Research Article

Discourse and Working Memory in Conduction Aphasia-A case study

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Abstract

This case study describes the language processing difficulties exhibited by the case with conduction aphasia with respect to the deficits in working memory capacity and discourse ability. The case presented here is the 33-year old right-handed female, who started exhibiting aphasic features following craniotomy for the anaplastic oligodendroglioma. In this case study, the medical report is presented first followed by the description of cognitive-linguistic deficits. The tasks used in this case study were narrative discourse task and working memory tasks such as, forward span task, backward span task and N-back tasks. These tasks were used to assess the cognitive-linguistic ability of the case presented here. The deficit exhibited by the case at the level of working memory was explained with the help of Allan Baddley's Working Memory Model. Where, this case demonstrated impairment at phonological storage or articulatory rehearsal with reference to the cognitive ability. The discourse deficits were observed only at propositional aspect with poor local coherence and good global coherence when compared to the non-propositional aspects of narrative discourse. The contributing factor for these cognitive communicative deficits would be the aphasic errors like perseveration and phonemic paraphasias. The coherence violation observed could be attributed to the patient's overt and covert attempt to use certain adaptive strategy to compensate for micro and macro-structural deficits. The same is discussed in this case study in detail.

Introduction

Working memory (WM) is one cognitive system believed to be involved with language processing in aphasia. A number of researchers have reported that deficits in memory capacity add to language processing difficulties in individuals with conduction aphasia (Wright, Newhoff, Downey, & Austermann, 2003). The relative preservation of comprehension in conduction aphasia with certain degree of circumlocution often engenders a self-critical attitude toward paraphasic output and, consequently, a halting quality in spontaneous speech. There is a disassociation between articulatory gesture and sound images resulting in repetition difficulty in spontaneous speech known as the disconnection syndrome. This repetition impairment is attributed to the disruption of word concept or inner speech (Benson, Sheremata et al., 1973) consequent to the lesion in arcuate fasciculus. This supports the evidence of impairment of the phonological component of speech production (Luria, Sokolov, & Klimkowski, 1967).

The presence of auditory-verbal short-term memory impairment in aphasic subjects with preserved perceptual and output mechanisms as the basis for repetition impairment was proposed by Warrington and her colleagues (Warrington, Logue & Pratt, 1971). Thus, repetition deficit in aphasia could be attributed to working memory disorder rather than attributing to linguistic processes alone.

The concept of WM has been well defined in the Model of Working Memory with first two components (phological loop and visuospatial sketch pad) and dependent on third component (central executive system). The additional component was the episodic buffer (Baddeley, 2000) (Figure 1), to explain the concept of chunks, similarity between chunks and to what extent phonological loop is used for remembering nonverbal material such as music and other environmental sounds. The "episodic buffer" acts as a backup storage and thus interacts with short-term memory, long-term memory, and working memory. Therefore, in conduction aphasia, the impaired storage capacity of the phonological loop is primarily related to the working memory deficits manifested at language level (Gvion & Friedmann, 2012; Wright & Shishler, 2005). There is a need to replicate similar studies in Indian context and develop a reliable working memory assessment tool which can be used in any clinical setup. The resulting outcomes of such studies may address the association and/or the correlation between linguistic processing deficits (aphasia

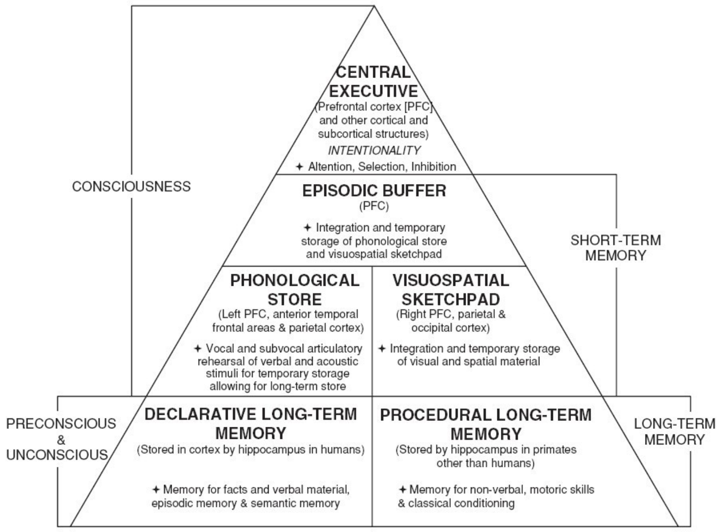

Figure 1: Schematic representation of Working Memory Model (Baddeley, 2000)

