DEVELOPMENT AND FIELD TESTING OF PROTOCOL TO PROFILE COGNITION, SOCIO- EMOTIONAL AND MOTORIC ASPECTS IN CHILDREN WITH STUTTERING IN KANNADA

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May, 2016

CERTIFICATE

This is to certify that this dissertation entitled **"Development and Field Testing of Protocol to Profile Cognition, Socio-Emotional and Motor Aspects in Children with Stuttering in Kannada"** is a bonafide work submitted in part fulfilment for degree of Master of Science (Speech-Language Pathology) of the student Registration Number: 14SLP006. This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CERTIFICATE

This is to certify that this dissertation entitled **"Development and Field Testing of Protocol to Profile Cognition, Socio-Emotional and Motor Aspects in Children with Stuttering in Kannada"** has been prepared 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.

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DECLARATION

This is to certify that this dissertation entitled **"Development and Field Testing of Protocol to Profile Cognition, Socio-Emotional and Motor Aspects in Children with Stuttering in Kannada"** is the result of my own study under the guidance of Dr.Y.V. Geetha, Prof. of Speech Sciences, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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CHAPTER 1

INTRODUCTION

"Communication is the essence of human life" as defined by ASHA (1991). Communication refers to transmission of thought, message and information connecting the individuals or groups using a familiar system of signs, signals, writing and behavior. Speech is a form of verbal communication which permits an individual to express his thoughts and ideas to the world. Speech requires a complex amount of cognitive processing. Speech is a "verbal behaviour" which mainly differentiates the human from the other animal species. Fluency is a fundamental aspect of speech which means 'to flow'. For effective communication the speech should flow, both motorically and linguistically. If there is any disruption in the flow of speech to sufficient extent, it can lead to a fluency disorder and stuttering or stammering is one such disorder.

Stuttering is a speech disorder most often beginning in early childhood or acquired later (Howell, 2004; Yaruss & Quesal, 2004). Stuttering is characterized by the interruptions in the flow of speech which is often established during early childhood years and it is usually characterized by disfluent expressions. Stuttering has been described as a speech motor disorder that disturbs the timing and coordination between the respiratory, laryngeal, and vocal tract symptoms of speech (Van Lieshout & Namasivayam, 2004). World Health Organization (WHO, 1997) defined stuttering as "Disorders in the rhythm of speech in which the individual knows precisely what he wishes to say, but at the same time is unable to say it because of an involuntary repetition, prolongation or cessation of a sound". Stuttering has been described as a

heterogenic disorder involving one or more of several associated speech and non-speech behaviours. Since the onset of stuttering in more than 90% of children is during the preschool period, during the peak of speech and language development, many speech and language problems in many children with stuttering (CWS), a strong connections between language and stuttering is speculated, especially the phonological skills. It is reported by researchers that there is a critical period in the child's development during which there is some interaction of these factors to precipitate stuttering. The persistence or recovery of stuttering is determined by the maturation of the neuromuscular skills within this critical period.

Stuttering is a disorder commonly associated with phonological and language disorders. From a nationwide sample which incorporated 1184 speech language pathologists (SLPs) considering 2628 children with stuttering (Blood, Ridenour, Qualls & Hammer, 2002), the authors noted that 62.8% had co-occurring speech and language disorders, 33.5% had articulation disorders, 12.7% had phonology disorders, 34.3% had co-occurring non speech –language disorder, 15.2% had learning disorders, and 5.9% had attention deficit disorders. Several studies have been reported that children with stuttering will have some degree of difficulties in cognition, motoric and social – emotional aspects.

Neisser (1967) states that cognition is a mental process by which external or internal input is transformed, reduced, elaborated, stored, recovered and used. As such, it involves a variety of functions such as perception, attention, memory coding, retention, and recall, decision-making, reasoning, problem-solving, imaging, planning and executing actions. In individuals with stuttering, few important factors thought to be impaired are the flow in thinking, and belief about their speaking ability. Fluency and

cognition share a comprehensive relationship. There will be high incidence of stuttering when persons have severe cognitive deficits (Van Riper, 1982). This could occur for more than one reason. In the first place, typically rapid and complex speech and language production depends on fully functioning perception, attention, working memory and executive functions. A compromise in any of these processes results in a break in the spoken language. Many studies have been done to understand the accurate nature and the etiology of stuttering as to whether they have a deficient sensory motor control system or deficiency in the cognitive processing. Howell (2004) viewed stuttering as a speech disorder which results from an impaired interaction between linguistic planning and execution of speech movements. He added that stuttering results when the linguistic and cognitive planning lags the speech production. It thus supports the statement of a cognitive as well as a temporal disco-ordination in stuttering. To explore the role of phonological encoding and phonological working memory in CWS, the non-word repetition task has been a popular choice (Anderson & Wagovich 2006; Bakhtiar & Sadegh, 2007; Smith, Goffman, Sasisekaran & Weber-Fox, 2012). The performance in non-word repetition is based on the collective influence of speech and language processes including phonological processing and working memory (Kent, 2000).

Speaking is a complex task which includes a lot of skills and coordination to speak fluently and accurately. CWS have unbalanced motor control for speech (Smith, 1990). Sometimes the speech motor control works smoothly but sometimes speech will be repeated, prolonged or blocked. Many investigators have emphasized that people who stutter have a general motor deficit (Webster, 1985; Selznick, Smith, Franz & Ho, 1997; Max, Caruso & Greco, 2003) or a timing deficit (Kent, 1983; Boutsen, Brutten & Watts,

2000) that contributes to the development and maintenance of the disorder. The DDK rates (capacity) and the rate of speech (performance) are some of the factors that determine the motor control abilities which have been investigated by researchers and found to have an influence on the onset and development of stuttering

Production of tongue twisters is a complex task which requires coordination of different systems and involves specific speech motor control, it requires precise, sequential speech motor coordination and it is difficult to produce quickly and correctly, even for normal individuals. Even though the production of tongue twisters does not have a communication intention, PWS show disfluencies and other speech errors and they use various strategies to defeat them. Although children with no stuttering (CWNS) also show speech errors, their type and frequency is less.

Measuring the number of syllables or words that a speaker produces per unit time is the most general approach to assess the speech rate (Logan, Byrd, Mazzocchi & Gillam, 2011). Speaking rate is an assessment of the overall rate of speech including pause times. Kormos and Denes (2004) likewise have shown that speech rate (in terms of number of syllable per unit time) is a good predictor of subjective fluency. Robb, Gilbert, Reed and Bisson (2003) suggest a protocol for assessing where each utterance is displayed on a computer screen as an amplitude-by-time waveform. Cucchiarini, Strikand and Boves (2002) have shown that, of the several objectively measured aspects of fluency, speech rate (as measured by phonemes per unit time) is the best predictor of subjective fluency. Research into the rate of speech in CWS suggests that it does not fall within normal limits. Clinicians believe that speaking rate often reflects the severity of stuttering and concomitantly the effect it is having on communication. If a client's speech

rate is markedly below or above normal, communication may be difficult for him. Depending on the individual situations the speech rate varies. In different tasks like spontaneous conversation, storytelling, influential speeches, rote materials or reading aloud people speak at different rates (Pindzola, Jenkins & Lokken, 1989). Ryan (1992) reported that though exceptional speech rates were not observed in CWS, the three lowest and highest speaking rates were demonstrated by CWS. Bloodstein (1987) noted that high speaking rates can result in stuttering. Meyers and Freeman (1985) found slower rates of fluent speech in preschool CWS. Recent research has advocated the use of articulation rate as a measure in CWS. The difference between both the rate measures is that the overall speaking rate includes all disfluencies whereas articulation rate excludes disfluent words or syllables from the rate calculations.

Speech rate reveals a processing demand that can result in increased disfluency while the Diadochokinetic rate (DDK) has been considered as an indication of the speaking ability/capacity of a child. A study investigating persistence and remission of stuttering in high risk children by Kloth, Kraaimaat, Janssen and Brutten (1999) indicated that children who stutter speak faster than their abilities allow and that the high risk children who developed stuttering subsequently on follow up differed only with respect to their speaking rates compared to those who did not. These results appear to provide support that children who stutter perform at speaking rates beyond their motor abilities. However, the relative lack of published norms in the area suggests a cautious interpretation of such findings. Yaruss, Newman and Flora (1999) found that 9 CWNS between the ages of 4-5 years exhibited a strong positive correlation between their articulatory speaking rate and diadochokinetic rate indicating that these children speak at

rates in line with their abilities. On the other hand, the nine children who stuttered showed a mild negative correlation between speaking rate and DDK suggesting that children who stutter may attempt to use speaking rates that exceed their ability to rapidly and precisely move their articulators. Yaruss (1997) found a tradeoff between production rate and DDK accuracy. Children exhibiting faster DDK rates also produced more errors than children with slower DDK rates, again suggesting that children who produced more errors were actually exceeding their ability to rapidly and precisely move their articulators in a speech related task. Yaruss, Logan and Conture (1995) noted that stuttering may be associated with a discrepancy between a child's speaking performance indicated by articulatory speaking rates and speaking ability indicated by DDK rates.

It is important to know the role of affective and social factors that play a major role in stuttering. Because speech is a social phenomenon as people speak to each other about variety of topics in a different situations. Also, stuttering has been observed to be situation and topic specific and the disorder is governed in part by affective factors that are socially moderated. There are numerous models that approach stuttering from a multifactorial viewpoint, most of which include an emotional or social component. One of the most primitive multifactor models of stuttering (Zimmerman, 1980) highlights the significance of the interface between motor speech behavior and a range of emotional and environmental conditions in the development and maintenance of the disorder. Wall and Myers (1984) noted that psycholinguistic factors, (i.e. discourse loads and communications with parents or peers) and physiological components interact to cause and maintain stuttering. One of the factors that may influence speech motor control is related to emotion. For example, top skilled performer who are even under stress keep

control over their movements whereas less skillful performer shows significant breakdowns in their performance (Robazza, Bortoli & Nougier, 1998; Hagtvet & Hanin, 2007; Yoshie, Kudo, Murakoshi & Ohtsuki, 2009) based on the interaction between performance and emotion . Emotions are assumed to affect speech fluency through pathways in the central nervous system which is involved in motor control, particularly through amygdala and basal ganglia loops (Alm, 2004). However, the accurate mechanisms underlying the effect emotion exerts on motor control is not completely clear. Many CWS experience cognitive self-reactions and negative emotions as a result of their communication difficulties (DeNil & Brutten, 1991; Vanryckeghem & Brutten, 1996; Vanryckeghem & Brutten, 1997; Logan & Yaruss, 1999). Particularly, stuttering may be accompanied by reduced self-confidence and low self-esteem (Manning, 1994), feelings of shame or embarrassment (Murphy, 1989; Murphy, 1999), and other adverse effects (Coleman, Yaruss & Quesal, 2004).These factors can have a negative impact on child's overall communicative competency (Blood & Blood, 2004).A familiar finding of past study is that individuals with stuttering are stereotyped as being more safeguarded, tense, hesitant, introverted, nervous, self-conscious, sensitive, and insecure than persons who do not stutter (Klassen, 2001). The factors that should be considered with start of school children and pre-school are intelligence, personality, attitudes and temperament. Bullying is common occurrence and influences stuttering once it is established in school and progress through adolescence.

The demands and capacities model (Starkweather, Gottwald & Halfond, 1990) views the onset and development of stuttering as related to a inequality between the child’s capacities (cognitive, linguistic, and emotional, motor) and self-imposed (internal)

or external speech demands. The models put forwarded by Smith (1999) and de Nil (1999) concentrates on the significance of disturbed speech processes and their connection with emotional, social and learned factors. All these models emphasize that linguistic, motoric, cognitive and affective factors influence speech motor functions. Riley and Riley (2000) in their revised stuttering assessment instrument preserved that speaker's temperamental factors and listeners' reactions to people who stutter were major factors that contributed to the onset and development of stuttering.

Need for the study:

Stuttering is a multidimensional problem but most of the stuttering assessment procedures involve only the overt characteristic features like the frequency, duration and severity of stuttering. A comprehensive assessment procedure is essential to obtain detailed information focusing towards assessing aspects of the child which includes socio emotional factors and motor skills. The detailed assessment of the data collected can provide a profile of skills and deficits in the child which provides direction towards the management.

There is no comprehensive protocol for profiling individuals with stuttering, more so in case of CWS to assess cognition, socio-emotional and motoric nature of stuttering. Although it is reported by many authors that there are many concomitant disorders associated with stuttering, there are very few attempts to develop a comprehensive protocol for the profiling of stuttering. There are not sufficient resources to assess CWS associated with other associated disorders in different languages and more so among Kannada speaking children. Such a tool would provide the SLPs to get very valuable

information for the differential diagnosis, management and importantly to build the data base for research on CWS. With this need, the present study was planned with the following aim and objectives of the study

Aim of the study:

The main aim of the study was to develop a comprehensive protocol for assessment of cognition, socio-emotional and motoric aspects CWS in Kannada language.

The study was planned with the following specific objectives:

- To develop a comprehensive protocol to assess cognition, socio-emotional and motoric aspects of stuttering for 6-10 year old CWS in Kannada language
- To field test the Protocol on 6-10 year old CWNS and CWS using the protocol
- To see if CWS differ from CWNS in various domains of cognition, motoric and socio-emotional skills

CHAPTER 2

REVIEW OF LITERATURE

Communication is an essential form of social behaviour used to exchange information about one's needs, desires, perception, and knowledge. Inability to communicate effectively leads to speech and language disorders. Speech is a verbal manifestation of communication which is made up of components such as voice, fluency, articulation and prosody. Fluency is one of the essential aspects of good speech or verbal form of communication.

2.1 Fluency

The term fluency is derived from the Latin word for "flure" which describes what the listener perceives when listening to someone who is truly adept at producing speech. Fluency is the ability to speak precisely and rapidly with suitable expressions and without any effort and breakdown in the sequence of words uttered which enables the listener to comprehend the spoken message without difficulty. In simpler term fluency is the effortless flow of speech. The ability to speak fluently plays an important role in communication in the society and every disruption in this will have a negative impact on the quality of life. As stated by Starkweather (1980) "fluency is the effortless production of long, continuous utterances at a rapid rate". Starkweather (1987) suggests that fluency can be considered as having both speech as well as language components and defines speech fluency in terms of continuity, rate, duration, coarticulation, and effort. He also suggests that fluent speech is characterized by little attention being paid to the process of

production as speaking is “automatic”. Stuttering is known to be one of the most frequently occurring fluency disorders.

2.2 Stuttering

Stuttering is regarded as disorder of fluency with no universally approved definition, but many definitions have been proposed by many authors from different perspectives. Stuttering is a complex and a puzzling disorder, with an incidence of 5% (Mansson, 2000) and prevalence below 1% for adults population (Andrews, Craig, Feyer, Hoddinot, Howie & Neilson, 1983). It is a typical developmental disorder which begins in early childhood around 30 months (Yairi & Ambrose, 1992) and persists to adulthood (Gordon, 2002; Craig & Tran, 2005). It is a highly unpredictable condition and depends on the situation involving cognitive or an emotional stress (Bosshardt, 2006). The definitions vary according to the noticeable behaviours, covert process, disfluencies and with the etiological factors. The term diffluent is sometimes used to describe the abnormal fluency breaks of people who stutter (PWS). Stuttered speech is effortful, and it disrupts the easy flow of speech. Johnson (1946) defined stuttering as the behavior presented by a person who stutters to avoid the disfluent speech, reflecting on the etiology of the disorder. Contrary to those who viewed stuttering as a type of primary neurosis, a symptom of basic emotional or psychological conflict, there is the tendency to define stuttering by citing the presumed source of conflict (cause) rather than by describing the stuttering behaviour. Taking a related approach Glauber (1958) described stuttering as a “symptom in the psychopathological condition categorized as a pregenital conversion neurosis”. According to Brutten and Shoemaker (1968), stuttering is that form of fluency failure that results from a conditioned negative emotion”.

Cooper (1993) defined "stuttering as a diagnostic label referring to a clinical syndrome characterized more frequently by abnormal and persistent disfluencies in speech accompanied by characteristic affective, behavioral and cognitive patterns". One of the mainly cited and comprehensive definition is given by World Health Organization (WHO) in 2005, based on the ICF classification. According to this stuttering is defined in 3 levels: (1). Impairment: neuropsychological and neurophysiologic events that immediately precede and accompany the audible and visible events of stuttering. Disruptions of speech and language production typically characterized by certain interruptions in the forward flow of speech and any associated audible or visible characteristics of those interruptions if present; (2). Disability: the audible/visible events that are the behavioral manifestations of stuttering that put limitations on the individual's ability to communicate and (3). Handicap: The disadvantages resulting from reactions of persons who stutter and listener to the audible and visible events of a person's stuttering which create limitations on a person's life, lack of fulfillment an individual has in his social life, school, job and community. Disability and handicap results from the way a person and significant listener responds to his stuttering rather than from stuttering itself. The description of stuttering makes it seem like a very complicated problem, one that will take a long time to learn about. Stuttering is associated with various types of motor behaviours (such as breathing abnormalities, muscular tension, avoidance behaviours, and negative emotions).

2.3 Causes of stuttering

The symptoms of stuttering have led to many different theories, hypotheses and models regarding the cause of the speech interruptions. The viewpoints about the cause of

stuttering have taken several shifts in reference to psychological to physiological to a more recent combination of the two, or the multifactorial dynamic theories. It has been frequently examined that stuttering changes from time to time, from situation to situation. For example, persons who stutter typically have the understanding that it is easier to speak when alone than speaking in front of a group of people. It is possible that this type of study has become extrapolated to also account for the cause of stuttering, leading to the theory that persons stutter because they tend to be more nervous and anxious than others. Researchers ever since years have tried to establish the cause of stuttering, however, the solitary cause of stuttering is not known and etiology remains speculative. There are a variety of causes underlying this disorder and so far there is no single cause which can be precisely said as to be the actual cause of stuttering. Is it the psychological constraints or emotions which lead to stuttering or is the disorder itself rooting to the psychological issues is still an arguable topic. The incidence of stuttering has constantly been found to be more in males than in females, with an approximate 4:1 ratio and possible causes of the unequal sex ratio may be biologically based because of the various ways in which males and females differ in neurological development. It is reported that the male hormone testosterone is likely to retard the neural maturation in the brain during the early stages of life influencing the growth and development in language and in turn in the development of fluency.

