COGNITIVE-LINGUISTIC SKILLS IN PERSONS WITH CLUTTERING AND STUTTERING

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MAY 2015

CERTIFICATE

This is to certify that the dissertation entitled "**Cognitive-Linguistic Skills in Persons with Cluttering and Stuttering"** is the bonafide work submitted in part fulfillment for the degree of Master of Science (Speech-Language Pathology) of the student (Registration No. 13SLP018). 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.

Mysuru,

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DECLARATION

This is to certify that this dissertation entitled "**Cognitive-Linguistic Skills in Persons with Cluttering and Stuttering"** is the result of my own study under the guidance of Mrs. Sangeetha M, Clinical Lecturer, Department of Clinical Services, All India Institute of Speech and Hearing, Mysuru, and has not submitted earlier in any other University for the award of any Diploma or Degree.

Mysuru **Register No: 13SLP018**

May , 2015

Dedicated to……

To all the individual with fluency disorders.

Don't say I didn't get a way for my "Cognition". Say here is a way for my "Cognition".

"Acknowledgements"

I feel very blessed; I take this moment to say thanks to you all.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

"Cluttering is a speech disorder characterized by one's unawareness of disorder, short attention span, disturbances in perception, articulation and formulation of speech and often excessive speed of delivery. It is a disorder of the thought process preparatory to speech and based on a hereditary disposition. Cluttering is the verbal manifestation of Central Language Imbalance, which affects all channels of communication (e.g. reading, writing, rhythm and musicality) and behaviour in general" (Weiss, 1964). Cluttering is defined as "a disorder of speech and language processing resulting in rapid, dysrhythmic, sporadic, unorganised and frequently unintelligible speech. Accelerated speech is not always present, but impairment in formulating language almost always is" (Daly, 1992).

Over many years, St. Louis and colleagues have been working on refining the diagnostic criteria for cluttering. The most recent revision of these criteria has been reported in St. Louis and Schulte's (2011) "Defining Cluttering" and is termed the "lowest common denominator" (LCD) definition. As the name suggests, it represents an attempt to reduce cluttering to its lowest common denominator components, that is, the minimum symptoms needed to allow a diagnosis of cluttering. "Cluttering is a fluency disorder wherein segments of conversation in the speaker's native language typically are perceived as too fast overall, too irregular, or both. The segments of rapid and/ or irregular speech rate must further be accompanied by one or more of the following: (a) excessive "normal" disfluencies: (b) excessive collapsing or deletion of syllables; and/ or (c) abnormal pauses, syllable stress, or speech rhythm" (St. Louis & Schulte, 2011). Various authors describe cluttering based on their perception of prominent characteristics of cluttering.

Cluttering is often difficult to diagnose before the age of 8 years. Two explanations for this point can be given: first, speech rate of young children as a group (e.g., Walker, Archibald, Cherniak, & Fish, 1992) is too slow (although there certainly are exceptions) to have a major influence on speech intelligibility and speech fluency. Secondly, errors in story, word, and sentence structures in children with cluttering (CWC) are difficult to differentiate from those of children with developmental language disorders (Van Zaalen, Wijnen, & Dejonckere, 2009b, 2009d).

As with cluttering another fluency disorder falling into the category is stuttering. According to Wingate (1964),

1. “Stuttering refers to a (a) disruption in the fluency of verbal expression, which is (b) characterized by involuntary, audible or silent, repetitions or prolongations in the utterance of short speech elements, namely: sounds, syllables, and words of one syllable. The disruptions (c) usually occur frequently or are marked in character and (d) are not readily controllable.
2. Sometimes the disruptions are (e) accompanied by accessory activities involving the speech apparatus, related or unrelated body structures, or stereotyped speech utterances. These activities give the appearance of being speech-related struggle.
3. Also, there are not infrequently (f) indications or report of the presence of an emotional state, ranging from a general condition of "excitement" or "tension" to more specific emotions of a negative nature such as fear, embarrassment, irritation, or the like. (g) the immediate source of stuttering is some in-coordination expressed in the peripheral speech mechanism; the ultimate cause is presently unknown and may be complex or compound”.

It is striking to note that as with stuttering, currently there is no known cause for cluttering. Few researchers have noted that both cluttering and stuttering have genetic basis and has been found to run in families (Freund, 1952; Luschinger & Arnold, 1965). In stuttering the males and females ratio was found to be 4:1 similarly seen in cluttering. (Arnold, 1960; St Louis & Hinzman, 1988). Though there is a speculation that prevalence rate of cluttering is less than stuttering and also there is little research on the same (Daly & Burnett, 1999; St. Louis, Raphael, Myers, & Bakker, 2003). Freund (1952) reported that there were 22% of persons with cluttering (PWC) in stuttering group. Also it was found that in a group of 51% of pure stuttering, had relatives with fluency disorders compared to 93% of stuttering-cluttering group.

According to Linguistic Disfluency Model of Cluttering (Daly & Burnett, 1999) five broad communicative dimensions are affected in PWC. They are cognitive, linguistic, pragmatic, speech and motor abilities. If an individual presents with one or more impairment(s) in each of these five broad communicative dimensions then cluttering exists. (a) Cognition relates to unawareness of the disorder (s), poor self monitoring, inadequate thought organisation, poor attention span, impulsivity (verbal and non verbal), and/ or perceptual deficits, such as auditory or visual processing, or poor auditory memory. (b) Language comprises of deficits in receptive and expressive domains. Receptive domains include difficulty in listening or following directions. Expressive domains includes poor storytelling, difficulty in language formulation, presence of revisions and repetitions, improper linguistic structure, presence of syllable or verbal transpositions, improper pronoun use, dysnomia/word finding difficulty, filler words, empty words. Expressive- Written domains include run on sentences, omissions and transpositions of letters, syllables and words and sentence fragments. Further specific deficits includes (c) Pragmatics refers to inappropriate topic introduction, maintenance, termination, turn

taking, poor listening skills; impulsive responses, lack of consideration of listener perspective, inadequate processing of non- verbal signals, verbose or tangential and poor eye contact (d) Speech disfluency relates to excessive repetition of words/phrases, presence of syllabic or verbal transpositions, irregularities in prosody like rapid or irregular rate, poor rhythm, lacks pauses between words, vocal monotony, slurred articulation, omit sound(s), omit syllable(s) (/r/ and /l/), dysrhythmic breathing and silent gaps/ hesitations will be present, (e) Motor refers to poor control, clumsy, in-coordination and poor penmanship. An Indian study (Aparna & Rajasudhakar, 2007) also supports the previous studies on cluttering who reports of having unawareness of the problems, fast rate of speech, reduced attention span, other disfluencies stuttering like features (repetition of words and phrases), articulation problems and reading-writing difficulties, also suggests cluttering as heterogeneous group.

From the assumption of various theories it was found that persons with stuttering (PWS) use a motor control strategy which differed from that of persons with no stuttering (PWNS) in several aspects and concluded that there is a deficiency in speech motor control. According to Perkins, Kent, and Curlee (1991) suggested that due to the difficulties seen in processing at semantic (Wingate, 1988; Bosshardt, 1993; Bosshardt & Fransen, 1996) or phonological level (Wingate, 1988; Postma & Kolk, 1993; 1997) desynchronization in speech plan can happen which can result in observable stuttering events. In PWS it was found that, in an ‘‘outer’’ cognitive control loop there was a longer processing time (Nudelman, Herbrich, Hess, Hoyt & Rosenfield, 1992). According to study done by Bosshardt (2006), dual task experiment was carried out, where word repetition, sentence generation and production tasks was done and found that in PWS,

sentence generation and production tasks required greater sustained attention processing than in PWNS.

Need for the study

Cluttering is a multifaceted and a complex speech-language disorder. Cluttering manifest itself as a "manner of producing speech" rather than in the form of a finite set of discretely identifiable clinical signs. Cluttering is considered as the orphan of the family of speech-language disorder as it is neglected by the professionals and even by PWC themselves. The nature of cluttering requires a descriptive and perceptual approach. Such an approach does still need to meet the expectation of producing valid and reliable quantifiable clinical data. Few authors support some of the cognitive-linguistic domains to be affected in even PWS. Minimal research exists on the assessment of various domains of cognition in cluttering and stuttering especially in the Indian context. Empirical study of stuttering and cluttering by judging perceptually is challenging because listener's perception can be by definition, subjective, can also be influenced by various variables such as experience, attitudes and training of the listener as well as the actual stimulus heard. Hence, an objective measure is essential to capture the diversities of cluttering as well as stuttering symptoms. In PWC cognitive linguistic deficits are specified by various researchers, however limited information is available regarding the extent of deficits. Researchers also found cognitive linguistic deficits in PWS though limited information is available. Hence, the present study investigated cognitive-linguistic abilities using adapted and standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT- K, Vandana & Shyamala, 2011).

Aim:

The primary aim of the present study was to investigate the cognitive-linguistic abilities in persons with Cluttering and Stuttering.

Objectives of the study

1. To compare cognitive-linguistic abilities within clinical groups (Cluttering, Stuttering and Cluttering-Stuttering).
2. To compare cognitive-linguistic abilities across the clinical group (PWC, PWS and PWCS).
3. To compare the findings of clinical group with literature.

CHAPTER II

REVIEW OF LITERATURE

Speech and language disorders may be classified into four categories: a) language; b) articulation; c) fluency and d) voice. Among these the major fluency disorders are stuttering and cluttering. *"*Stuttering is a disorder characterized by a high frequency of involuntary interruptions of the forward flow of speech, regarded by the PWS as "stutters", which are often accompanied by a feeling of loss of control. These interruptions usually take the form of (1) repetitions of sounds, syllables or one syllable words; (2) prolongations of sounds; (3) blocks of airflow or voicing in speech" (Curlee & Conture, 2007; Guitar, 2006; Quesal, 2004; Shapiro, 1999; Van Borsel & Tetnowski, 2007; Ward, 2006). According to experts, cluttering is characterized by three main features: (1) a rapid and/or irregular articulatory rate (Daly, 1993; Damsté, 1984; Dinger, Smit, & Winkelman, 2008; St. Louis, 1992; St. Louis, Myers, Cassidy, Michael, Penrod, Litton et al., 1996; St. Louis, Raphael, Myers, & Bakker, 2003; Weiss, 1964); (2) a higher than average frequency of disfluencies, dissimilar to those seen in stuttering (Myers & Bradley, 1992; St. Louis, 1992, 1996; St. Louis et al., 2003) and (3) reduced intelligibility due to exaggerated coarticulation (deletion of syllables or sounds in multi-syllabic words) and indistinct articulation (Daly & Burnett, 1999; Damsté, 1984; Dinger et al., 2008; Gutzmann, 1893; Mensink-Ypma, 1990; St. Louis et al., 2003; St. Louis, Raphael, Myers, & Bakker, 2007; Van Zaalen & Winkelman, 2009; Voelker, 1935; Ward, 2006; Weiss, 1964). Further since decades cluttering, has been considered as same phenomenon as stuttering. However in the present years both has been considered as different entities and combined entity, where the core features of stuttering and cluttering coincides and termed as "cluttering- stuttering".

There are several theories which describe stuttering as having deficits in motor planning (Adams, 1974; Perkins, Rudas, Johnson, & Bell, 1976), cerebral planning (Travis, 1931) and language processing (Moore & Haynes, 1980). Similarly cluttering is described as deficits in cognitive, linguistic, pragmatic, speech and motor abilities (Daly & Burnett, 1999). Hence, Ward (2006) termed cluttering as "spectrum behaviour" because it commonly exists alongside with other disorders. The cluttering behaviour may overlap with stuttering, articulation disorders, learning difficulty and attention deficit hyperactive disorders.

Daly and Cantrell (2006) suggested ten significant features associated with cluttering. They are: a) telescopes or condenses words (e.g., omits sounds; b) lack of effective self-monitoring skills; c) lack of pauses between words; run-on sentences; d) lack of awareness; e) imprecise articulation (e.g., distorts sounds); f) irregular speech rate; speaks in spurts; g) interjections; revisions; filler words; h) compulsive talker; verbose; circumlocutions; i) disorganized language; confused wording; j) seems to verbalize before adequate thought formulation.

Studies on Cognitive-Linguistic aspects in Cluttering

Researchers evidenced deficits in multiple domains among PWC. A study was conducted by Daly and Burnett (1996) on an eight year old boy with cluttering. At the time of assessment procedure they found that the child had difficulty in organising and formulating language, topic maintenance, rate and tempo of speech, intelligibility, prosody and also he was unaware of his problem and unconcerned with the listener's incomprehensibility of his speech. The child was followed up after two years after availing

linguistic based therapy, the authors found improvement in all areas. Hence they concluded that PWC appears to present language deficit, which should be identified during diagnostic procedure through detailed evaluations. Further the focus on domains such as oral-motor coordination; rate; language abilities (including formulation of stories, topic maintenance and sequencing of events); awareness of deficits; and reading difficulties should be assessed and treated.

The assessment of pragmatics favoured poor performance in persons with the features of cluttering. Teigland in 1996 conducted a study and investigated the pragmatic skills of PWC. Twelve participants with the age range of 13-16 years were considered. The author found more significant errors in pragmatics and communication failures while giving directions in PWC than controls. It was concluded that PWC are poor in communication due to breakdowns in linguistic aspects such as word finding difficulties or due to problems in forming grammatical utterances.

Various researchers describe cluttering either in terms of linguistic or motoric type deficit. Ward (2006, 2011b) classified cluttering into two types: motoric cluttering and linguistic cluttering. Linguistic cluttering includes difficulties at various linguistic levels majorly affecting syntax, semantic and pragmatic processing. Consequently, it is justifiable to note the difficulty to organise their speech while telling/re-telling stories and also experiences word finding difficulties. Under motoric type disruptions of speech in terms of speech rate, rhythm and articulation were found. Van Zaalen, Wijnen and Dejonckere (2011) also mentions that cluttering has a linguistic component, and Van Zaalen, et al. (2009b) defined cluttering as a two types of language based disorder, where one is ‘phonological cluttering’ and other is ‘syntactic cluttering. Authors viewed phonological

cluttering as similar to the idea of motoric cluttering given by Ward, and syntactic cluttering as Ward's linguistic cluttering.