symptoms) and the cognitive deficits in individuals with conduction aphasia. Understanding the impact of cognitive deficit on communication and its role in language processing deficits in aphasia is also studied by Wright et al. (2003). Conversely, many tasks of memory and attention that have been developed for individuals with aphasia have been created with high linguistic load, posing greater contribution of phonological, semantic, and/or lexical processing to follow the task instructions and/or give a response. Consequently, interpretation of the results for these tasks is restricted. For example, whether the observed deficit is due to a linguistic processing problem or a discourse or cognitive domain deficit is still questionable. Hence, in the present study the linguistic processing ability is checked at the level of discourse and the cognitive processing ability at working memory task discretely. Interpretation of these results separately would describe if any association exist between the two skills.

To find the relationship between narrative discourse production and working memory in individuals with closed head injury, Youse and Coelho (2005) considered fifty-five native speakers of English in the age range of 16-69 with closed head injury (CHI). The narrative samples (story generation- The Runway & story-retelling- Bear and the Fly picture story) were subjected to T-unit analysis and cohesion analysis. For WM assessment, subtests from the Wechsler Memory Scale (WMS) such as digit span, logical memory and associative learning were administered. The results revealed significant correlation between measures of narrative discourse and working memory. The higher scores in working memory measures were associated with better discourse production abilities. In their extended study, the Daneman and Carpenter's Reading Span task is considered as the stronger measure of working memory because this task requires both processing of information following the storage.

For processing different types of linguistic information in participants with aphasia (nine in number) a study was attempted to investigate the working memory and examine whether a relationship exists between auditory comprehension measures and working memory (Wright, Downey, Gravier, Love & Shapiro, 2007). They administered 2 level n-back tasks (level 1 & 2), each tapping SemBack (semantic level), PhonoBack (phonological level) and SynBack (syntactic level) type of linguistic information. Participants' performance was better on SemBack task compared to SynBack task and PhonoBack; however, differences were not statistically significant. The clinical features of language deficit exhibited by the patients would depend upon the underlying impairment in the working memory ability. Hence their findings strengthen the evidence that in an individual with aphasia a working memory deficit may contribute to the language-processing difficulties.

Studies have reported an association between repetition and Auditory and Verbal Short-Term Memory (AVSTM) and others have reported dissociation between both. The latter one was studied by Attout, Van der Kaa, George, and Majerus (2011) who developed the task for language and STM processing through retention of the item versus order information task in the immediate serial recall. Here, language processing is linked with retention of items and STM is linked with order information. They reported two case studies with a conflicting pattern of performance in the given task. One case with a mild phonological impairment performed poorly on item recall and the other case with no residual language impairment exhibited the opposite pattern. Their study strengthens the importance and the challenge in teasing out verbal and STM component in a verbal

STM task.

It is also observed that the individuals with aphasia have deficits in cognitive system (for example, WM) which impacts their language sources which are not noticed or predicted from routine aphasia batteries (Christensen & Wright, 2010). Under executive functions, the task related to working memory is one of the most typical examples. Many studies have investigated the role of Executive Function (EF) in successful communication, particularly at conversation level in individuals with aphasia (Penn, Frankel, Watermeyer, & Russell, 2010). Therefore the conversational success depends not on language ability but on EF as well. There exist a separate role for inhibition and working memory (component of EF) in discourse features according to Penn et al. (2010). These EF components are important for effectively generating self repair to error correction or planning and monitoring any individuals communicative performance which includes shifting between communication strategies to successfully convey information (Ramsberger, 2005), maintaining focus and initiating new topics.