Numerous hypothetical viewpoints have been proposed to account for constitutional factors in stuttering. Some of these views include: an abnormality of how the brain is structured for speech and language (Travis, 1927), a result of deficits in the internal modeling process used to control speech production (Neilson & Neilson, 1987), a

disorder of timing of the sequential movements for speech (Van Riper, 1990) and a disorder of spoken language production (Kolk & Postma, 1997). The first view point focuses on dysfunctions of cortical and subcortical mechanisms that organize the planning and production of speech and language to generate the initial repetitions and prolongations of early stuttering. The last view point proposes neuro-muscular failure that might enlighten the tension and tremors of secondary stuttering.

The anticipatory struggle theory proposes that a child may build up stuttering as a product of negative anticipation of talking after he has had annoying, embarrassing or frustrating experiences in communicating (Bloodstein, 1987, 1997). The Diagnosogenic theory proposes the influence of listeners' reaction to the so called normal disfluencies of the child as triggering stuttering (Johnson, 1943).

On the other hand, the demands and capacities model by Starkweather, (1987) hypothesized that stuttering occurs when the child's capability for rapid fluent expressions are uneven to the demands within the child himself or within the surroundings. According to this model stuttering results when demands for fluency increases from the child's environment beyond the child's linguistic, motor, or emotional, cognitive capacities for fluent speech. This model examines the internal and external aspects which influence the production of fluent and non-fluent speech in children. The model proposes that CWS acquire genetically influenced tendencies for disfluent speech. Capacities are innate tendencies, and perceptions strengths, weaknesses which influence the child's ability to speak effortlessly. The demands may be put on the child on his/her behalf or through other listeners. Illustrations of possible demands

include rapid rate of speech, and speech continuity. The demands may change and strengthen as the child matures in his capacities.

Guitar (1998) proposed a two stage etiological model of stuttering. According to this model the first phase is primary stuttering, which involves repetitions and prolongations that are recurrently the first indications of stuttering. These signs are considered to be the result of constitutional feature: a dys-synchrony at some point of the speech and language production process. The second phase is secondary stuttering which involves the tension, struggle, escape and avoidance behaviors that are regularly present in persisting stuttering. These behaviors are recommended to be the result of a separate constitutional factor: a reactive temperament that elicits a defense response from behavioral inhibition system that makes the individual more emotionally conditionable than the average speakers. According to Perkins, Kent and Curlee (1991), speech involves linguistic and paralinguistic factors where both the factors have general output systems. Though, every factor is processed by separate neural systems, both these factors require to be integrated in synchrony as it is a vital condition of fluent speech. Any disturbance in the synchrony can arise when the parts of speech plan are not timed exactly, leading to stuttering.

The main components of stuttering consist of the core behaviors, i.e., repetitions, prolongations and blocks (Van riper, 1971, 1982). The further components include the resulting behaviors such as the physical concomitants, escape and avoidance behaviors and the feelings and attitudes. Stuttering frequently tends to precipitate and leads to negative emotions for instances of fear, frustration, anger, embarrassment etc. Situational

fear and fear on an exact sound or word or fear for persons can amplify tension and disrupt idea leading to more stuttering which might lead to the development of negative feelings and attitudes.

2.4 Multi dimensional nature of stuttering

Multidimensional model of stuttering has extensive factors that can be defined and assessed qualitatively and quantitatively. The Model contains CALMS components (i.e., cognitive, affective, linguistic, motor, and social) as key components that maintain and contribute to stuttering. These five components are the prime cause of the disorder, and evaluation should include organized measurement of all of these components. After therapy, it should reveal changes in the CALMS performance that were the focus of treatment. According to this model stuttering is influenced by how stutters think about and feel about themselves and their stuttering. The motor component is related with features such as the frequency, duration, type, severity of stuttering, also the episodes of coping and secondary behaviors and largely speech motor control that is connected with stuttering. The cognitive component comprises of thoughts, perceptions, awareness, and understanding of stuttering. Researchers have noted that clients who developed thinking that were self-directed, realistic, or positive had superior results and longer term resistance to relapse than those who failed to make these cognitive changes (Craig & Andrews, 1985; Madison, Budd, & Itzkowitz, 1986). Social component includes patient's communicative competence relative to reactions of the person who stutters have with different communicative partners in all speaking situations. It is also related with escaping from the speaking situations; friends teasing that could affect stuttering. This

factor also focuses on the pragmatics of communication. The affective factor within the model focuses on experiences that are related with feelings, emotions, and attitudes that accompany stuttering and communication in common. Van Riper (1982) placed a great deal of prominence on having a person who stutters deal with attitudes, and emotional reactions to stuttering and negative feelings. The linguistic component in the model is related to the disfluent speaker's language skills and abilities that impact the frequency of stuttering .

2.5 Stuttering and associated factors

Stuttering has been expressed as a heterogenic disorder involving one or more of several associated speech and non-speech behaviors. In view of the fact that the onset of stuttering in more than 90% of children is at some stage in the preschool period, during the peak of speech and language development, a strong relationship among stuttering and language has been speculated. It is reported by researchers that there is a critical period in the child's development during which there is some interaction of these factors to precipitate stuttering. The persistence or recovery of stuttering is determined by the maturation of the neuromuscular skills within this critical period. CWS have been reported to have lower scores for receptive and expressive language (Murray & Reed, 1977; St Louis & Hinzman,1988; Byard & Cooper,1989; Anderson & Conture, 2000), more immature language (Wall, 1980 ;Howell & Yeung, 1995),less well developed articulatory systems(Melnick & Conture,2003) and reduced grammar (Westby, 1974), and reduced ability to plan, or retrieve sentence level units of speech (Cuadrado& Weber-Fox,2003; Anderson & Conture, 2004). A recent study found that a third of all

children who stuttered also had co-morbid articulation disorders, while just fewer than 13 percent of the 2628 children also presented with phonological disorders. In total, around two-thirds of all the children who stuttered also had some form of speech language or non-speech disorder (Blood, Ridenour, Qualls & Hammer, 2004). Stuttering appears to be more common amongst the learning disabled. Blood (2004) found that LD children had 15 percent of their large sample of children who stuttered .

CWS are more expected to be late in acquiring speech milestones, and may have low articulatory skills (Wolk, Edwards & Conture, 1993). Some researchers have stated that the increased time pressure on verbal responses (being told to react using advanced language; high level of expectation can lead to increased risk of stuttering (Stewart, 1960; Rustin, Botterill & Kelman, 1996), as can negative listener reactions (Johnson et al., 1959).Some research has shown that children who have associated language delay are at risk of developing stuttering than those who do not (Andrews & Harris, 1964; St Louis & Hinzman, 1988). Likewise, some believe that those with a phonological disorder are at greater risk of stuttering (Louko, Edwards & Conture, 1990). Though, there are some researchers who have claimed, arguing that better experimental studies are needed to prove these findings (Nippold, 1990)

Findings recommend that adolescents and adults who stutter have significantly more negative attitudes towards their own communication abilities than their fluent peers (Blood & Blood, 2004; Vanryckeghem & Brutten, 2011). Such attitudes can have far reaching implications, particularly at a social and psychological level (Koedoot, Bouwmans, Franken, &Stolk, 2011) .

2.5.1 Language

Ntourou, Conture and Lipsey (2011) summarized language abilities of CWS and CWNS from empirical studies. Their results indicated that CWS performed significantly lower than CWNS on norm- referenced measures of overall language, receptive and expressive vocabulary, and mean length of utterance. It suggests that children's language abilities are possible significant variables linked with childhood stuttering. Numerous stuttering models suggest that fluency breakdown is connected with failure in encoding or retrieving lexical, syntactic, phonological, phonetic, and or suprasegmental targets of speech production. (e.g., Wingate, 1988; Perkins, Kent, & Curlee, 1991; Postma & Kolk, 1993; Karniol, 1995; Packman, Onslow, Richard, & van Doorn, 1996; Bernstein, 1997; Howell, 2004; Bloodstein, 2006) .

Several authors have reported that CWS show some degree of retardation in the use and learning of language skills (Van Riper, 1971; Bloodstein, 1975). Language component is related to have an impact on the frequency of stuttering. This variation in the language formulation demands have negative impact on the fluency and linguistic complexity, with changes in syntactic complexity and increased length (Wall, Starkweather & Cairns, 1981; Bernstein & Sih, 1987; Gaines, Runyan & Meyers, 1991; Watson, 1993; Howell & Au Yeung, 1995; Logan & Conture, 1995) and changes in the narrative demands (Weiss & Zebrowski, 1993; Scott, Healey, Norris, 1995; Trautman, Healey & Norris, 2001).

2.5.1.1Phonology

The relationship between stuttering and phonology has been studied for several years. It was found that CWS have either different or delayed phonological development, suggesting that of all the speech language problems that are seen with stuttering, phonological difficulties are the most common (Cantwell & Baker, 1985; Bloodstein, 1987; St. Louis & Hinzman, 1988; Louko, Edwards, & Conture, 1990; Wolk, Edwards, & Conture, 1993; Paden, 2004). Hakim and Ratner (2004) also noted that children who stutter show more phonological errors. Wolk et al. (1993) reported that on average, 30-40% of children who stutter also demonstrate disordered articulation or phonology. Bloodstein and Bernstein (2008) suggested that "there is tendency of stutterers to have functional difficulties of articulation. Findings by Pellowski (2001) suggest that there are subtle to not-so-subtle articulation differences between CWS and CWNS. Findings of clinically significant differences in articulation suggest that articulation disorders are more prevalent among CWS than CWNS (Blood et al., 2003).

Articulatory capacity in PWS was measured using various paradigms like reaction time and kinematic analysis of articulatory movements. Several acoustic studies have shown longer VOT, stop gap durations, vowel durations and consonant-vowel transition durations in PWS compared to people who do not stutter, although these differences were sometimes limited to certain conditions of phonetic context or articulatory complexity. These studies focus on speech movements and not on the speech motor control systems and sequential motor movements that require speech motor coordination. A study done by, Caruso, Abbs and Gracco (1988) found that person who stutters showed longer movement durations and longer temporal intervals between articulatory and phonatory events than did non-stuttering speakers.

Among the mixed views regarding etiology of stuttering, few of them consider stuttering as articulatory disorders. Evidence for this view comes from many studies that have found many articulatory abnormalities and errors in PWS. Models have been proposed in this regard which try to explain stuttering as an articulatory disorder.

2.5.1.2 Semantics

Recent experimental studies of children (e.g., Anderson & Conture, 2000, 2004; Melnick, Conture & Ohde, 2003; Pellowski & Conture, 2005) as well as AWS (e.g., Weber-Fox, 2001; Cuadrado & Weber-Fox, 2003; Weber-Fox, Spencer, Cuadrado, & Smith, 2003; Weber-Fox, Spencer, Spruill & Smith, 2004) suggest that the speech–language planning of these individuals with stuttering may be slightly dissimilar and lexical/semantic skills show less than typical for young CWS (Pellowski & Conture, 2005). For example, Pellowski and Conture stated that CWS display slower speech reaction times (SRTs) than CWNS in response to semantically related primes (e.g., hearing "dog" just before naming a picture of "cat")

Anderson (2008) studied the effects of age of acquisition and repetition priming on picture naming latencies and errors in 22 CWS and CWNS (3;1 and 5;7) The results showed that all children's picture naming latencies and errors were less following repetition priming and in response to early acquired words relative to late acquired words. Age of acquisition and repetition priming effects were similar for children in both talker groups, with one exception, namely, CWS benefitted significantly more, in terms of error reduction, than CWNS from repetition priming for late acquired words. In addition, CWNS revealed a significant, positive relationship between linguistic speed and measures of vocabulary, but CWS did not show same like CWNS group. These results

were taken to put forward the notion that the (a) semantic–phonological connections of CWS may not be as strong as those of CWNS and (b) existing lexical measures may not be sensitive enough to differentiate CWS from CWNS in lexically related aspects of language production.

The studies mentioned above shows that there is relationship between stuttering and semantics. It is determined by the studies that when compared to CWNS, CWS have poor semantic skills. Some researchers did not find any significant difference and research in this area has to be done extensively to arrive at the conclusion.

2.5.1.3 Syntax

Wall, Starkweather & Cairns (1981) examined the location and rate of stuttering in the spontaneous speech of 9 stutterers (4.0-6.6 year) in relation to certain aspects of syntactic structure of a sentence. The spontaneous speech was recorded in a play session. Stuttering was found with significantly higher frequency at clause boundaries than at internal positions of clauses. Logan (2000) assessed whether syntactic complexity continues during adolescence and adulthood. 12 PWS produced self generated sentences within a structured conversation task and prepared sentence within a reaction time task. The frequency of stuttering was less in prepared sentence task than during length matched conversation.

Wall, Kadi-Hanifiand Howell (1992) studied the amount of usage of various sentence types in groups of CWS and CWNS in the age ranges 4, 6, and 11years. They found that there was no difference in the amount of usage of various sentence categories. The reason attributed to difference is the use of semantically based sentence analysis and

the second discrepancy between Wall, Kadi-Hanifi and Howell (1992) involve the incidence of stuttering on syntactic sentences which are complex.

2.5.2 Reading disorders associated with stuttering

Reading is one of the linguistic components which require the ability in understanding, formulating and use of language. Poor knowledge about syntax and semantics and other skills for processing of language will lead to problem in reading skills. Bosshardt and Nandyal (1988) showed variation among oral and silent reading in CWS. However, Conture, (2001), and Nippold and Schwarz, (1990) found that CWS did not change from their normal aged peers in reading capacity and narrative skills.

Janssen, Kraaimaat and van der Meulen (1983) compared the reading abilities of elementary school children who stutter with their non-stuttering peers. 44 stuttering children from 4 grade levels were matched with a group of fluent controls on the basis of age, sex, and grade level. Reading ability was assessed by means of 3 Dutch standardized tests yielding a total of 6 scores. The disfluency scores during oral reading were also obtained for each participant. Their findings indicated significant differences between both the groups on reading rate and reading errors, but not on reading comprehension. Analysis of reading errors did not show qualitative differences among subjects: stuttering and non-stuttering children made the same kinds of reading errors. The findings are discussed regarding the possible relations between verbal performance and linguistic competence in reading ability measures, particularly for the stuttering child.

Schindler (1955) checked oral reading accuracy in 2 through 5 grade CWS (n = 24) and silent reading comprehension in 9 through 12 grade CWS. The Gray Oral

Reading Test was provided to the younger group, and the Advanced Form of the Iowa Silent Reading Tests to the older group. The result indicated that the younger CWS were delayed roughly around one year in oral reading but the older group performed better in silent reading. In this study, it should be observed that the Gray Oral Reading Test is a timed task in which slow readers receive poor scores than fast readers (Compton, 1980). The fact that PWS under time pressure frequently become more disfluent (Van Riper, 1982) Andrews and Harris (1964) evaluated the reading skills of 80 CWS and CWNS ages 9 through 11. The Word Recognition and Word Comprehension sections of the Schonell Reading Tests (Schonell, 1950) were measure to all CWS. The conclusion of the study showed that the CWS obtained slightly lesser reading quotients than the CWNS on both tests. Though, the differences were not statistically significant.

Since the early part of this century, reports have suggest that children who stutter may be at higher risk than their non-stuttering peers for poor scholastic achievement (Root, 1926; McAllister, 1937; Darley, 1955; Schindler, 1955; Williams, Melrose, and Woods, 1969). Upon investigating the research in this area, Andrews et al. (1983) reported that CWS "lag some 6 months behind their peers educationally". The studies which compared stuttering and non-stuttering children in reading capability present a varied impression. The studies that checked oral reading (Schindler, 1955; Andrews & Harris, 1964; Conture & van Naerssen, 1977; Janssen et al., 1983), two revealed that CWS scored below the expected levels (Schindler, 1955; Janssen et al., 1983). Studies have shown that some CWS also display problems in learning to read (Blood & Seider, 1981; Daly, 1981). Evidence suggests that CWS having a history of delayed speech and

language development may be particularly vulnerable to reading problems later (Daly, 1981).

McDowell (1928) administered an early version of the Stanford Achievement Tests to 45CW and CWNS. McDowell observed no significant variation between both groups on any of reading sections of the test - paragraph meaning, sentence meaning, and word meaning or on any other sections of the test including arithmetic and spelling. However, the mean scores of the stuttering group performed lower than CWNS on all section of the test.

2.5.3 Cognition

Cognitive process refers to "a broad perception which includes the higher order executive functions of planning, attention processing, problem solving, verbal reasoning, and task switching (Monsell, 2003) and the initiation and monitoring of actions (Chan, Shum, Toulopoulou & Chen, 2008)". The area in the brain responsible for the cognitive control is the frontal cortex (Wagner, Bunge & Badre, 2004). These processes making up cognition include language and perception, which refer to the organization, identification and interpretation of all the sensory information present in the environment.

In the recent years, working memory has been greatly implicated in the onset and development of stuttering. Working memory is recognized as "a neuro-cognitive system which provides temporary storage and processing of incoming information". Baddeley (2003) envisioned working memory as a multi-component neuro-cognitive system that consists of a central executive, visuo-spatial sketchpad and a phonological loop. The phonological loop comprises the short term storage as well as rehearsal of the incoming

verbal information which enables comprehension. Phonological encoding during the process of speech planning involves retrieval of phonological material from the existing storage and to build articulatory plans (Levelt, 1989). Working memory has been considered vital to phonological encoding (Gathercole & Baddeley, 1993) and critical to the higher level cognition (Rosen & Engle, 1997).

The Covert Repair Hypothesis, one of the recent prominent theories by Postma and Kolk (1993) assumes that "stuttering arises because inefficient or slow phonological encoding leads to an increase in covert repairs to the phonological plan, particularly when the individual is intent on speaking at a rate exceeding the compliance of the phonological encoding mechanism".

The cognitive models with regard to speech production, such as the one proposed by the author Levelt and his colleagues (1999) provide a very useful framework in order to consider the linguistic processing that might probably be deficient in individuals with stuttering. Various studies have tried to explore the hypothesis which says, retrieving semantic as well as phonological information for linguistic encoding might be a potential source of delay or deficit in stuttering (Newman & Bernstein, 2007).

Yairi (1996) studied two groups of children who stutter (those who recovered and those who did not) and normal controls on an intelligence test, The Arthur Adaptation of the Leiter International Performance Test (Arthur, 1952). The group of children who persisted to stutter scored significantly lower than the non-stuttering control group but children in the recovered group did not score significantly lower than the controls. Hence, some cognitive abilities may be related to a neural resilience allowing recovery from

stuttering. In other words, children with slightly higher cognitive functioning may have the extra resources needed to reorganize their speech and language processing, allowing them to develop a workaround for the problem causing them to stutter. Some aspects of cognitive development may compete with spoken language development for the same neuronal resources, thereby jeopardizing fluency.

Between the ages of 3 and 4 years, children's cognition mature enough so that they internalize the standards of behavior of those around them including their peers. According to Lewis (2000), at this point children can evaluate how they are performing in comparison to others and will experience the "self - conscious" emotions such as embarrassment, pride, guilt and shame. These emotions may tend to play an essential role in stuttering and the persistence of stuttering.

