-7 years		7-8 years	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
RAN Letters	0.98	0.020	0.98	0.02	0.98	0.01	0.98	0.02
RAN Digits	0.99	0.01	0.99	0.02	0.99	0.01	0.99	0.01
RAN Objects	0.99	0.01	1.00	0	1.00	0	1.00	0.00
RAN Colors	0.97	0.03	0.99	0.02	0.98	0.01	0.98	0.01
RAS DL	0.99	0.01	0.97	0.03	0.99	0.01	0.99	0.01
RAS CDL	0.97	0.02	0.97	0.03	0.97	0.02	0.98	0.02

**CWS- Children who stutter, CWNS- Children who do not stutter, RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli- Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

The results indicated that the accuracy of responses remained the same for RAN Letters (98%) and RAN Digits (99%) in 6-7 and 7-8 year-old children who stutter. The accuracy of responses for RAN Objects and colors showed a mild surge from 99 to 100% and 97 to 99%, respectively, in 6-7 and 7-8-year-old children. RAS DL decreased in accuracy from 99 to 97%, and RAS CDL continued to show a constant accuracy of responses, i.e., 97%.

In typically developing children of 6-7 and 7-8-years, there was no difference in the accuracy of responses across the age groups for RAN L (98%), RAN D (99%), RAN O (100%), RAN C (98%) and RAS DL (99%). RAS CDL indicated a rise in accuracy of responses from 97 to 98% across 6-7 to 7-8 years.

4.4.2. Mann Whitney U Test to analyze the effect of age on accuracy measures

The accuracy of responses for RAN L, RAN D, RAN O, RAN C, RAS DL and RAS CDL were subjected to non-parametric statistics of Mann Whitney U Test since the data didn’t fall under normality when Shapiro Wilk’s Test of Normality was carried out. The standard deviation scores were observed to be outside the acceptable limits. The results are displayed in Table 4.6.

Table 4.6

Results of the Mann-Whitney U Test for the effect of age on the accuracy measures

		RAN-L	*RAN-D*	*RAN-O*	*RAN-C*	*RAS-DL*	*RAS-CDL*
CWS	|z|	-0.16	-0.20	**-2.52**	-1.68	-0.62	0.00
	p-value	0.87	0.84	**0.01***	0.09	0.53	1.00
CWNS	|z|	-0.24	-0.11	0	0	-0.84	-1.44
	p-value	0.81	0.91	1.00	1.00	0.40	0.15

**significant difference, CWS- Children who stutter, CWNS- Children who do not stutter, RAN L- Rapid Automatized Naming- Letters, RAN D- Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL- Rapid Alternating Stimuli-Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

According to the Mann Whitney U Test, the accuracy of responses didn't reveal any significant differences across 6-7 and 7-8-year-old CWS for all the tasks (RAN L (|z| =-0.16, p>0.05), RAN D (|z| =-0.20, p>0.05), RAN C (|z| =-1.68, p>0.05), RAS DL (|z| =-0.62, p>0.05) and RAS CDL (|z| =0.00, p> 0.05)) except for RAN Objects (|z| =-2.52, p<0.05).

All the tasks except RAN O did not show any effect of age on the tasks in CWS. RAN-K normative data that was developed by Ranjini (2018) supports the fact that age does not have an effect on accuracy. Denckla and Rudel (1974) also support the same in their study. The current study observed a significant difference in RAN objects in CWS across age groups. Narhi et al. (2005) observed a significant age effect in the naming of objects in 8-11 year-old children from Finland. The results indicate that all the other tasks, especially the alphanumeric, remained constant across the age groups because of the large variance in naming tasks and the lack of automatization in the younger group.

Pictures of objects, including very common daily use objects, were familiar for most children. This could be the reason why these followed a pattern of reduced response time in older children.