Multidimensional speech and language aspects such as fluency (during reading and spontaneous speech), speech rate (while reading and short "fluent" utterances), diadochokinetic rates, movement of articulators, phonetic aspects, prosody, language, handwriting, voice, intelligibility, pragmatic skills, hand preference, family history of fluency disorders and attitude to speech were examined in order to understand the aetiology of cluttering. Lees, Boyle and Woolfson (1996) examined a single case study considering fifteen year old boy. When formally assessed the findings indicated that the language skills were adequate, but limited range of syntactic structures were exhibited in spontaneous speech. Therefore the authors concluded that the client had no linguistic deficit, but exhibited more of motoric type of cluttering. However the authors opine that it is very difficult to conclude whether cluttering is a motoric or linguistic deficit based on single case studies (Daly & Burnett, 1996; Lees et al., 1996).

A study was conducted by Van Zaalen et al. in 2009b with the aim of studying the extent of disturbances in the fluency and language planning in CWC and children with learning disabilities and also to check whether the disturbances is same or different in both the condition. They considered 150 Dutch speaking children in the age range of 10.6 to 12.11 years. There were three groups (cluttering, learning difficulties and controls) and a range of speech and language variables were analysed. For story retelling task The Wallet story (Van Zaalen & Bochane, 2007) based on Renfrew's (1997) Bus Story, was used. Authors analysed (a) percentage of primary plot elements (building stones of the stories), secondary plot elements (details) or noise (added phrases not being part of the story, for

instance, ‘‘I do not remember the story’’); (b) percentage of direct and indirect sentence structures produced correctly; (c) percentage of incomplete or ungrammatical sentences; and (d) the type and frequency of disfluencies in retelling a memorized story. Results obtained showed differences disturbance in language process is different between CWC and those with learning disabilities. Authors concluded that for children with learning disabilities due to the problem at the conceptualizator and formulator stages of Levelt’s language processing model there are disturbances seen in language production, while for CWC disturbances in language planning is due to inadequate time to complete the editing phase of sentence structuring. These findings indicate that based on the number of main and secondary story plot elements and by the percentage of correct sentence structures CWC can be differentiated from children with learning disabilities.

Van Zaalen-op’t Hof, Myers, Ward, and Bennett (2011) put forth that PWC experiences language deficits along with articulation problem. Therefore it is important to assess their language skills along with articulatory skills. Notably, language deficits may be word finding difficulty, poor syntactic structure, lack of coherence and cohesion in discourse and narratives, and compromised pragmatics. Hence the authors speculated that cluttering like disfluencies are more of linguistic type rather than motoric and termed as ‘linguistic maze behaviours’

The linguistic processing specifically lexical access and use of maze behaviour in story re-telling and sequencing tasks in PWC were investigated by Furness and Ward (2012). Eight participants with the mean age of 27.5 years participated in the study. To assess lexical access and maze behaviour subsections of the Mount Wilga High Level Language Test (MWHLLT; Christie, Clark, & Mortensen, 1986) were used. The three subtests of the MWHLLT: naming to a description, category naming, and semantic and

phonological constrained word generation were used to assess lexical access and also to analyse potential maze behaviours. Participants were instructed to describe a procedure, to retell a short story and recalling as much information from the original as possible. The tests of MWHLLT were used to determine the word finding difficulties and usage of maze behaviours in PWC compared to controls, during story re-telling and simple sequencing tasks. Their results showed that in lexical access and sentence completion tasks PWC were significantly slower than control participants, but when naming items within a semantic category were considered mixed findings were found for. Significantly more maze behaviours were seen in PWC than controls, in a task where participants were required to explain how to undertake commonly performed actions, but no difference were seen between the groups while retelling a story from memory. They concluded that the language deficits at lexical discourse levels are prevalent in PWC even though the findings showed mixed results. The authors remarked that their study comprised of fewer participants, and for reliable results the study should be conducted on more number of participants.

To summarize the findings of literature on cognitive-linguistic aspects with regard to cluttering, the results are reasonably consisting with one another. Authors classified cluttering into two subgroups as linguistic or motoric. Due to limited number of participants in the studies it is very difficult to decide whether cluttering is linguistic or motoric and also to extrapolate the findings. Researchers evidenced the linguistic deficits such as, organisation and formulating language, topic maintenance, intelligibility, sequencing, word finding difficulty, incomplete sentence, poor grammar, lack of coherence and cohesion, speech deficits such as oral-motor coordination, rate and tempo and prosody and cognitive deficits such as awareness of disfluencies and unconcerned about the problem in PWC.

Studies on Cognitive-Linguistic aspects in Stuttering

Children with stuttering (CWS) have lower scores for receptive and expressive language (Anderson & Conture, 2000; Byrd & Cooper, 1989; Murray & Reed,1977; St Louis & Hinzman, 1988), have more immature language (Howell & Au- Yeung, 1995; Wall, 1980), have less well- developed articulatory systems (Melnick & Conture, 2003), and have poor grammar (Westby, 1974), have reduced abilities to plan, or retrieve sentence level units of speech (Anderson & Conture, 2004; Cuadrado & Weber-Fox, 2003).

Kamhi and McOsker (1982) conducted a study to investigate the ability of PWS and PWNS to concurrently perform speech and nonspeech tasks. Participants were 10 PWS with the age range of 18-66 years and 10 PWNS with the age range of 19-45 years and two experiments were conducted. In the first experiment, the subjects were asked to execute a non attention task where a simple gross-motor activity, 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 before, during and after performing the task. The disfluencies were calculated for the tasks. In the second experiment, reading comprehension task was performed were the participants were asked to respond to questions about the content of four read passages. Effects of attention on reading comprehension were determined. Results indicated that there was no significant difference among PWS in both experiments, i.e speech task with gross motor activity as well as in reading comprehension tasks. However, PWS performed significantly poorer than PWNS on the reading comprehension task. The authors concluded that PWS devote more attention to speech than PWNS. It was speculated that the relationship between attention

and stuttering appears to be contradictory at times because of developmental changes that affect the nature of this relationship.

The performance of PWS and normal speaking adults on a variety of perceptual/ memory tasks in both unisensory and bisensory tasks were compared by Carpenter and Sommers (1987). Participants were grouped into two, where one was experimental group consisting of nine adult male PWS and one adult female PWS ranging in age from 21 to 34 years, with a mean age of 26.3 years. Another group consisted of control group with the age range of 17 to 24 years with a mean of 20.3 years. All participants were tested in two sessions where the first session included unisensory tasks and the second session included bisensory tasks. Unisensory tasks involved three tasks; a) unisensory manual form discrimination: where participants were given different geometric forms on hands and instructed to feel the shapes with the fingers and respond whether the forms are same or different b) unisensory oral form discrimination: where participants were given different forms and should respond whether they are "same" or "different" by moving around the mouth c) unisensory auditory memory for words: here participants heard the words presented and wrote the words in the serial order. Bisensory tasks involved four conditions where form identification and auditory word strings from the unisensory tasks were randomly selected. Participants were instructed to feel the forms (neither with finger nor in the mouth) along with that few words were presented. The experimenter instructed the client to respond whether the forms are same or different or had to write the words heard in the same order. Results revealed that on unisensory tasks there was no significant difference found between the two groups on all three tasks. On bisensory tasks, in form discrimination the PWS performances were equal to the normals, but on word recall task the PWS performed poorer compared to normals. Authors concluded based on few

hypotheses that, there can be disruption in sequencing and timing which may be related that the PWS use right hemisphere for recalling words, processing the manual and oral forms. Poor performances on bisensory task in PWS are due to the mistiming and faulty sequencing. In addition, activation of unintended nodes in PWS leads to poor performance in auditory recall task.

Researchers demonstrated poor verbal working memory in a group of CWS. A study was conducted by Reilly and Donaher (2005) to examine the verbal working memory skills of CWS. Participants were divided into two groups, CWS and children with no stuttering (CWNS). They were 5 male CWS with the mean age of 7.9 years and 4 males and 1 female with the mean age of 8.5 years under age matched control group. Digit and letter span task was carried out where all the participants were instructed to write their responses for half of the items and repeat their responses to other half. This was done in order to assess whether response modality (i.e., oral or written) influence recall accuracy or not. Results revealed that there was a significant difference between CWS and CWNS, where CWS had reduced recall than compared to CWNS and these differences were evident across both oral and written recall modalities. Based on the results the authors concluded that the differences are due to correlation between speech rate and working memory paradigm. The results suggest that recall is due to the relationship between speech rate and individual's maximum capacity of phonological storage. The speech rate and working memory paradigm indicates that if the speed of the articulation increase, the speed of memory span also increases. Therefore the authors hypothesized two fundamental assumptions that (a) CWS exhibit a slower overt speech rate than CWNS; and (b) slower *overt* speech is indicative of slower *covert* rehearsal. The authors concluded that CWS has slower speech rate which will affect their working memory. However, various researchers

reported inconsistent findings with regard to speech rates and hence further research is warranted in this area.

To investigate cognitive differences between PWS and PWNS a study was conducted by Bosshardt (2006). Fourteen adult PWS and sixteen adult PWNS participated in the study. Dual task experiment was carried out where word repetition and sentence production tasks were performed. In word repetition task the participants were instructed to verbally and continuously repeat the sequence of words. Considering the sentence production experiment two tasks were carried out, where in immediate production task, as soon as the nouns were presented, the participants has to produce a sentence containing two nouns. In delayed production task participants were instructed to silently generate a sentence containing two nouns as soon as the nouns were presented and then to produce them overtly 10 sec later. The results of word repetition task indicates that speech of PWS is sensitive to interference from concurrent attention-demanding cognitive processing particularly when phonological coding is involved. In sentence production experiment PWS under dual task condition produced sentences containing smaller number of content units than PWNS. Therefore the results suggest that for PWS sentence generation and production task required greater sustained attention processing than PWNS.

The relationship between measures of linguistic processing speed and two aspects of cognition: phonological working memory and attention were examined by Anderson and Wagovich (2010). A total of 9 CWS (3 girls and 6 boys) and 14 CWNS, (8 girls and 6 boys) between the ages of 3.6 and 5.2 (years and months) were considered. Each child was assessed in a quiet room on two separate occasions. One week prior the parents received temperament behaviour questionnaire, Children's Behavior Questionnaire (CBQ-SF;

Putnam & Rothbart, 2006) through mail, from which information about the children's attention skills was collected. During the first visit, the child engaged in the parent–child interaction, responded to the standardized speech and language tests, and completed the hearing screening. During the second visit, the child completed a nonword repetition task (Anderson et al., 2006) and a computerized picture naming task (Anderson, 2008). In non word repetition task, Children's Test of Non-Word Repetition (CNRep; Gathercole et al., 1994; Anderson et al., 2006) was administered where phonological working memory skills were measured. Children were instructed to repeat 40 nonwords, 10 each containing 2-, 3-, 4-, and 5-syllables. Each child's repetition attempt was scored as phonologically correct or incorrect. Further, linguistic processing speed was measured using computerised picture naming task. Latency of each child's picture naming response (i.e., speech reaction time, SRT) was measured in milliseconds. Results revealed that, i) on attention or SRT, there was no significant difference between the groups, but CWS performed significantly worse in non-word repetition; ii) significantly negative relationship there found between SRT and non word repetition in CWS; iii) when age was considered, there was no significant relationships was found between the aspects of attention and SRT for either group and iv) a significant relationship was found only in CWNS for non-word repetition and focused attention skills. These results highlight the need to consider the essential skills associated with lexically related aspects of language production while examining the task performances of CWS and CWNS.

To summarize the review on cognitive-linguistic aspects in stuttering the findings suggested PWS pay more attention to speech than PWNS. In PWS there is a disruption in sequencing and timing which can be due to the role of right hemisphere and poor performances on bisensory task are due to the mistiming and faulty sequence. For sentence

generation and production task PWS require greater sustained attention. Few researchers support the view point of slower speech rate which might affect the working memory in CWS.

Studies on Cognitive- Linguistic abilities in cluttering-stuttering

Heitmann, Asbjornsen and Helland (2004), conducted a study which determined attentional functions in fluency disorders. Participants were divided into three groups, where nine PWS, eight PWC and nine controls participated in the study. A set of attention tasks while psychophysiological indices of activation (heart rate variability and skin conductance) were recorded. Posner Test of Covert Attention Shifts and Wisconsin Card Sorting Test was administered. Results revealed longer response time was found in PWS group compared to other two groups, and the outcome was most obvious when the target appeared in the right visual field. This indicates PWS has impaired processing of stimuli that is directed towards the right perceptual field/left hemisphere in lateralized cognitive tasks. Hence authors say this can be due to increased activation in right hemisphere and decreased activation in left hemisphere. PWC showed shorter response time in an automatic and stimuli-driven form of attention, indicating impulsiveness and impatience. Further no significant differences were found between the groups for psychophysiological measures. Therefore the study support the hypothesis that PWS has deficit in focused attention and PWC has deficit in executive functions.

A study was conducted by St. Louis**,** Hinzman and Hull in 1985, to investigate the disfluencies and language measures in young PWC and PWS. Participants were divided into three groups: possible cluttering, stuttering and controls. Spontaneous speech samples were tape recorded and analysed according to eleven disfluency variables and seven

language measures. The results revealed that the three groups were diverse with respect to disfluency and language. Abnormally high frequencies of word and phrase repetitions were observed in the speech of possible PWC, unlike PWS. In addition, PWC had fewer sound/syllable repetitions, prolongations and instances of struggle than PWS. On language measures, possible PWC scored lower than did PWS and controls, particularly on measures of utterance completeness and complexity. Therefore the authors concluded that the PWC have abnormal disfluencies which are deviant from that of PWS and also have language deficits. However in these studies a subgroup with both the features of stuttering and cluttering were not considered.

A single case study was conducted by Williams and Wener (1996) who examined a client with a compliant of stuttering. During assessment procedure the characteristics of both cluttering and stuttering were found. Stuttering like features included prolongations, syllable repetitions; escape behaviours were present in both speech task and reading tasks. Cluttering features like rapid speech rate, poor expressive language, unawareness of the problem, decreased intelligibility were evident on speech task as well as in reading tasks. Further, the writing sample evidenced incomplete sentences, sentence fragments, omissions of noun phrases in sentence, inappropriate punctuation, misspelled words and punctuation errors. Along with these characteristics the case had positive family history of stuttering as well as history of change in handedness. Based on these prominent features he was diagnosed as having cluttering-stuttering. After diagnosis the case was given therapy for 13 months which focussed on improving breath control, slow rate, easier onset of articulation and increased awareness of speech. Prognosis was consistent and was able to generalise and maintain the therapeutic technique in order to improve the fluency and

intelligibility. The study focussed not only confirmed the diagnosis of an individual with cluttering- stuttering but also emphasized on the evidence based therapy.