Attention and memory in relation to stuttering

Attention is one of the important components of higher cognitive processes, Attention, means concentrating on a particular feature of the setting in the presence of distracters, which involves the behavioural control and judgmental actions or the capability to change the approaches or use feedback functions in persons with fluency disorders. The central features of the cognitive and psychological theories of stuttering lies in attentional bias. The cognitive models and theories of stuttering presumed that the emotional position of the PWS not only leads to an attentional bias, it also plays a significant role in its causation and maintenance. The focus of attentional bias varies with the type of emotional trauma experienced by an individual. There exists a "vicious cycle" wherein the attentional process becomes hyper vigilant with respect to the areas of

concern (e.g., threat of social harm or negative appraisals of others), leading to an emotional response (e.g., increased anxiety). Thus, this increase in the conscious awareness to those areas of concern tends to overestimate the level of threat ultimately resulting in an emotional disturbance. The results from a large number of studies done in this area of research confirmed that there is an attentional bias in individuals with emotional disorders as the attentional process in these individuals are biased to the threat related information. PWS display a deficit in cognitive flexibility and they can adopt their strategy to succeed on a certain task, but this change in strategy is less flexible compared to people who do not stutter.

Kamhi and McOsker (1982) conducted a study in which investigation of the ability of stutterers and non-stutterers to simultaneously perform speech and non-speech tasks was compared. The subjects were 10 stutterers and 10 non-stutterers. Two experiments were conducted. In the first, the subjects performed a non-attention-demanding gross-motor task, where the participants were asked to step up and down 10 –ft high, 4-ft square table or toe-raise has to be performed and should read rainbow passage aloud. In the second, the subjects performed an attention-demanding task (reading comprehension) during speech. The results indicated that there was no significant change in the disfluency values of stutterers during the motor activity or as a result of the reading comprehension task. However, stutterers were found to perform significantly poorer than non-stutterers on the reading comprehension task. This finding was taken as evidence that stutterers devote more attention to speech than do non-stutterers.

The PWS exhibit attentional problem causing stuttering (Bosshardt, 2002; Vasic & Wijnen, 2005). In order to focus attention on appropriate stimuli in the environment,

cognitive control is required which puts forth a question as to whether there is an indeed attentional problem associated with the emotional disturbances or there is a broader problem in other cognitive control abilities. The PWS have been observed to show increased demands on the attentional resources when performing speech and language tasks under dual task conditions (Heitmann et al., 2004; Bosshardt, 2006; Smits- Bandstra & De Nil, 2009; Jones, Fox, & Jacewicz, 2012).

In a study done by Loisy and Roulin (2003) using dual task experiments where the subjects were asked to carry out 2 or more tasks simultaneously (e.g., to process both visual and verbal material simultaneously), the authors reported that the stuttering frequency decreased in PWS when the focus of attention was drawn away from speech production with a secondary task. A few other studies done with respect to this topic show an opposite result of the dual task experiments on the stuttering frequency (Caruso, Chodzko, Zajko, Bidinger & Sommers, 1994; Bosshardt, 2002) whereas some studies showed that there was no effects of these tasks (Kamhi & McOsker, 1982; Thompson, 1984). The nature of these attentional tasks is not completely understood.

Schwenk, Conture and Walden (2007) directly examined attention in their participants who included 3–5 year old CWS and CWNS. They compared the frequency at which the children got distracted or disengaged from the conversational interaction with their caregivers or parents to watch the movement of a video camera that was mounted in the room. The results show that, although the frequency of camera movements did not vary between the groups, proportion of times for which the children disengaged from activity to watch the camera movement was significantly greater in CWS than CWNS. The findings interpreted suggests that CWS react to a larger extent to

the environmental stimuli and also that they are usually unable to regulate their responses to changes within the environment. These findings seem to emphasize the potential differences present in selective attention (Anderson, Pellowski, Conture, and Kelly, 2003; Karrass et al., 2006). Anderson et al., using the Behavioral Style Questionnaire (BSQ; McDevitt & Carey, 1978) examined the aspects of temperament in CWS, aged 3–5, and their peers. They found that CWS group had better performances in the attention dimension of the questionnaire, pointing to a greater persistence and reduced attentional flexibility than their peer group. Similarly, Karrass et al. (2006) used the same measure and the similar age range of children and found that the CWS had less ability to control attention.

Anderson and Wagovich (2010) did a study to explore possible relationships between measures of linguistic processing speed and two aspects of cognition: phonological working memory and attention, in 9 CWS and 14 CWNS between the ages of 3; 6 and 5; 2 years. Children participated in a computerized picture naming task (an index of linguistic processing speed) and a non-word repetition task (an index of phonological working memory). The parents completed a temperament behavior questionnaire, from which information about the children's attentional skills was collected. Their findings revealed that (a) the groups did not differ from each other on speed of picture naming or attention. However, the CWS performed significantly worse in non-word repetition. In addition, there was a significant negative relationship between picture naming speed and non-word repetition in CWS; (b) there were no significant relationships for either group between aspects of attention and picture naming speed; and

(c) only the CWNS showed a significant relationship between non-word repetitions and focused attentional skills.

The purpose of assessment of memory is to explore the role of verbal memory and its operations in the development of stuttering. Oyoun, Dessouky and Fawzy (2006) carried out working memory recall tests, such as recall of short versus long word sets, digit span versus letter sequences, and picture-number test. There was no significant difference between the controls and the stutterers in all parameters of the working memory recall tasks except the digit span and picture-number test in which the controls had a better recall score than stutterers.

Some researchers have observed poor working memory in a group of CWS. Reilly and Donaher, 2005 examined verbal working memory skills of children who stutter via a digit and letter span experiment. The participants included 5 CWS with mean age of 7.9 years and 5 age-matched CWNS with mean age of 8.5 years. The group of CWS included 5 males, and the group of CWNS included 4 males and 1 female. All CWS demonstrated at least moderate or greater stuttering. The digit and letter span task was carried out where all the participants were instructed to write their response for half of the items and repeat their response to other half. This was done in order to assess whether response modality (i.e., oral or written) influence recall accuracy or not. The result revealed significant difference between CWS and CWNS. The CWS showed significantly reduced recall when compared to an age-matched group of CWNS. This effect was apparent across both written and oral response modalities. Based on the results, the authors concluded that the differences are due to correlation between speech rate and working memory, indicating that if the speed of the articulators increase, the

speed of memory span also increases. Therefore, the authors hypothesized that CWS exhibit slower rate than CWNS, slower overt speech is indicative of slower covert rehearsal. The conclusion of the study was that the CWS have slower speech rate which will affect their working memory. However, various researchers reported inconsistent findings with respect to speech rates and hence further research is wanted in this area.

To summarize the review on cognitive skills of CWS, the findings from above review suggests that slower speech rate which might affect the working memory in CWS. The studies view that children with stuttering may have some degree of delay and slowness in memory abilities when compared to normal children.

2.5.4 Motor Skills

Stuttered speech presents an output which is motorically disturbed or "a limitation in speech motor skill" (Van Lieshout et al., 2004) "A common finding is that across a range of motor speech tasks which are considered to provide indices of motor control, in individual with those who stutter it has been found to perform either more slowly or with greater variability (or both) than in those who do not stutter. This difference in motor speech performance can be seen at respiratory, laryngeal and articulatory levels, and may also these will be observed in non-speech as movements".

Speaking is a compound task which includes a lot of skills and coordination to speak fluently and accurately. Stuttering is a developmental speech disorder in which the prime signs are motor and the flow of smooth speech is interrupted as the nervous system fails to produce the suitable command signals to drive the muscles which is involved in

speech production. It is influenced by numerous variables and the rate of speech is one among them.

Zimmermann (1980) published a multidimensional model of stuttering. He speculated that individual with stuttering have irregular motor abilities and have lowered thresholds of interruption in the motor control of speech. CWS have unbalanced motor control for speech (Smith 1990). Sometimes the speech motor control works smoothly and sometimes speech will be repeated, prolonged or blocked. Many examiners have emphasized that individual who stutters have a general motor deficit (Webster, 1985; Zelaznik, Smith, Franz & Ho, 1997; Max, Caruso, & Gracco, 2003) or a timing deficit (Kent, 1983; Boutsen, Brutten & Watts, 2000) that contributes to the development and maintenance of the disorder. The diadochokinetic (DDK) rates (capacity) and the rate of speech (performance) are factors that determine the motor control abilities which have been investigated by researchers and shown to have an influence on the onset and development of stuttering.

Studies showed that persons who stutter were slower whether they were responding to auditory or visual signals (Cross & Cooke, 1979). Following these studies which accounted that PWS had slower reaction times and slower segments in their fluent speech, investigators began to study complex motor coordination of non-speech muscles and structures. In a study of both sequential finger movements and sequential counting aloud fluently, Borden (1983) found that persons with severe stuttering, but not mild ones, were slower than PWNS in executing both finger movements and speech tasks. Thus, persons with severe stuttering may have substantial deficits in certain sensory-motor tasks, but mild ones may have only slight deficits in certain sensory-motor tasks.

Webster (1993) expanded a finger movement task in which contestants tapped four number keys in a predetermined sequence. To make the task somewhat like speech, participants were allocated a novel sequence of keys at the start of each trial. In both timed and untimed tests, PWS made more errors in sequencing and were slower in initiating the task but were comparable to PWNS in execution time. Webster suggested that PWS may have difficulty in "response planning, organization and initiation" (Webster 1993).

According to Zimmerman (1980) stuttering should be viewed as a disorder of movement. The focus on parameters such as velocity, displacement and duration of movement and the coordination and timing between articulatory events was motivated by the possibility of relating these events to underlying neurophysiologic processes. Disfluent events are associated with particular patterns that preceded and followed them. These findings led to the speculation about the association between disfluent events and aberrant activation of brainstem pathways that physiologically link the articulators. Precisely, it was recommended that lower velocities and displacements and longer durations in the movements of PWS are associated with processes that keep activation of BS pathways below "threshold" level during perceptually fluent speech. Bernstein (1967) proposed that the onset of any movement is preceded by preliminary tuning of the excitability of all participating sensory and motor elements. Tuning or biasing facilitates or inhibits the excitability of certain pools of motor neurons and thereby alters the relationships among groups of muscles and determines the kind of behavior they will promote.

McFarlane and Prins (1978) found consistently longer reaction times for PWS in a lip closure task, regardless of whether the participant was producing a syllable such as /pae/ or a simple movement of the lips. Strother and Kriegman (1943) found no significant differences in the DDK rates of the tongue, jaw and lips of PWS and PWNS matched for age, gender, dextrality quotient and rhythm discrimination. Van Lieshout and Peters (1993) studied 15 PWS and 20 age matched controls. Lip round gestures in speech were analyzed. EMG signals of muscle orbicularis oris inferior during lip rounding had higher levels of EMG and longer duration of EMG. PWS even had significantly higher EMG levels at the moment of speech onset and during speech production than normal individuals. Shapiro (1980) measured EMG in PWS during diffluent as well as fluent utterances (muscles included orbicularis oris muscle, superior longitudinal and intrinsic laryngeal muscle). The findings revealed excessive muscular activity during the production of diffluent as well as fluent utterances, inappropriate burst of activity before and during periods of acoustic silences and lack of coordination of muscles during blocks.

According to Mac Kay and MacDonald's (1982) model, the basic controls underlying motor control are content nodes each consisting of one or more neurons. These nodes are organized into 3 independently controllable systems such as the muscle movement system that involves respiratory system, larynx and articulators as tongue, velum and lips and the sentential system and phonological system representing cognitive units for controlling the movements. These nodes work together in making up a pre-programmed sequence such as a word or a phrase.

Nodes are hypothesized to share 3 dynamic properties such as priming, activation and linkage strength that are relevant for the occurrence of stuttering and other speech errors. Priming is an excitatory input that active nodes to pass on to the nodes connected to them. The priming a node receives summates over at which a node is fully ready for activation.

Activation is the highest level of activity of a node. Activation of the lowest level muscle movement nodes is necessary for behavior to arise. The order and timing of activation of these nodes determines the sequence and timing of activity in the trial output. Linkage strength is a long term characteristic of the connection between nodes that determines the asymptotic level and rate at which a connection passes priming from one node to another. Increased linkage strength yields lower probability of error for a given rate of speech. Apart from the nodes mentioned above, there are additional two nodes which help in coordinating the movements, Sequence nodes are non-specific activating mechanism for activating content nodes in proper serial order. Timing nodes represent the components of an internal clock which determines when the sequence nodes become activated. Errors occur whenever another node in the domain has greater priming than the intended to be activated node, when the sequence node for the domain of content nodes is activated. As a consequence the wrong node becomes activated under the most-primed-wins principle, and an error results which will be more likely the faster the rate of speech. The error in the system is leading to disfluencies in speech.

2.5.4.1 Word and Non-word repetition abilities

Non-word repetition was considered to be a phonological short term memory task, in which the phonological forms of the stimuli are unknown thus requiring children to code new phonological sequences and maintain the same in phonological memory. By repeating non-words the speaker relies rely on the storage component of the phonological loop without the complicating effects of prior lexical knowledge (Gathercole et al., 1994).

The non-word repetition task includes several processes which include, auditory processing, encoding the acoustic information into phonological representations, holding the representation in working memory, motor planning and execution of the response (Gathercole, 2006). It was observed that younger children have more difficulties in repeating non words that did not resemble words compared to word-like non words, and such differences decreased with age suggesting that prior lexical knowledge can influence performance (Munson, 2001).

Hakim and Ratner (2012) tested phonological working memory ability in 4 to 8 year old children using children non-word repetition test. CWS repeated few items correctly and showed more phonological errors than fluent children by increasing the length of the syllables but by increasing the length of non-word but fluency of non-word repetition did not change. Also, CWS were fluent in long non-words as well as short ones.

According to a study done by Anderson et al. (2010) the capacity of repeating non-words was assessed in children with stuttering and in normal children. The results of the

study noted that the ability of normal children to repeat non-words was different from individuals who stutter, and the difference was correlated to poor language performance in children who stutter or stuttering occurrence in periods that non-words are repeated. Non-word repetition is further influenced by the frequency of phonemic sequences in a language measured as high vs. low phonotactic probability (e.g., Gathercole, Frankish, Pickering & Peaker, 1999; Storkel, 2001; Storkel, Armbruster & Hogan, 2006). Non-word repetition offers support for difficulties experienced by school-age CWS in phonemic encoding/working memory abilities (Sasisekaran & Byrd, 2013). Anderson and Wagovich, (2010) studied phonological working memory, and attention in 9 CWS and 14 CWNS between the ages of 3-5 years. Using non-word repetition task as index of phonological working memory, the study revealed that CWS performed significantly worse in non-word repetition than CWNS.

Non-word repetition skills in 5-6 year old Kannada speaking children with and without stuttering were measured by Somy and Geetha (2008). The study focused on how the CWS differ from CWNS in the number of correct response produced, number of phonemes correct on a word and non-word repetition task. The result of the study indicated that CWS differed from CWNS in the number of phonemes correct and they had more difficulty in maintaining fluency. Bakhtiar and Sadegh (2007) did non-word repetition task and examined phonological encoding in 12 children who stutter and 12 children without stuttering. Their results indicated that children with stuttering showed slightly poorer performance when compared to CWNS but the difference was not significant.

The studies of phonological working memory in CWS are very few, measured through non-word repetition in CWS (Hakim & Bernstein, 2004; Anderson & Wagovich 2006; Bakhtiar & Sadegh., 2007). Hakim and Bernstein Ratner found that "CWS, ages 4–8, produced significantly fewer 3-syllable non-words accurately, compared to age- and gender-matched peers, and they produced significantly more phoneme errors on 3-syllable stimuli than peers. Non-word stimuli of 2, 4, and 5 syllables resulted in no between-groups differences ". On the contrary, Anderson and Wagovich (2006) observed "non-word repetition in a younger group of CWS, aged 3–5 and found that the CWS produced significantly fewer 2- and 3-syllable non-words correctly, with significantly more phoneme errors on 3-syllable non-words". In contrast to the above mentioned studies, different results were obtained in a recent study by Bakhtiar and Sadegh (2007) "This study examined non-word repetition and the phonological skills of CWS and their peers, The participants were 5–7 years monolingual speakers of Persian using 2- and 3-syllable non-words, The findings were that the CWS did not differ from peers in the number of phonological errors produced in repeating the non-words". All three studies were with CWS who did not differ from CWNS in language scores, and all three incorporated 3-syllable non-words (on which between-groups differences were found for two of the studies). Thus, there is some similarity across studies. It is possible that the stimuli across studies differed in overall difficulty for the children. For example, the Children's Non-word Repetition Test (Gathercole et al., 1994), employed (Hakim and Bernstein, 2004; Anderson et al. 2006) tends to reveal robust differences among children with language impairments and their peers (Estes, 2007). It is not known if this is the case for the non-word repetition task developed by Bakhtiar and colleagues (2007) although,

based on the description of stimuli development, it appears that the non-words were carefully developed. In sum, the evidence to date does not present a clear picture of the non-word repetition skills of CWS relative to peers.

Hakim and Bernstein (2004) "compared eight CWS (4;3 to 8;4 years; months) to age matched CWNS using the Children's Test of Non word Repetition (Gathercole, Willis, Baddeley & Emslie, 1994), CWS had fewer correct productions and more phonemic errors than CWNS in one, two, and three-syllable non words, but group differences were observed at three-syllable level. A higher percent of phoneme errors was observed in both groups for the longer, four- and five-syllable non words".

The studies mentioned above give us an insight into relationship between language skills of CWS and non word reading skills and hence into phonological and language skills in the children. In general it appears that CWS have poorer word and non word reading than CWNS.

2.5.4.2 DDK Rate

The diadochokinetic rate (DDK) can be considered as one measure of the oro-motor capacity of an individual. The DDK rate measures how quickly a person can accurately repeat a series of rapid, alternating phonetic sounds using different parts of mouth. DDK rate determines if there are problems in the speech mechanisms that control motor skills or speech planning functions in the brain. For example, the sounds "puh," "tuh," and "kuh" use the front (the lips), middle (the tip of the tongue with palate), and back part of the mouth (back of the tongue with the soft palate), respectively.

Jeena, Kanaka, Sunila and Rajashekar (2012) "conducted a study to establish normative for motor speech profile in Kannada speaking adults. In their study, native Kannada speakers (n=300) were divided into three age groups (20-40 years, 41-50 years and 51-60 years) with 50 male and female in each group. The obtained data are reported across age and gender for the parameters of DDK, second formant transition and voice and tremor characteristics of MSP software. The findings indicated statistically significant difference for seven parameters across gender, whereas across age statistically significant difference was seen for nine parameters in the age group of 51-60 years than other groups".