The accuracy of responses didn't reveal any significant differences across 6-7 and 7-8-year-old CWNS for all the tasks (RAN L (|z| =-0.24, p>0.05), RAN D (|z|=-0.11, p>0.05), RAN O (|z| =-0.00, p<0.05), RAN C (|z| =-0.00, p>0.05), RAS DL (|z| =-0.84, p>0.05) and RAS CDL (|z| =-1.44, p> 0.05). Similar responses were observed in the study by Ranjini (2018). The current study also revealed accuracy scores within 97% in all the tasks. The RAN studies were carried out on children as early as five years of age. In children under six years of age, the automatization is not achieved, especially for the alphanumeric and colors. Denckla and Rudel (1974) stated that above six years of age, the inaccuracies in automatized naming are negligible, with a maximum of 2 per fifty items. For those above six years, the automatization occurs till the age of 8 years (Narhi et al., 2005) This could possibly justify the equally accurate responses from both the age group lacking significant difference in RAN and RAS tasks in CWNS.

RAN Colors and RAS CDL were the two tasks where accuracy was comparatively reduced, this also supports Denckla and Rudel's, (1974) finding, where alternate category put forth more errors. Narhi et al. (2005) quote from the previous literature review that executive functions are associated with rapid serial naming. The rapid serial naming of alternate categories integrates the low-level skills that are needed for each of the single categories involved. Therefore, this processing takes longer than a single category since the children have to pay more attention to patterns and larger context Wolf (1984,1986).

4.5. Accuracy of Rapid Automatized Naming (RAN) & Rapid Alternating Stimuli (RAS) between CWS and CWNS

4.5.1 Comparison of Descriptive measures of the accuracy scores between CWS and CWNS

The accuracy measures underwent Shapiro Wilk test of normality and they didn’t fall under normality. The standard deviation scores were found to be beyond the acceptable limits. The descriptive statistical measures of the accuracy scores obtained for each task of the RAN tasks between CWS and CWNS are provided in Table 4.5.

The results indicated that the accuracy of responses remained almost the same for RAN Letters (98%), RAN Digits (99%), RAS DL (99%) and RAS CDL (97%) between CWS and CWNS in 6-7 year-old children. The accuracy of responses for RAN Objects and colors showed a mild surge from 99 to 100% and 97 to 98%, respectively, from CWS to CWNS.

In 7-8-year old children, there was no difference in the accuracy of responses between the CWS and CWNS groups for RAN L (98%), RAN D (99%), RAN O (100%). RAN C revealed a mild decrease in accuracy from 99% to 98%. RAS DL and RAS CDL indicated a rise in the accuracy of responses from 97 to 99% and 97 to 98% from CWS to CWNS, respectively.

4.5.2. Mann Whitney U Test to analyze the effect of group on accuracy measures

The accuracy of responses for RAN L, RAN D, RAN O, RAN C, RAS DL and RAS CDL were subjected to non-parametric statistics of Mann Whitney U Test since the data didn't fall under normality when Shapiro Wilk's Test of Normality was performed. The standard deviation scores were observed to be out of the acceptable limits. The results are displayed in Table 4.7.

Table 4.7

Results of the Mann-Whitney U Test for the effect of group in 6-7 & 7-8-year-old children on the accuracy of responses

		RAN-L	*RAN-D*	*RAN-O*	*RAN-C*	*RAS-DL*	*RAS-CDL*
6-7 years	|z|	-0.24	-0.50	-1.90	-0.08	-0.21	-0.20
	p-value	0.81	0.61	0.06	0.93	0.83	0.84
7-8 years	|z|	-0.16	-0.16	-1.00	-1.60	-1.47	-1.10
	p-value	0.87	0.87	0.32	0.11	0.14	0.27

**RAN L- Rapid Automatized Naming- Letters, RAN D-Rapid Automatized Naming- Digits, RAN O- Rapid Automatized Naming- Objects, RAN C- Rapid Automatized Naming- Colors, RAS DL-Rapid Alternating Stimuli-Digits, Letters, RAS CDL- Rapid Alternating Stimuli- Colors, Digits, Letters*

According to the Mann Whitney Test, the accuracy of responses didn’t reveal any significant differences between CWS and CWNS for all the tasks (RAN L ($|z| =-0.24$, $p>0.05$), RAN D ($|z| =-0.50$, $p>0.05$), RAN O ($|z|=-1.90$, $p>0.05$), RAN C ($|z| =-0.08$, $p>0.05$), RAS DL ($|z| =-0.21$, $p>0.05$) and RAS CDL ($|z| =-0.20$, $p> 0.05$)) in 6-7-year-old children. No studies are currently available to support this finding in CWS.

