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Production and Comprehension Deficit in Broca's Aphasia: A Test in Bengali

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Abstract

This thesis aims to examine the nature of language production and comprehension deficits of Bengali speaking Broca's aphasics. Two grammatical aspects have been the focus of the present research: postpositions and word order. Two tests were designed and performed on Bengali speaking aphasics. A task related to postposition was aimed at production deficits whereas a task on variation of word order concentrated on comprehension deficits. The results show that the Broca's aphasics face more difficulties in both tasks than normal speakers of Bengali. The results of the comprehension task involving word order show that the people suffering from Broca's aphasia cannot deal with the complexity of alternative word orders. Apparently, movement in the syntactic tree creates complications for the Broca's aphasics. In particular the OVS construction of sentences with 'distractor' and 'opposite' pictures shows more marked results than other constructions.

Sammendrag

Denne oppgaven vil undersøke problemer i språkproduksjon og -forståelse hos bengalitalende pasienter med Broca-afasi. Denne forskningen har fokusert på aspekter mht. grammatika: postposisjoner og ordstilling. To tester ble utviklet og utført på bengalitalende pasienter med Broca-afasi. Den ene testen om postposisjoner var rettet mot språkproduksjonsproblemer, mens den andre om ordstilling var rettet mot språkforståelsesproblemer. Resultatene viser at Broca-pasienter har flere problemer i begge tester sammenlignet med normale bengalitalende personer. Resultatene av forståelsestesten om ordstilling viser at Broca-pasienter kan ikke håndtere kompleksiteten av varianter i setningsstruktur. Tilsynelatende lager flyttinger i det syntaktiske treet komplikasjoner for pasientene. Spesielt OVS-konstruksjonen i setninger med distraktører og motsatte bilder viser flere markerte resultater enn andre konstruksjoner.

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Chapter 1: Introduction

This chapter will introduce the research topic, will underline its importance and will explain the purpose and hypothesis of this research. It will also provide an overview of Bengali language and grammar, and will give a background in the nature of aphasia and previous work on this topic in Bengali and other languages.

1.1 Research topic

This thesis presents a comparative study of two groups of Bengali speakers: neurologically intact individuals and individuals with Broca's aphasia. Many previous studies have been conducted on Broca's aphasia in different languages. Bengali has received very little attention in this area. Broca's aphasia is mainly known to imply problems in the production of language. The language area of the brain, which is called Broca's area, is the seat of the language production capability. Damage in Broca's area not only hampers the production of the language but also creates a barrier for the grammatical components of a language. This means that the ability of using grammatical categories of a language can be interrupted due to an injury in Broca's area. The reduced ability to use grammatical components is called agrammatism. It is one of the most salient features of Broca's aphasia. The manifestation of agrammatism is not same for all languages. A particular grammatical component might be impaired in one language but not necessarily in other languages. In the present research, the grammatical and functional categories of Bengali are taken into account to study the nature of agrammatism for Bengali-speaking Broca's aphasics as compared to neurologically intact individuals.

1.2 Research purpose

The main purpose of this research is to classify the pattern of impairment in both language production and comprehension of Bengali speaking Broca's aphasics, specifically with respect to two grammatical categories, which are postposition and word order in the Bengali language. These two categories in Bengali grammar are considered interesting due to the finding that Broca's aphasics have met difficulty with these categories in other languages. Therefore, there is a possibility that Bengali speaking Broca's aphasics also exhibit difficulty in similar grammatical categories. The concept of postposition in Bengali is similar to that of

preposition in English. Both are closed class grammatical items with comparable functions. Postpositions typically occur after the object in Bengali and link nominal objects to other parts of sentences. Most postpositions require a case marker on the object nouns. In Bengali, sentences that with postpositions can usually be paraphrased using a locative marker instead, as will be discussed and illustrated below. In fact, the following constructions are possible in comparable situations. One possibility is to produce a sentence with a postposition only. Another possibility is to mark the object with the locative case and a third possibility is to produce both a postposition and a locative marker. All these possibilities in Bengali can be considered as a correct response. In the current research, I have designed and carried out a test which was focused on the production of postpositions. The materials and method for this test were designed so that the production of a postposition is forced while the production of a locative marker is avoided. The primary assumption is that the use of postposition might be difficult for the Bengali speaking Broca's aphasics, and that they might omit the postposition or exchange it with other functional words.