Wong, Allegro, Tirado, Chadha and Campisi (2011) "conducted a study to report the motor speech characteristics in healthy paediatric population using 112 subjects (58 males and 5 females) aged 4 to 18 years. The subjects were divided into 3 sub-groups (4-8 years, 9-13 years and 14-18 years). The speech samples were recorded and analyzed using MSP software. The results indicated that there was an increase in average DDK rate and standard syllabic duration with age. There were no identified differences in motor speech characteristics between males and females across the measured age range. The average DDK rate among children aged 4-18 years was 5.07 syllables/ second. The DDK rate increased with age in both male and females".

Andrade, Queirózand Sassi (2010) observed a significant difference for SMR, fluent children presenting a better capacity to rapidly move their articulators. When comparing the AMR and SMR, the SMR task requires higher motor demand which involves deficits in planning or in motor programming. The DDK tasks have long been used in both research and clinical assessment contexts as a means of gaining insight into

an individual's speech motor ability. (Wang, 2008) performed acoustic analysis and compared performance of 26 CWS and CWNS on DDK task and found no difference between CWS and CWNS but between age groups significant difference was observed., Further, the differences were related to speech motor age development and not to stuttering itself (Fabilola, Silmara & Paula, 2012).

Some studies comparing DDK rates of CWS have observed that on the performance during speech motor task, a large percentage of CWS showed oral motor problems (Yaruss, Logan & Conture, 1995; Olander, Smith & Zelaznik, 2010) showed statistically significant variations in SMR tasks only between fluent speakers and CWS, which suggests that CWNS were able to rapidly change the positions of articulators than CWS. The ability to control voluntary sequential motor speech movements (required for the positioning of articulators during the production of phonemes) also depends upon the accuracy of the motor commands and on the smoothness of the transition between articulatory positions.

DDK is measured in two ways, alternate motion rates (AMR) and sequential motor rates (SMR). Oral- diadochokinesis is a phono-articulatory speech task that involves the repetition of combination of a consonant and a vowel (a single syllable, /pa/, /ta/ and /ka/) or of a long syllabic sequence (/pataka/) as quickly as possible in a clear and continuous way (Ziegler, 2002). Although it involves speech sounds, it is considered as a non speech oral motor task (Ziegler, 2002). As DDK is established as a tool to assess the speed, range and coordination between the speech articulators, it can be used as a valuable task to study the speech motor abilities in CWS. While relatively a few studies have observed

the speech motor control processes in CWS, some evidence recommends that CWS show signs of difficulty in the planning and/or programming of speech movements.

Riley and Riley (1979) "suggested that a large percentage of CWS exhibits oral motor problems, as supported by their performance during the DDK task". Still, direct comparisons of DDK rates produced by CWS and CWNS have reported no significant between-group differences (Wolk, 1993; Yaruss, Logan & Conture, 1995). Haswlager, Slis and Rietveld (1991) "conducted a study to investigate the development of rate of speech in children in the age range of 5-11 years. Both DDK and spontaneous speech sample were collected. The result indicated that speech rate increases with age and is higher in long than in short utterances. The rate of spontaneous speech and the DDK rate were found to be weakly related. Also no significant gender effect was noticed for both the groups". Other studies report that normally developing children produce many errors during the standard DDK task (Canning & Rose, 1974; Henry, 1990; Williams & Stackhouse, 2000).

Rusell (1941) reported a study based on the rate of diadochokinetic movements of the jaw at the ages from seven to maturity. The subjects selected were 21 normal males, 18 normal females, 18 male PWS and 18 female PWS. He concluded that there is increase in rate of DDK of jaw from the age range of 7 to 18. Statistically, the rate of DDK movement does not closely correlate with the age. The female norm established in this study was greater than the male norm for DDK. There seems to be no correlation with age after 17.

The outcome of various researches have indicated that as the motor systems of children mature, the DDK rates were also found to be increasing (Kent et al., 1987; Henry, 1990), and by 9-10 years adult like rates are achieved (Canning & Rose, 1974) or by age 15 (Fletcher, 1972). Studies have also shown that DDK rates are highly variable, both within and between participants, in which higher variability was apparent for the younger age groups (Canning & Rose, 1974; Robbins & Klee, 1987; Williams & Stackhouse, 2000). Various authors have documented that articulator movement variability is greater in children than adults (Sharkey & Folkins, 1985; Green et al., 2002; Grigos, Saxman & Gordon, 2005). Physiologic findings indicate that oromotor coordination (i.e., lip and jaw movement) remains more variable for 8 years than for younger adults at 14 years of age (Smith & Zelaznik, 2004). This finding suggests that maturation of speech motor control continues to develop throughout adolescence. Although coordination between lips was shown to be more variable in children at 14 years of age than in adults, a plateau in performance was observed between 7 and 12 years of age (Smith & Zelaznik, 2004).

From the studies mentioned above we can conclude that children with stuttering have deficits in planning or in motor programming during oral task when compared to fluent children who present a better ability to rapidly move their articulators. The studies of the DDK rates of CWS have reported that a large percentage of these children demonstrate oral motor problems, as supported by their performance during motor tasks involving speech.

2.5.4.3 Abilities to produce tongue twisters

Speech production requires control and coordinated activity of different speech subsystems. Disturbance in the coordination and control in these speech subsystems leads to disruption in the speech motor control, which in turn lead to fluency failures or stuttering. Currently the causes for stuttering have been viewed as disruptions in the speech motor control system, because of which the individual exhibits disfluencies such as repetitions, prolongation, and breakdown in his or her speech.

The production of tongue twisters is a compound task which requires coordination of different systems and involves specific speech motor control. It requires precise, sequential speech motor coordination and it is difficult to produce quickly and correctly, even for normal individuals. Even though the production of tongue twisters does not have a communication intention, PWS show disfluencies and other speech errors and they use various strategies to defeat them. Although normal subjects also show speech errors, their type and frequency was less.

Smith et al., (1986)," using words and phrases of two syllables, found that utterances of tongue twisters containing relatively unusual sound sequences, which one supposes intuitively to be difficult to say rapidly and took more time in both overt and silent production than control stimuli. In addition, there was a significant interface between stimulus type and speech condition. The most slowly produced stimuli in the silent condition differed even more strongly from the other stimuli when uttered aloud". Smith and colleagues concluded that the planning of certain utterances might proceed problematically, in a way that it prolongs both inner and overt production of these utterances. Motor execution, in line, may add to these premotor disturbances, as reflected

by extra longer durations for overt tongue twisters. Similar results were obtained by Haber and Haber (1982), "which shows that subjects took longer to read full-blown tongue twister sentences at maximum speed than matched control sentences, both silently and overtly. The difference between tongue twisters and control sentences was largest for the overt reading". However, in contrast with Smith (1986), this interaction was not significant.

Postma and Kolk (1990) performed a study where they compared the disfluencies, self-repairs and speech errors in normal and PWS groups during production of tongue twisters and neutral sentences in Dutch language under high-accuracy and low-accuracy conditions. The end results showed that tongue twisters extracted more speech errors, disfluencies and self-repair than neutral sentences. Additionally, it has been found that stimulus type by accuracy condition was significant for the speech errors. Tongue twisters produced considerably more errors in low-accuracy condition than in high-accuracy condition. Peters et al., (1989) showed that the difference between PWS and PWNS in initiating an oral response become larger with longer utterances. They suggested that PWS have difficulties in speech organization earlier to the actual motor execution.

Postma and Kolk (1993) "recommend that individuals who stutter make larger numbers of phonological encoding errors, which are detected during the monitoring of inner speech and repaired, with stuttering-like disfluencies as a result. In their study, 32 PWS and fluent controls matched for age, gender and education, recited tongue twisters and self-reported any errors they perceived themselves to have made. The result reported that in 50% of trials the tongue twisters were recited silently and errors found were those

detected in inner speech. When compared to controls, PWS had produced significantly more word-onset and word-order errors. Significantly, this differentiation was found in inner as well as in overt speech. Comparison of experimenter ratings and participants' own self-ratings of their overt speech revealed similar levels of accuracy across the two groups, which provides suggestion that person with stuttering were simply more sensitive to the errors they made.

Vedha, Deepa and Geetha (2012) studied the ability of PWS to produce tongue twisters, and compared speech errors and disfluencies during the production of tongue twisters between adult PWNS and PWS in Kannada and English in reading and reciting tasks. They observed significant difference between PWS and PWNS in total duration during reading task in English. The subjects showed significant differences in frequency, type of articulatory errors and disfluencies.

From the above studies we can speculate that children with stuttering have poor speech motor control when compared to normal children. Even though normal subjects also show speech errors, their type and frequency was less compared to CWS who show disfluencies and other speech errors. Further research is required to arrive at better conclusion.

2.5.4.4 Rate of speech

Research into the influence of speech rate on disfluencies discloses mixed findings. Some studies report no significant effect of articulation rate on disfluent speech whereas few studies have revealed a difference. The inconsistency in the findings can be

attributed to the significant differences in the measurement technique, with few exploring the overall speaking rate, and few, the articulation rate.

Speaking rate is defined as the number of spoken units (e.g., words/syllables) per unit of time (minute/second). Depending upon the clinician the unit of measurement can vary. Some calculate rate using words per minute, others use syllables per minute as it can be calculated more quickly than words because clinicians can use the "beat" of syllables to call them online. The syllables per minute approach also accounts for the fact that speech often consists of mono to multi-syllable words which may alter the rate measurements using words as the count often.

Kapoor et al., (2011) studied rate of speech of native Punjabi normal speaking children in the age range of 10-14 years. It was checked whether their speech rate differed in various speech tasks, that is, reading, picture description and spontaneous speech. The results obtained that the rate of speech was in the range of 148-216 words-per-minute (wpm) during reading; 139-171 wpm during picture description and 127-156 wpm during spontaneous speech. The rate of speech was similar across gender .The rate of speech was highest in reading than picture description and followed by spontaneous speech.

Ravi Kapoor, Gurvinder, Survinder, and Arjun (2008) compared the rate of reading in Manipuri and Kannada language across gender using 10 literate participants (18 to 25 years) of native language speakers. A standard reading passage in Kannada and a story passage in Manipuri were used. The subjects were instructed to read the passage at comfortable pitch and loudness. The pauses in the sample were truncated using cool-

Edit software and the rate of reading was measured as syllables per seconds, syllables per minute and words per minute. The results indicated a significantly faster rate of reading in Kannada as compared to Manipuri speakers and no gender differences were observed.

Kormos and Denes (2004) have shown that speech rate is a good predictor of subjective fluency. Clinicians have trust that speaking rate often reflects the severity of stuttering and concomitantly the effect it is having on communication. If a client's speech rate is markedly below or above normal, communication becomes difficult for him. Cucchiarini, Strik and Boves (2002) have revealed that, of the several objectively measured aspects of fluency, speech rate (as measured by phonemes per unit time) is the best predictor of subjective fluency.

Savithri and Jayaram (2004) reported data on rate of speech/reading across 4 Dravidian languages (Kannada, Tamil, Telugu and Malayalam) with respect to words per minute, Syllables per minute and syllables per second. Their results indicated that there was a significant difference between different age- groups and languages. There was a developmental trend in the rate of speech till the age of 40 and decreased after that except in Tamil. Malayalam had the highest syllable per second (SS) and syllable per minute (SPM) compared to other languages. No significant difference between genders was observed. Though the rate of speech is an important parameter it has not been studied extensively in the Indian context. As the linguistic structure of Dravidian and Indo European languages differ, it is probable that the rate of speech also differs.

Cucchiarini et al., (2002) found that, in addition to rate of speech, the number and duration of both filled and silent pauses strongly correlated with expert's ratings of perceived fluency of language during spontaneous speech. Research reveals speech rate differences across ages and tasks. The rate of speech gradually increases as children progress from the preschool years through the upper elementary-school years (Logan et al., 2011). Shipley and McAfee (2008) insist that the conversational speech rate for kindergarteners is around 125 wpm. In 2007, a study by Sturm and Seery, the average conversational speech rate for 7-year olds was 117.7 wpm (range of 91.1-152.3) and the average speech rate for narratives was 124.6 wpm (range of 86.7-153.5). Tilstra and McMaster (2007) elicited narratives from kindergarten children using a single picture prompt and found that their average rate of speech was 58.6 wpm. Oral reading tasks are not typically used with five to six year old children as reading is not an expected skill in kindergarten. Rates continue to increase until about age 11, when they plateau. One of the differences between native speech (L1) and speech in a person's second language (L2) may simply be speaking rate. Previous studies reported that the overall speech rate in L2 is slower than in native speech (Derwing & Munro, 1997; Prezas, 2008). Garcia (1991) proposed that bilingual speakers take longer to process both of their languages, and that slower speech rate is the natural result.

Research into the rate of speech in CWS recommends that it does not fall within normal limits. Ryan (1992) reported that though exceptional speech rates were not observed in CWS, the three lowest and highest speaking rates were demonstrated by CWS. Bloodstein (1987) noted that high speaking rates can result in stuttering. Meyers and Freeman (1985) found slower rates of fluent speech in preschool CWS. Recent

research has advocated the use of articulation rate as a measure in CWS. The difference between both the rate measures is that the overall speaking rate includes all disfluencies whereas articulation rate excludes disfluent words or syllables from the rate calculations. In certain studies it is reported that the speech rate of girls are faster when compared to that of boys until the age of 12 (Dawson, 1929).

Stuttering and speaking rate in CWS

In the speech samples of 14 preschool CWS , Chon and associates (2012) excised stuttering-like disfluencies , the result they found was, opposite to that of adults, that in CWS longer utterances are significantly slower than shorter utterances. They hypothesized that, in preschoolers, a slower articulation rate contains the stuttered words for the increased longer, more complex utterances which has more demands on speech motor and linguistic capacities. In statements that have used this removed disfluency method for articulation rate, there is a tendency for disfluent utterances to be slower to some extent. But it was not significantly slower compared to perceptibly fluent utterances, both in preschoolers (Yaruss & Conture, 1996; Logan & Conture, 1997; Sawyer, Chon, & Ambrose, 2008; Chon et al. 2012) and in school-age children who stutter (Logan et al., 2011).

Tumanova, Zebrowski, Throneburg and Kayikci (2011) found that slower the articulation rate, if stuttering frequency is higher and longer the sound prolongation duration. Sargent, Robb and Zebrowski (2006) observed the speaking rate of 5 CWS and CWNS and they observed that CWS spoke slower than CWNS. In conclusion, there is no united view that CWS speak at a significantly unusual rate than CWNS.

In the Illinois longitudinal project, Dailey Hall and associates (1999) found that preschool CWS performed significantly slower, speaking at a rate of 7.7–10.2 phones per second (pps), when compared to CWNS whose articulation rates were in the 11.4–12.2 pps range.

Yaruss and Conture (1995) found no difference in the articulation rate between preschoolers CWS and CWNS, but they accounted data in syllables per second (sps). Also, in preschoolers who stutter measuring sps is an investigation , Guitar et al., (1992) also reported a major relationship between child`s amount of stuttering and mother`s speaking rate. This conclusion recommends that speech rate may contribute to the onset, developmental and maintenance of stuttering.

Ryan (1992) conducted a study in 20 preschool CWS and CWNS to examine difference in performance between the two groups on articulation, language and fluency. Speaking rate was also measured. The CWS performed lower on seven out of eight language trials than the CWNS and somewhat lower scores than the standard score for their age group when compared with the tests' normative samples. There were no differences between both the groups on articulation proficiency. Within each of the two groups of children there were few significant correlations between measures of stuttering rate, speaking rate, and language performances.

Much attention has been given to the speech rate of CWS, and one commonly used therapy is to counsel parents of CWS to reduce their own rate of speech while talking with CWS (Meyers & Freeman, 1985). Theories surrounding the speech rate of CWS provide suggestion that they may speak faster than they are able to co-ordinate their

articulators (Conture, Louko, & Edwards, 1993), a view supported by some researchers (Kloth, Janssen, Kraaimaat, & Brutten, 1995). However, Meyers and Freeman (1985) found that CWS spoke slower than their CWNS and researches were not able to find any differentiation between the speech rate of CWNS and CWS (Kelly & Conture, 1992; Yaruss, Logan, & Conture, 1995). They reported that the articulation rate of their 12 preschool CWS was significantly slower, (mean = 3.51 S/S), than that of their 12 CWNS counterparts, (mean = 4.18 S/S). Meyers and Freeman (1985) found that mothers of CWS spoke significantly faster to mothers of CWS. Also they found that CWS spoke slower than CWNS and the children's who were diagnosed as having severe stuttering spoke slower than the children's who were diagnosed as moderate stuttering. In addition they stated that there is significant negative association between speaking rate and severity of stuttering.

Jannsen, Kraaimaat and Brutten (1995) found that for children who developed stuttering later, had fast rate of speech before they developed stuttering, faster than CWNS. Hall, Amir and Yairi (1999) also reported that on average, slower speaking rate in those children's whose stuttering was recovered than persisted (as well as in CWNS)

Pindzola, Jenkinsand Lokken (1989) suggested normative data on speaking rates in conversation for 30 non stuttering children, ages 3, 4, and 5, with total mean of 148.4 S/M and mean articulation rate of 179.3 S/M. The differences in findings among the various speaking rate studies above may have been due to any or all of the factors discussed above. However, as a starting place, one may conclude from the research that speaking rates of 170-200 S/M and ARs of 3-4.0 S/S are reasonable first order estimates. Richardson (1985), excluding pause time, found speaking rates, means = 201.0 S/M and

195.9 S/M, respectively, and articulation rates, means = 4.0 S/S and 3.7 S/S, respectively, for 12 CWS& CWNS.

Johnson (1980) reported speaking rates of 7 preschool stutterers 3-6 years of age as a mean pre- and post-therapy of 182 syllables per min (S/M) and 163 S/M, respectively.

In other study young CWS were also found to produce faster articulatory movements in either fluent (Kowalcyzk & Yairi, 1995) or disfluent speech (Throneburg & Yairi, 1994; Zebrowski, 1994). These results support the statement of Conture and colleagues (1993) who speculated that CWS speak faster than their capacity allow. The relationship between stuttering and speech rate has long been studied evaluating the moment of stuttering. Some of the many justifications surrounding the relationship between speaking rate and stuttering include: (1) that CWS attempt to speak faster than they are physically capable of (Conture et al., 1993) and (2) that parents of CWS put them under pressure by talking to them at fast rate (Costello & Ingham, 1984). Speaking rate has also been observed in AWS, showing that as speaking rate decreases fluency increases (Adams et al., 1973; Van Riper, 1973; Ingham, 1987; Onslow & Zebrowski & Kelly, 2002). Logan and LaSalle (1999) reported that higher incidence of disfluency clusters are observed in the adults with the fastest speech rates.