Mayer and Murray (2012) have explored the influence of domain-specific (language) factors and domain-general (age, reaction time, WM load) in n-back task. Individuals with aphasia were significantly more affected by increasing WM load with significantly greater WM accuracy for nameable versus non-nameable stimuli when compared to the controls. RT effects were in consensus to accuracy data, whereas age effects were not parallel across tasks. Hence, n-back task holds well in measuring WM for adults with aphasia and can quantify to clinical population.

Need of the study

Different discourse genres have its own clinical implication in the assessment of linguistic functions of aphasic population apart from the routine standardized language assessment. Efficient production of discourse depends on a myriad of cognitive functions working in concert to process, store and manipulate information. Reliance over any one task will limit our knowledge about the underlying cognitive abilities which are very much important for a proper linguistic functioning. Deficits in working memory will limit the efficiency with which individuals with aphasia comprehend and produce the discourse. It is, therefore, reasonable to assume that impairments in working memory will also reduce the efficiency and overall organization of language production. Hence, knowledge of the relationship between cognitive deficits and discourse production may assist clinicians in developing more effective diagnostic and treatment plan for individuals with aphasia (Youse & Coelho, 2005). In the present study, the linguistic encoding task would be the narrative discourse task and recall of information on STM would be the N-back task. The study highlights whether the repetition error in conduction aphasia is due to the linguistic deficit or working memory impairment. A relatively pure case of conduction aphasia is presented in the following section in the form of a case report study.

Method

Participant

Ms. A was a 33-year old right-handed female, a bilingual speaker of Kannada (L1) and English (L2) with the graduation in Biotechnology. She worked as a system engineer for over two years. Ms. A reported with complaints of left temporal headache, left temporal eyelid sharp pain with burning sensation, progressive memory disturbance, headache, vomiting and double vision. All peripheral motor, sensory and cerebellar exams were found to be normal on clinical examination. The clinical impression made after the neuro-imaging procedures (MRI) was Left frontal-temporal anaplastic oligodendroglioma. MMSE (Mini- Mental Status Examination) score obtained was 26/30. Ms. A was conscious, alert and oriented on examination of higher mental function. Ms. A underwent left frontotemporal craniotomy and near total decompression of high-grade glioma. The tumor was solid cystic, yellowish grey and moderately vascular, diffusely infiltrating. Following the surgical treatment, the patient was under antibiotics, antiepileptics, drugs to reduce oedema, and other supportive measures.

The surgery rendered her aphasic. She also developed seizures and memory difficulties as documented by the neurosurgeon. After a 6-month post-operative period, the same neurosurgeon referred the client to a Speech-Language Pathologist at All India Institute of Speech and Hearing (AIISH) for a detailed investigation. All the evaluations were done in her native language Kannada (L1). Ms A was pre-morbidly literate and the medium of instruction was Kannada. Hence Kannada version of Western Aphasia Battery (K-WAB) (Shyamala & Ravikumar, 2008) was administered and an aphasia quotient (AQ) score of 0.5 was obtained. The impression made was global aphasia. Ms. A attended speech therapy sessions at her native place, after which she reported back to AIISH (after 8 months). At this second time of the investigation, her speech was fluent and occasionally interrupted with circumlocutions, word-finding pauses and literal or verbal paraphasias. The K-WAB was re-administered and Ms. A obtained an AQ score of 42.4 and was diagnosed with conduction aphasia. She obtained a score of 8 for naming, 16 for spontaneous speech, 11 for repetition and 7.4 for comprehension. During the assessment of discourse under the sub-section of spontaneous speech, Ms. A was partially organized with respect to the overall plan, but the verbal output was confusing due to the repetition errors, phonemic paraphasias, and grammatical errors, which were present occasionally. Coherence violations were present especially at local coherence and she demonstrated good communication intent and maintained a good eye contact. Her comprehension of conversation, including discussion of relatively complex ideas, was good, though she made occasional errors with words in isolation, particularly colors, numbers and body parts. Many paralexic errors were seen in reading task which was very laborious. Several spelling errors and paraphasic substitutions were seen on spontaneous writing task. Furthermore, her repetition was marked by an overt rehearsal which was audible and filled with literal paraphasias; she could repeat monosyllabic high-frequency words correctly, the frequency of paraphasic errors increased with increase in syllable length. This observation is in support with the study by Strub and Gardner (1974). Similar errors were seen in confrontation naming as well, she displayed occasional phonemic and semantic substitutions (paraphasias) and circumlocutions. Arithmetic skills w.r.t simple additions, subtractions, multiplications, and divisions was assessed. Ms. A was able to do simple additions and subtractions, but refused to do the rest. When shifting from one task to the next, Ms. A exhibited perseveratory behaviors such as adding when she was supposed to divide the digits.