The reason why there was no significant difference between CWS and CWNS like in adults, as reported by Pothen et al. (2020) could be because the largely in children with stuttering rapidly and effectively completing phonological encoding tasks show only mild deficits when compared to normally developing children (Byrd et al.,2007; Richels et al., 2010). Therefore, CWS was not performing poorly as CWNS of their age and gender-matched peers.

In 7-8-year old children, the accuracy of responses didn’t reveal any significant differences between CWS and CWNS for all the tasks (RAN L ($|z| =-0.16$, $p>0.05$), RAN D ($|z| =-0.16$, $p>0.05$), RAN O ($|z| =-1.00$, $p<0.05$), RAN C ($|z| =-1.60$, $p>0.05$), RAS DL ($|z| =-1.47$, $p>0.05$) and RAS CDL ($|z| =-1.10$, $p> 0.05$).

In 7-8-year-old children as well, the same findings were observed in 6-7-year-old children because of the comparably similar phonological encoding skills in CWS as it is in CWNS.

To summarize the findings of the current study, which aimed at analyzing and comparing the rapid naming abilities in 6-8-year-old children who stutter and who do not stutter; The percentage of stuttered syllables was measured by calculating the number of stuttered syllables per 100 syllables produced by the child. When this measure was compared in spontaneous speech, RAN and RAS tasks across the severity of stuttering, it was evidently observed that the percentage of stuttered syllables increased on increasing severity of stuttering. The RAN and RAS tasks revealed less percentage of stuttered syllables than spontaneous speech tasks, which revealed the role of visual input in RAN & RAS, and other cognitive skills involved in framing spontaneous speech.

When the response time was analyzed and compared in all six tasks of RAN and RAS, there was a developmental pattern which was observed across age groups for all the RAN and RAS tasks except for RAN colors. That implies, that there was a drop in the response time taken to complete the tasks from 6-7 to 7-8-year-old children in both the groups, but the drop was not statistically significant. The largest response time was recorded for RAN colors out of all the tasks which was followed by RAN colors-digits-letters. The least time or the quickest response time was measured for RAN digits.

While focusing into the accuracy scores between groups, there was no significant effect of age on accuracy scores except for RAN Objects in CWS. All other accuracy measures were comparable but did not show any significant difference across the age groups in both CWS and CWNS. The longitudinal study by Avall et al. (2019) lines with this finding. The possible explanations that the authors give is the improved "automatization" of the items as age increased.

In case of the effect of group on accuracy scores in both 6-7 and 7-8-year old children, there was again no significant difference between CWS and CWNS in both the age groups which was supported by the studies which showed very little or no phonological deficits in CWS comparing with CWNS.

CHAPTER V

Summary & Conclusion

The present study aimed to examine the rapid naming abilities of 6 to 8-year-old children who stutter and who do not stutter. The study was carried out to analyze and compare the stuttered syllables in spontaneous speech, Rapid Automatized Naming(RAN), and Rapid Alternating Stimuli(RAS) across the severity of stuttering, to compare the response time, and accuracy scores of RAN Letters, RAN Digits, RAN Objects, RAN Colors, RAS Digits-Letters, and RAS Colors-Digits-Letters. Previous literature on the topic was thoroughly reviewed, and it exposed the importance of investigating rapid naming abilities in analyzing phonological processing abilities, cognitive abilities, and the ability to respond under time pressure in children who stutter.

Several studies revealed a significant difference in phonological awareness and phonological memory skills in children who stutter when compared with those who did not. Rapid Naming ability, being another major component of phonological processing skill, was studied in this particular study in children of 6 to 8 years of age in CWS and CWS.