Flexible word order is another grammatical feature of the Bengali language. Normally, variations in word order do not change the meaning of the sentence. Alternations of the standard SVO (subject-object-verb) order only shift the focus of the sentence. In the current research, I have designed and carried out a test in which three different word orders have been associated with three different pictures. These pictures show variations on the actor which may be associated with the subject or object. This word order task is completely focused on the understanding of the action of the pictures and relates those pictures with the sentences. The purpose of this task is to identify impairments related to processing sentences with different word orders in Bengali speaking Broca's aphasics. The dissociation between the word order and picture order might indicate that Bengali speaking Broca's aphasics have comprehension difficulties in processing different word orders.

In sum, the conducted research has tested both the production and comprehension incompatibility of Bengali speaking Broca's aphasics.

1.3 Importance of the research

From the perspective of Bengali, this research will be able to add a new dimension to understanding production and comprehension deficits of Bengali speaking Broca's aphasics. If there is no difference between the Broca's aphasics and the control group in producing the

postpositions, this might indicate that the damage in the Broca's area does not have any impact on the production of such functional categories in the Bengali language. In that case, other tests for the production and comprehension closed or open class elements of Bengali may be considered. Furthermore, the tests involving variations of word order is a check of the comprehension ability in Broca's aphasics. The recent discussions on Broca's aphasia in different languages (see below) suggest that in Broca's aphasia not only the production but also the comprehension capacity partially or fully could hamper. The word order task contributes to testing whether the Bengali speaking Broca's aphasics comprehension ability is either intact or affected. The effect of affected comprehension could be partial or full; a possible outcome of the word order task is that the comprehension ability might be intact for a specific word order or for all word orders of the sentence. The same idea could applicable if the result shows any interruption in the comprehension. The interruption could occur for all the word orders or for a specific word order.

In sum, the expected outcome of this research may contribute to an assessment of the nature and extent of certain impairments in Broca's aphasics. The findings may be relevant for developing therapies to counteract the impairment and improve the language ability of Broca's aphasics.

1.4 Research Question and Hypothesis

The main hypothesis underlying this research is that Bengali speaking Broca's aphasics show impairment with respect to postpositions and word orders in comparison to neurologically intact individuals of Bengali language. Our primary idea was that normal speakers of Bengali language would not make any mistake in producing postpositions and give correct responses in both tasks. On the other hand, the Broca's aphasics are expected to mistakes in both tasks as their language production capacity is damaged due to injury in the language area of the brain.

This research has focused on two different areas, which is an innovative aspect with respect to the Bengali language. Two experiments have been developed. Experiment 1 focuses on production capability whereas experiment 2 focuses on comprehension capability. The usual knowledge about Broca's aphasia is that it implies an impaired production capability with an intact comprehension capacity, although some recent research has shown that these aphasics

have comprehension problems as well, especially in dealing with complex syntactic structures.

The following two specific research questions are guiding the present research:

1. What is the pattern of difficulties in both production and comprehension tasks for the Bengali speaking Broca's aphasics?

2. What are the specific characteristics of the impairment exhibited in these tasks?

1.5 Some characteristics of the Bengali Language

Bengali is the world's fifth largest language with a total number of about 260million speakers. Bengali is the official language of Bangladesh and of the state West Bengal of India. The Bengali language belongs to the Indo-European language family (Thompson, 2009). The basic sentence pattern of Bengali is SOV (subject, object, and verb). However, this pattern can be reshuffled into different orders. The meaning of the sentence does not change with the shuffling of word orders. Bengali has postpositions which follow the nouns. Their function corresponds to that of prepositions in English.

Bengali has no grammatical gender. Since Bengali pronouns do not differentiate for gender, the same pronoun is used for 'he' and 'she'. However, Bengali has different third-person pronouns for proximity. In addition, verbs have three separate inflections in the 2nd and 3rd person to indicate the relative status of speaker and subject (Dalby, 1998). Bengali verbs have person agreement with their subjects but do not have any number agreement. Verbs are conjugated according to tense and person by marked on endings attached to their stems.