Jayaram (1976) did a study aimed to linguistically analyze stuttering patterns in speech of 2 bilingual (Kannada – English) adult PWS with average age of 26 years. The subjects were asked 5 questions in each language to elicit their spontaneous speech and also were asked to read a passage in both the languages. Different questions were asked

in both the languages, and were asked to speak spontaneously in the two languages. Their speech was recorded for further analysis. Any of the hesitations, repetition and prolongation of sounds and syllables was considered as a moment of stuttering. No attempts were made to analyze the secondaries. The results revealed that in both the cases repetitions were more, compared to prolongations and hesitations. The speaking rates for both subjects were same in both the languages but for reading rate subject 2 was lower than subject 1 in both the languages. In both subjects, difficulty was more in English. The findings of this study suggest that stuttering may be purely a motor phenomenon and.

From the above mentioned studies it is speculated that there is variation among speaking rate in CWS when compared to fluent speakers. Even though the nature of the relationship between stuttering and speech rate is not yet well understood, but it has been accepted that there is a relationship between them. There is mixed findings with respect to speaking rate and it is also observed that speaking rate in CWS increases under time pressure and speech rate varies with severity of stuttering.

2.5.5 *Socio – emotional Skills*

The development of negative communication attitudes in natives with stuttering has been considered for several years (Andrews & Cutler, 1974; Bloodstein, 1993; Menzies, Onslow, & Packman, 1999; Vanryckeghem & Brutten, 2011; Beilby, Byrnes, & Yaruss, 2012). Initially, studies were focused exclusively on the communication attitudes of adults with stuttering as it was thought that the negative impact of stuttering do not develop until adulthood.

Latest theoretical explanations of stuttering in childhood propose that emotions contribute to its development (Conture et al., 2006; Conture & Walden, 2012). Such hypothesis is steady with experimental proof showing that CWS exhibit more negative emotions (Eggers, De Nil, & Van den Bergh, 2010) and further emotion reactivity to their surroundings (Karrass et al.,2006; Schwenk, Conture, & Walden, 2007). The results also suggests that CWS, differ in their use of effortful control when compared to CWNS (Eggers et al., 2010) and seem less well-equipped to self-regulate emotional responses and adapt to novelty (Lewis & Goldberg, 1997; Embrechts, Ebben, Franke, & van de Poel, 2000; Anderson, Pellowski, Conture, & Kelly, 2003; Williams, 2006; Karrass, 2006; Schwenk, 2007; Johnson, Walden, Conture, & Karrass, 2010). (Calkins, 1994; Cole, Michel, & Teti, 1994; Diener & Manglesdorf, 1999; Stifter & Wiggins, 2004) "Observed that the development of emotion regulation is assumed to progress with age, beginning in infancy, and changing from external sources of emotion regulation (e.g., caregivers) to more internal sources of self-regulation".

Emotional processes are reported to influence speech fluency of preschool-age CWS (Walden, 2012). In the field of psychology emotion regulation has been broadly studied, that is mechanisms which allow modulation of internal emotion and behavior reactions (Thompson, 1994; Eisenberg et al., 2000; Cole, Martin, & Dennis, 2004). Regulatory mechanisms can preserve or improve emotional excitement, as well as inhibit or suppress arousal (Thompson, 1994).

The majority of study has evaluated communication attitudes between CWS and CWNS in order to decide whether the negative consequences of stuttering are incurred by

children. Answers from majority of the studies have found the existence of negative communication attitudes more in preschool-aged CWS (Vanryckeghem, 2005; Vanryckeghem & Brutten, 2007; Clark, 2012; Vanryckeghem, Vanrobayes, & De Niels, 2015) and also in school-aged CWS (De Nil & Brutten, 1991; Vanryckeghem, Hylebos, Brutten & Peleman, 2001; Kawai, Healey, Nagasawa & Vanryckeghem, 2012) when compared to CWNS. Other results have indicated no considerable differences between both the groups during the preschool period (Abbiati, Guitar, & Hutchins, 2013) or primary school stage (Devore, Nandur, & Manning, 1984).

In addition, it has been studied that as children get older negative attitudes towards communication increases (De Nil & Brutten, 1991; Vanryckeghem & Brutten, 1997; Bernardini, 2009; Clark, 2012) and whether there is any impact on the development of negative communication attitudes in CWS with gender or stuttering severity (DeNil & Brutten, 1991; Vanryckeghem, 2001; Bernardini, 2009; Kawai, 2012). Of the few studies that have been studied communication attitudes with respect to age, studies have been consistently indicated that communication attitude of CWS reduces less negative as children's get older (Vanryckeghem & Brutten, 1997; Clark, 2012) while those of CWS become increasingly negative (Vanryckeghem, 2001; Clark, 2012; Kawai, 2012). Gender effect has been not been reported in relation to the communication attitudes of children who stutter (De Nil & Brutten, 1991; Vanryckeghem, 2005), some early reports have showed that there is a connection between speech-associated communication attitudes and stuttering severity. That is, negative communication attitudes will be more in children with severe stuttering (Vanryckeghem & Brutten, 1996; Vanryckeghem, 2001; Kawai, 2012).

During the 1990s investigators began to understand that negative attitudes to communication were also present in school-aged CWS (Bloodstein, 1993). Following, examiners began to focus on the communication attitudes of preschool CWS. It was found that awareness about stuttering was seen in children as young as 2 years (Ambrose & Yairi, 1994; Boey, 2009). By 3 years of age, children were able to acquire the capacity to assess and compare their performance with their peers (Lewis, 2000). This finding is same with latest studies which reported that preschool CWS develop negative attitudes towards communication (Vanryckeghem, 2005; Clark, Conture, Frankel & Walden, 2012). In recent times Clark (2012) recommended that the development of negative attitudes towards communication is close to the onset of the disorder which may inhibit a child's "capacity to begin normally fluent speech-language planning and production" (p. 230). This is a causal assumption that persistence of stuttering influences a child's tendency to develop negative attitudes towards communication. From the above studies it is consistent that preschool CWS have negative attitudes towards communication. Stuttering can be a multifaceted disorder for some children from the onset of the disorder, given the presence of negative communication attitudes in many preschool CWS.

Multi-dimensional nature and need for comprehensive assessment

Stuttering is characterized by the disruptions in the behavioural, cognitive and affective changes which can occur as a result of speech disruptions, and it is also characterized by disruptions in the motor speech which are identified as moments of stuttering, hence stuttering is a complex multifactorial phenomenon. As stuttering is viewed as associated with several concomitant disorders, it is necessary to carry out

comprehensive assessment which checks all the domains which are affected in children with stuttering. This in turn could immensely facilitate the overall management of the disorder.

CHAPTER III

METHOD

The main objective of the study was to develop a comprehensive protocol to assess cognition, socio-emotional and motoric aspects of stuttering in 6-10 year old CWS in Kannada language. It was also intended to field test the Protocol on 6-10 year old CWNS and comparing the performance of age matched CWS on cognition, motoric and socio-emotional skills. The study was carried out as follows.

3.1 Participants:

The current study considered 20 children who were diagnosed as having stuttering (CWS) by experienced speech and language pathologist and an age matched group of 40 children with no stuttering (CWNS).

The following inclusion criteria were used to select the participants for the study.

i. Age range of 6-10 years
ii. Kannada as their native language
iii. No complaints of any peripheral sensory impairment (hearing or visual)
iv. No problems in the general intellectual and motoric abilities
v. No psychological and neurological deficits
vi. Should be diagnosed as having stuttering by a qualified speech and language pathologist (for the clinical group)

The participants for the clinical group were recruited from the Department of Clinical Services, AIISH, Mysuru, who had the diagnosis of stuttering, based on stuttering severity instrument (SSI-3; Riley, 1994).

The group consisting of normal children had to satisfy the same inclusion criteria except that they did not exhibit any stuttering and all the participants were screened for the inclusion criteria by using WHO Ten test.

The CWNS group of 40 participants was further divided into 4 groups with 10 (i.e., 5 girls and 5 boys) in each group based on their age range, which consisted of i) 6-7 years; ii) 7-8 years; iii) 8-9 years and iv) 9-10 years.

3.2 Tools and Materials

The following tools/materials were used to compile the protocol for the assessment of cognition, motoric and socio emotional aspects in children with stuttering and data collection for the study.

The test materials included in this study were:

1) A checklist developed to obtain information regarding the demographic data, family, birth and developmental history, general intellectual abilities, peripheral sensory abilities, academic performance, native language, and medium of instruction at school, and exposure to number of languages from all the participants. In addition, it included information regarding onset, development, severity of stuttering, attitudinal and behavioral aspects, from CWS group participants.

2) WHO Ten Test (ICF checklist 2003) to screen the participants for associated conditions
3) Stuttering severity instrument (SSI-3; Riley, 1994) was used to obtain stuttering severity values for all CWS as per the instructions in the manual.
4) Cognitive –linguistic assessment protocol (CLAP; Anooroopa, 2006)
5) Checklist to assess Socio-emotional skills in CWS (Adapted from CALMS and OASES checklist)
6) Video recorder (Sony handycam)
7) LS 100 audio recorder
8) Motor Speech Profile (MSP) module 5145 from Computerized Speech Laboratory (CSL) Model 4500 (KayPENTAX, Lincoln Park, New Jersey)
9) SPSS 17.0 software for data entry and analyses

3.3 Procedure:

The children who registered at AIISH with the complaint of disfluent speech, satisfying the study criteria for CWS group were recruited from the department of clinical services. Children fulfilling the age, gender and other selection criteria for the CWNS group were selected from the nearby schools.WHO checklist was used to screen for any other associated problems for inclusion of participants in both groups. Before administering the protocol informed written consent was obtained from the caregivers/ parents of the children/participants.

The method was carried out in two phases.

Phase I:

In Phase I, checklist was prepared to collect information regarding the demographic data and other details from all participants including details of stuttering history from CWS. Based on the survey of literature and available tests and tools, a Protocol was developed along with the score sheets for the data collection purpose as per the study objectives. The Protocol was given to 3 expert SLPs for validation. After incorporating the suggested modifications, the tool was ready for administration.

The domains included in the protocol were as follows:

1. Cognition
2. Motoric
3. Socio-emotional

3.3.1 Protocol for obtaining cognitive aspects of CWS

Cognitive linguistic protocol for children (CLAP; Anuroopa, 2006) in Kannada was used to measure the cognitive aspects. It consists of tasks in the auditory and visual modes for assessing attention, discrimination, memory and problem solving skills. Attention is assessed using digit count test, sound count test, auditory word discrimination through auditory mode and through visual mode, odd one out, letter cancellation, and visual word discrimination.

Memory is assessed using digit forward span, digit backward span and word recall, through auditory mode and alternate sequence, picture counting and story sequencing through visual mode.

3.3.2 Protocol for obtaining Motoric aspects of CWS

3.3.2.1. DDK

The MSP software provides option for capturing and analyzing Diadochokinetic rate (DDK) parameter which includes AMR (Alternate Motion Rates) and SMR (Sequential Motion Rates).

AMR was recorded by asking the participant to take a deep breath and repeat the single syllable /pa/ iterations as clearly, as long and as quickly as possible. Similarly /ta/ and /ka/ were also recorded separately using a mic placed 10-15 centimeter away from participant's mouth. SMR was recorded by asking the child to take deep breath and say the multi syllable sequence /p^t^ka/ as quickly and for as long as possible. Practice trials were given before the commencement of the actual recording. The AMR and SMR tasks were recorded three times. The average of AMR and SMR of 3 recordings were considered for the calculation of rate of DDK in syllable per second.

The DDK parameter was analyzed using MSP module. Each sample in AMR and SMR recordings were loaded to the software. The samples were selected and analyzed. Average DDK rates were measured.

3.3.2.2 Word and Non-word repetition

Initially the participants were instructed to listen to 5 words and non words for familiarity following the instruction. After this the actual tasks were given by instructing the participants to listen to 40 words and non words through head phone and repeat the same. Accuracy was measured by checking total number of words correct and also the number of words correct at each syllable length.

Score 1 was given for each item the child repeats correctly, with all the phonemes of the target word or non word present in the correct order. A score of 0 was given to those the child did not attempt or the response was incorrect after the transcriptions of the responses were done.

3.3.2.3 Tongue twisters

The participants were individually made to sit comfortably in front of the tape recorder (microphone kept 6-8 inches from the mouth) and were presented three tongue twisters in Kannada language with increasing complexity such as / ka:ge pUkka gube pUkka/, / kappU kUmkUma kempU kUmkUma/, /ṯerIkere erImele mUru karI kUrI marI mejUṯiṯU. They were written neatly and separately on cards for the reading task. The participants were instructed to read them thrice loudly and later recite them as fast as they could to see the effect of time pressure in the production of tongue twisters. However, no efforts were made to restrict the time limit given for the production of tongue twisters in either condition. A high quality professional tape recorder was used to record the speech samples of the participants which was later transcribed and analyzed. Accuracy and total time taken were measured.

3.3.2.4. Rate of speech

The measurement of rate of speech was on general conversation and picture description tasks. Pictures from the Fluency Test (Nagapoornima, 1990) were shown and children were asked to describe them. They were also asked to narrate /talk about topics of their choice (like festival, favorite places, zoo and exhibition).

Narrated speech samples of not less than 300 words were collected from each participant individually. The rate of speech was estimated by considering the perceptually fluent syllables in each utterance by removing all instances of stuttering like disfluencies like sound/syllable/word repetitions, prolongation, blocks, other disfluencies like interjection, revisions and pauses (greater than 250 ms) based on waveform depiction and audio sample using PRAAT software. The rate of speech in syllables per minute was measured in narrated speech.

3.3.4 Checklist to assess socio emotional skills in CWS

A checklist was developed for CWS to check feelings, emotions, and attitudes that accompany with stuttering and social component such as reactions that the person who stutters has to various communicative partners in a variety of speaking situations, avoidances of speaking situations, as peer teasing. It was based on the domains from CALMS checklist (such as Cognitive - child's knowledge, understanding and awareness of stuttering; Affective - feelings and emotions regarding stuttering, response to teasing, other people's reactions, and avoidance of stuttering and self-image; Motoric - secondary behaviors, frequency of stuttering with different partners; and Social - avoidance of situations and degree of stuttering in certain situations impact on peer relationships. Also,

questions from Overall Assessment of the Speaker's Experience of Stuttering (Yaruss and Quesal, 2006) such as general perspectives about stuttering, affective, behavioral, and cognitive reactions to stuttering, functional communication difficulties, and impact of stuttering on the speaker's quality of life for the assessment of socio-emotional skills.

Total 20 questions were given to participants and they were instructed to rank their confidence level using 4 point rating scale from 0-3, where 0 indicates no difficulty, 1 indicates some difficulty, 2- significant difficulty, and 3- extreme difficulty.

Phase II

Following the development of protocol, in Phase II, a pilot study was undertaken in which the protocol was administrated on 5 participants with appropriate procedures.

Each child was initially administered the checklist to confirm that the child passes the inclusion criteria. After that SSI-III was administered on all CWS and the severity of stuttering was assessed. The scoring procedure of the stuttering severity was similar as that suggested in the manual of SSI-3. For the elucidation of spontaneous speech samples, the child was instructed to narrate an event or stories and general conversation questions regarding hobbies and school.

The Praat software was used to manually analyze the rate of speech in CWS and CWNS and also to remove background noise if present. Video recorder (Sony handycam) and LS 100 audio recorder was used to record rate of speech. The Motor Speech Profile (MSP) module 5145 was used to measure the DDK parameters for the study. It is an integrated software and hardware system from Computerized Speech Laboratory (CSL)

Model 4500 (Kay PENTAX, Lincoln Park, New Jersey). It provides a reproducible, non–invasive and objective method for assessing DDK in subjects.

3.4 Statistical analysis

All the samples were transcribed; test scores were tabulated for each parameter for both groups for each of the age groups selected. For the statistical analysis, SPSS (Statistical Package for the Social Sciences) – Version 20.0 software was used. Descriptive statistics was carried out for the various tasks to obtain the mean, median and standard deviation (SD) values. Inferential statistics including both parametric and non-parametric tests were used to arrive at various statistical values. The data obtained was appropriately tabulated and subjected to quantitative analysis. Descriptive analysis of the performance of all participants on each task in all the domains was done.

To compare between the groups, a test of normality, (Shapiro Wilk's test of normality) was administered and it was observed that all the parameters did not have normal distribution except for the DDK. Hence, parametric test (One - way MANOVA) was done to obtain the significant difference in DDK between the two groups. Mann-Whitney U test was done to compare between CWNS and CWS for all the other parameters which did not show normality. To compare across the age groups in CWNS and CWS, Kruskal- Wallis test was done. Further, Mann-Whitney U test was done to find the age groups which differed significantly. Cronbach's alpha test was done for determining the test-retest reliability.

CHAPTER 1V

RESULTS AND DISCUSSIONS

The aim of the study was to develop a comprehensive protocol for assessment of CWS in Kannada language that would help to identify the cognitive, motoric and socio-emotional aspects, to aid in assessment, identification of associated disorders in CWS and to allow intervention. A protocol was developed specific to the present study objectives in order to study the emergence of cognitive, motoric and socio-emotional skills in normally developing children and CWS across the age range of 6 to 10 years. 40 normal children (CWNS) and 20 CWS grouped into 4 subgroups based on age (6-7, 7-8, 8-9 and 9-10 years) participated in the study. The protocol was administered on the participants and cognitive, motoric and socio-emotional abilities were compared between the two groups and across ages.

Participants

The study included total of 60 native Kannada speaking participants. All participants were subdivided into 6-7 years, 7-8 years, 8-9 years and 9-10 years.

Table 4.1

Number and gender of CWNS and CWS in four age groups

Age groups (years)	**CWNS**		**CWS**		**Total**
	Male	Female	Male	Female	
6-7 years	5	5	4	1	15
7-8 years	5	5	4	1	15
8-9 years	5	5	4	1	15
9-10 years	5	5	4	1	15
Total	20	20	16	4	60

The clinical group consisted of 20 children with stuttering (CWS) and the normal group consisted of 40 children with no stuttering (CWNS). Table 4.1 shows details of the participants used in the study.

A checklist was administered on CWS for extracting information regarding their family, developmental, birth history and about their academic performances. According to the data obtained in CWS group, out of twenty CWS, sixteen children were male and four were female. Two children had family history of stuttering and none of them had history of delayed speech and language development, abnormal structural and functional oral mechanism and academic difficulties and all the children had English has their medium of instruction except one child.