Stimulus material and procedure

1. Working Memory (WM)

The Software used in the study was "Cognitive Module" (Kumar & Sandeep, 2012) to assess WM in individuals with and without aphasia. Working memory capacity has been conceptualized as a single "resource" pool for attention, linguistic, and other executive processing (Just & Carpenter, 1992). The WM assessment includes N-Back task, Forward Span Task (FST) and Backward Span Task (BST). This requires the participants to hold the set of items presented in their memory and then recall a previously presented item that is related to the current item.

Procedure (1)- Working Memory assessment: In forward and backward visual span task, the client with conduction aphasia had to view the visual stimulus (pictures) presented on the computer screen, remember this set of separately presented pictures and then had to recall the individual pictures after each set of pictures. Pictures to be remembered were concrete and phonologically simple words. The task was to recall by selecting the three target visual stimuli presented in the specific sequence (forward and backward) amongst the given multiple-choice arrays. Items recalled after the time limit was scored as incorrect responses. The indicator for the WM capacity was the storage score (accuracy and reaction time).

In the N-back task, a judgement had to be made as to whether the presented stimulus matched with the one that was presented 'n' places previously in a sequence (Illustrated in Figure 2). Prior to the experimental n-back tasks, Ms. A had to attempt trials for 0-, 1-, and 2-back conditions initially in order to ensure that she understood the instructions. This would facilitate her to perform with reference to the actual instruction (Emphasizing both speed and accuracy) and not on speculation in the actual task. The actual task minimized the possible effects of auditory comprehension deficits in the participant by including both demonstration and pictured examples.

The software was loaded in a laptop and the same was used for the N-back task. Each stimulus in the N-back task was displayed for 900 ms and an inter-stimulus interval of 1600 ms. This relatively rapid presentation rate was chosen to discourage attempts to covertly verbalize the linguistic stimuli (note that it was expected that participants would covertly verbalize the nameable stimuli). The participant was seated at a comfortable distance from the screen and dominant hand was rested on the keyboard. The participant was instructed to click on the left part of the mouse whenever the target stimulus was seen. For WM tasks, participant was given 3 trials for each level across all the tasks. Accuracy score was determined by 1 and 0. Correct performance with a score of 3 out of 3 trials was considered as an accurate re-

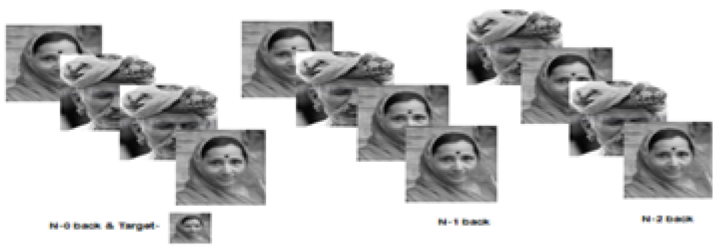

Figure 2: Schematic representation of the N-back tasks at 0-, 1-, and 2-back levels

sponse and a score of one is provided for accurate responses. A score of zero is provided when the subject makes an incorrect response for any one of the three trials.

The length of each n-back sequence was varied automatically by the software according to WM load. There was 'n' of trials specified (Example: 1-back to 8-back) and when individuals performed well in the task, level of stimulus presented was increased. Thus, the data of the participant was then examined manually to record the reaction times (RT) associated with correct and wrong responses.