There are different opinions about the Bengali case system because there is some syncretism of case markers. According to some, Bengali has the following seven cases (Debajit, 2012):

i) Nominative Case

In Bengali, the nominative case receives the Ø (null) marker. The nominative case marks the subject (usually an actor or agent) of the verb. By way of exception, the /-e/, /-y/ or /-te/ suffixes can be found on some nouns to mark the nominative.

ii) Accusative Case

The accusative case marks the object of the verb. The accusative suffix is /-ke/, /-re/, /-e/ or /-y/.

iii) Dative case

The basic role for the dative case is to distinguish the recipient of something given, transferred, etc., usually the indirect object, but also a range of meanings similar to the meaning expressed by English 'to' or 'for'. The accusative marker /-ke/ also acts as a dative marker.

iv) Genitive Case

The genitive case on a noun or pronoun generally indicates a possessive or other relation corresponding to similar relations in languages such as English. The genitive marker is /-r/ but with consonant ending, the marker is /-er/.

v) Instrumental case

The instrumental case marks the instrument to carry out the action or cause of the action identified by the verb. For inanimate objects, the postposition /-diye/ is used. For animate objects, /-dara/ has traditionally been used. Nowadays, however, /-diye/ can be used both for inanimate and animate objects. The instrumental case also can take the locative marker /-e/.

vi) Ablative case

The basic role of ablative case is to indicate movement away from some location. Therefore ablative is the case of separation from the source in performing the action carried by the verb. In Bengali the ablative case is realized as /-theke/, /-hotey/, /-r/, /-er/, /-e/, /-te/ and Ø (null).

vii) Locative case

The locative case generally marks the location with both the spatial and temporal reference. This case indicates the location of the event/action identified by the verb. The locative case is marked by a marker /-e/ in Bengali.

According to some linguists, Bengali has only four cases, which are nominative, objective, genitive and locative, as shown in Table 1.1. The nominative case is unmarked. Determiners are realized as a suffix with nouns to formulate the number and definiteness. The inflection pattern of Bengali case marker depends on the noun's degree of animacy. Plural markers for animate and inanimate nouns are distinct from one another (Thompson, 2009).

The accusative and dative case in Bengali both takes the same marker /-ke/. This might be the reason that some people take it in general as the objective case. The instrumental case can use the locative marker. These two also marked together in some discussions.

Case	Singular	Plural
Nominative	Ø	-ra/-era; -gulo
Objective	-ke	der(ke)/-eder(ke); -guloke
Genitive	-r/-er	-der/-eder; -gulor
Locative-Instrumental	-te/-e or -ete	-gulote

Table 1.1: Bengali case markers (Comrie, 2011)

Overall Bengali is a grammatically enriched language with some distinctive features. This offers good possibilities to indentify possibly relevant aspects of grammar to examine patterns of agrammatism in Bengali speaking Broca's aphasics.

1.6 Postposition

As mentioned above, postpositions in Bengali have a similar function to that of prepositions in English. Grodzinsky (1988) has discussed the syntactic deficits of Broca's aphasia, focused on the impairment in the use of prepositions. His hypothesis is linked to the notion of Government (Chomsky 1981): when a preposition is governed, the agrammatic speakers will tend to omit it, while an ungoverned preposition will be intact in the production of the agrammatic speakers. Simply speaking, in English a preposition is ungoverned when it is a sentential adjunct, as illustrated in example (1a); elsewhere prepositions are governed, as illustrated in example (1b).

(1) a. John plays tennis *after* work.

b. John always counted *on* Mary.

Friederici et al. (1982), referred to by Grodzinsky (1988) showed that agrammatic aphasics performed almost normally in picking a correct preposition in a sentence completion task where the preposition carried semantic content, as in (2).

(2) The cat is lying under the table.

The discussion by Grodzinsky and others stimulated my investigation of the role of postpositions in Bengali. Either the agrammatic speakers of Bengali have difficulty to produce all types of postpositions or they might show difficulty in certain types of postpositions. There is also the possibility that Broca's aphasics perform well in all postposition tasks, which would imply no impairment of this functional category of Bengali.

Postpositions are used after nouns and pronouns in Bengali. Postpositions need case markers in Bengali to relate with a noun phrase. A very common pattern of Bengali postpositions is that they can act as functional adverbs in postpositional or adverbial phrases. Postpositions are functionally capable of expressing spatial, temporal, situational, locational, directional and conditional information. The materials that have been used in the experiment 1, which is a sentence production task, where the semantic interaction between postposition and noun phrase has been observed.

In Bengali, postpositions can be divided into two categories based on their linguistic roles and functions. The first category consists of postpositions acting as an adverb. In this category, the postpositions tend to express information such as time, place and manner of an action expressed by the noun or verb. This is exemplified by the postposition *paʃe* 'beside' in (3).