Table 4.2

Summary of data obtained from the checklist for CWS

Particulars	**Age range (years) in CWS**				
Response from the checklist	6-7 yrs	7-8 yrs	8-9 yrs	9-10 yrs	Total
Number of subjects (N)	5	5	5	5	20
Positive family history of stuttering	0	0	0	2	2
Delayed speech and language development	0	0	0	0	0
Kannada as a medium of instruction	0	0	0	1	1
Below average academic performance	0	0	0	0	0
Exposure to more than 2 languages	0	5	5	4	14
Abnormal articulation	1	1	0	0	2

For the statistical analysis, SPSS (Statistical Package for the Social Sciences) – Version 20.0 software was used. Descriptive statistics was carried out for the various

tasks to obtain the mean, median and standard deviation (SD). Inferential statistics including both parametric and non-parametric tests were used to arrive at various statistical values. The data obtained was appropriately tabulated and subjected to quantitative analysis. Descriptive analysis of the performance of all subjects on each task in all the domains was done.

The results of the study are discussed under the following headings within each domain:

4.1 Attention

4.2 Memory

4.3 Word repetition and Non word Repetition

4.4 DDK

4.5 Tongue twisters

4.6 Rate of speech

4.7 Socio-emotional skills

4.8 Reliability

4.1 Attention

Two types of attention processes were assessed (selective attention and sustained attention) using CLAP. Through auditory mode digit count test, sound count test, auditory word discrimination task was done. In the visual mode, odd one out task, letter cancellation, visual word discrimination was done. Every correct response was given a score of "1" and every wrong response was given a score of "0". The total score was 40.

Table 4.3 provides mean, median and SD on attention task for CWS and CWNS across the four age groups studied. Figure 4.1 shows the differences across the mean scores on attention task for CWS and CWNS across the four age groups.

Table 4.3
Mean, Median, SD and significance of CWNS and CWS on attention task

Age Range	Attention in CWNS			Attention in CWS			/Z/	P
	Mean	S.D	Median	Mean	S.D	Median		
6-7 years	29.50	0.52	29.50	22.00	1.87	23.00	3.18*	.001
7-8 years	36.80	0.91	36.50	25.20	0.83	25.00	3.13*	.002
8-9 years	36.80	3.45	38.00	27.60	3.84	26.00	2.85*	.004
9-10 years	38.00	1.56	39.00	28.60	1.34	28.00	3.13*	.002

Note: *p < 0.05

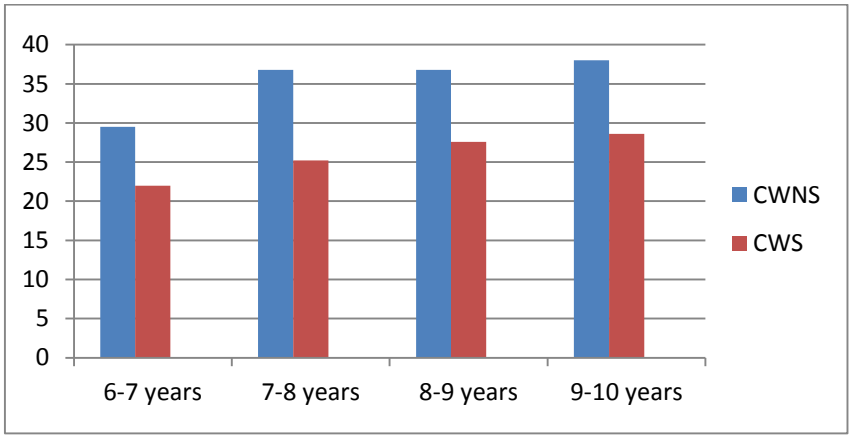

Figure4.1: Mean scores of CWS and CWNS across age groups for attention task

As seen in the above figure, CWS performed consistently poorly in the attention tasks in all the four age groups as compared to the CWNS group. The Mann-Whitney U test revealed significant differences between the two groups as depicted in the table (p value<0.05).

Within the CWNS group, the mean values increased from 6-7 years group to 9-10 years group. The 6-7 years group had the least score and the 8-10 years group had the

maximum score. Kruskal Wallis test performed on the CWNS group revealed a significant difference (p value<0.05). Mann-Whitney test showed that all the age groups differed significantly in their performance (p value<0.05).

The mean values of the age groups within CWS also showed an increase with age. The 6-7 years group and 7-8 years group had approximately similar scores, which increased in the older age groups, although not to the extent seen in CWNS. The Kruskal Wallis test performed on the CWS group revealed a significant difference (p value<0.05). Further, Mann-Whitney test showed that 6-7 years group differed significantly with 8-9 year group as well as 9-10 year group. Also 7-8 year group showed significant difference with 9-10 year group (p value<0.05)

The result of the current study supports that of Anderson et al. (2010) that the group of CWS obtained lesser attentional flexibility than peers. Similarly, Karrass et al. (2006) found that the CWS were less able to control attention. Schwenk, Conture, and Walden (2007), also noted that CWS react to a greater extent to environmental stimuli and that they are perhaps less able to regulate responses to changes within their environment. These findings seem to point to potential differences in selective attention.

4.2 Memory

Different subtests were used to assess memory using CLAP, and through auditory mode memory was assessed using subtest like digit forward span, word recall, digit backward span. Through visual mode, memory was evaluated using tasks like simple alternate sequence, picture counting and story sequencing. Every correct response was

given a score of "1" and every wrong response was given a score of "0". The total score was 40

Table 4.4
Mean, Median, SD and significance of CWNS and CWS on Memory task

Age Range	Memory in CWNS			Memory in CWS			/Z/	P
	Mean	S.D	Median	Mean	S.D	Median		
6-7 years	12.10	0.99	11.50	11.00	1.58	11.00	0.129	.897
7-8 years	18.40	1.26	18.00	11.4	1.14	11.00	3.09*	.002
8-9 years	19.90	2.07	20.00	14.2	3.34	13.00	2.545*	0.01
9-10 years	25.90	26.00	1.728	15.2	1.09	15.00	3.107*	.002

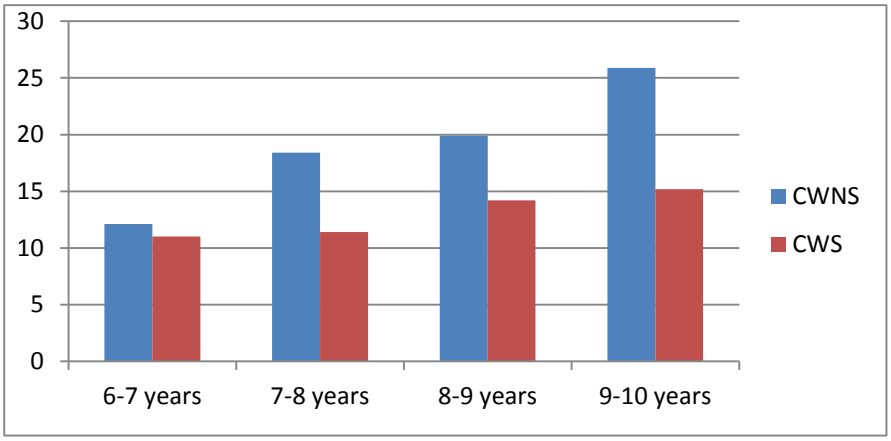

Figure 4.2: Mean scores of CWS and CWNS across age groups for memory task

As apparent from table 4.4, the mean values show that CWS had poor scores across age groups when compared to CWNS. Mann-Whitney U test revealed significant differences between the two groups as depicted in the table (p value<0.05), except for children within 6-7 years of age where the performances of the two groups were similar.

The descriptive statistics in table 4.4 shows that within the CWNS group, a developmental trend could be observed similar to the attention task. The mean values

increased from 6-7 years group to 9-10 years group. The 6-7 years group had the least score and the 9-10 years group had the maximum score. Kruskal Wallis test performed on the CWNS group revealed a significant difference (p value<0.05). Mann-Whitney test showed significant difference between all the age groups (p value<0.05).

The mean values of the age groups within CWS also showed an increase with age. The 6-7 years group and 7-8 years group had approximately similar scores, which increased in the other age groups. Kruskal Wallis test performed on the CWS group revealed a significant difference (p value<0.05). Further, Mann-Whitney test showed that 6-7 years group differed significantly with 8-9 year group as well as 9-10 year group. Also, 7-8 year group showed significant difference with 9-10 year group (p value<0.05)

It is evident from study done by Reilly and Donaher (2005) that CWS showed significantly reduced recall when compared to an age-matched group of children who do not stutter through a digit and letter span experiment and they observed poor working memory in a group of CWS.

4.3. Repetition

The participants were instructed to listen to Word and Non Word and repeat the same. Accuracy and total duration was measured. Score 1 was given for correct response and a score of 0 for incorrect response.

Table 4.5 shows the mean values of word and non-word repetition across age groups. Analysis of results shows that when compared with CWNS, CWS had poor scores irrespective of age in WR and NWR task. Mann-Whitney U test was used to compare between age groups for total accuracy measures on Word and non-word

repetition. The results revealed that there was a significant difference between age groups, ($p<0.05$).

Table 4.5: *Mean, Median, SD and significance of CWNS and CWS on Repetition task*

		CWNS			CWS				
Age group	Task	Mean	SD	Median	Mean	SD	Median	/z/	P
6-7 years	WR	39.90	0.3162	40.00	29.20	5.93	27.00	3.34*	.001
	NWR	39.80	0.6324	40.00	25.40	3.57	26.00	3.45*	.001
7-8 years	WR	40.00	.0000	40.00	37.20	4.65	39.00	2.62*	.009
	NWR	39.90	.3162	40.00	31.00	3.87	32.00	3.45*	.001
8-9 years	WR	40.00	.0000	40.00	31.80	3.70	31.00	3.64*	.001
	NWR	40.00	.0000	40.00	27.60	3.20	28.00	3.64*	.001
9-10 years	WR	40.00	0.000	40.00	35.60	1.67	36.00	3.65*	.000
	NWR	40.00	0.000	40.00	28.00	2.16	29.00	3.65*	.000

Note: *p < 0.05, WR=Word repetition, NWR=Non-word repetition

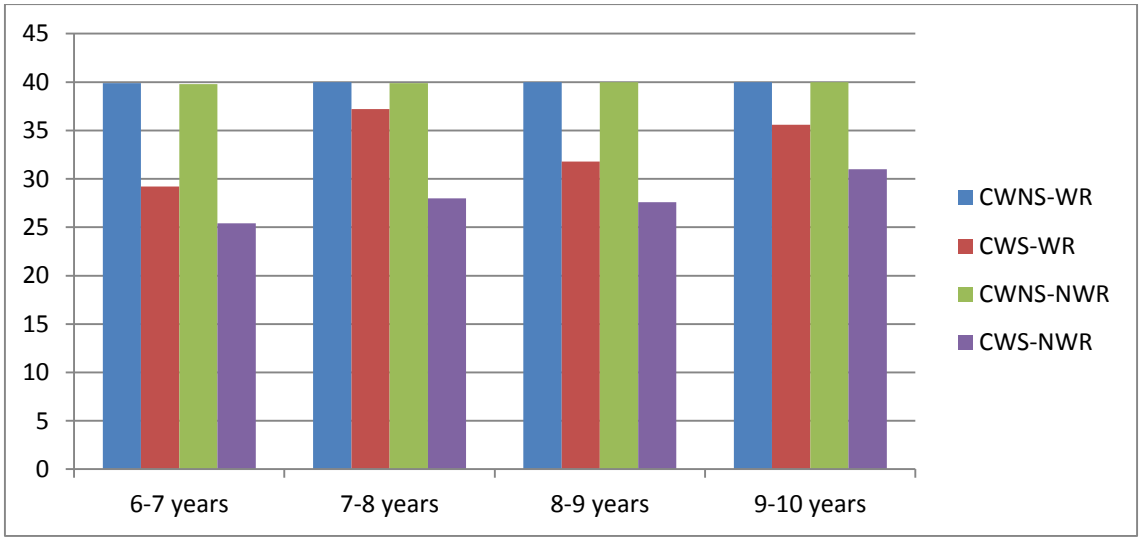

Figure 4.3: Mean scores of CWS and CWNS across age groups for Repetition task

The descriptive statistics as in table 4.5 shows that within the CWNS group, WR showed good scores except in 6-7 years age group, In NWR 7-8 years demonstrated good scores compared to other age groups. These results are also supported by study done by Munson (2001), which reports younger children had more difficulties in repeating non words that did not resemble words compared to word-like non words, and such differences decreased with age suggesting that prior lexical knowledge can influence performance. The findings are in concordance with the Hakim and Bernstein-Ratner (2004), who also found that a higher percent of phoneme errors was observed in both groups in CWS and CWNS for the longer, four- and five-syllable non words.

Kruskal Wallis test performed on the CWNS group revealed a significant difference (p value<0.05). Further, Mann-Whitney test showed significant difference in both WR and NWR in all the age groups (p value<0.05).

The mean values of the age groups within CWS also showed an increase with age, except in the 7-8 years group having more scores compared to other age group as illustrated in table 4.5. Kruskal Wallis test performed on the CWS group revealed a significant difference in both WR & NWR task (p value<0.05). It is also evident in a study done by Anderson et al. (2010) who noted that the ability of normal children to repeat non-words was different from individuals who stutter, and the difference was correlated to poor language performance in children who stutter or stuttering occurrence in periods that non-words are repeated. Another information which can be ensued from the result is that CWS had fewer correct productions and more phonemic errors than CWNS in one, two, and three-syllable non words (Hakim & Bernstein, 2004)

4.4 DDK

AMR (/p/, /t/, /k/) and SMR (/pataka/) tasks were carried out to analyze DDK measure. Each sample in AMR and SMR recordings were loaded to the MSP module. The Average DDK rates were measured.

Table 4.6:

Mean, Median, SD and significance of CWNS and CWS on DDK task

CWNS					CWS		
Age group	DDK	Mean	SD	Median	Mean	SD	Median
6-7	/p/	4.91	0.593	4.98	4.36	0.47	4.162
	/t/	5.05	1.159	4.97	3.78	0.58	3.99
	/k/	4.97	0.8381	4.84	3.88	0.72	3.68
	/ptk/	5.42	0.65	5.58	4.99	0.59	4.66
7-8	/p/	4.52	0.79	4.62	4.136	0.87	4.57
	/t/	5.05	0.88	5.03	4.61	0.7	4.37
	/k/	4.44	0.85	4.35	4.98	0.65	4.94
	/ptk/	5.56	0.98	5.51	5.21	1.17	5.36
8-9	/p/	4.98	0.45	4.92	5.28	0.907	5.47
	/t/	4.97	0.87	4.71	4.38	0.83	4.36
	/k/	4.79	0.57	4.54	4.49	1.104	4.15
	/ptk/	5.59	0.41	5.67	5.16	1.42	4.96
9-10	/p/	5.27	0.66	5.16	5.13	0.479	5.27
	/t/	5.13	0.66	4.93	4.74	0.34	4.63
	/k/	5.08	0.76	4.94	4.85	0.533	5.05
	/ptk/	6.21	0.57	6.09	5.75	0.99	5.86

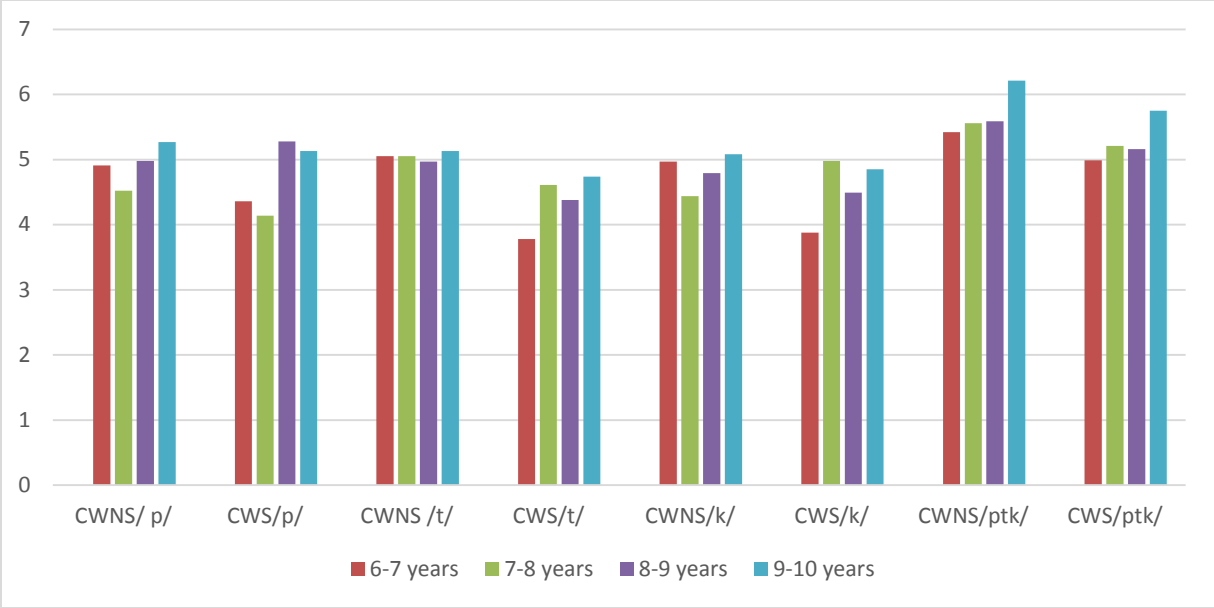

Figure 4.4: Mean scores of CWS and CWNS across age groups for DDK task

The table 4.6 illustrates the performance of participants on each DDK task. The mean values show that CWS had poor scores consistently when compared to CWNS, irrespective of age. It is evident from the figure 4.4 that the performance varied across each group. The mean values show that CWS had poor scores across age groups when compared to CWNS. Since parameters follow normal distribution, parametric test (1-way MANOVA) was done to see the significant difference between two groups. Significant difference was observed only for the AMR task on /ta/ between the two groups (Table 4.7).

The descriptive statistics as in table 4.6 shows variable values across age groups within the CWNS group. It can be encapsulated from the results by authors (Canning & Rose, 1974; Robbins & Klee, 1987; Williams & Stackhouse, 2000) that DDK rates are highly variable, both within and between participants, in which higher variability was apparent for the younger age groups. Other authors (Sharkey & Folkins, 1985; Green et

al., 2002; Grigos, Saxman & Gordon, 2005) also documented that articulator movement variability is greater in children than adults. Likewise in the current study also it was found that the DDK values varied across age.