Van Zaalen-op't Hof, Wijnen and De Jonckere (2009) conducted study to differentially diagnose the characteristics of PWS, PWC and person with cluttering-stuttering (PWCS). A total of 79 subjects participated in the study where 54 were in experimental group and 25 were in control group. Experimental group consisted of 41 males with the mean age of 10.2 years (range; 6.0–39.4 years) and 13 females with the mean age of 12.9 years (range; 6.3–47.2 years). Control group consisted of 17 males with the mean age of 24.3 years (range; 12.6–47.3 years) and 8 females with the mean age of 25.2 years (range; 12.4–52.1 years). All participants in the experimental group were diagnosed based on subjective clinical judgement on audio recordings of three different speech tasks: spontaneous speech, reading and retelling a story. Participants in the study were given speech tasks: i) monologue; ii) reading; iii) story retelling; iv) speech motor coordination and were checked for articulatory rate; articulatory accuracy and smooth-flow frequency and type of normal disfluencies. Results showed that mean articulatory rate was slower for PWS compared to PWC and controls. Fast articulatory rate was seen in PWC and not in PWS. PWC produced more of normal disfluencies compared to stuttering like disfluencies. PWC produced more accuracy errors compared to controls and PWS. With respect to smooth flow of speech (coarticulation, flow and sequencing) more errors were seen in PWC, followed by PWS and control group, PWCS lies between PWS and PWC. Based on the results authors concluded that articulatory rate and type of disfluencies are major important measures in differentiating PWC, PWS and PWCS. Therefore the authors suggest the combination of subjective and objective measures which aids in differentially diagnosis of cluttering and stuttering.

LaSalle and Wolk (2011) conducted a study to determine the phonological complexity of disfluencies in PWC and/or PWS which would help in understanding the phonetic factors. The authors studied three 14-year-old males who were diagnosed as PWS, PWC and PWCS. Spontaneous speech samples were recorded, transcribed and coded for disfluent words and then they were matched for grammatical class (i.e., function vs. content) on fluent words, number of syllables and word familiarity. An index of phonological complexity was determined per word, word frequency, density and phonological neighbourhood frequency from an online database. Results revealed that compared to fluent words, disfluent words were more phonologically complex and 'sparser', implying that PWS and PWCS have fewer phonological neighbours or words in which a single phoneme is added, deleted or substituted. Therefore in PWS phonological density is a more influential factor for predicting disfluent words in a spontaneous speech sample. While misarticulations abound in PWC, cluttering is indeed thought to have more of a language-based pathogenesis than stuttering.

To summarize the review on cognitive-linguistic aspects in cluttering and stuttering the finding suggested that PWC have abnormal disfluencies which are deviant from PWS and also have language deficit. Articulatory rate and type of disfluencies are major important measures in differentiating PWC, PWS and PWCS. Phonological density is a more prominent factor for predicting disfluent words in PWS while in PWC greater occurrence of misarticulation seems to be the influential factor.

Various researchers have compared the speech and language characteristics of cluttering and stuttering (Weiss, 1964; Lushsinger & Arnold, 1965; Van Riper, 1970;

Daly, 1996; and Daly & Burnett, 1999). Tables 1 and 2 displays the differences and similarities between cluttering and stuttering respectively.

Table 1. *Differences in speech and language characteristics between stuttering and cluttering.*

Features	Cluttering	Stuttering
Started talking late; language delay	Typical	Atypical
Slurred articulation; telescope/ condense/ omit sounds or syllables		
Clumsy, uncoordinated; hasty motor activities		
Repeats longer words and/ or phrases		
Prosodic deviances; irregular rate, rhythm		
Language formulation difficulties		
Disorganised discourse; poor sequencing/ story telling		
Word finding difficulties		
Improper linguistic structure/ syntax; grammatical errors		
Reading disabilities		
Poor written expression; parallels verbal errors		
Inappropriate topic introduction/ maintenance/ termination		
Lack of awareness of communication difficulty		
Attention deficits	More frequent	Less frequent
Fluent episodes	Atypical	Typical
Secondary characteristics		
Repeats sounds or short words		
Tension/ struggle behaviours		
Word substitution and circumlocutions		
Heightened awareness of disfluencies		

Table 2. *Similarities in speech and language characteristics between Cluttering and Stuttering.*

Feature	Cluttering	Stuttering
Rapid rate of speech	Typical	Typical
Breathing dysrhythmia		
Silent pauses; hesitations		
Interjections; revisions; filler words		
Poor oral coordination		
Poor eye contact		
Familial history		

Various standardized tools to assess cognitive-linguistic abilities in adults are: Measures of Cognitive Linguistic Abilities (MCLA) (Ellmo et al., 1995), Ross Test of Higher Cognitive process (Ross & Ross, 1979), Cognitive Linguistic Assessment Protocol for Adults in Kannada (CLAP) (Kamath, 2001), Cognitive Linguistic Quick Test (CLQT) (Helm Estabrooks, 2001), adapted and standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT- K) (Vandana & Shyamala, 2011) and so on. The cognitive-linguistic abilities in the participants are assessed using CLQT-K in the present study. Hence, the descriptive of CLQT-K are provided further.

Cognitive Linguistic Assessment Protocol for Adults in Kannada (CLAP) (Kamath, 2001), is one of the most widely used standardised cognitive-linguistic test to assess cognitive-linguistic abilities in individual with cognitive-linguistic deficit with the age range of 40 to 70 years. It consists of four main domains. They are:

(1) Attention, perception and discrimination

(2) Memory

(3) Reasoning and problem solving

(4) Organisation

Adapted and standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT- K) (Vandana & Shyamala, 2011), is also one of the standardised cognitive-linguistic test to assess cognitive-linguistic abilities in the age range of 20 to 80 years. It has been used in different population like Parkinson's disease in an Indian setup (Sushma, 2013). However, this test has not been used on persons with fluency disorders either in Western or in the Indian scenario.

To summarize the review there have been few studies conducted to assess cognitive and linguistic aspects in PWC, PWS and PWCS. These studies revealed poor performance on both cognitive and linguistic tasks in PWC, PWS and PWCS. Few of the speech and language characteristics presented overlapping features in cluttering and stuttering. Authors such as Weiss (1964), Lushsinger and Arnold (1965), Van Riper (1970), Daly (1996) and Daly and Burnett (1999) have commented about specific features of cluttering and stuttering. The researchers concluded a definite cognitive-linguistic deficit in PWC to a greater extent and to some extent in PWS. However, objective assessments on the cognitive-linguistic domains are limited. Hence there is a great need to explore more into the characteristic features of cluttering and stuttering. There are no specific tests developed to evaluate the cognitive and linguistic aspects in both cluttering and stuttering. Hence the present study was planned to investigate the cognitive-linguistic abilities in PWC, PWS and PWCS using an objective tool.

CHAPTER III

METHOD

The primary aim of the present study was to investigate the cognitive- linguistic abilities in PWC, PWCS and PWS.

Objectives of the study

1. To compare cognitive-linguistic abilities within persons with cluttering, cluttering-stuttering and stuttering.
2. To compare cognitive-linguistic abilities across clinical group (cluttering, cluttering-stuttering and stuttering).
3. To compare the findings of clinical group with literature.

Participants: Seventeen number of Kannada speaking individuals in the age range of 18-40 years, clinically diagnosed as cluttering, cluttering-stuttering and stuttering by the speech- language pathologist were considered for the study. Group 1 included three PWC with the mean age of 26.93 years (range; 26.2- 28 years). Group 2 included four PWCS with the mean age of 23 years (range; 18-32 years). Group 3 consisted of ten PWS with the mean age of 21.7 years (range; 20- 27 years). Table 3 shows the demographic details of the participants.

Table 3. *Demographic details of the participants.*

Participants	Age/ Gender	Provisional Diagnosis
PWC1	26.6 years/ Male	Cluttering
PWC2	28 years/ Male	Cluttering
PWC3	26.2 years/Male	Cluttering
PWCS1	18 years/ Male	Cluttering-Stuttering
PWCS2	24 years/ Male	Cluttering-Stuttering
PWCS3	18 years/Male	Cluttering-Stuttering
PWCS4	32 years/ Male	Cluttering-Stuttering
PWS1	27 years/ Male	Moderate Stuttering
PWS2	20 years/Male	Moderate Stuttering
PWS3	21 years/Male	Moderate Stuttering
PWS4	23 years/Male	Moderate Stuttering
PWS5	21 years/Male	Moderate Stuttering
PWS6	20 years/Male	Severe Stuttering
PWS7	20 years/Male	Moderate Stuttering
PWS8	20 years/Male	Moderate Stuttering
PWS9	22 years/Male	Severe Stuttering
PWS10	23 years/Male	Severe Stuttering

Notes. PWC = persons with cluttering; PWCS= persons with cluttering-stuttering; PWS= persons with stuttering

Materials:

The test materials included:

- Predictive Cluttering Inventory (PCI, Daly, 2006)
- Stuttering Severity Instrument-3 (SSI-3, Riley, 1994)
- 300-word reading passages in Dravidian languages (Savithri & Jayaram, 2005)
- Adapted and standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT-K, Vandana & Shyamala, 2011)
- NIMH socio economic scale (Venkatesan, 2006)
- Audio- video recording equipment.

Procedure:

A rapport was built with the client by engaging in a casual conversation. Ethical procedures were followed. A written consent was taken from all the participants before the data collection. The NIMH socio economic scale (Venkatesan, 2006) was administered to determine the socio- economic status. All the participants presented with mid socio-economic status. Following this, the assessment procedures were carried out. A detailed case history was taken which revealed the information about experience of normal fluency, speech- language development for any delay in speech-language, reading and writing abilities, family history, extent of disfluencies and awareness of the disorder.

Speech tasks like spontaneous speech were elicited using some common questions pertaining to individual's background and hobbies. Narration task was carried out by asking the client to talk about their favourite sport or leisure activity, or topic of their interest or tell a story about a recent exciting event that the participant experienced, followed by oral reading using a 300-word reading passages in Dravidian languages

(Savithri & Jayaram, 2005) specifically in Kannada. The clients were instructed to comprehend the passage while reading and later questions were asked on the passage. Subsequent to speech tasks, a writing sample was collected by asking the client to write about the topic of interest. Audio- video recording of the speech sample was performed in a room with less ambient noise and visual distractions. Further, the recorded sample was analyzed based on SSI-3 and PCI domains.

Predictive Cluttering Inventory (PCI, Daly, 2006) was administered to confirm the diagnosis of Cluttering and Cluttering-Stuttering. PCI is a 7- point rating scale and consists of 33 items under different domains like, pragmatics, speech- motor, language-cognition and motor coordination- writing problems, with a total score of 198. If an individual obtain a score of 120+ indicates a diagnosis of Cluttering, scores between 80 and 120 indicates a diagnosis of Cluttering- Stuttering. Stuttering Severity Instrument-3 (SSI-3, Riley, 1994) was used to assess the severity of stuttering.

Adapted standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT- K, Vandana & Shyamala, 2011) was administered to persons with Cluttering, Cluttering-Stuttering and Stuttering. CLQT-K was used to assess cognitive-linguistic abilities of the participants. The test assesses the cognitive-linguistic performance of Kannada speaking individuals within the age range of 20-80 years on five primary domains of cognition i.e., attention, memory, executive function, language and visuospatial skills. The different tasks and the domains included under CLQT-K are provided in Table 4. The scoring procedure used to rate the performance on each task is illustrated in Table 5.

Table 4. *Major cognitive-linguistic domains of CLQT-K.*

Cognitive-linguistic domains	Tasks
Attention	Symbol cancellation, clock drawing, story retelling, symbol trails, design memory, mazes, design generation
Memory	Personal facts, clock drawing, story retelling, generative naming, design memory
Executive functions	Clock drawing, symbol trails, generative naming, mazes, design generation
Language	Personal facts, confrontation naming, clock drawing, story retelling, generative naming
Visuospatial skills	Symbol cancellation, clock drawing, symbol trails, design memory, mazes, design generation.

Each task of CLQT-K was administered one at a time as per the instruction provided in the manual. The details of the tasks are as follows:

1. ***Personal facts:*** This was tested by asking four questions related to the participants' date and place of birth, current age and address.
2. ***Symbol cancellation*****:** The participants were instructed to cross out target symbols within two minutes.
3. ***Confrontation naming:*** Ten common pictures were presented one at a time for naming. Each picture was presented for 30 seconds.
4. ***Clock drawing*****:** The participants were asked to draw a clock on a page and instructed to write all the numbers inside the circle and then set the hands to "ten minutes past eleven". Three minutes were given to complete the task.
5. ***Story retelling:*** Participants were instructed to listen to the story which is read aloud by the tester and asked to repeat the story verbatim. Later yes/no questions were asked to probe their auditory comprehension.

6. ***Symbol trail:*** The task involved drawing a single line to connect a total of 11 circles and triangles in an alternating fashion according to the size and shape beginning with the smallest circle. Three minutes were given to complete the task.
7. ***Generative naming:*** The participants were instructed to list out as many names of animals and as many words (excluding proper nouns) beginning with letter 'm' in 1 minute.
8. ***Design memory:*** Three target abstract designs were presented one at a time for memorization and the participants were instructed to identify the designs immediately from the arrays of six. 10 seconds were given for each response to each task.
9. ***Mazes:*** Two mazes at two levels of difficulty were used. The participants were instructed to trace a continuous line through the maze "alleys" without entering any dead ends or crossing any line. One minute was given for maze one and two minutes for maze two.
10. ***Design generation***: The participants were provided with four dots and four line and were instructed to construct different designs using those. A maximum time of three minutes were given for this activity.

Table 5. *Scoring procedure used to rate the performance on each task of CLQT-K.*

Task	Scoring	Maximum Score
Personal facts	2- correct, 0- incorrect	8
Symbol cancellation	Total correctly cancelled- Total incorrectly cancelled	12
Confrontation naming	1-correct, 0-incorrect	10
Clock drawing	Details mentioned in Appendix I	13
Story Retell	1-correct , 0-incorrect	7
Symbol Trails	1-correct, 0-incorrect	10
Generative naming	Correct animals and 'm' words	9
Design Memory	1-correct, 0-incorrect	6
Mazes	4 points - Maze 1 + 4 points- Maze 2 (-1: incorrect and later self corrected) 0- incorrect	8
Design Generation	1-correct design	13

Scoring and Analysis:

The audio-video recorded samples across various tasks were analyzed for stuttering and cluttering features among the participants. The mean scores obtained for the major sections and the subsections of cognitive-linguistic domains were analysed. The scores on the domains of CLQT-K for clinical group were compared within, across clinical group and with norms. Inter-test and Intra-test reliability was carried out on approximately 10 percent of the raw data randomly selected from the clinical group data sets.