The current study included 20 CWS in the age range of 6 to 8 years and 20 age and gender-matched CWNS. All the subjects were native Kannada speakers and were further divided into 6-7 years and 7-8 years. A spontaneous speech sample was collected from each of the twenty CWS. The percentage of stuttered syllables was calculated for the same.

All 40 participants were made to complete all four RAN and two RAS tasks. The response time and accuracy scores were recorded for all six tasks.

Statistical analysis of the obtained data was performed across both the age groups and between CWS and CWNS. The results of the analysis in summary are mentioned below:

- The percentage of stuttered syllables increased with increasing severity of stuttering. The RAN and RAS tasks indicated less percentage of stuttered syllables than spontaneous speech tasks.
- The response time showed a developmental pattern, i.e., slower for 6-7 year olds than 7-8-year-olds in all the tasks except RAN colors across age groups. However, the differences were not statistically significant.
- Accuracy scores didn’t show any significant differences in the scores across age groups and between groups except for an effect of age in RAN Objects in CWS.
- Both response time and accuracy measures did not show significant differences between CWS and CWNS. This implies that the stuttering group did not perform different or poor from typically developing children in these tasks. This could imply that the tasks/ stimuli were not difficult enough to tap the phonological processing difficulties which are present in children who stutter.

The current research study concludes the following hypotheses:

- There is a significant difference in the ***percentage of stuttered syllables*** across tasks and the severity of stuttering. Therefore, the null hypothesis has been rejected.
- There is no significant difference in the total time taken in ***Rapid Automatized Naming*** of Letters, Digits, Objects, and Colors (RAN-L, RAN-D, RAN-O, and RAN-C) between groups (CWS & CWNS, and 6-7 & 7-8 years). Therefore, the null hypothesis has been accepted.
- There is no significant difference in the total time taken in ***Rapid Alternating Stimuli*** naming of Digits-Letters & Colors- Digits-Letters (RAS-DL & RAS-CDL) between groups (CWS & CWNS, and 6-7 & 7-8 years). Therefore, the null hypothesis has been accepted.
- There is no significant difference in the ***accuracy of responses*** between groups (CWS & CWNS, and 6-7 & 7-8 years) in each of the following tasks:

1) RAN-L, RAN-D, RAN-O and RAN-C
2) RAS-DL & RAS-CDL

Except for an effect of age on RAN Objects in children who stutter. Therefore, the null hypothesis has been accepted except for RAN Objects in CWNS.

Clinical Implications

- RAN and RAS can be included in the assessment and management of children with stuttering to assess rapid naming under time pressure.
- RAN and RAS can also teach us about possible phonological processing difficulties and cognitive difficulties, such as visual attention, discrimination, or identification difficulties in children who stutter.

Limitations

- The sample size of twenty was less to make appropriate conclusions about RAN and RAS.
- The study's age range could be broader or older children can be included to understand the relative development of rapid naming skills.
- Equal number of female and male participants were not taken because of the high prevalence of stuttering in males.
- More detailed background information about the child’s academic performance, parent literacy and socio economic status could help to dive deeper into the findings.

Future Directions

- The current study can be expanded to larger samples with an equal number of each gender and a wider age group.
- The rapid naming abilities can be tested using more complex stimuli (words, two digit numbers etc.)
- Further studies can focus on how rapid naming can be adapted to the assessment and therapy of children who stutter.

REFERENCES

Acheson, D., & MacDonald, M. (2009). Verbal working memory and language production: Common approaches to the serial ordering of verbal information. *Psychological Bulletin, 135(1),* 50-68

Ambrose, N. G., Yairi, E., & Cox, N. (1993). Genetic aspects of early childhood stuttering. *Journal of speech and hearing research*, 36(4), 701–706. https://doi.org/10.1044/jshr.3604.701

Anderson, J. D., Wagovich, S. A., & Hall, N. E. (2006). Nonword repetition skills in young children who do and do not stutter. *Journal of fluency disorders*, 31(3), 177-199.