(3) Karim Rahim-er paʃe boʃe ac^{h}e
Karim Rahim.ABL beside.POST sit be
'Karim is sitting beside Rahim'

Postpositions of the second category are in phrases which express some other aspects of nouns and verbs such as causation, content, direction, comparison, status etc. (Dash, 2015). An example is the postposition /diye/ 'by' in (4).

(4) take diye e kaɟ hɔbe-na
He by.POST the.DET work do.NEG
'This task cannot be done by him'

In Bengali, postpositions can take the locative or ablative case. The direct use of a locative marker on the noun does not require the use of a postposition. It is possible to produce a sentence without a postposition if the situation indicates a locative aspect on the noun. This does not mean that locative case and postposition cannot apply in the same sentence. It is still possible that both can be in the same sentence. However, the appropriateness of each construction may depend on the context. These possibilities of context are exploited in the design of an experimental task in which the speaker's production of postpositions can be examined. Some examples are discussed below that can give a clear view about the use of postpositions and locative case.

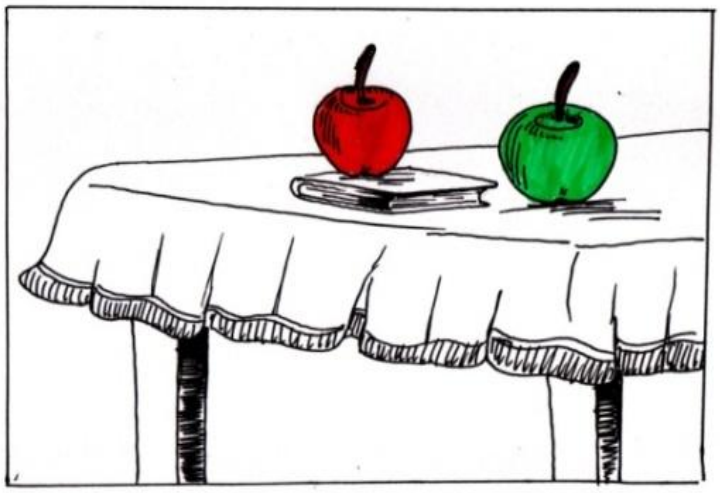


Figure 1.1: Picture regarding postposition and locative case

(5) a. ʃabuɟ apel-ti tebil-e rak^{h}a ac^{h}e.
Green apple.DET table.LOC keep be
'A green apple is on the table.'

b. ʃabuɟ apel-ti tebil-er upore rak^{h}a ac^{h}e.
Green apple.DET table.ABL on.POST keep be
'A green apple is on the table.'

The example (5a) shows a locative case while (5b) shows a postposition combined with an ablative marker on the noun. Figure 1.1 shows a picture where locative and postposition are both applicable, as expressed in (5). However, two different situations have been put in this picture. The first situation is that a green apple is on the table and the second situation is the red apple is on the book. Examples (6) which are two possible questions could be formed with this picture.

(6) a. apel-ti koʈʰay rakʰa acʰe ?
Apple.DET where keep be ?
'Where is the apple?'

b. ʃabuɟ apel-ti koʈʰay rakʰa acʰe ?
Green apple.DET where keep be ?
'Where is the green apple?'

Question (6a) does not require the answer to have a postposition. The answer can be given with locative case, which will be correct in Bengali. Question (6b) does not indicate any locative part of the sentence so that the answer requires the use of a postposition. To make the statement more unambiguous, examples (7) are discussed.

(7) a. lal apel-ti boiy-e rakʰa acʰe.
Red apple.DET book.LOC keep be
'A red apple is on the book.'

b. lal apel-ti boi-er upore rakʰa acʰe.
Red apple.DET book.ABL on.POST keep be
'A red apple is on the book.'

Figure 1.1 is also applicable to these examples. Example (7a) is showing a locative trace in the sentence and (7b) is showing a postposition with an ablative marker in the sentence. Now the view will be more structured. The question can be formed as (8).

(8) lal apel-ti koʈʰay rakʰa acʰe ?
Red apple.DET where keep be ?
'Where is the red apple?'

The answer to the question (8) can come out only with a postposition. Example (7b) is the right answer to this question, which shows the postposition. Sentence (7a) is not an appropriate answer to this question; it is unable to convey the idea clearly and the meaning of the sentence would also be ambiguous.