Statistical analysis

The data obtained from each task of CLQT-K from all the three groups were totalled and tabulated. This data was analysed statistically using SPSS-17.0 version software. Both descriptive and inferential statistics were carried out. The following statistical analyses were used:

1) Under descriptive statistics, mean and standard deviation were measured for all the three groups: PWC, PWCS and PWS
2) Friedman non parametric test was administered for within group and across group comparison of domains of CLQT-K.
3) Non parametric Wilcoxon Signed Ranks test was used for within groups and across group comparisons.

Inter- and intra-judge reliability

Three of the total seventeen participants (one each from three clinical groups) were randomly chosen for the purpose of checking reliability. For inter-judge reliability, the cognitive-linguistic measures made by the investigator were correlated with another judge, resulting in Pearson correlations of r= 0.980. For intra-judge reliability the investigator re-analyzed the cognitive-linguistic measures on 10% of the sample and correlated, which resulted in Pearson correlations of r= 0.970.

CHAPTER IV

RESULTS

The present study aimed at investigating cognitive-linguistic abilities in PWC, PWCS and PWS. The results of the present study are discussed under six sections, which included cognitive-linguistic abilities in PWC, PWCS, PWS and comparison across the three clinical groups.

4.1 Cognitive-linguistic abilities in PWC

The five major domains of CLQT-K were compared within the group of PWC (three participants). Table 6 presents the descriptive data of the five major domains of CLQT-K obtained for the group of PWC. It can be seen that percentage score of CLQT-K domains presented the decreasing rank order for visuospatial skills, attention, executive functions, memory and language.

Table 6. *Mean % and Standard Deviation (SD) values of major domains of CLQT-K in PWC group.*

Domains of CLQT-K	Mean %	SD
Attention	84.05	5.02
Memory	74.41	6.97
Executive functions	77.98	4.74
Language	71.62	4.42
Visuospatial skills	87.63	6.51.

4.1.1 Attention in PWC

One of the major domains of CLQT-K is attention. All the seven tasks under attention domain were analysed. The tasks under attention domain are Symbol Cancellation (SC), Clock Drawing (CD), Story Retelling (SR), Symbol Trails (ST), Design

Memory (DM), Mazes (MZ) and Design Generation (DG). The data was subjected to descriptive statistical methods to obtain the mean percentage and the standard deviation. Table 7 depicts the mean % and SD values for different tasks of attention. Considering the subsections of attention, PWC group presented a decreasing rank order of performance for ST, DM, SC, MZ, CD, DG and SR. Results suggested better performance for ST and DM (100%) and poor performance for SR (52%) for PWC group.

Table 7. *Mean % and SD values for tasks of attention in PWC group.*

Subsections of attentior	Mean %	SD
SC	94.44	9.62
CD	76.91	26.64
SR	52.37	8.25
ST	100.00	0.00
DM	100.00	0.00
MZ	91.66	14.43
DG	74.35	27.01
Total attention score	84.05	5.02

Notes. Symbol Cancellation (SC), Clock Drawing (CD), Story Retelling (SR), Symbol Trails (ST), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

4.1.2 Memory functions in PWC

The next major domain of CLQT-K is memory. All the five tasks of memory domain were analysed and included: Personal Facts (PF), Clock Drawing (CD), Story Retelling (SR), Generative Naming (GN) and Design Memory (DM). Table 8 depicts the mean percentage and SD values of different tasks of memory. While comparing the subsections of memory in PWC group the decreasing rank order indicated PF, DM, CD, SR and GN. The findings indicated better performance for PF and DM (100%) and poor performance for GN (48%).

Table 8. *Mean % and SD values of tasks of memory in PWC group.*

Subsections of memory	Mean %	SD
PF	100.00	0.00
CD	76.91	26.64
SR	52.37	8.25
GN	48.14	12.82
DM	100.00	0.00
Total memory score	74.41	6.97

Notes. Personal Facts (PF), Clock Drawing (CD), Story Retelling (SR), Generative Naming (GN) and Design Memory (DM).

4.1.3 Executive function in PWC

The next major domain of CLQT-K is executive functions. All the five tasks of executive function domain were analysed and the details included: Clock Drawing (CD), Symbol Trails (ST), Generative Naming (GN), Mazes (MZ) and Design Generation (DG). Table 9 depicts the mean % and SD values of different tasks of executive functions. The comparison of subsections of executive function in PWC group indicated a decreasing rank order of ST, MZ, CD, DG and GN. The data suggested better performance for ST (100%) and reduced performance for GN (48.14%) among PWC.

Table 9. *Mean % and SD values for tasks of executive functions in PWC group.*

Subsections of executive function	Mean %	SD
CD	76.91	26.64
ST	100	0.00
GN	48.14	12.82
MZ	91.66	14.43
DG	74.35	27.01
Total executive function score	77.98	4.74

Notes. Clock Drawing (CD), Symbol Trails (ST), Generative Naming (GN), Mazes (MZ) and Design Generation (DG).

4.1.4 Language in PWC

The next major domain of CLQT-K is language. All the five tasks of language domain were analysed and related to: Personal Facts (PF), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), and Generative Naming (GN). Table 10 depicts the mean % and SD values of different tasks of language. Considering the subsections of language the decreasing rank order related to PF, CN, CD, SR and GN. The findings corresponded to better score for PF (100%) and reduced score for GN (48.14%).

Table 10. *Mean % and SD values for tasks of language in PWC group.*

Subsections of language	Mean %	SD
PF	100	0.00
CN	93.33	5.77
CD	76.91	26.64
SR	52.37	8.25
GN	48.14	12.82
Total language score	71.62	4.42

Notes. Personal Facts (PF), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), and Generative Naming (GN).

4.1.5 Visuospatial skills in PWC

The last major domain of CLQT-K is visuospatial skills. All the six tasks of visuospatial domain were analysed and included: Symbol Cancellation (SC), Clock Drawing (CD), Symbol Trails (ST), Design Memory (DM), Mazes (MZ) and Design Generation (DG). Table 11 depicts the mean % and SD values of different tasks of visuospatial skills. The decreasing rank order in performance included ST, DM, SC, MZ, CD and DG. It was observed that ST and DM demonstrated higher score (100%), while DG had lower score (73.35%) among PWC group.

Table 11. *Mean % and SD values for tasks of visuospatial skills in PWC group.*

Subsection of visuospatial skill	Mean %	SD
SC	94.44	9.62
CD	76.91	26.64
ST	100	0.00
DM	100	0.00
MZ	91.66	14.43
DG	74.35	27.01
Total visuospatial score	87.63	6.51

Notes. Symbol Cancellation (SC), Clock Drawing (CD), Symbol Trails (ST), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

4.1.6 Cognitive-linguistic abilities across PWC and normal group

The tasks of CLQT-K were compared across PWC and normal group (Standard mean value as provided in CLQT-K). Table 12 presents the descriptive data of the tasks of CLQT-K across PWC and normal population. Results suggested PWC performed within normal range for all the tasks. It can be noted from the results that as a whole group, PWC behaved in a similar way as that of normal group.

Table 12. *Mean and SD values for tasks of CLQT-K in PWC and normal group.*

Tasks of CLQT-K	PWC		Normal	
	Mean	**SD**	**Mean**	**SD**
PF	8.00	0.00	7.63	0.81
SC	11.33	1.15	10.10	3.67
CN	9.33	0.57	9.13	0.97
CD	10.00	3.46	9.60	3.55
SR	3.66	0.57	5.17	1.05
ST	10.00	0.00	4.27	3.63
GN	4.33	1.15	4.27	1.08
DM	6.00	0.00	4.63	1.01
MZ	7.33	1.15	6.10	2.42
DG	9.66	3.51	4.13	3.50

Notes. Personal Facts (PF), Symbol Cancellation (SC), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), Symbol Trails (ST), Generative Naming (GN), Design Memory (DM) Mazes (MZ) and Design Generation (DG).

4.1.7 Comparison of cognitive-linguistic abilities within PWC group

The PWC group included only three participants. The comparison of mean value obtained by each participant was contrasted with the standard norm (mean value in CLQT-K). Results indicated that all three participants performed within the normal range. Only PWC2 performed poorer in story retelling task, the participant left many keywords while retelling the story. The findings indicated that all three PWC performed similar to that of normal group in all the domains except PWC2.

4.2 Cognitive-linguistic abilities in PWS

Similar to above mentioned results the analyses were performed for the clinical group of PWS (ten participants). Table 13 presents the descriptive data of mean % and SD of the five major domains of CLQT-K. It can be seen that percentage score of CLQT-K

domains is greater in language, followed by memory, visuospatial skills, attention and executive functions.

Table 13. *Mean % and SD values for major domains of CLQT-K in PWS group.*

Major domains of CLQT-K	Mean %	SD
Attention	69.70	14.61
Memory	74.41	10.34
Executive functions	64.33	14.76
Language	77.44	8.69
Visuospatial skills	70.47	14.62

4.2.1 Attention in PWS

All the seven tasks under attention domain were analysed for PWS group. Table 14 depicts the mean % and SD values of different tasks of attention. Considering the subsections of attention, PWS group presented a decreasing rank order of performance for MZ, DM, SC, CD, ST, SR and DG. Results suggested better performance for MZ (93.75%) and poor performance for DG (38.45%) for PWS group.

Table 14. *Mean % and SD values for tasks of attention in PWS group.*

Subsections of attention	Mean %	SD
SC	82.49	24.04
CD	72.30	17.08
SR	67.13	20.25
ST	68.00	36.14
DM	84.99	14.59
MZ	93.75	15.86
DG	38.45	22.35
Total attention score	69.70	14.61

Notes. Symbol Cancellation (SC), Clock Drawing (CD), Story Retelling (SR), Symbol Trails (ST), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

4.2.2 Memory functions in PWS

The five tasks under memory domain were analysed for PWS group. Table 15 depicts the mean % and SD values of different tasks of attention. Considering the subsections of memory, PWS group presented a decreasing rank order of performance for PF, DM, CD, SR and GN. Results suggested better performance for PF (92.50%) and poor performance for GN (59.99%) for PWS group.

Table 15. *Mean % and SD values for tasks of memory in PWS group.*

Subsections of memory	Mean %	SD
PF	92.50	12.07
CD	72.30	17.08
SR	67.13	20.25
GN	59.99	14.99
DM	84.99	14.59
Total memory score	74.41	10.34

Notes. Personal Facts (PF), Clock Drawing (CD), Story Retelling (SR), Generative Naming (GN) and Design Memory (DM).

4.2.3 Executive function in PWS

The five tasks under executive function domain were analysed for PWS group. Table 16 depicts the mean % and SD values of different tasks of executive function. Considering the subsections of executive function, PWS group presented a decreasing rank order of performance for MZ, CD, ST, GN and DG. Results suggested better performance for MZ (93.75%) and poor performance for DG (38.45%) for PWS group.

Table 16. *Mean % and SD values for tasks of executive functions in PWS group.*

Subsections of executive function	Mean %	SD
CD	72.30	17.08
ST	68.00	36.14
GN	59.99	14.99
MZ	93.75	15.86
DG	38.45	22.35
Total executive function score	64.33	14.76

Notes. Clock Drawing (CD), Symbol Trails (ST), Generative Naming (GN), Mazes (MZ) and Design Generation (DG).

4.2.4 Language in PWS

The five tasks under language domain were analysed for PWS group. Table 17 depicts the mean % and SD values of different tasks of executive function. Considering the subsections of language, PWS group presented a decreasing rank order of performance for CN, PF, CD, SR and GN. Results suggested better performance for CN (95%) and poor performance for GN (59.99%) for PWS group.

Table 17. *Mean % and SD values for tasks of language in PWS group.*

Subsections of language	Mean %	SD
PF	92.50	12.07
CN	95.00	5.27
CD	72.30	17.08
SR	67.13	20.25
GN	59.99	14.99
Total language score	77.44	8.69

Notes. Personal Facts (PF), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), and Generative Naming (GN).

4.2.5 Visuospatial skills in PWS

The six tasks under visuospatial skill domain were analysed for PWS group. Table 18 depicts the mean % and SD values of different tasks of visuospatial skill. Considering the subsections of visuospatial skill, PWS group presented a decreasing rank order of performance for MZ, DM, SC, CD, ST and DG. Results suggested better performance for MZ (93.75%) and poor performance for DG (38.45%) for PWS group.

Table 18. *Mean % and SD values for tasks of visuospatial skills in PWS group.*

Subsections of visuospatial skill	**Mean %**	**SD**
SC	82.49	24.04
CD	72.30	17.08
ST	68.00	36.14
DM	84.99	14.59
MZ	93.75	15.86
DG	38.45	22.35
Total visuospatial skill score	70.47	14.62

Notes. Symbol Cancellation (SC), Clock Drawing (CD), Symbol Trails (ST), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

4.2.6 Comparison of major sections of CLQT-K in PWS group

The Friedman non-parametric test was administered for within group comparison of the major domains of CLQT-K in PWS group (ten participants). The results revealed significant difference [χ^2 (4) = 12.56, p <0.05] across the domains in PWS. The non parametric Wilcoxon Signed Ranks test was used to determine the pair-wise comparisons within the domains of CLQT-K. The results revealed significant difference, across attention in comparison to executive functions (/z/ = 2.19; p <0.05), language (/z/ = 2.29; p <0.05); across memory in comparison to executive functions (/z/ = 2.49; p <0.05),

language (/z/ = 2.49; p <0.05); across executive functions in comparison to language (/z/ = 2.70; p < 0.05), visuospatial skills (/z/ = 2.34; p < 0.05); across language in comparison to visuospatial skills (/z/ =1.98; p < 0.05). Table 19 depicts the results of Wilcoxon Signed Ranks test with respect to major domains of CLQT-K in PWS. The findings revealed that language was significantly different from all major domains. PWS scored higher in language when compared to attention, memory, executive functions and visuospatial skills. In addition, executive functions varied significantly from attention, memory language and visuosaptial skills. PWS scored lower in executive functions when compared to attention, memory, language and visuospatial skills. Visuospatial skills varied significantly from language and executive functions. PWS scored higher in visuospatial skills when compared to executive functions and lower when compared to language.