The mean values of the age groups within CWS also show highly variable values across age groups. Studies of the DDK rates of children who stutter have suggested that a large percentage of these children exhibit oral motor problems. It has been noted that the performance during speech motor task show that a large percentage of CWS exhibit oral motor problems (Olander, Smith & Zelaznik, 2010). Yaruss, Logan and Conture, (1995) reported statistically significant differences in SMR tasks only between fluent speakers and CWS, which suggests that fluent children are able to rapidly change the positions of articulators than CWS as evidenced by their performance during motor tasks involving speech.

Table 4.7:
Results of one –way MANOVA for DDK task

DDK	F	p value
AMR /pa/	.985	.325
AMR /ta/	8.896	.004*
AMR /ka/	1.536	.220
SMR	3.313	.074

Note: *p < 0.05 significant difference

4.5. Tongue twisters

The subjects were made to sit comfortably in front of the tape recorder individually and were presented three tongue twisters in Kannada language with increasing complexity. They were instructed to read them thrice loudly and later recite them as fast

as they could, to see the effect of time pressure in the production of tongue twisters. Accuracy and total time taken were measured.

Table 4.8:

Mean, Median, SD and significance of CWNS and CWS on Tongue twisters

		CWNS			CWS				
Age group	**TTW**	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**	**/z/**	**P**
	D1	2.78	0.611	2.81	2.61	0.43	2.47	0.49	0.62
6-7 years	D2	2.71	0.82	2.66	3.11	0.75	3.45	1.11	0.26
	D3	4.16	1.11	4.41	9.06	3.34	10.6	2.46*	0.01
	A1	9.99	12.9	4.16	21.66	17.27	25	1.40	0.16
	A2	16.66	19.6	8.33	24.99	19.54	16.66	1.06	0.28
	A3	20.64	28.6	14.28	35.44	32.85	14.28	0.81	0.42
7-8 Years	D1	2.58	0.49	2.39	2.91	0.468	2.81	1.84	0.65
	D2	2.67	0.82	2.62	3.41	0.44	3.45	1.97*	0.04
	D3	4.53	0.79	4.48	8.12	1.97	8.7	2.70*	0.03
	A1	14.16	11.8	16.66	11.66	11.17	16.66	0.58	0.56
	A2	28.33	19.7	29.16	33.33	16.66	25	0.43	0.66
	A3	13.8	5.7	14.28	48.88	12.11	44.44	3.08*	0.00
8-9 years	D1	2.18	0.499	2.22	3.05	0.27	2.96	2.69*	0
	D2	2.64	0.95	2.4	3.24	0.97	3.31	1.04	0.29
	D3	5.29	2.55	4.48	7.6	2.06	8.7	1.7	0.07
	A1	11.66	11.24	12.4	11.66	13.94	58.51	0.06	0.94
	A2	20.83	18.52	20.8	41.66	16.65	13.71	1.79	0
	A3	17.11	8.76	15.4	58.51	41.6	62.96	3.01*	0
9-10years	D1	2.13	0.562	2.23	13.33	12.6	16.66	6.17*	0.53
	D2	2.53	0.58	2.2	39.99	19	41.66	3.09*	0
	D3	7.68	1.75	8.15	55.55	16.3	62.9	3.09*	0
	A1	3.33	10.5	0	3.1	0.35	3.31	2.76*	0
	A2	0.833	2.63	0	3.68	0.69	3.45	2.76*	0
	A3	17.4	7.41	14.8	7.21	1.87	7.26	3.1*	0.002

Note: *$p < 0.05$,
D1= Duration of first tongue twister; D2= Duration of second tongue twister; D3= duration of third tongue twister; A1= Accuracy of first tongue twister; A2= Accuracy of second tongue twister; A3=Accuracy of third tongue twister

In Table 4.8, the mean values show that CWS had poor scores consistently when compared to CWNS, irrespective of age in duration and accuracy of all the tongue

twisters. The duration and accuracy of the third tongue twister in CWS had poorer scores compared to CWNS group when compared to the same for smaller ones.

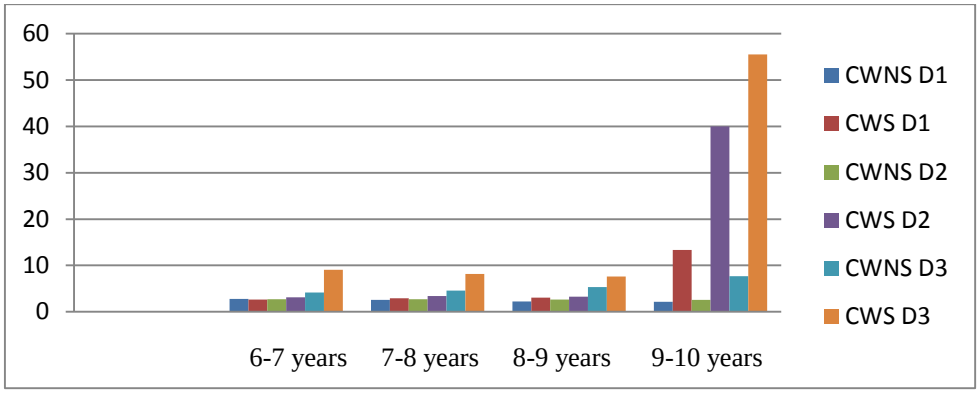

Figure 4.5: Mean scores of CWS and CWNS across age groups for TTW-Duration task

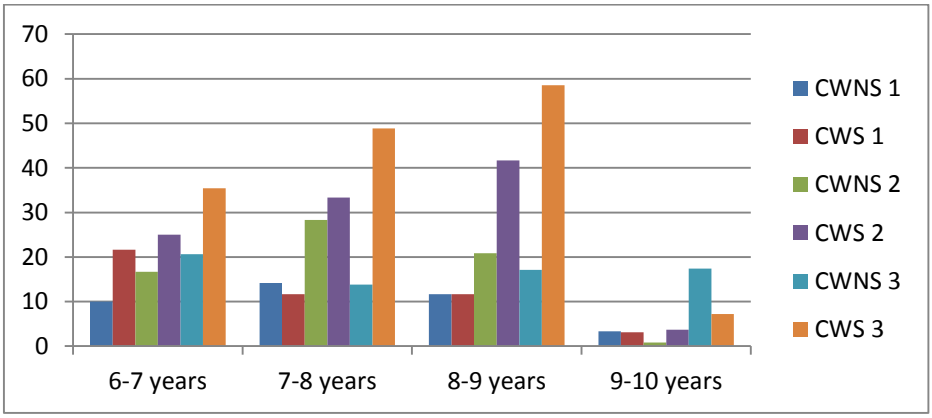

Figure 4.6: Mean scores of CWS and CWNS across age groups for TTW-Accuracy task

Both the groups had errors on tongue twisters but as complexity increased CWS had more errors than CWNS. Mann-Whitney U test revealed significant differences between the two groups as depicted in the table (p value<0.05). In elaboration, the present findings suggest that the difference between CWS and CWNS in initiating an oral response become larger with longer utterances. This further suggests that CWS have difficulties in speech organization prior to the actual motor execution as reported by Peters et al. (1989).

The descriptive statistics in table 4.8 show that within the CWNS group, a developmental trend could be observed. The mean values increased from 6-7 years group to 9-10 years group. The 6-7 years group had the higher score and the 9-10 years group had the least score in both accuracy and duration of all the tongue twisters. 6-7 year group had high scores in D3 and A3 when compared to other age groups. This finding was also evident in a study by Vedha, Deepa and Geetha (2012) on the ability of PWS to produce tongue twisters. They compared speech errors and disfluencies during the production of tongue twisters between adult controls and PWS in Kannada and English in reading and reciting tasks. They observed significant difference between PWS and Controls in total duration during reading task in English.

Kruskal Wallis test performed on the CWNS group revealed a significant difference (p value<0.05). Further, Mann-Whitney test showed that 6-7 years group differed significantly with all the other age groups (p value<0.05).

The mean values of the age groups within CWS also showed an increase with age, with the 6-7 years group having the higher score and the 9-10 years group having the least score as seen from table 4.8. This finding is also evident in study by Haber and Haber (1982), which shows that PWS took longer time to say tongue twisters than matched control participants.

Kruskal Wallis test performed on the CWS group revealed a significant difference (p value<0.05). Further, Mann-Whitney test showed that 6-7 years group differed significantly with all the other age groups (p value<0.05).

Production of tongue twisters is a complex task requiring coordinated activity of different systems and involves precise speech motor control. Even though the production of tongue twisters does not have a communicating intent, PWS did display disfluencies and other speech errors and used various strategies to overcome them. Although control group subjects also showed speech errors, their type and frequency was less. The use of tongue twisters in the treatment of stuttering to facilitate motor control strategies, especially with the feared sounds could be explored.

4.6 Rate of speech

The children's rate of speech samples were collected using general conversation and later pictures from the Fluency Test (Nagapoornima, 1990) which were presented and the children were asked to describe the presented picture and were also asked to narrate about topics of their choice (like festival, favorite place, zoo and exhibition) .

Narrated speech samples of not less than 300 words were collected from each participant individually. The rate of speech was estimated by considering the perceptually fluent syllables in each utterance by removing all instances of stuttering like disfluencies like sound/syllable/word repetitions, prolongation, blocks, other disfluencies like interjection, revisions and pauses (greater than 250 ms) based on waveform depiction and audio sample using PRAAT software. Later the rate of speech in syllables per minute was measured.

Table 4.9:

Mean, Median, SD and significance of CWNS and CWS on Rate of speech.

		CWNS			CWS				
Age group	Task	Mean	SD	Median	Mean	SD	Median	/Z/	P
6-7	CS	234.6	29.549	228	165.2	23.037	173	3.065	.002*
	SN	233.4	29.064	232.5	170.2	32.591	163	2.572	.010*
7-8	CS	229.3	12.129	231.5	188.40	23.309	189	2.939	.003*
	SN	235.5	23.339	233	221.60	24.966	229	0.552	0.581
8-9	CS	238.1	23.956	238.5	208.8	35.933	217	1.595	0.111
	SN	229.8	21.837	236	238	22.136	246	0.736	0.462
9-10	CS	242.8	20.842	245	207.80	24.844	206	2.147	0.032*
	SN	232.3	25.452	238	216.20	30.646	218	0.86	0.39

Note: *p < 0.05; CS= Conversation; SN= Story Narration

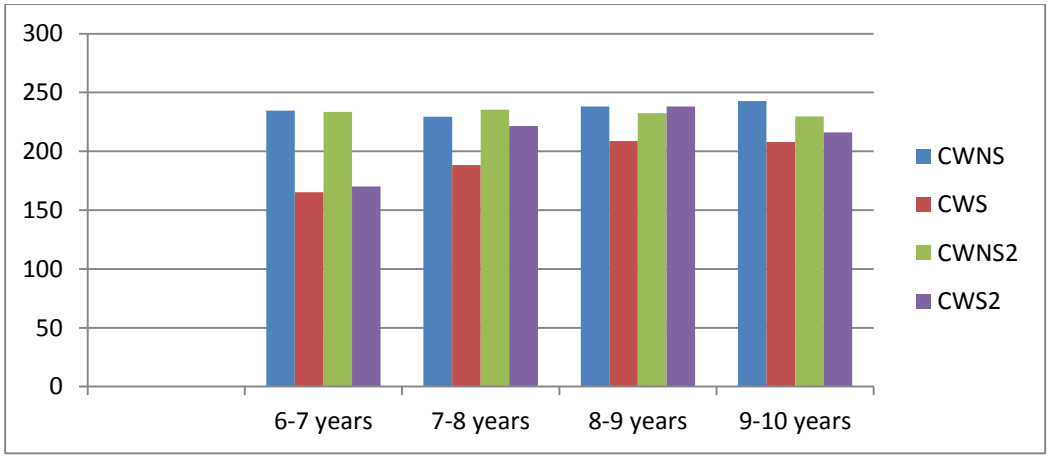

Figure 4.7: Mean scores of CWS and CWNS across age groups for speech rate task

As apparent from table 4.7, the descriptive statistics show that both the CWNS and CWS groups showed difference in conversation and story narration tasks. CWS had poor scores across age groups when compared to CWNS. Mann-Whitney U test revealed significant differences between the two groups as depicted in the table (p value<0.05)

except in 7-8 & 8-9 years group in story narration task, also differs in 9- 10 years group for conversation task.

The descriptive statistics as in table 4.7 show that within the CWNS group, the mean values of rate in conversation task increased from 6-7 years group to 9-10 years group, except for the 7-8 years group which had the least scores. In story narration task there was not much variation across age groups.

Kruskal Wallis test was administered on CWS and CWNS and there was no significant difference across age groups in CWNS. In CWS demonstrates that 6-7 years age differs significantly with other group in story narration task with the other group.

Finding of the present study is that age group differences were not significant when a younger age group was compared with a higher age group which was similar to the findings of study done by Pindzola, Jenkins, and Lokken (1989) which reveals that there were no significant differences in speaking rate across the 3-5 years age group. Amster and Starkweather (1985) found significant differences in rate between 2-year-olds and older preschoolers but no significant differences among 3 to 5-year-olds. This suggests that developmental rate changes do not proceed on a yearly basis but rather increase sporadically at certain age intervals. According to Kowal et.al (1975) there is a significant increase in the rate of speech between 2 and 3 years but not again until the early school year.

The findings of the present study are supported by various studies where they have suggested reduction in the segmental duration with age in children (Kubaksha & Keating, 1981; Nittrouer, 1993; Robb & Saxman, 1990 & Iverson, 2010). In line with the

present study, Smith (1978) also suggested that the duration of segments were longer in children when compared to adults in which reduction in duration was found in 4 year olds when compared to 2 year old children.

4.7 Socio- emotional skill

Socio-emotional skills in CWS were assessed after developing a questionnaire for assessing the feelings, emotions, and attitudes that accompany with stuttering and social component such as reactions that the person who stutters has to various communicative partners in a variety of speaking situations, avoidances of speaking situations, peer teasing etc. The participants were instructed to rank their confidence level using 4 point rating scale from 0-3, where 0 indicates no difficulty, 1 indicates some difficulty, 2- significant difficulty, and 3- extreme difficulty.

Table 4.10:

Mean, Median, SD and significance of CWNS and CWS on Socio –emotional skills

Age Range	**Socio-Emotional in CWNS**			**Socio-Emotional in CWS**			**/Z/**	**P**
	Mean	S.D	Median	Mean	S.D	Median		
6-7 years	.0000	.00000	000	54.16	40.72	.4500	3.65*	0.00
7-8 years	.0411	.0865	.0000	.7800	.2252	.9000	3.32*	0.00
8-9 years	.0350	.0747	.0000	.920	.3598	.950	3.32*	0.00
9-10 years	.0500	.1054	.0000	.6100	.1746	.5000	3.33*	0.00

Note: *$p < 0.05$

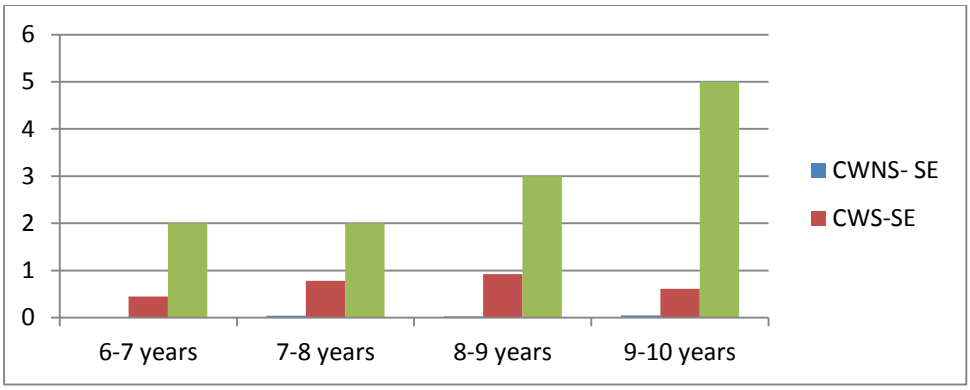

Figure 4.8: Mean scores of CWS and CWNS across age groups for socio-emotional task

As evident from table 4.8, the mean values show that CWS had poor scores consistently when compared to CWNS, irrespective of age. Mann-Whitney U test revealed significant differences between the two groups as depicted in the table (p value<0.05). The present findings on socio-emotional skills reveal that CWS are poorer as compared to the CWNS group. Many of the studies have established the presence of more negative communication attitudes in preschool-aged CWS. This is consistent with recent studies which demonstrated that preschool CWS develop negative attitudes towards communication (Clark, Conture, Frankel, & Walden, 2012; Vanryckeghem et al., 2005)

The descriptive statistics as in table 4.8 show that within the CWNS 6-7 year children had normal mean values and slight differences were observed in other age groups. Kruskal Wallis test performed on the CWNS group revealed a significant difference (p value<0.05).

The mean values of the age groups within CWS also showed an increase with age, with the 6-7 years group having the least score and the 9-10 years group having the maximum score as seen from table 4.8. Kruskal Wallis test performed on the CWS group

revealed a significant difference (p value<0.05). Further, Mann-Whitney test showed that 6-7 years group differed significantly with all the other age groups (p value<0.05). Also, 7-8 years and 8-9 years group showed significant difference compared to 9-10 years group.

4.8 Reliability:

Testing was repeated on 10% of participants from both the groups. The test-retest reliability was done using the Cronbach's alpha co-efficient of reliability test.

Table 4.11:
Results of test-retest reliability

	CWNS	CWS
Attention	0.917	0.989
Memory	0.99	0.981
WR	0.917	0.781
NWR	0.99	0.711
/p/	0.983	0.812
/t/	0.951	0.893
/k/	0.941	0.815
/ptk/	0.993	0.792
TTA1	0.978	0.706
TTA2	0.993	0.786
TTA3	0.856	0.772
TTD1	0.853	0.747
TTD2	0.983	0.687
TTD3	0.864	0.663
CN	0.978	0.701
SN	0.963	0.996
SE	1	1

Note: WR = Word Repetition, NWR= Non Word repetition, TTA1=Tongue Twisters Accuracy 1, TTA2= Tongue Twisters Accuracy 2, TTA3=Tongue Twisters Accuracy 3, TTD1= Tongue Twisters Duration 1, TTD2= Tongue Twister Duration 2, TTD3= Tongue Twister Duration 3, SE= Socio –emotional, CN =Conversation, SN = story narration

Thus to conclude, the results of the present study indicated that CWS performed poorly when compared to the age matched CWNS on all the domains. The statistical significance was found for almost all the measures including motoric, cognitive and social-emotional aspects. Although individual differences were noted in both group participants, as a group CWS showed significant differences in all the measures across the four age groups considered for the study. It is surprising that children as old as 9-10 years still show differences in various developmental measures compared to their normal counterparts. Further large scale investigations, considering gender and severity sub groups would throw more light on the nature of this puzzling disorder of fluency which would enable the SLPs in the management.