2. Discourse

The discourse was assessed using a standardized "Discourse Analysis Scale" (DAS) (Hema & Shyamala, 2013) for narration task.
Procedure (2)-Narrative Discourse Assessment: To obtain discourse samples of narration, a neutral topic like "Journey to a place" was given to the participant and was instructed 'to imagine his/her past/future journey to a place and narrate the same in past or future tense. Only few neutral prompts like "ok", "yes", 'then' and 'later' in Kannada language was used only for one time in the context where the participant showed aphasia symptoms. The narrative discourse sample of the participant was video recorded and transcribed verbatim. The sample was 16 minutes long and the discourse involving both the speaker (participants) and listener (investigator) was transcribed. The DAS analyzed the discourse samples qualitatively using a perceptual rating scale. It consists of a set of parameters and a list of skills under each parameter. Each skill was rated separately, and a final index was obtained for them. The parameters of propositional and non-propositional aspects have been described and statements have been framed to rate them. The (three-point perceptual) rating scale consisted of uniform rating of 0, 1 and 2 where '0' represented the behaviors that were poor, '1' represented behaviors that were fair (at least 50% of the time there is a positive response) and '2' when the behaviours were good. Thus, total scores of the Discourse Analysis Scale (DAS) for narration could be obtained. These total scores of DAS for this task have been further divided into two sub-levels, the propositional and non-propositional total. The same DAS was administrated for Ms. A in her native language and thus, the scores were obtained for narration task.

Results

Performance of Ms. A in WM task

From Table 1, it is clear that the ability to retain more than two items (level) correctly was impaired grossly. Ms. A exhibited accurate response at a lower level and inaccurate response at a higher level with greater reaction time in both forward and backward span task. The above observations with reference to the levels and reaction time could be attributed to the phonological storage or articulatory rehearsal being impaired in an individual with aphasia. This reduced score in Ms. A suggests that reduced working memory capacity is likely to have central executive and attentional component in addition to impairments in the phonological loop.

Table 1: Reaction time and Accuracy score for Forward and Backward visual span task

Working Memory Tests	Level	RT (in msec)	Accuracy score
Forward Span	1	1200	1
Task (FST)	2	13100	1
	3	16100	0
Backward Span	1	4100	1
Task (BST)	2	5250	0
	3	6100	0
N Back task	1	NA	100%

Note: Accuracy score for FST and BST is numerical but for N back it is in percentage

Performance of Ms. A in narrative discourse

Ms. A obtained a score of 16 out of 42 under propositional aspects and 6 out of 10 under non-propositional aspects of narrative discourse with the discourse quotient of 42 as seen in Table 2.

Table 2: Parameters of Narrative Discourse

Parameters of Narrative Discourse	Scores
Propositional aspects	
Discourse structure	1
Communication Intent	4
Coherence	1
Topic Management	5
Other discourse parameters	3
Speech related parameters	2
Propositional aspects Total	**16/42**
Non-propositional Aspects	
Revision behavior	1
Repair Strategy	5
Non-propositional Aspects Total	**42/52**

Discussion

The study revealed some findings of interest which have been discussed below under different subsections.

Performance on working memory task

Ms. A had a pronounced difficulty in performing the working memory task. Ms. A was overtly rehearsing the names of items presented on the screen, which was audible to the examiner in spite of relative rapid presentation rate chosen to discourage this attempt to covertly verbalize the linguistic stimuli. Her overt rehearsal of names of visual stimuli was filled with literal paraphasias and perseveration. The consequence of this erroneous rehearsal was reflected in the selection of items in the response window as well, during which she was not able to recall or select the items in both forward and backward span task. This deficit exhibited by Ms. A can be explained with the help of Allan Baddeley's Working Memory Model (Baddeley & Hitch, 1974) at the level of phonological storage or articulatory rehearsal.