Table 19. *Results of Wilcoxon Signed Ranks test with respect to major domains of CLQT-K in PWS.*

Comparisons	**/z/**	**p**
Attention-Memory	1.47	0.13
Attention-Executive functions	2.19	0.02*
Attention-Language	2.29	0.02*
Attention-Visuospatial skills	0.25	0.79
Memory-Executive functions	2.49	0.01*
Memory-Language	2.49	0.01*
Memory-Visuospatial skills	1.27	0.20
Executive functions-Language	2.70	0.00*
Executive functions-Visuospatial skills	2.34	0.01*
Language-Visuospatial skills	1.98	0.04*

Notes. * = significant at 0.05 level.

4.2.7 Cognitive-linguistic abilities across PWS and normal group

The tasks of CLQT-K were compared across PWS and normal group. Table 20 presents the descriptive data of the tasks of CLQT-K across PWS and normal group. Results suggested PWC performed all the tasks within normal range.

Table 20. *Mean and SD values for tasks of CLQT-K in PWS and normal group.*

Tasks of CLQT-K	**PWS**		**Normal**	
	Mean	**SD**	**Mean**	**SD**
PF	7.40	0.96	7.63	0.81
SC	9.99	2.88	10.10	3.67
CN	9.50	0.52	9.13	0.97
CD	9.40	2.22	9.60	3.55
SR	4.70	1.41	5.17	1.05
ST	6.80	3.61	4.27	3.63
GN	5.40	1.34	4.27	1.08
DM	5.10	0.87	4.63	1.01
MZ	7.50	1.26	6.10	2.42
DG	5.00	2.90	4.13	3.50

Notes. Personal Facts (PF), Symbol Cancellation (SC), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), Symbol Trails (ST), Generative Naming (GN), Design Memory (DM) Mazes (MZ) and Design Generation (DG).

4.2.8 Comparison of cognitive-linguistic abilities within PWS group

The comparison of cognitive-linguistic domains suggested varied findings between the participants of PWS group. In a total of thirteen designs (DG task) the participants PWS1, PWS4 and PWS8 could draw only two, one and one designs respectively. PWS5 and PWS6 in story re-telling task left out several key words and scored poor. PWS10 performed poorer in personal facts and symbol cancellation. In personal facts the participant was unable to answer his date of birth and his address correctly. In symbol cancellation the participant missed few target symbols.

4.3 Cognitive-linguistic abilities in PWCS

Results for mean % and SD of the five major domains of CLQT-K were analysed for the group of PWCS (four participants). Table 21 presents the descriptive data of the five major domains of CLQT-K. It can be seen that percentage score of CLQT-K domains is greater for language, followed by memory, visuospatial skills, attention and executive functions.

Table 21. *Mean % and SD values of major domains of CLQT-K in PWCS.*

Domains of CLQT-K	**Mean %**	**SD**
Attention	55.79	21.48
Memory	66.27	9.58
Executive functions	53.77	13.65
Language	72.33	4.91
Visuospatial skills	56.04	21.89

4.3.1 Attention in PWCS

The scores obtained for the seven subsections under attention domain were analysed for the group of PWCS. Table 22 depicts the mean % and SD values of different tasks of attention. Considering the subsections of attention, PWCS group presented a decreasing rank order of performance for MZ, DM, CD, SC, SR, ST and DG. Results suggested better performance for MZ (75%) and poor performance for DG (28.84%) for PWCS group.

Table 22. *Mean % and SD values for tasks of attention in PWCS group.*

Subsections of attention	Mean %	SD
SC	56.24	41.59
CD	67.30	17.05
SR	53.56	17.97
ST	52.50	33.04
DM	70.83	28.46
MZ	75.00	22.82
DG	28.84	29.70
Total attention score	55.79	21.48

Notes. Symbol Cancellation (SC), Clock Drawing (CD), Story Retelling (SR), Symbol Trails (ST), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

4.3.2 Memory functions in PWCS

The scores obtained for the five subsections under memory domain were analysed for the group of PWCS. Table 23 depicts the mean % and SD values of different tasks of memory. Considering the subsections of memory, PWCS group presented a decreasing rank order of performance for PF, DM, CD, SR and GN. Results suggested better performance for PF (87.50%) and poor performance for GN (52.77%) for PWCS group.

Table 23. *Mean % and SD values for tasks of memory in PWCS group.*

Subsections of memory	Mean %	SD
PF	87.50	10.20
CD	67.30	17.05
SR	53.56	17.97
GN	52.77	18.97
DM	70.83	28.46
Total memory score	66.27	9.58

Notes. Personal Facts (PF), Clock Drawing (CD), Story Retelling (SR), Generative Naming (GN) and Design Memory (DM).

4.3.3 Executive function in PWCS

The scores obtained for the five subsections under executive function domain were analysed for the group of PWCS. Table 24 depicts the mean % and SD values of different tasks of executive function. Considering the subsections of executive function, PWCS group presented a decreasing rank order of performance for MZ, CD, GN, ST and DG. Results suggested better performance for MZ (75%) and poor performance for DG (28.84%) for PWCS group.

Table 24. *Mean % and SD values for tasks of executive functions in PWCS group.*

Subsections of executive function	**Mean %**	**SD**
CD	67.30	17.05
ST	52.50	33.04
GN	52.77	18.97
MZ	75.00	22.82
DG	28.84	29.70
Total executive function score	53.77	13.65

Notes. Clock Drawing (CD), Symbol Trails (ST), Generative Naming (GN), Mazes (MZ) and Design Generation (DG).

4.3.4 Language in PWCS

The scores obtained for the five subsections under language domain were analysed for the group of PWCS. Table 25 depicts the mean % and SD values of different tasks of language. Considering the subsections of language, PWCS group presented a decreasing rank order of performance for CN, PF, CD, SR and GN. Results suggested better performance for CN (97.50%) and poor performance for GN (52.77%) for PWCS group.

Table 25. *Mean % and SD values for tasks of language in PWCS group.*

Subsections of language	**Mean %**	**SD**
PF	87.50	10.20
CN	97.50	5.00
CD	67.30	17.05
SR	53.56	17.97
GN	52.77	18.97
Total language score	72.33	4.91

Notes. Personal Facts (PF), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), and Generative Naming (GN).

4.3.5 Visuospatial skills in PWCS

The scores obtained for the six subsections under visuospatial skill domain were analysed for the group of PWCS. Table 26 depicts the mean % and SD values of different tasks of visuospatial skill. Considering the subsections of visuospatial skill, PWCS group presented a decreasing rank order of performance for MZ, DM, CD, SC, ST and DG. Results suggested better performance for MZ (75%) and poor performance for DG (28.84%) for PWCS group.

Table 26. *Mean % and SD values for tasks of visuospatial skills in PWCS group.*

Subsections of visuospatial skill	Mean %	SD
SC	56.24	41.59
CD	67.30	17.05
ST	52.50	33.04
DM	70.83	28.46
MZ	75.00	22.82
DG	28.84	29.70
Total visuospatial skill score	56.04	21.89

Notes. Symbol Cancellation (SC), Clock Drawing (CD), Symbol Trails (ST), Design Memory (DM), Mazes (MZ) and Design Generation (DG).

4.3.6 Comparison of major sections of CLQT-K domains within group of PWCS

The Friedman non-parametric test was administered for within group comparison of the major domains of CLQT-K. The results revealed no significant difference [χ^2 (4) = 7.800, p >0.05] across the domains in PWCS. The findings evidenced almost similar performance by PWCS as a group while comparing the major domains of CLQT-K.

4.3.7 Cognitive-linguistic abilities across PWCS and normal group

The tasks of CLQT-K were compared across PWCS and normal group. Table 27 presents the descriptive data of the tasks of CLQT-K across PWCS and normal group. Results suggested PWC performed all the tasks within normal range. Further analyses of only mean scores (if SD is not considered) it can be observed from table 27 that 50% of the cognitive-linguistic domains are lowered compared to normal. The tasks with reduced mean score included SC, SR, DM, MZ and DG among PWCS group.

Table 27. *Mean and SD values for tasks of CLQT-K in PWCS and normal group.*

Tasks of CLQT-K	**PWCS**		**Normal**	
	Mean	**SD**	**Mean**	**SD**
PF	7.00	0.81	7.63	0.81
SC	6.75	4.99	10.10	3.67
CN	9.75	0.50	9.13	0.97
CD	8.75	2.21	9.60	3.55
SR	3.75	1.25	5.17	1.05
ST	5.25	3.30	4.27	3.63
GN	4.75	1.70	4.27	1.08
DM	4.25	1.70	4.63	1.01
MZ	6.00	1.82	6.10	2.42
DG	3.75	3.86	4.13	3.50

Notes. Personal Facts (PF), Symbol Cancellation (SC), Confrontation Naming (CN), Clock Drawing (CD), Story Retelling (SR), Symbol Trails (ST), Generative Naming (GN), Design Memory (DM) Mazes (MZ) and Design Generation (DG).

4.3.8 Comparison of cognitive-linguistic abilities within PWCS group

The performance of all the four participants varied across the domains of CLQT-K. The participant PWCS2 showed normal score for all the cognitive-linguistic domains, remaining three participants exhibited poor performance on few domains. PWCS1 performed poorer in personal facts where the participant was unable to tell complete address. PWCS3 performed poorer in tasks like story retelling and generative naming. In story retelling the participant left out several keywords. In generative naming the participant could name animals up to eighteen numbers, moreover the words beginning from /m/ were numbered up to four. PWCS4 performed poorer in tasks like symbol cancellation, story retelling, design memory and design generation. In symbol cancellation the participant cancelled other symbols and missed many target symbols hence scored zero. In story retelling the participant left out several keywords. In design memory the participant got confused between designs of same pattern. In design generation the participant was unable to draw designs and scored zero. Hence, these findings suggested that PWCS4 exhibited greater cognitive-linguistic deficits compared to other three participants.

4.4 Cognitive-linguistic abilities between PWC and PWS.

The performance on the major domains of CLQT-K was analysed and compared between the two groups, PWC and PWS. Figure 1 represents the findings of major domains of CLQT-K, which indicates PWC scored greater in visuospatial skills, attention and executive functions and similar scores for memory and lesser score for language across PWS.

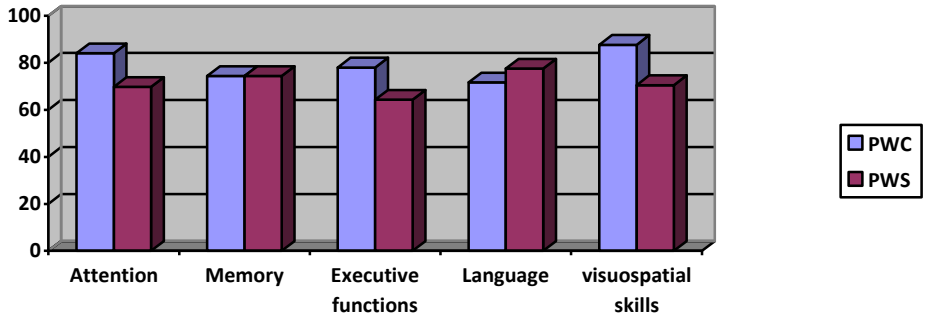

Figure 1. Comparison of CLQT-K domains across PWC and PWS

Figure 2 illustrates the findings within attention domain of CLQT-K which indicates PWC scores as greater in ST, DM, CD, SC and DG tasks and lesser score in SR and MZ across PWS.

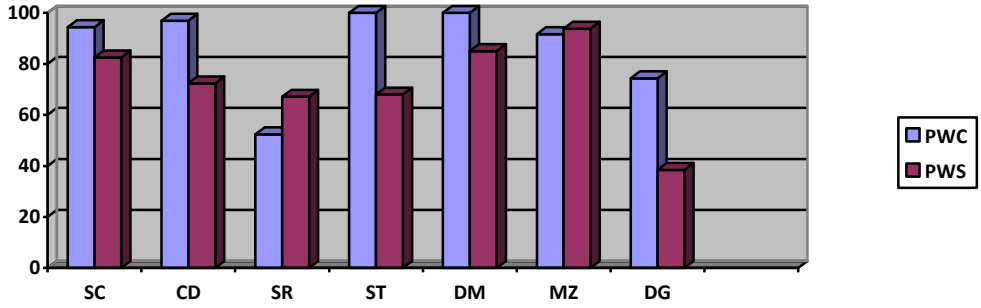

Figure 2. Comparison of attention domain across PWC and PWS

Figure 3 represents the findings within memory domain of CLQT-K which indicates PWC scores as greater in DM, PF and CD tasks and poor in SR and GN tasks compared to PWS.

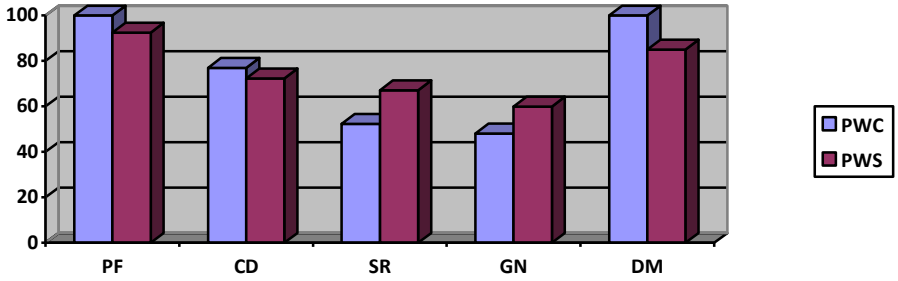

Figure 3. Comparison of memory domain across PWC and PWS

Figure 4 represents the findings within executive functions domain of CLQT-K which indicates PWC scores as greater in ST, MZ, CD and DG tasks and poor in GN task compared to PWS.

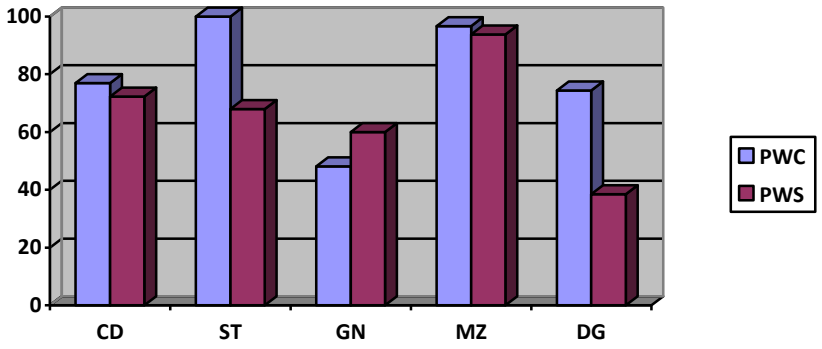

Figure 4. Comparison of executive functions domain across PWC and PWS

Figure 5 depicts the findings within language domain of CLQT-K which indicates PWC scores as greater in PF, CN and CD tasks and poor in SR and GN tasks compared to PWS.