Anthony, J. L., Williams, J. M., McDonald, R., & Francis, D. J. (2007). Phonological processing and emergent literacy in younger and older preschool children. *Annals of Dyslexia, 57(2),* 113–137. https://doi.org/10.1007/s11881-007-00088

Åvall, M., Wolff, U., & Gustafsson, J. E. (2019). Rapid automatized naming in a developmental perspective between ages 4 and 10. *Dyslexia*, 25(4), 360-373.

Baddeley, A. (1998). Random generation and the executive control of working memory. *The Quarterly Journal of Experimental Psychology: Section A*, 51(4), 819-852.

Baddeley, A., & Wilson, B. A. (1993). A developmental deficit in short-term phonological memory: Implications for language and reading. *Memory*, 1(1), 65-78.

Badian, N. A. (1993). Phonemic awareness, naming, visual symbol processing, and reading. *Reading and Writing,* 5, 87-100.

Bakhtiar, M., Abad Ali, D. A., & Sadegh, S. P. M. (2007). Nonword repetition ability of children who do and do not stutter and covert repair hypothesis. *Indian Journal of Medical Sciences,* 61(8), 462-470. https://doi.org/10.4103/0019-5359.33711

Blomgren, M., & Goberman, A.M. (2008). Revisiting speech rate and utterance length manipulations in stuttering speakers. *Journal of communication disorders*, 41 2, 159-78 .Andrews, G., & Harris, M. (1964). The syndrome of stuttering.

Bloodstein, O. N. (1944). Studies in the Psychology of Stuttering: XIX: The Relationship Between Oral Reading Rate and Severity of Stuttering. *Journal of Speech Disorders*, 9(2), 161-173.

Bloodstein, O., & Bernstein Ratner, N. (2008). A handbook on stuttering (6th ed.), San Diego, CA: Singular Publishing Group

Bloodstein, O., Ratner, N. B., & Brundage, S. B. (2021). A handbook on stuttering (7th ed.). Plural Publishing.

Boberg, E., & Kully, D. (1985). Comprehensive stuttering program. San Diego: College-Hill Press.

Boberg, E., & Sawyer, L. (1977). The maintenance of fluency following intensive therapy. *Human Communication,* 2, 21-28.

Bowey, J. A., & Muller, D. (2005). Phonological recoding and rapid orthographic learning in third-graders' silent reading: A critical test of the self-teaching hypothesis. *Journal of experimental child psychology*, 92(3), 203-219.

Butterworth, B., Campbell, R., & Howard, D. (1986). The uses of short-term memory: A case study. *The Quarterly journal of experimental psychology*, 38(4), 705-737.

Byrd, C. T., Conture, E. G., & Ohde, R. N. (2007). Phonological priming in young children who stutter: Holistic versus incremental processing. *American Journal of Speech-Language Pathology, 16(1), 4*3–53. https://doi.org/10.1044/1058-0360(2007/006)

Carte, E. T., Nigg, J. T., & Hinshaw, S. P. (1996). Neuropsychological functioning, motor speed, and language processing in boys with and without ADHD. *Journal of Abnormal Child Psychology*, 24(4), 481-498.

Coady, J. A., & Evans, J. L. (2008). Uses and interpretations of non-word repetition tasks in children with and without specific language impairments (SLI). *International journal of language & communication disorders*, 43(1), 1-40.

Coles, M.G.H., Smid, H.G.O.M., Scheffers, M.K., & Otten, L.J. (1995). Mental chronometry and the study of human information processing. In M. D. Rugg & M. G.H. Coles (Eds.), *Electrophysiology of Mind: Event-Related Brain Potentials and Cognition.* Oxford: Oxford University Press.

Coltheart, M., Rastle, K., Perry, C., Langdon, R., & Ziegler, J. (2001). DRC: a dual route cascaded model of visual word recognition and reading aloud. *Psychological review*, 108(1), 204.

Cummine, J., Szepesvari, E., Chouinard, B., Hanif, W., & Georgiou, G. K. (2014). A functional investigation of RAN letters, digits, and objects: how similar are they?. *Behavioural brain research*, 275, 157-165.