Therefore, the impairment exhibited by Ms. A could be allocated to the phonological loop. The phonological loop could be divided into two subcomponents, a temporary storage system, and a subvocal rehearsal. The temporary storage system is responsible for retaining memory traces for over a matter of seconds; the traces could decay unless rehearsed by the second component. Hence the subvocal rehearsal is not only very important to retain information within the store, but also to register visual information within the store. Ms. A exhibited marked impairment in recalling the names of visually presented items during the WM task because of literal paraphasias and repetition impairment. Since the articulatory rehearsal itself was impaired, the subvocal rehearsal system could not retain the information within the temporary storage system which caused decay of visual images in the system. Hence, the corresponding result of WM performance is also poor on forward, backward and n-back visual span task. Though this task requires the subject to retain the sequences of images for immediate recall either in forward or backward depending on the task, despite their visual presentation, subjects often subvocalize them and hence their retention had to depend crucially on their phonological or acoustical characteristics. The visual images in the task consisted of a peacock, cake, fan, glasses, octopus, palm, star, sun and the letter Y. Neither of these words is phonologically or semantically related to each other, hence we can rule out the influence of semantic or phonological similarity effect.

Support for these findings comes from studies that have compared patients with left hemisphere lesions to neuro-typical individuals. Patients with left hemisphere lesion performed significantly poorer on verbal memory and spatial memory tasks than the neurotypical individuals (Caspari, Parkinson, LaPointe, & Katz, 1998). Similar results which support the differences in working memory capacity between individuals with aphasia and neuro-typical individuals using tasks like forward and backward digit span, word span, the N-back task and judgement task have also been reported (Mayer & Murray 2012). In the present case study, the first contributing factor for the poor performance of Ms. A could be the differences in the strategies used to orally rehearse the name of the visual image and keep a count of the same in the correct sequence at subconscious level. Thus, she could not organize the responses in backward or forward order. Overall, Ms. A's reaction time was faster on forward order compared to backward order. This particular result of the present case study is in support with the Lezak (1995) study, where it was reported that patients with brain dysfunction performed better in digit forward task than digit backward task, which infer that digit forward task stores information in short-term memory whereas digit backward task places highest demands on working memory where manipulation is required to identify the information.

The second contributing factor is the language impairment in Ms. A causing the deficit in the phonological loop and hence performed poor on the FST and BST. Past research has demonstrated that individuals with aphasia (IWA) exhibit deficit in the phonological loop (Martin, 1987) which is related to the comprehension deficits (Ostrin & Schwartz, 1986). Thus, the language learning is facilitated by the working memory capacity and this working memory is reported to be affected in IWA (Murray, 2004). But, in the previous studies, it is unclear that poor performance by IWA is indeed because of the deficient phonological loop or rather there could be another possibility of the paradigm used to assess working memory. In the present case study, the current paradigm (FST & BST) used to assess working memory capacity has been shown to be very effective in assessing the cognitive skills without being influenced by the impaired linguistic deficits of any individuals with aphasia. Hence, this is an initial attempt to differentiate or study the association between cognition and language in individuals with aphasia.

Performance on narrative discourse task

On observation, Ms. A obtained a score of 1 for the sub-parameter 'discourse structure' of propositional aspects. The discourse of Ms. A was partially organized with respect to the overall plan and it was confusing because of the repetition errors and phonemic paraphasias. However, she maintained the contextual theme of the narration by obtaining good scores for the parameter 'global coherence'. Coherence measures were not satisfactory at 'local coherence' level, where she demonstrated few information gaps, excessive repetition and more irrelevant propositions which accounted for her coherence violation. The contributing factor could be the syntactic and lexical deficits in discourse resulting in the production of paragrammatical structure, which altogether resulted in impairment at the microlinguistic structures of discourse. Though Ms. A was able to access the lexico-semantic and syntactic information, they were often substituted and distorted giving the listener an impression of incoherent utterance thus making the narrative confusing. Thus, maintaining a good relationship between the meaning and context of verbalization resulted in a better score for 'global coherence'. Whereas the impaired microlinguistic structure resulted in poor 'local coherence' (obtained zero scores). Under coherence measure, the participant obtained a score of zero for local coherence and 1 for global coherence, giving the total value of 1 under coherence measure out of 4. The coherence violation observed could be attributed to the patient's overt and covert attempt to use certain adaptive strategy to compensate for micro and macro-structural deficits, similar observations were reported by Christiansen (1995) on subjects with conduction, anomic and Wernicke's aphasia.