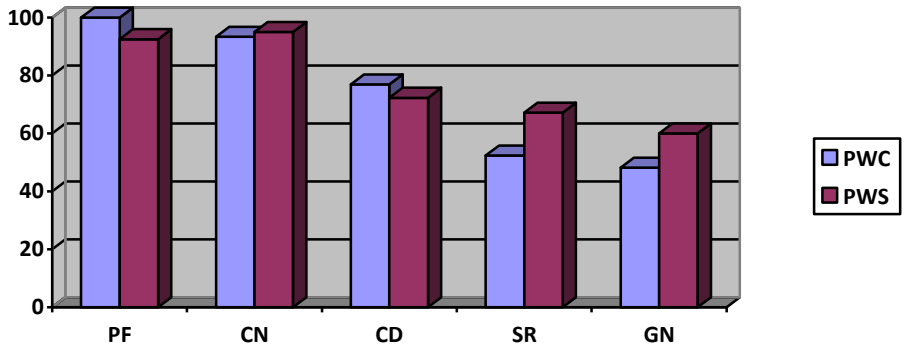

Figure 5. Comparison of language domain across PWC and PWS

Figure 6 represents the findings within visuospatial skills domain of CLQT-K which indicates PWC scores as greater in ST, DM, SC, MZ, CD and DG tasks compared to PWS.

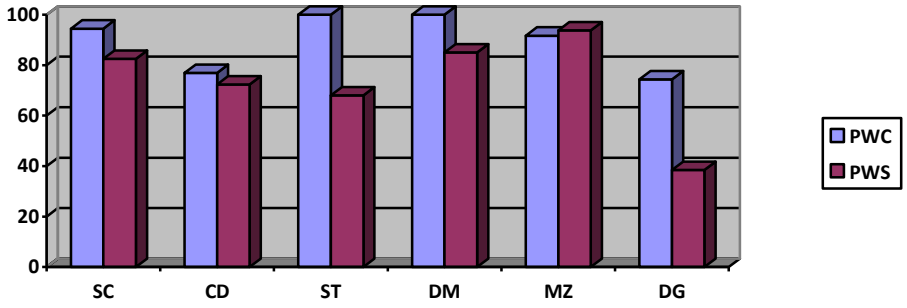

Figure 6. Comparison of visuospatial skills domain across PWC and PWCS

4.5 Cognitive-linguistic abilities between PWC and PWCS

Considering the reduced sample size of PWC and PWCS the comparisons across the CLQT-K domains is performed descriptively. The performance on the major domains of CLQT-K were analysed and compared between the two groups, PWC and PWCS. Figure 7 represents the findings of major domains of CLQT-K, which indicates PWC scored greater in visuospatial skills, attention, executive functions and memory domains and lesser scores for language across PWCS.

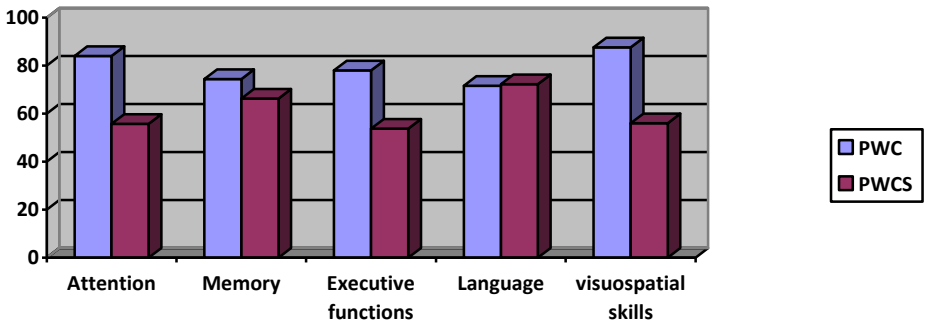

Figure 7. Comparison of CLQT-K domains across PWC and PWCS

Figure 8 represents the findings within attention domain of CLQT-K which indicates PWC scores to be greater in ST, DM, CD, SC, MZ and DG tasks and slightly lesser score in SR across PWCS.

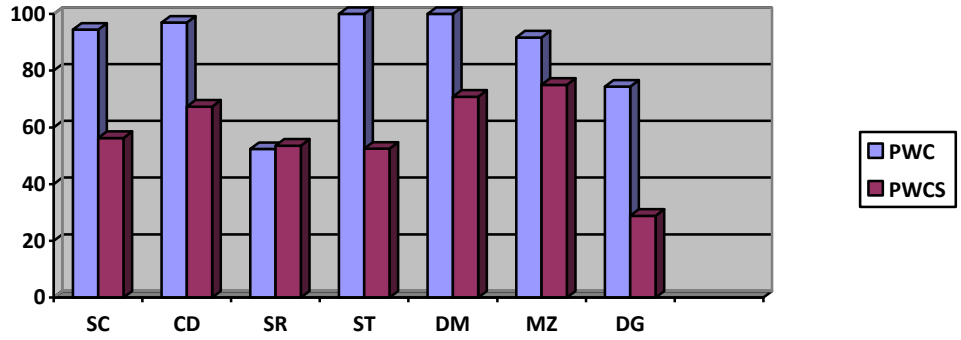

Figure 8. Comparison of attention domain across PWC and PWCS.

Figure 9 represents the findings within memory domain of CLQT-K which indicates PWC scores to be greater in DM, PF and CD tasks and poor in SR and GN tasks compared to PWCS.

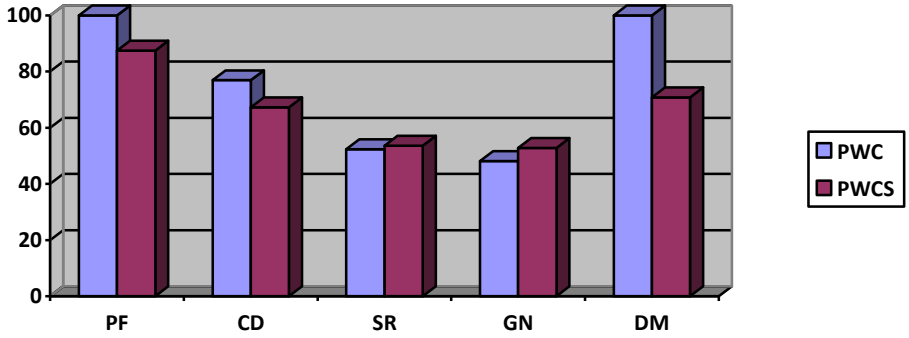

Figure 9. Comparison of memory domain across PWC and PWCS

Figure 10 depicts the findings within executive functions domain of CLQT-K which indicates PWC with greater scores in ST, MZ, CD and DG tasks and poor in GN task compared to PWCS.

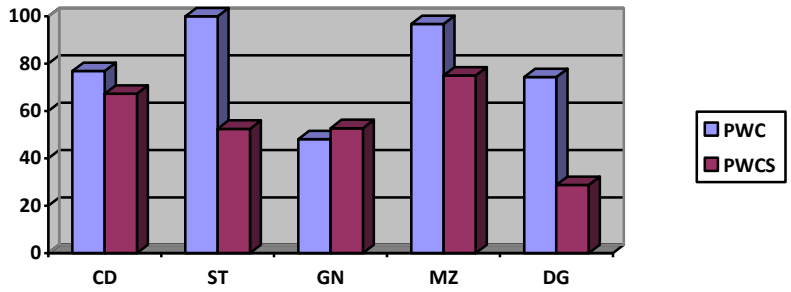

Figure 10. Comparison of executive functions domain across PWC and PWCS

Figure 11 represents the findings within language domain of CLQT-K which indicates PWC who score greater in PF, CN and CD tasks and poor in SR and GN tasks compared to PWCS.

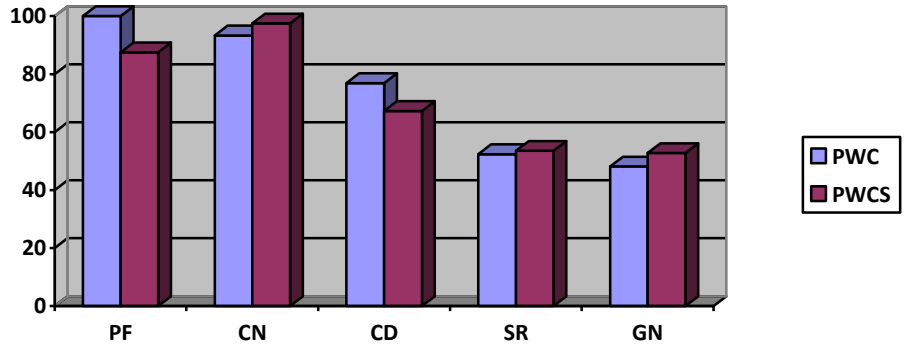

Figure 11. Comparison of language domain across PWC and PWCS

Figure 12 represents the findings within visuospatial skills domain of CLQT-K which indicates PWC with greater score in ST, DM, SC, MZ, CD and DG tasks compared to PWCS.

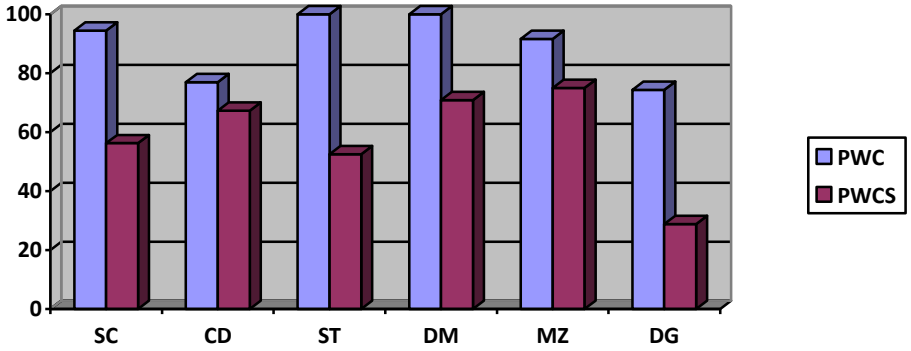

Figure 12. Comparison of visuospatial skills domain across PWC and PWCS

4.6 Cognitive-linguistic abilities between PWCS and PWS

The performance on the major domains of CLQT-K was analysed and compared between the two groups, PWCS and PWS. Figure 13 represents the findings of major domains of CLQT-K, which indicates PWS scored greater in language, memory, visuospatial skills, attention and executive functions when compared to PWCS.

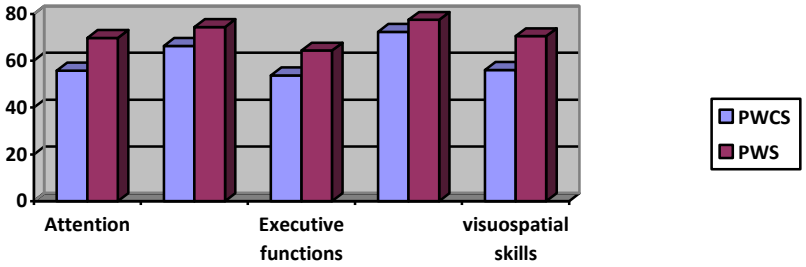

Figure 13. Comparison of CLQT-K domains across PWCS and PWS

Figure 14 represents the findings within attention domain of CLQT-K which indicates PWS scored greater in MZ, DM, SC, CD, SR, ST and DG in comparison with PWCS.

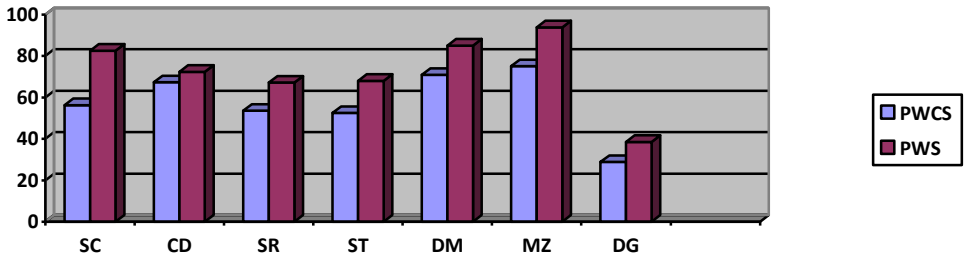

Figure 14. Comparison of attention domain across PWCS and PWS

Figure 15 represents the findings within memory domain of CLQT-K which indicates PWS scored greater in PF, DM, CD, SR and GN compared to PWCS.

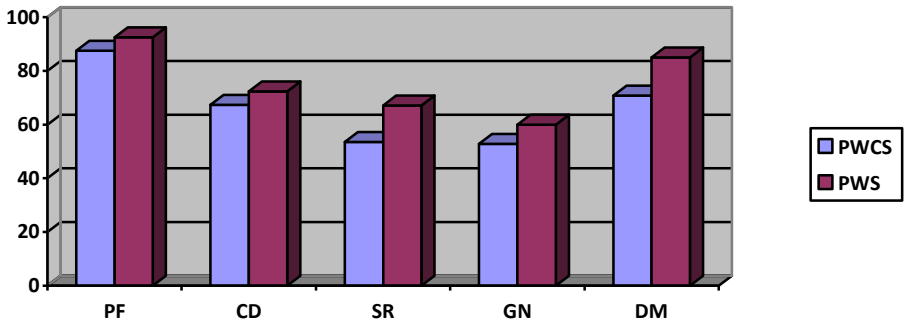

Figure 15. Comparison of memory domain across PWCS and PWS

Figure 16 represents the findings within executive functions domain of CLQT-K which indicates PWS scored greater in MZ, CD, ST, GN and DG compared to PWCS.