Darley, F. L., & Spriestersbach, D. C. (1978). Diagnostic methods in speech pathology. HarperCollins Publishers.

de Jong, P. F., & Vrielink, L. O. (2004). Rapid automatic naming: Easy to measure, hard to improve (quickly). *Annals of Dyslexia, 54(1),* 65–88. https://doi.org/10.1007/s11881-004-0004-1

Denckla, M. B., & Cutting, L. E. (1999). History and significance of rapid automatized naming. *Annals of Dyslexia*, 49, 29-42.

Denckla, M. B., & Rudel, R. G. (1974). Rapid "automatized" naming of pictured objects, colors, letters and numbers by normal children. *Cortex*, *10(2),* 186-102

Denckla, M. B., & Rudel, R. G. (1976a). Naming of pictured objects, colors, letters and numbers by normal children. *Brain and Language*, *3,* 1-15.

Denckla, M.B., & Rudel, R. G.(1976b). Rapid Automatized naming (R.A.N): Dyslexia differentiated from other learning disabilities. *Neuropsychologia*, *14*, 471-479.

doi.org/10.1044/2017_JSLHR-S-16-0323

Gathercole, S. E. (1995). Is nonword repetition a test of phonological memory or long-term knowledge? It all depends on the nonwords. *Memory & cognition*, 23(1), 83-94.

Gathercole, S. E., Alloway, T. P., Kirkwood, H. J., Elliott, J. G., Holmes, J., & Hilton, K. A. (2008). Attentional and executive function behaviours in children with poor working memory. *Learning and individual differences*, 18(2), 214-223.

Gupta, P. (2003). Examining the relationship between word learning, nonword repetition, and immediate serial recall in adults. *The Quarterly Journal of Experimental Psychology Section* A, 56(7), 1213-1236.

Gupta, P., & MacWhinney, B. (1997). Vocabulary acquisition and verbal short-term memory: Computational and neural bases. *Brain and language*, 59(2), 267-333.

Hakim, H. B., & Ratner, N. B. (2004). Nonword repetition abilities of children who stutter: An exploratory study. *Journal of fluency disorders*, 29(3), 179-199.

Hartley, T., & Houghton, G. (1996). A linguistically constrained model of short-term memory for nonwords. *Journal of memory and language*, 35(1), 1-31.

Howell, P. (2004). Assessment of some contemporary theories of stuttering that apply to spontaneous speech. *Contemporary issues in communication science and disorders: CICSD, 31*, 122

Howell, P., & Au-Yeung, J. (2002). The EXPLAN theory of fluency control applied to the diagnosis of stuttering. In E. Fave (Ed.), *Clinical linguistics: Theory and applications in speech* *pathology and therapy* (pp. 75–94). John Benjamins Publishing Company.

Hulme, C. (1996). Gordon DA Brown University of Warwick, UK Charles Hulme University of York, UK. *Models of Short-term Memory*, 129.

Johnson, W., & Rosen, L. (1937). Studies in the psychology of stuttering: VII: Effect of certain changes in speech pattern upon frequency of stuttering. *Journal of Speech Disorders*, 2(2), 105-110.

Kolk, H., Postma, A., & Curlee, R. (1997). Nature and treatment of stuttering: New directions.*Language, and Hearing Research*: JSLHR, 60(9), 2537–2550. https://

Levelt, W. J. M., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22(1), 1–38. doi:10.1017/S0140525X99001776

Manis, F. R., Seidenberg, M. S., & Doi, L. M. (1999). See Dick RAN: Rapid naming and the longitudinal prediction of reading subskills in first and second grade. *Scientific Studies of Reading*, 3(2), 129.

Melnick, K. S., Conture, E. G., & Ohde, R. N. (2003). Phonological priming in picture naming of young children who stutter. *Journal of Speech, Language, and Hearing Research: JSLHR, 46(6),* 1428–1443. https://doi.org/10.1044/1092-4388(2003/111)

Meyer, A. S. (1992). Investigation of phonological encoding through speech error analyses: Achievements, limitations, and alternatives. *Cognition, 42,* 181-211

Meyer, A. S., & Van der Meulen, F. F. (2000). Phonological priming effects on speech onset latencies and viewing times in object naming. *Psychonomic bulletin & review,* 7, 314-319.