CHAPTER 5

SUMMARY AND CONCLUSION

Stuttering is a multi-dimensional fluency disorder exhibiting many overt and covert characteristics. The clinicians dealing with stuttering often focus only on the overt symptoms in both assessment and management. There is dearth of tools or test materials in various languages to identify some of the subtle deficits in the domains of linguistic, motoric, cognitive and social-emotional aspects of the problem. There are not sufficient resources to assess CWS associated with other associated disorders in different languages and more so among Kannada speaking children. Such a tool would provide the SLPs to get very valuable information for the differential diagnosis, management and importantly to build the data base for research on CWS.

The present study mainly aimed to develop a comprehensive protocol to assess cognition, socio-emotional and motoric aspects of stuttering in 6-10 year old CWS in Kannada language and to field test the Protocol on 6-10 year old CWNS. It was taken up with the purpose to determine and compare the performance of CWS and CWNS on cognitive, motoric and socio-emotional skills in 20 CWS and in an age matched group of 40 CWNS. The participants were further divided into 4 groups with 10 each (i.e., 5 girls and 5 boys) in CWNS group and 5 each in CWS group based on their age range, which consisted of i) 6-7 years; ii) 7-8years; iii) 8-9 years and iv) 9-10 years.

Method included two phases. In Phase I, checklists were prepared to collect information regarding the demographic data and other details from all participants including details of stuttering history from CWS. Based on the survey of literature and

available tests and tools, a protocol was developed along with the score sheets for the data collection purpose. The developed protocol consisted of subsection from CLAP (attention, and memory) to assess cognition. To check speech motor control, four tasks were given such as DDK, three tongue twisters with increasing complexity, word and non word repetition and speech rate using general conversation and narration task. To assess socio-emotional skills, a questionnaire was developed to investigate negative attitudes, avoidance behavior, coping behavior, individual and situational variability of CWS using checklist such as CALMS and OASES. The developed material was administered on the experimental and the control group and was rated on a 4 point rating scale in which they were asked to score according to their difficulty level, which was then compared and measured across age groups.

For the statistical analysis, SPSS – Version 20.0 software was used. Descriptive statistics was carried out for the various tasks to obtain the mean, median and standard deviation (SD). Inferential statistics including both parametric and non-parametric tests were used to arrive at various statistical values. To compare between the groups, a test of normality, (Shapiro Wilk's test of normality) was administered and it was observed that all the parameters did not have normal distribution except for the DDK. Hence, parametric test (One - way MANOVA) was done to obtain the significant difference in DDK between the two groups. Mann-Whitney U test was done to compare between normal and CWS for all the other parameters which did not show normality. To compare across the age groups in CWNS and CWS, Kruskal- Wallis test was done. Further, Mann-Whitney U test was done to find the age groups which differed significantly. Cronbach's alpha test was done for determining the test-retest reliability.

The results revealed several points of interest. It was observed that CWS showed poor performance as compared to the CWNS in all the tasks. CWS obtained poor scores irrespective of their age. It was found that the performance in the tasks such as attention, memory and word and non-word repetition in CWNS and CWS followed a developmental trend. The results also suggest that as the complexity of stimulus advanced there was a decline in the performance of the children in both the groups in all the domains. Hence, the results of the present study are in agreement with the previous studies that CWS exhibit poor attention while performing a task and reduced memory skills. The results also report that CWS had significantly poorer scores in DDK task, both AMR and SMR. The social emotional skills in CWS were also found to be poor when compared to CWNS. Speech rate was noted to be slower in CWS. The results have been supported by the existing literature. The test and retest reliability obtained using Cronbach's alpha co-efficient reliability test suggested good reliability. Highlight the results a little more with findings for different domains, it is too brief

The present study highlights the need for comprehensive assessment of various domains in CWS like linguistic, motoric, cognitive and social-emotional skills. Although not all children with stuttering exhibit problems in one or more of these domains, research over the past many decades have accumulated evidence to show that a significant proportion of this population have deficits in many different domains. It is not known clearly as to the nature of interaction of these variables in the onset, development and persistence of stuttering. But the available literature suggests that stuttering is a heterogenic problem possibly with many combinations of underlying pathophysiology. Only when a norm referenced assessment tools are used one could evaluate the complex

nature of the problem in all CWS which in turn would facilitate our understanding of the complex nature of the problem and able to device means to develop more comprehensive management approaches to improve treatment outcome in dealing with young CWS.

Clinical implications

1. There is scarcity of resources available for the comprehensive assessment of stuttering in general in in Kannada speaking children in particular. Even though it is reported by many authors that there are many concomitant disorders associated with stuttering, there are very few attempts made to develop a comprehensive protocol for profiling CWS. It would be the first comprehensive Protocol to be developed for the assessment of stuttering in CWS in Kannada language in the age range of 6 to 10 years. The Protocol would enable to get systematic information on cognition, socio-emotional and motoric nature of stuttering which would in turn facilitate planning individualized management protocols in young CWS along with the required documentation for future research purposes.

2. Children who stutter usually tend to have poor speech motor control, particularly in situations with more cognitive load. The goals of the treatment involve helping CWS to not only change the obvious relatively overt behaviors of stuttering but also to improve the quality of life. The speech motor stability is said to be lacking in CWS which can be targeted during therapy that will in turn aid in improving the motoric skills.

3. CWS usually tend to have higher levels of anxiety, especially in social situations. The levels of confidentiality will give us an insight regarding the severity as well as the impaired socio –emotional skills in CWS. The goals of the treatment involve helping CWS to improve the quality of life. The improvement in the emotional stability can be targeted during therapy after assessing with the checklist which gives an idea regarding the level of severity across individuals and situations.
4. Developing the database with regard to the involvement of various domains in CWS would throw more light on the theoretical underpinnings of stuttering which also would aid in research purposes.

Limitations

1. The study considered limited number of participants in both groups
2. The gender effect could not be explored in both the groups due to disproportionate gender subgroups.
3. The severity of stuttering could not be considered in the study due to lack of availability of participants, although severity is one of the important aspects affecting the nature of associated defects in stuttering.

Future directions

1. The protocol can be standardized over a larger population
2. To replicate the same study with increased number of participants
3. To compare between all the domains before therapy and after therapy among CWS to see the long term effects of management
4. To probe into the speech motor skills by using the kinematic measures of speech motor control
5. To cover wider age range, especially in the lower ages

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APPENDIX- A

CHECKLIST

Case Name: DOR:
Case number:
Age/gender:
Date of birth:
Education:
Contact Address/ mobile number/E-mail Id:

1. Annual income of the family: a) Slab I b) Slab II c) Slab III
2. Number of languages uses (specify the language): a) one b) Two c) > Two
3. Handedness: a) R-Right b) L-Left c)Ambidextrous
4. Change in handedness (if yes, specify): a) No b)Yes
5. Family history (specify relation if any): a) Not available b) NA c)+ve d)-ve
6. Family Pedigree if available (Draw and specify):
7. Type of Fluency disorder:
   a) NNF b) Stuttering c) Fast rate d) Cluttering e) Cluttering-Stuttering
8. Severity of the disorder:
   a) Very mild b) mild c) Moderate d) Severe f) Very Severe
9. Age of Onset of disorder:
10. Nature of onset (if sudden specify the reason): a) Gradual b) Sudden (specify)
11. Chronicity (duration of the problem): a) Not known b)Acute (<1month since onset) c) 1-3 months d) 3-6 months e) 6 -12 months f)>12 months
12. Awareness of the problem: a)Not aware b)Aware
13. Concern of the parent/care giver about the problem:
    a) Not concerned b) somewhat concerned c) Highly concerned
14. Variability of the disorder:
    I) Person a) No b) somewhat Variable c) Highly variable
    ii) Situations a) No b) somewhat Variable c) Highly variable
    iii) Languages a) No b) somewhat Variable c) Highly variable
15. Rate of speech: a)Very Slow b)Slow c)Average d)Fast e)Very fast
16. Type of Dysfluencies:
    SLDs: a) Repetition b) Prolongation c) Block
    NDs: a) Pauses b) Interjections c) Broken words

17. Position of disfluency: a) Initial b) Intermediate c) Final; d) No position effect

18. Secondaries: a) Absent b) Present (specify)

19. Avoidance behaviour: a) Absent b) Present (specify)

20. Breathing pattern: a) NA b) clavicular c) thoracic d) paradoxical e)Diaphragmatic

21. Associated problem if any

a) Voice; b) Fluency; c) Articulation; d) Language; e) Learning Disability; f) MR; g) Hearing Impairment; h) Others (specify)

28. Whether therapy attended: a) Yes; b) No

30. Any other kinds of treatment tried for stuttering: a) No; b) Yes
If yes, specify

31. Academic performance at school: a) Below Average b) Average c)Above average

33. SSI Scores

Appendix B

CLAP Score sheet

Sl. No.	Auditory mode	Score	Visual mode	Score
I.	**Attention discrimination**			
a)	Digit Count test	5	Odd one out test	5
b)	Sound Count test	5	Letter Cancellation	5
c)	Auditory word Discrimination	10	Visual –Word discrimination	10
	Total Score	**20**		**20**
II.	**Memory**			
a)	Digit forward span	5	Alternate Sequence	5
b)	Word recall	5	Picture counting	5
c)	Digit backward span	5	Story sequencing	5
	Total Score	**15**		**15**

APPENDIX C

Checklist for social-aspects in children with stuttering

Instructions

Even though you may not typically find yourself in some of these situations, when indicating your confidence level score a number from 0 to 3.

0 - No difficulty, Normal
1- Some difficulty, Mild
2- Significant difficulty, Moderate
3- Extreme difficulty, severe

Situations	Score
1. Do you find your speech to be disfluent?	
2. Are you afraid to communicate because of disfluency?	
3. Are you afraid to initiate speech?	
4. Do you avoid speaking situation or certain people?	
5. Do you get nervous when your teacher calls you?	
6. Do you use words such as " umm" or Throat clearing to avoid stuttering?	
7. Is it hard to talk to your teacher?	
8. Are you afraid to say answer, even when you know the right answer?	
9. Would you go up to a new boy/ girl in your class?	
10. Do you like to tell stories to your friend?	
11. Does your friends make fun of you because of disfluent speech?	
12. Would you rather look at a comic book than talk to a friend?	
13. Is it fun to talk to your dad?	
14. Do mom and dad like the way you talk?	
15. Do you feel anger or frustration because of disfluencies?	
16. Are you sometimes unhappy because of your speech?	
17. Do you like the way you talk, is talking hard for you?	
18. Do you wish to say clearly as other children say?	
19. Do you feel helpless or ashamed about stuttering?	
20. Do you exhibit facial grimaces, eye blinking arm movements during stuttering?	

Appendix D

TONGUE TWISTERS

Instruction:

Ask the participants to read each tongue twister thrice loudly and later recite them as fast as they can, measure Accuracy and Total time taken to recite the tongue twisters.

1. / ka:ge pUkka gube pUkka /,

2. / kappU kUmkUma kempU kUmkUma/,

3. /t̲erIkere erI mele mUru karI kUrI marI mejUt̲it̲U /

Appendix D

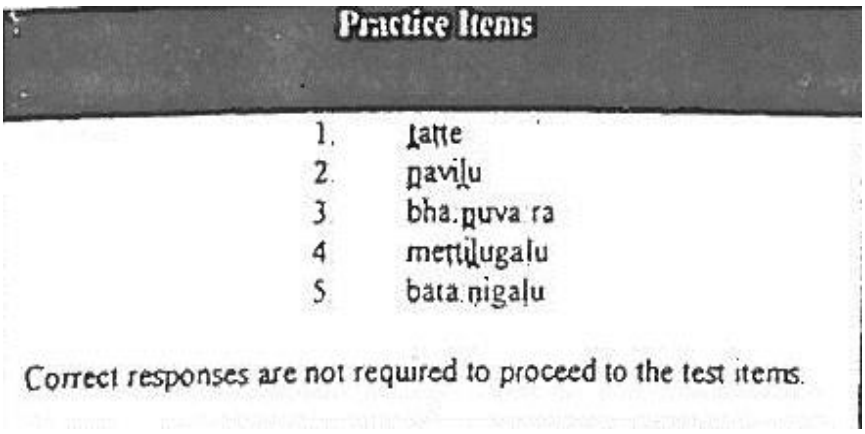
WORD SCORE SHEET

Number of presentation	Discontinue Rule	Accuracy
If the child does not respond to practice item allow up to 2 further presentation	NONE : Attempt to administer all items	Calculate : total number of words correct

Item score:

Score 1 was given for each item the child repeats correctly, with all the phonemes of the target Word or Non-word present in the correct order.

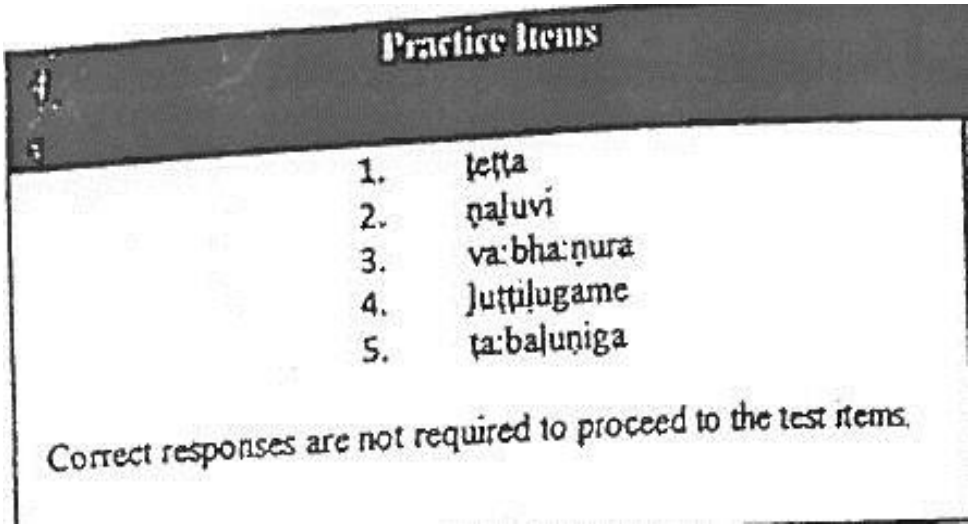
A score of 0 was given to those the child did not attempt or the response was incorrect after the transcriptions of the responses were done



Take proper, neat scan and replace all these

No.	Target	Score			Transcription
1	maɳe	1	0	NR	
2	ʧappaḷi	1	0	NR	
3	ʈaraka:ri	1	0	NR	
4	ʧamaʧagaḷu	1	0	NR	
5	ʧa:pe	1	0	NR	
6	kaṯṯaḷe	1	0	NR	
7	garagasa	1	0	NR	
8	vima:ɳagaḷu	1	0	NR	
9	ɳi:ʟi	1	0	NR	
10	ʈabaḷa	1	0	NR	
11	maɳejaṯṯi	1	0	NR	
12	ʧiraʈegaḷu	1	0	NR	
13	ɖa:ra	1	0	NR	
14	kaɖime	1	0	NR	
15	ɖi:pagaḷu	1	0	NR	
16	ɳo:duʈiɖɖa:ɳe	1	0	NR	
17	beɳɳu	1	0	NR	
18	ʈakkaɖi	1	0	NR	
19	maḷagiɖe	1	0	NR	
20	baḷapagaḷu	1	0	NR	
21	mi:ɳu	1	0	NR	
22	ʧapa:ʈi	1	0	NR	
23	ʃaɳiva:ra	1	0	NR	
24	ma:viɳamara	1	0	NR	
25	waɖe	1	0	NR	
26	ʧakkuḷi	1	0	NR	
27	maɳegaḷu	1	0	NR	
28	kuɖuregaḷu	1	0	NR	
29	ɖi:pa	1	0	NR	
30	basava	1	0	NR	
31	bi:gagaḷu	1	0	NR	
32	ʈagijuvuɖu	1	0	NR	
33	ka:ge	1	0	NR	
34	gaɳe:ʃa	1	0	NR	
35	baḷegaḷu	1	0	NR	
36	kaɳɳaɖigaḷu	1	0	NR	
37	ba:ji	1	0	NR	
38	beraḷu	1	0	NR	
39	maragaḷu	1	0	NR	
40	baɖaɳeka:ji	1	0	NR	
	Word total	40			

NON-WORDS REPETITION



Practice Items

1. ṭeṭṭa
2. ṇaḷuvi
3. va:bha:ṇura
4. juṭṭiḷugame
5. ta:baḷuṇiga

Correct responses are not required to proceed to the test items.

No.	Target	Score			Transcription
1	mɛɲa	1	0	NR	
2	ɟippatʃa	1	0	NR	
3	raka:ʈari	1	0	NR	
4	tʃagaɭumatʃa	1	0	NR	
5	tʃe:pa	1	0	NR	
6	ɟeʈʈaka	1	0	NR	
7	ga rasaga	1	0	NR	
8	ma:ɭuvigaɲa	1	0	NR	
9	ɲo:ɟi	1	0	NR	
10	ɟabaʈa	1	0	NR	
11	jaɖɖiɲema	1	0	NR	
12	tʃiɭuʈeraga	1	0	NR	
13	ɖe:ra	1	0	NR	
14	ɖikamɛ	1	0	NR	
15	paɖi:gaɭu	1	0	NR	
16	ɲo:ʈiɲeɖɖa:ɖu	1	0	NR	
17	buɲɲe	1	0	NR	
18	ɖikkaʈa	1	0	NR	
19	giɭaɖema	1	0	NR	
20	pabaɭugaɭa	1	0	NR	
21	mu: ɲi	1	0	NR	
22	ʈipa:tʃa	1	0	NR	
23	ɲiva:ʃara	1	0	NR	
24	ma:raviɲama	1	0	NR	
25	weɖa	1	0	NR	
26	ɟikkutʃa	1	0	NR	
27	maɭuɲega	1	0	NR	
28	gareɭukuɖu	1	0	NR	
29	ɖa:pi	1	0	NR	
30	sabava	1	0	NR	
31	gabi:ɭuga	1	0	NR	
32	ɖugijuʈavu	1	0	NR	
33	ke:ga	1	0	NR	
34	ʃaɳe:ga	1	0	NR	
35	gaɭebaɭu	1	0	NR	
36	diɲɲakagaɭu	1	0	NR	
37	bi:ja	1	0	NR	
38	beɭura	1	0	NR	
39	maɭugara	1	0	NR	
40	ɖabaka:ɲeji	1	0	NR	
	Nonword total	40			
	Word total	40			
	Word + Nonword Score	80			