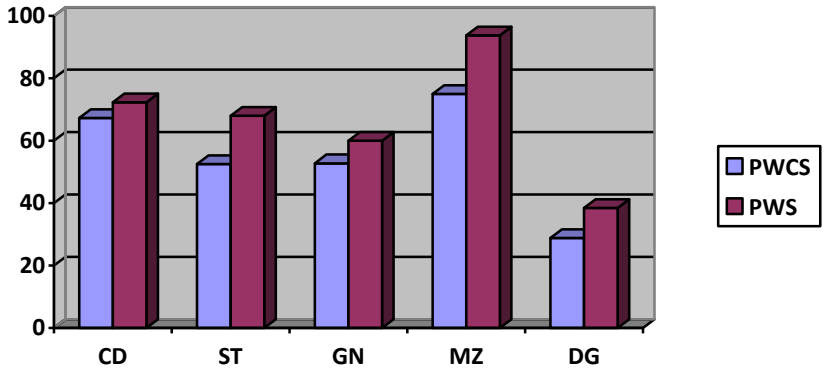

Figure 16. Comparison of executive functions domain across PWC and PWS

Figure 17 represents the findings within language domain of CLQT-K which indicates PWS scored greater in PF, CD, SR and GN tasks and poor in CN task compared to PWCS.

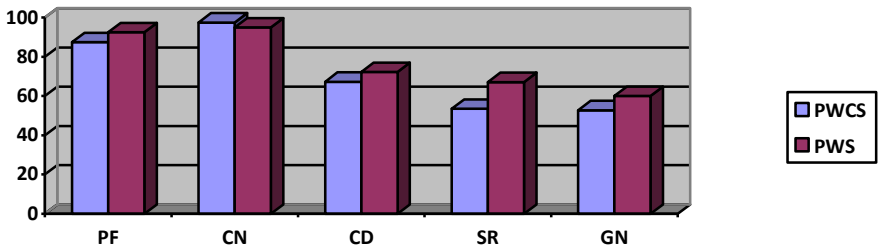

Figure 17. Comparison of language domain across PWCS and PWS

Figure 18 represents the findings within visuospatial skills domain of CLQT-K which indicates PWS scored greater in MZ, DM, SC, CD and ST and poor in DG task compared to PWCS.

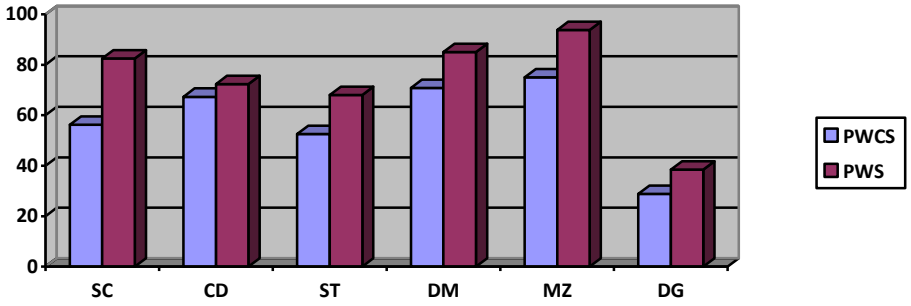

Figure 18. Comparison of visuospatial skills domain across PWCS and PWS

The Friedman non-parametric test was administered for across group comparison of the major domains of CLQT-K in PWCS and PWS. The results revealed significant difference [χ^2 (4) = 20.114, p< 0.05] across PWCS and PWS. The non-parametric Wilcoxon Signed Ranks test was used to determine the pair-wise comparison within the domains of CLQT-K across PWCS and PWS. The results revealed significant difference across attention in comparison to executive functions (/z/ = 2.10; p < 0.05) and language (/z/ = 2.66, p < 0.05); across memory in comparison to executive functions (/z/ = 3.04; p < 0.05) and language (/z/ = 3.11; p < 0.05); across executive functions in comparison to language (/z/ = 3.23; p < 0.05) and visuospatial skills (/z/ = 2.32; p < 0.05); across language in comparison to visuospatial skills (/z/ = 2.48; p < 0.05). Table 28 depicts the results of Wilcoxon-Signed Ranks test for CLQT-K domains across PWCS and PWS. The findings revealed language and executive functions were significantly different from other major domains. Higher scores were obtained in language when compared to attention, memory, executive functions and visuospatial skills among both the groups. In addition, executive functions varied significantly from attention, memory language and visuospatial

skills. Lower scores were obtained in executive functions when compared to attention, memory, language and visuospatial skills among both the groups. Visuospatial skills varied significantly from language and executive functions. Higher score in visuospatial skills were obtained when compared to executive functions and lower when compared to language across both the groups.

Table 28. *Results of Wilcoxon-Signed Ranks test for CLQT-K domains across PWCS and PWS.*

Comparisons	**/z/**	**p**
Attention-Memory	1.85	0.06
Attention-Executive functions	2.10	0.03*
Attention-Language	2.66	0.00*
Attention-Visuospatial skills	0.50	0.61
Memory-Executive functions	3.04	0.00*
Memory-Language	3.11	0.00*
Memory-Visuospatial skills	1.66	0.09
Executive functions-Language	3.23	0.00*
Executive functions-Visuospatial skills	2.32	0.02*
Language-Visuospatial skills	2.48	0.01*

*Notes. * = significant at 0.05 level.*

4.7 Summary of the results

All the three groups PWC, PWS and PWCS (mean performance of each group) performed within normal range when compared with norms of CLQT-K. Among PWC, all three participants performed within the normal range, except PWC2 who performed poorer in story retelling task which indicates difficulty in domains like attention, memory and language. Among PWS, mean performance of all the ten participants were within the normal range. PWS1, PWS4 PWS8 scored poorer in design generation. PWS5 and PWS6 scored poorer in story re-telling task. PWS10 performed poorer in personal facts and symbol cancellation which indicates difficulty in all the major domains such as: attention,

memory, executive functions, language and visuospatial skills. Among PWCS, mean performance of all the four participants were within the normal range however individual variability persisted. PWCS1 performed poorer in personal facts. PWCS3 performed poorer in tasks like story retelling and generative naming. PWCS4 performed poorer in tasks like symbol cancellation, story retelling, design memory and design generation which indicates difficulty in all the major domains such as: attention, memory, executive functions, language and visuospatial skills. Across PWC and PWS, PWC scored greater in visuospatial skills, attention and executive functions and similar scores for memory and lesser score for language in comparison with PWS. Across PWC and PWCS, PWC scored greater in visuospatial skills, attention, executive functions and memory domains and lesser scores for language compared with PWCS. Across PWCS and PWS, PWS scored greater in language, memory, visuospatial skills, attention and executive functions compared to PWCS.

CHAPTER V

DISCUSSION

The present study aimed at investigating cognitive-linguistic abilities in PWC, PWS and PWCS. The results revealed several points of interest.

5.1 Cognitive-linguistic abilities in PWC

The five major domains of CLQT-K were compared within the group of PWC (three participants). It was found that PWC group scored high in visuospatial skills and scored lower in language domain of CLQT-K. The percentage score of CLQT-K domains presented the rank order for visuospatial skills, attention, executive functions, memory and language. Comparing the mean scores of major domains with norms, the participants performed well within the normal range. Only PWC2 performed poorer in story retelling task, where the participant left many keywords while retelling the story, which indicates difficulty in domains like attention, memory and language. In agreement with the present study the researchers found similar results in PWC. In Ward's (2006, 2011b) classification of linguistic cluttering, PWC finds difficulty in organising speech while retelling stories and exhibits word finding difficulties. Van Zaalen, Wijnen and Dejonckere (2011) also support the presence of linguistic type of cluttering. Various researchers like Wiess (1964); Moore and Haynes (1980); St. Louis et al. (1985); Daly (1992); Daly and Burnett (1996, 1999); Daly and Cantrell (2006); Ward (2006, 2011b); Van Zaalen et al. (2009, 2011); Furness and Ward (2011) also found deficit in language in support of the speculation of linguistic deficit in PWC. Contradicting to above mentioned findings, Boyle and Woolfson (1996) found no deficit in linguistic aspects in PWC. However, their study was a single case study hence it is difficult to generalize the finding of no linguistic deficit in PWC.

Weiss (1964); Daly and Burnett (1999); Aparna and Rajasudhakar (2007) found reduced attention span in PWC. Daly and Burnett (1999) found deficit in memory. Other aspect like pragmatics was also affected in PWC where Teigland (1996); Daly and Burnett (1999); Van Zaalen et al. (2011) found more of pragmatic errors which leads to linguistic breakdowns which are due to word finding difficulty or due to problems in forming grammatical utterances. Heitmann et al. (2004) found deficit in executive functions among PWC. However, the findings cannot be generalized as the study considered only three participants with diagnosis of cluttering.

As cluttering is considered as "central language imbalance", to investigate neural basis in cluttering, various studies have been conducted where the researchers found disturbances in different regions of brain. Seeman (1970), Lebrun (1996) found disturbance in basal ganglia circuitry and, Alm (2010) reported disinhibition or premature release of the signals in basal ganglia. Alm (2011) further suggested disruption in the medial wall of the left frontal lobe. Ward, Connally, Pliatsika, Furness and Watkins (2015) found greater activity in cortical regions like, medial surface (left pre-supplementarymotor area), anterior cingulated cortex (ACC) on medial wall, and several regions in lateral premotor cortex (pre and post central gyri) bilaterally and subcortical regions in striatum (head of caudate nucleus and putamen) of basal ganglia bilaterally. In addition reduced activity in lateral anterior cerebellum bilaterally was also evidenced. The brain areas described as abnormally active in adults who clutter have been in regions associated with motor planning (preSMA), motor execution (SMA, premotor and sensorimotor cortex and putamen, cerebellum), linguistic selection and cognitive control (caudate nucleus and ACC). There was additional overactivity in adults who clutter in two areas outside this network, namely, the right superior temporal sulcus and right angular gyrus. Activity in

these regions is not strongly associated with language processing, though they are commonly activated in the left hemisphere during multisensory speech perception and in reading.

5.2 Cognitive-linguistic abilities in PWS

The five major domains of CLQT-K were compared within the group of PWS (ten participants). It was found that PWS group scored high in language and scored lower in executive functions domain within the domains of CLQT-K. The percentage score of CLQT-K domains presented the rank order for language, memory, visuospatial skills, attention and executive functions. Comparing the mean scores of major domains with norms, the participants performed well within the normal range. However, few participants performed poorer for some of the tasks. In a total of thirteen designs (DG task) the participants PWS1, PWS4 and PWS8 could draw only two, one and one designs respectively. PWS5 and PWS6 in story re-telling task left out several key words and scored poor. PWS10 performed poorer in personal facts and symbol cancellation. In personal facts the participant was unable to answer his date of birth and his address correctly, probably due to increased anxiety. In symbol cancellation the participant missed few target symbols. The results indicate difficulty in all the major domains such as: attention, memory, executive functions, language and visuospatial skills. In agreement with the present study the researchers found similar results in PWS. PWS exhibits deficits in language processing (Moore & Haynes, 1980). Desynchronization in speech plan can happen due to processing deficit at semantic (Wingate, 1988; Bosshardt, 1993; Bosshardt & Fransen, 1996) or phonological level (Wingate, 1988; Postma & Kolk, 1993; 1997) in PWS. Longer processing time was noted in an ‘‘outer’’ cognitive control loop according to Nudelman et al. (1992). Anderson and Conture (2000); Byrd and Cooper (1989); Murray

and Reed (1977) and St Louis and Hinzman (1988) found CWS performed poor in receptive and expressive language, have more immature language (Howell & Au- Yeung, 1995; Wall, 1980), poor grammar (Westby, 1974), have reduced abilities to plan, or retrieve sentence level units of speech (Anderson & Conture, 2004; Cuadrado & Weber-Fox, 2003). Deficit in linguistic processing speed in CWS was reported by Anderson and Wagovich (2010). Bosshardt (2006) found greater sustained attention processing in PWS. The author suggested that PWS reduce the amount of conceptual work in order to reduce the difficulty with fluency. Further, it was concluded that in PWS the neural system related to speech planning is less adaptable. Kamhi and McOsker (1982) found PWS devote more attention to speech tasks. Attention deficit was also reported in CWS by Anderson and Wagovich (2010) and Heitmann et al. (2004). Carpenter and Sommers (1987) found poor performance in auditory recall task who suggested that PWS use right hemisphere for word recall. Reilly and Donaher (2005) concluded that the presence of slower speech rate actually affects the verbal working memory in CWS. Deficits in phonological working memory were found by Anderson and Wagovich (2010) and Bajaj et al. (2004) in CWS.

The neural correlates of stuttering were investigated by various researchers. Chang et al. (2008); Beal et al. (2013) found less gray matter volume in the left and right inferior frontal gyri in CWS. Specifically, in the left inferior frontal, less gray matter volume was found in the pars opercularis, pars triangularis and pars orbitalis. In the right inferior frontal gyrus less gray matter volume was found in the pars opercularis and pars triangularis. In contrast, Beal et al. (2007) and Lu et al. (2010) found to have more gray matter volume in adults with stuttering (AWS) in the left inferior frontal gyrus as well as the bilateral pre and post central gyri, superior temporal gyri, middle temporal gyri, basal ganglia and cerebellum. On the other hand Kell et al. (2009) and Lu et al. (2010) found

less gray matter volume in the left inferior frontal gyrus, left superior frontal gyrus as well as the bilateral middle frontal gyri, cerebellar posterior lobes, dorsal part of medulla and the cerebellar tonsil. Researchers hypothesized varying thickness in cortical region across life span in PWS. Beal, Lerch, Cameron, Henderson, Gracco and De Nil (2015) evidenced absence of gradual thinning of gray matter across lifespan in PWS where there was abnormality seen in the developmental trajectory of gray matter in left pars opercularis. In PWS reduced left-hemisphere activation of the auditory cortex was found by Bhatnagar and Buckingham (2010); Brown, Ingham, Laird, & Fox (2005); De Nil et al. (2008) and Fox et al. (1996) also found hyperactivity in right primary and premotor cortex in both speech tasks. Meanwhile, Chang, Kenney, Loucks, and Ludlow (2009) found activation in the same regions for non speech tasks. Increased cerebellar activation was found by Brown et al. (2005); De Nil, Kroll and Houle (2001); and Fox et al. (1996). Reduced gray and white matter density in auditory cortex was found by Beal, Gracco, Lafaille and De Nil (2007) and Lu et al. (2010). Increased activation levels in right-hemisphere inferior frontal cortex by De Nil et al. (2008), specifically in the frontal operculum (Neumann et al., 2003). De Nil et al. (2000) found an increased activation in left anterior cingulate cortex, which may be either a direct neural correlate underlying stuttering or reflective of cognitive anticipatory reactions. For lexical retrieval and semantic access, activation in middle temporal lobe in PWS was evidenced by Fiez, Raichle, Balota, Tallal and Petersen (1996). For semantic reading, activation in the triangular part of the inferior frontal gyrus has been found by Friederici, Opitz and von Cramon (2000). For phonological encoding Palumbo, Alexander and Naeser (1992) found activation in the supramarginal gyrus. The brain areas described as abnormally active in PWS have been in regions associated with motor execution (right primary and premotor cortex), linguistic selection and cognitive control (left anterior cingulated cortex).