The above discussion has explained some relevant aspects of the use of postpositions in Bengali. Postpositions in Bengali are considered as a complex functional category like prepositions in English. Therefore, the Broca's aphasics of Bengali language could face problems in using and producing the postposition. They might omit the postposition in the sentences and use the locative case or another grammatical category in the position of the postposition. This research will focus on the production of the postpositions along with the omission or replacement of the target item; these phenomena could reveal deficits of agrammatic aphasics.

1.7 Word order

Some comprehension difficulty in noncanonical sentences in different languages is widely observed in Broca's aphasia. Noncanonical sentences are derived from the movement of certain sentence constituents in the syntactic tree. The basic word order in Bengali is Subject-Object-Verb. The flexible word order in Bengali keeps the meaning unchanged. The alternation of word order depends on the emphasis on a specific action and situation. Some examples of Bengali sentence constructions are discussed below to illustrate this.

Simple sentences in Bengali are formed with one or two nouns and a verb, as in (9). The first noun is normally the subject, the second noun is then an object of the verb and the verb is placed at the final position of the sentence. If the sentence has only one noun then it is considered as the subject. Adjuncts can be added to subjects; for the predicates, adjunct and complement both can be added. An adjunct is an optional element and can be deleted from the sentence without affecting the sentence construction (Morshed, 1982).

(9) a. Paul kʰaccʰe.
Paul eat.PRS.PROG
'Paul is eating'

b. Paul bʰaṯ kʰaccʰe.
Paul rice eat. PRS.PROG
'Paul is eating rice'

Example (9a) shows a sentence with a noun and a finite verb. Sentences without subject can only be constructed in certain discourse contexts. Example (9b) shows the basic SVO sentence structure of Bengali where the first noun 'Paul' is the subject, the second noun /bʰaṯ/ 'rice' is the object and /kʰaccʰe/ 'is eating' is the verb.

(10) a. Paul raṯ-e dudʰ kʰay.
Paul night.LOC milk drink.PRS
'Paul drinks milk at night'

b. raṯ-e dudʰ kʰay Paul.
night.LOC milk drink.PRS Paul
'Paul drinks milk at night'

c. raṯ-e Paul dudʰ kʰay.
night.LOC Paul milk drink.PRS
'Paul drinks milk at night'

Examples (10) show alternative positions of the subject in Bengali sentences. Example (10a) shows the default construction where the subject, which is 'Paul', occurs at the beginning of the sentence. The subject also can be placed in the other parts of the sentence that do not have any effect on the meaning. Examples (10b) and (10c) show the movement of the subject to the end and middle of the sentence, respectively.

Usually, in a Bengali sentence, the indirect object comes before the direct object. This order also can be altered due to focusing of the argument without changing the meaning of the sentence.

(11) a. Paul Mary-ke upohar dicchʰe.
Paul Mary.DAT gift give.PRS.PROG
'Paul is giving a gift to Mary'

b. Mary-ke Paul upohar dicc^{h}e.
Mary.DAT Paul gift give.PRS.PROG
'Paul is giving a gift to Mary'

c. Paul upohar dicc^{h}e Mary-ke.
Paul gift give.PRS.PROG Mary.DAT
'Paul is giving a gift to Mary'

* d. Paul upohar Mary-ke dicc^{h}e.
Paul gift Mary.DAT give.PRS.PROG
'Paul is giving a gift to Mary'

e. Mary-ke upohar dicc^{h}e Paul.
Mary.DAT gift give.PRS.PROG Paul
'Paul is giving a gift to Mary'

f. upohar Paul Mary-ke dicc^{h}e.
gift Paul Mary.DAT give.PRS.PROG
'Paul is giving a gift to Mary'

The examples in (11) are showing the direct and indirect object situation of Bengali. In (11a), 'Paul' is the subject, /dicc^{h}e/ 'is giving' is the verb, /upohar/ 'gift' is the direct object and 'Mary' is the indirect object. The examples in (11b–f) are the possible alternations of Bengali sentences. The changing pattern of word order in these examples does not affect the meaning of the sentences. In (11b), the indirect object starts the sentence and in (11c) the sentence ends with the indirect object. In (11e) the direct object is placed before the verb and in (11f) it is in initial position. If the direct object were placed before the indirect object without any particle or determiner then the sentence would be ungrammatical. In example (11d), the direct object /upohar/ occurs before the indirect object *Mary* without any particle or determiner and the verb is in final position, making the sentence ungrammatical. Placement of the verb between the direct and indirect object, as in (11c), is grammatical in Bengali.