Närhi, V., Ahonen, T., Aro, M., Leppäsaari, T., Korhonen, T. T., Tolvanen, A., & Lyytinen, H. (2005). Rapid serial naming: Relations between different stimuli and neuropsychological factors. *Brain and language*, 92(1), 45-57.

Nippold, M. A. (2002). Stuttering and phonology: Is there an Interaction. *American Journal of Speech-Language Pathology, 11(2),* 99–110. https://doi.org/10.1044/1058-0360(2002/er01)

Onslow, M., Costa, L., Andrews, C., Harrison, E., & Packman, A. (1996). Speech outcomes of a prolonged-speech treatment for stuttering. *Journal of Speech, Language, and Hearing Research*, 39(4), 734-749.

Pelczarski, K. M. (2011). Phonological processing abilities of adults who stutter [Doctoral dissertation]. *University of Pittsburgh.*

Pelczarski, K. M., & Yaruss, J. S. (2008). Phonological processing in children who stutter. Technical paper presented at the *American Speech-Language and Hearing Association.*

Pelczarski, K. M., Tendera, A., Dye, M., & Loucks, T. M. (2019). Delayed phonological encoding in stuttering: Evidence from eye tracking. *Language and Speech, 62(3),* 475–493. https://doi.org/10.1177/0023830918785203

Perkins, W. H., Kent, R. D., & Curlee, R. F. (1991). A theory of neuropsycholinguistic function in stuttering. *Journal of Speech, Language, and Hearing Research, 34(4),* 734–752. https://doi.org/10.1044/jshr3404.734

Phonological processing. (1987). American Speech-Language-Hearing Association | ASHA. https://www.asha.org/Practice-Portal/Clinical-Topics/Written-Language-Disorders/Phonological-Processing

Postma, A., & Kolk, H. (1993). The covert repair hypothesis: Prearticulatory repair processes in normal and stuttered disfluencies. *Journal of Speech, Language, and Hearing Research, 36(3),* 472–487.https://doi.org/10.1044/jshr.3603.472

Pothen, K. R., John, S., & Guddattu, V. (2022). Rapid naming ability in adults with stuttering. *Applied neuropsychology. Adult*, *29*(4), 761–766. https://doi.org/10.1080/23279095.2020.1808787

Ramus, F., Peperkamp, S., Christophe, A., Jacquemot, C., Kouider, S., & Dupoux, E. (2010). A psycholinguistic perspective on the acquisition of phonology. *Laboratory phonology*, 10(3), 311-340.

Ranjini G.C., & Rajasudhakar R. (2011). Rapid Automatized Naming-Kannada (RAN-K) in 6-8-years old typically developing children. *Dissertation submitted to University of Mysore,* Mysore

Richels, C., Buhr, A., Conture, E., & Ntourou, K. (2010). Utterance complexity and stuttering on function words in preschool-age children who stutter. *Journal of fluency disorders*, 35(3), 314-331.

Riley, G. D., & Bakker, K. (2009). Stuttering Severity Instrument: SSI-4: Pro-Ed. Vincent, I. (2017). Semantic and phonological encoding in adults who stutter: Silent responses to pictorial stimuli. *Journal of Speech, Language, and Hearing Research: JSLHR, 60(9),* 2537–2550. https:// doi.org/10.1044/2017_JSLHR-S-16-0323

Riper, C. V. (1982). The nature of stuttering.

Rodríguez, C., van den Boer, M., Jiménez, J. E., & de Jong, P. F. (2015). Developmental changes in the relations between RAN, phonological awareness, and reading in Spanish children. *Scientific Studies of Reading*, 19(4), 273-288.

RUNYAN, G. B. (1987). Effects of the mnemonic-keyword method on recalling verbal information: A meta-analysis. The Florida State University.

Sasisekaran, J., & De Nil, L. F. (2006). Phoneme monitoring in silent naming and perception in adults who stutter. *Journal of Fluency Disorders, 31(4),* 284-302.