Ms. A exhibited very good 'communication intent' by asking for assistance whenever required without hesitation, initiating her narration without any prompts and obtained a score of 4 in this parameter. Ms. A obtained a better score on the parameter topic management through the correct introduction of the topic, proper topic shift and change. She obtained a score of 5 in this parameter. Other discourse parameters like 'Information adequacy', 'Information content' and 'Message accuracy' and 'Temporal-causal relation' were observed to be partially adequate. Speech related parameters like 'vocabulary specificity' and 'linguistic fluency' were greatly affected because of repetition of proposition, hesitations, literal paraphasias and stuck in type of perseveratory behavior, whereas non-propositional measures were observed to be adequate as she was able to correct the errors in her discourse through the use of repair strategies reflecting preserved self-monitoring skills. This was evidenced by her overt self-corrective behavior through multiple repetitions of propositions to correct her grammatical and lexical errors. Ms A obtained a score of 6 in this parameter. However, these adaptive strategies did not improve or correct her utterance.

To summarize, these impairments at discourse level were associated with aphasic errors such as phonemic paraphasias, word-finding difficulties and repetition errors in conduction aphasia. Because of these aphasic features, their discourse was perceived as disorganized and out of context. Probing further into this pattern of error and response unveils the importance of cognition for performing these tasks. Ms. A experienced more difficulty in narration task because of its reliance over cognitive-linguistic organization. A very good episodic memory is important to recall events from the past experience and narrate on it. In addition, sustained and focused attention is equally important for narration task to give relevant propositions. That is, the macro linguistic and microlinguistic processing deficits in individuals with aphasia is due to the poor working memory abilities. The support for this finding can be substantiated through the findings from our working memory assessment. Some of the errors exhibited by aphasia participants such as, use of unspecific vocabulary, poor discourse structure, and coherence violation are due to underlying cognitive deficit such as poor attention, perception, executive function and memory about recent past, which is important for appropriate discourse pattern and good performance on WM assessment. According to McCabe and Peterson (1991), narrative discourse involves recalling a series of events in a sequential manner. In order to narrate, an individual must possess the ability to understand and produce large chunks of text/verbal utterance well organized according to listener perception, topic and also convey meaning (Ewing-Cobbs, Brookshire, Scott, & Fletcher, 1998). Therefore, for better narration skills, there is a need for strong correlation between higher linguistic comprehension level and cognitive capacity. This knowledge facilitates memory and understanding through organizing and relating events in the utterance of a narrative discourse task. Thus, in any narrative task, in order to produce a coherent narrative, an individual speaker must plan and generate the linguistic content into an acceptable form while identifying the social rules that are built-in into the narratives. Thus, narrative discourse needs more advanced linguistic knowledge when compared to other discourse tasks. Thus any patient with conduction aphasia should undergo cognitive-linguistic assessment in terms of WM assessment, discourse assessment along with a conventional language assessment.

Conclusion

From this case study, we conclude that the linguistic deficit exhibited by Ms. A was due to an underlying cognitive processing deficit. The cognitive process which is affected in this case is the phonological loop of the working memory system because of the erroneous articulatory rehearsal at microlinguistic level. Though the case was able to access the lexico-semantic and syntactic information, they were often substituted and distorted giving the listener an impression of incoherent utterances, thus making the narrative confusing. The coherence violation observed could be attributed to the patient's overt and covert attempt to use certain adaptive strategy to compensate for micro and macro-structural abilities of discourse task and the memory task.

This study provides an insight into the importance of discourse assessment and its proper selection for management purpose. Introducing discourse as a therapeutic goal will not only facilitate the improvement of linguistic domain but also the underlying cognitive domain which is important to nourish the linguistic domain. The present study has some limitations. This is a single case study; hence the findings cannot be generalized to all the individuals with conduction aphasia. The second limitation is the type of working memory task used that is forward, backward span task and n-back task. This can be replaced and studied further by using semantic back, syntactic back task which is purely based on linguistic domain rather than a discourse task. Hence, it is important to consider linguistic working memory task than the non-linguistic one. The study can be carried out on a larger sample consisting of fluent and non-fluent aphasics in future. Normative data also can be developed for neurotypicals and individuals with aphasia for N-back task.

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