5.3 Cognitive-linguistic abilities in PWCS

Similarly the five major domains of CLQT-K were compared within the group of PWCS (four participants). It was found that PWCS group scored high in language and scored lower in executive functions domain when it was compared within the domains of CLQT-K. The percentage score of CLQT-K domains presented the rank order for language, memory, visuospatial skills, attention and executive functions. Comparing the mean scores of major domains with norms, the participants performed well within the normal range. However, majority of PWCS did obtain lower score in few of the tasks. PWCS1 performed poorer in personal facts where the participant was unable to tell complete address. PWCS3 performed poorer in tasks like story retelling and generative naming. In story retelling the participant left out several keywords. In generative naming the participant could name animals' up to eighteen numbers, moreover the words beginning from /m/ were numbered up to four. PWCS4 performed poorer in tasks like symbol cancellation, story retelling, design memory and design generation. In symbol cancellation the participant cancelled other symbols and missed many target symbols hence scored zero. In story retelling the participant left out several keywords. In design memory the participant got confused between designs of same pattern. In design generation the participant was unable to draw designs and scored zero. The results indicate difficulty in all the major domains such as: attention, memory, executive functions, language and visuospatial skills. In agreement with the present study the researchers found similar results in PWCS where deficit in language was seen by William and Wener (1996). A neurological correlate in PWCS suggests greater activity in the right ventral premotor cortex and in right ACC (Ward, Connally, Pliatsika, Furness & Watkins, 2015).

5.4 Cognitive-linguistic abilities across clinical groups

The clinical groups PWC, PWS, and PWCS were compared for cognitive-linguistic domains on CLQT- K. On comparing the two groups, PWC and PWS it was found that PWC scored greater in visuospatial skills, attention and executive functions and similar scores for memory and lesser score for language compared to PWS. The findings indicated a definite language deficit in cluttering as reported by St. Louis et al. (1985); Van Zaalen et al. (2009, 2011); Furness and Ward (2011). In addition, PWS performed poorly on the cognitive domains compared to cluttering. Heitmann et al. (2004) also found deficit in focused attention in PWS than compared to PWC. Meyer and St. Louis (1992) reported that PWC have a better capability to sustain attention than PWS, it can be due to that PWC manage better under pressure and also they are unconcerned with their speech problems. However, these findings should be considered with caution as the sample size of PWC was only limited to 3 participants.

On comparing the other groups, PWC and PWCS the participants of PWC scored greater in visuospatial skills, attention, executive functions and memory domains and lesser scores for language compared to PWCS. As mentioned earlier even in these groups, the findings indicated a definite language deficit in pure cluttering as reported in literature. Also, PWCS performed poorly on the cognitive domains compared to cluttering. The probable reason for PWCS to perform poorly on cognitive aspects could be due to increased anxiety and tension which is associated with stuttering. However, these findings should be considered with caution as the sample size of PWC and PWCS were 3 and 4 respectively.

Lastly, on comparing the PWCS and PWS groups, the participants of PWS had better performance in language, memory, visuospatial skills, attention and executive functions in comparison with PWCS. This poorer performance in PWCS are supported by various researchers on neural deficit and evidence abnormal activities in the brain regions such as in caudate nucleus and ACC which controls the linguistic and cognition in PWCS (Ward et al., 2015).

To summarize, the present study indicate that one of the participant with cluttering had difficulty in attention, memory and language and it has been supported by various authors and also researchers found the neural regions that are impaired which could result in deficits in those domains. Similarly 50% of the PWS group also had deficit in attention, memory, executive functions, language and visuospatial skills. This has also been supported by studies and also found the neural deficits which has been proven by various researchers. Along with this, the present study also investigated deficit in PWCS where deficits were seen in domains like: attention, memory, executive functions, language and visuospatial skills. In 75% of the participants considered across the clinical groups behaved differently for the major and subsections of CLQT-K. A detailed analysis indicated that the scores varied as normal, low and high for the tasks considered under CLQT-K. Various studies have evidenced the neural deficits in these clinical groups in support of the present findings, on comparing the PWC and PWS, PWC performed poor in language compared to PWS, but performed better in attention domain. While, PWC and PWCS were compared, PWC scored poor in language and better in attention than PWCS. Also while, PWCS and PWS were compared, PWS performed better in language and attention than PWCS.

To conclude, the present study highlights the fact that few participants among PWC, PWS and PWCS group evidenced cognitive-linguistic deficits. However, the findings should be considered with caution due to limited sample size of PWC and PWCS. In addition the heterogeneity of the participants across the clinical groups also needs to be considered. Inspite of such limitation, the present study used an objective standardized tool to assess cognitive-linguistic domains in persons with fluency disorders which is relatively rare research. Cluttering being a perplexing disorder such research may upgrade the state of knowledge about the disorder.

CHAPTER VI

SUMMARY AND CONCLUSION

One of the highlight of literature represents deficits in cognitive-linguistic aspects in fluency disorders, cluttering and stuttering. There is a paucity of data on cognitive-linguistic functions in PWC, PWS and PWCS in Indian scenario. Meanwhile, the results obtained from the western studies cannot be generalized to Indian context. However, there are limited investigations on this area and most of the studies defined cluttering and stuttering symptoms based on their observations and with specified tests which could list only few deficits in some of the domains. Also, there is scarcity in the objective tool which could asses both cognitive and linguistic aspects in PWC, PWS and PWCS. Hence, there is a need to study the cognitive-linguistic abilities in PWC, PWS and PWCS using an objective tool specifically in the Indian context.

The present study aimed to investigate cognitive-linguistic abilities using adapted and standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT- K, Vandana & Shyamala, 2011). The specific objective was to compare cognitive-linguistic abilities within and across clinical groups (PWC, PWCS and PWS) and also to compare the findings of clinical group with literature. The group of seventeen number of Kannada speaking individuals in the age range of 18-40 years, clinically diagnosed as cluttering, cluttering-stuttering and stuttering by the speech-language pathologist were considered for the study. The participants were divided into three groups. Group 1 included three PWC; group 2 included four PWCS and group 3 consisted of ten PWS.

Adapted standardized version of Cognitive Linguistic Quick Test in Kannada (CLQT-K, Vandana & Shyamala, 2011) was administered to PWC, PWS and PWCS. CLQT-K was used to assess cognitive-linguistic abilities of the participants. The test assesses the cognitive-linguistic performance of Kannada speaking individuals within the age range of 20-80 years on five primary domains of cognition i.e., attention, memory, executive function, language and visuospatial skills through ten different tasks incorporating the different cognitive processes. The clinical group underwent a series of procedures to confirm the diagnosis after which CLQT-K was administered. After the scoring of each task the data was subjected to different statistical analysis using SPSS version 17 software. The mean and standard deviation was computed. The mean values were subjected to different non parametric statistical procedures such as Friedman and Wilcoxon Signed Ranks test.

The results revealed that all the three groups PWC, PWS and PWCS performed within normal range when compared with norms of CLQT-K. However, due to feature of heterogeneity it was found that few participants in different clinical groups performed poorer in few tasks. Within the group of PWC, only PWC2 performed poorer in story retelling task which indicates difficulty in domains like attention, memory and language. Within the group of PWS, PWS1, PWS4 and PWS8 scored poorer in design generation, PWS5 and PWS6 scored poor in story re-telling task, PWS10 performed poorer in personal facts and symbol cancellation which indicates difficulty in all the major domains such as: attention, memory, executive functions, language and visuospatial skills. Within PWCS, PWCS1 performed poorer in personals facts, PWCS3 performed poorer in tasks like story retelling and generative naming, PWCS4 performed poorer in tasks like symbol cancellation, story retelling, design memory and design generation which indicates difficulty in all the major domains such as: attention, memory, executive functions,

language and visuospatial skills. Across PWC and PWS, PWC scored greater in visuospatial skills, attention and executive functions and similar scores for memory and lesser score for language compared to PWS. Across PWC and PWCS, PWC scored greater in visuospatial skills, attention, executive functions and memory domains and lesser scores for language in comparison with PWCS. Across PWCS and PWS, PWS scored greater in language, memory, visuospatial skills, attention and executive functions against PWCS. When compared across PWC and PWS, PWC performed poor in language compared to PWS, but performed better in attention domain. When PWC and PWCS were compared, PWC scored poor in language and better in attention than PWCS. When PWCS and PWS were compared, PWS performed better in language and attention than PWCS. Hence it can be concluded that in all three clinical groups PWC, PWS and PWCS, some of the participants exhibited deficit in cognitive-linguistic aspects.

Due to limited sample size of the participants, descriptive statistics was performed for PWC group. Along with limited sample size and heterogeneity in the characteristics of the participants significant difference was not found within group and PWCS. Significant difference was found only within the group of PWS and across the group of PWCS and PWS, while comparing cognitive-linguistic domains of CLQT-K. The results further indicated the need for comprehensive assessment of those presenting with such complex fluency disorder. Cluttering being a perplexing disorder such research may upgrade the state of knowledge about the disorder.

Implications of the study

The results of the present study provide an insight into the cognitive-linguistic abilities in PWC, PWS and PWCS. The results throw light on the possible inclusion of cognitive-linguistic abilities, along with the traditional assessment tools to assess PWC, PWS and PWCS. It emphasizes the importance of including cognitive-linguistic abilities along with fluency aspects during the development of treatment plans for PWC, PWS and PWCS. The knowledge of the cognitive and linguistic aspects in speech-language pathologist is absolutely necessary during counselling.

Limitations of the study

- Sample size for PWC and PWCS group was limited.
- Different severities of stuttering were included, as mechanism underlying stuttering may vary in each severity.
- Under PWCS variations were found with respect to cluttering and stuttering aspects, where few had more of cluttering characteristics and few with more stuttering symptoms.
- Mean performance of all the group were within the normal range in all tasks of CLQT-K which indicates that CLQT-K may not be much sensitive in assessing cognitive-linguistic abilities in PWC, PWS and PWCS.
- Though CLQT-K assesses both cognitive and linguistic domains but the tasks are more of non linguistic type. Other cognitive-linguistic test called CLAP in Kannada would provide information on linguistic task emphasizing more on verbal information.

Future directions

The present study is a preliminary attempt towards understanding the cognitive-linguistic abilities in PWC, PWS and PWCS. More sensitive test in assessing cognitive-linguistic abilities can be taken up to assess cognitive-linguistic abilities in PWC, PWS and PWCS group. More Indian studies in this area need to be explored. Larger sample within different clinical groups with fluency disorders can be considered and studied. As CLQT-K has norms for wider age range (20-40 years, 40-60 years and 60-80 years) if that is reduced it will help to check for the sensitivity within ages. Appropriate treatment plan can be done based on the cognitive-linguistic deficit.

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APPENDIX I

Scoring for clock drawing test

(CLQT-K, Vandana & Shyamala, 2011)

1. **How many numbers are present? Are they legible in context?**

   3= Numbers 1-12 are present with no perseverated or extra numbers

   2= At least one of the following is present

   - Only 6 to 11 correct numbers present.
   - One or more numbers higher than the number 12 is present in addition to 6 to 12 correct numbers.
   - 6 to 12 correct numbers are present, with one or more numbers perseverated.

   1= Only 1 to 5 correct numbers perseverated

   0= No correct numbers presented

2. **Does the clock show 12 and only 12 of something?**

   1= The clock is divided by 12 of something (e.g.; numbers, hands, dots)

   0= One of the following is present

   - The clock is divided by less than 12 of something.
   - The clock is divided by more than 12 of something (perseveration, extra numbers).

3. **Are the numbers oriented correctly for reading vs. rotated?**

   1= 0 to 2 numbers are rotated.

   0= 3 or more numbers are rotated.

4. **Are the numbers spaced correctly?**

   1= The numbers 12, 3, 6 and 9 are in the correct places and the other numbers are reasonably well spaced.

   0= numbers are poorly spaced.

5. **Are the numbers inside the circle arranged in a circular pattern?**

   1= Numbers are arranged in a circular pattern inside the circle. One or two numbers may stay from a circular pattern, but no numbers or less than half of any number is placed outside the circle.

   0= At least one of the following is present.

   - No circle arrangement of numbers is evident.
   - Three or more numbers stay from a circular pattern.
   - At least of one or more numbers is placed outside the circle.
   - One or more numbers is placed outside the circle.

6. **Are the numbers presented clockwise?**

   1= All numbers written are clockwise around the clock

   0= At least one of the following is present

- Numbers are counter clockwise.
- Numbers are in a random arrangement.
- Numbers are in columns.

7. **How many hands are there?**

   1= Two hands are present

   0= At least one of the following is present

   - No hands are present.
   - Only one hand is present.
   - More than two hands are present (No penalty for a “seconds” hand).

8. **What lengths are the hands?**

   1= A distinguishable long hand and short hand are present

   0= At least one of the following is present

   - Equal size hands are present.
   - Only one hand is present.
   - More than two hands are present (No penalty for a “seconds” hand).

9. Where do the hands originate?

1= Hands (or a single hand if only one hand is present) emanate from the center of the circle, or within ½ inch from the center of the circle. Hands (if more than a single hand) touch, or come within ½ inch of touching at the point of origin.

0= At least one of the following is present

- Hands originate more than ½ inch from the center.
- Hands are separated by more than ½ inch at the point of origin.
- No hands are present.

10. Where do the hands point?

1= One hand is pointing to 11 and the hand is pointing to 2, or one two-directional hand is pointing to 11 and 2.

0= At least one of the following is present

- One or more hands is not pointing to 11 and 12.
- No hands are present.
- More than two hands are present (No penalty for a "seconds" hand).

11. Do the hands tell the correct time?

1= The short hand points to 11 and the long hand points to 2

0= At least one of the following is present

- One or more hands does not point to the correct number.

- Equal size hands are present.
- No hands are present.
- Only one hand is present.
- More than two hands are present (No penalty for a “seconds” hand).

Maximum score = 13