Sasisekaran, J., De Nil, L. F., Smyth, R., & Johnson, C. (2006). Phonological encoding in the silent speech of persons who stutter. *Journal of Fluency Disorders, 31(1)*, 1-21.

Savage, R. S., Frederickson, N., Goodwin, R., Patni, U., Smith, N., & Tuersley, L. (2005). Relationships among rapid digit naming, phonological processing, motor automaticity, and speech perception in poor, average, and good readers and spellers. *Journal of learning disabilities*, 38(1), 12-28.

Semel-Mintz, E., Wiig, E., & Secord, W. (2003). Clinical evaluation of language fundamentals. *Psychological Corporation*

Singer, J. K., Lichtenberger, E. O., Kaufman, J. C., Kaufman, A. S., & Kaufman, N. L. (2012). The Kaufman Assessment Battery for Children—Second Edition and the Kaufman Test of Educational Achievement—Second Edition. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues (pp. 269–296)*. The Guilford Press.

Spring, C., & Capps, C. (1974). Encoding speed, rehearsal, and probed recall of dyslexic boys. Journal of Educational Psychology, 66(5), 780. stutter: Silent responses to pictorial stimuli. *Journal of Speech,*

Tannock, R., Martinussen, R., & Frijters, J. (2000). Naming speed performance and stimulant effects indicate effortful, semantic processing deficits in attention-deficit/hyperactivity disorder. *Journal of abnormal child psychology*, 28, 237-252.

Van den Bos, K. P., Zijlstra, B. J., & lutje Spelberg, H. C. (2002). Life-span data on continuous-naming speeds of numbers, letters, colors, and pictured objects, and word-reading speed. *Scientific Studies of Reading*, 6(1), 25-49.

Vincent, I. (2017). Semantic and phonological encoding in adults who

Waber, D. P., Wolff, P. H., Forbes, P. W., & Weiler, M. D. (2000). Rapid automatized naming in children referred for evaluation of heterogeneous learning problems: How specific are naming speed deficits to reading disability?. *Child neuropsychology*, 6(4), 251-261.

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101(2), 192–212.* https://doi.org/10.1037/0033-2909.101.2.192

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). Comprehensive Test of Phonological Processing. *Austin*, TX: PRO-ED.

Weber-Fox, C., Spencer, R. M. C., Spruill, J. E., III, & Smith, A. (2004). Phonologic processing in adults who stutter: Electrophysiological and behavioral evidence. *Journal of Speech Language and Hearing Research*, *47(6),* 1244-1258.

Webster, R. L. ESTABLIS~ ffiNT OF FLUENT SPEECH IN STUTTERERS. 197.

Wijnen, F., & Boers, I. (1994). Phonological priming effects in stutterers. *Journal of Fluency Disorders*, *19,* 1-20.

Wingate, M. E. (1988). The structure of stuttering: A psycholinguistic approach.

Wolf, M. (1984). Naming, reading and the dyslexias: A longtitudinal overview. *Annals of Dyslexia, 34*, 87-115

Wolf, M. (1986). Rapid alternating stimulus naming in the developmental dyslexias. *Brain and Language, 27,* 360-379

Wolf, M., & Denckla, M. B. (2005). RAN/RAS: Rapid automatized naming and rapid alternating stimulus tests. Pro-Ed.

Wolk, L., Edwards, M. L., & Conture, E. G. (1993). Coexistence of stuttering and disordered phonology in young children. *Journal of Speech, Language, and Hearing Research, 36(5),* 906–917. https://doi.org/10.1044/jshr.3605.906

WORLD HEALTH ORGANIZATION. International Classification of Impairments, Disabilities, and Handicaps-a manual of classification relating to the consequences of disease. Geneva, WHO, 1980.

Yairi, E., & Ambrose, N. (1992). A longitudinal study of stuttering in children. *Journal of Speech, Language, and Hearing Research, 35*, 755–760

Yairi, E., & Ambrose, N. G. (2005). Early childhood stuttering for clinicians by clinicians. Pro-Ed.