Determiners, adjectives, and adverbs can be included in simple sentences to extend the meaning in different situations. The determiner always comes before the noun in a noun

phrase. Adverbs are placed before the verb and after the nominal subject. Adjectives are placed before the head noun in a noun phrase. Examples including determiner, adjective and adverb are presented in (12).

(12) a. Mary ɖruʈo hatcʰe.
Mary fast.ADV walk.PRS.PROG
'Mary is walking fast'

b. meye-ti ʃunɖor ɟuʈa porecʰe.
Girl.DET beautifull.ADJ shoe wear.PRS.PROG
'The girl is wearing a beautiful shoe'

Another important aspect of sentence construction is relative clauses. A relative clause can be constructed with a relative pronoun, antecedent, postcedent along with other elements like determiner and so on. In Bengali, relative pronouns are added in the relative clauses in terms of honor, number, and animacy. Relative pronouns have correlatives to make relative clauses in Bengali such as /ɟe/ 'who' and /ʃe/ 'he or she'; /ɟini/ 'who' and /ʈini/ 'he or she'; /ɟa/ 'what' and /ʈa/ 'that' and /ɟara/ 'who' and /ʈara/ 'they'. The use of Correlative items is regular phenomena in the construction of complex sentences in Bengali. Some examples of relative clauses are given in (13) and discussed below.

(13) a. Paul Mary-ke upohar diccʰe.
Paul Mary.DAT gift give.PRS.PROG
'Paul is giving a gift to Mary.'

b. Paul ʃe je Mary-ke upohar diccʰe.
Paul he who Mary.DAT gift give.PRS.PROG
'Paul is the one who is giving a gift to Mary.'

c. Mary-ke upohar diccʰe je ʃe Paul
Mary.DAT gift give.PRS.PROG who he Paul.
'Paul is the one who is giving a gift to Mary.'

The examples in (13) show the pattern of relative clauses. (13a) shows the basic SVO word order of Bengali. The examples in (13b) and (13c) are expanded with relative markers to make it a relative clause. In (13b), there is an object relative clause and in (13c) there is a subject relative clause.

Bengali has two patterns of making question sentences, with a Wh-marker and without a Wh-marker. Yes-no questions can be formed without using any Wh-marker. In that case, an additional particle will be added which is /ki/ ‘it’ or ‘this’ for the yes/no questions. Wh-questions are typically formed with the Wh-marker at the focus position of the sentence. Some examples in (14) are discussed about the formation of Wh-question in Bengali.

(14) a. kot̪^{h}ay t̪omar baɽi ?
where.Q your home
Where is your home?

b. kot̪^{h}ay [hoy] t̪omar baɽi ?
where.Q is your home
Where is your home?

c. t̪omar baɽi kot̪^{h}ay ?
Your home where.Q
Where is your home?

d. baɽi kot̪^{h}ay t̪omar ?
Home where.Q your
Where is your home?

The examples in (14) are showing Wh-questions. A notable feature in the case of both declarative and interrogative sentences is that the verb could be omitted and this does not have any effect on the meaning. Example (14a) presents a question using a Wh-marker that does not contain any verb. Example (14b) presents the sentence with the verb /hoy/ ‘is’ which is also grammatical, but this is not usual in Bengali. This kind of constructions is only produced for stylistic and discourse demands. The examples in (14c) and (14d) show the free word order of Bengali that is also appropriate for the Wh-question.

As mentioned before, the formation of yes/no question requires an extra particle /ki/. Some examples regarding this phenomenon are discussed in (15).

(15) a. Paul ki Mary-ke upohar dicc^{h}e ?
Paul this.Q Mary.DAT gift give.PRS.PROG
'Is this Paul who is giving a gift to Mary?'

b. Mary-ke upohar dicc^{h}e ki Paul
Mary.DAT gift give.PRS.PROG this.Q Paul
'Is this Paul who is giving a gift to Mary?'

c. upohar dicc^{h}e ki Paul Mary-ke ?
Gift give.PRS.PROG this.Q Paul Mary.DAT
'Is this Paul who is giving a gift to Mary?'

d. Paul ki ʃe je Mary-ke upohar dicc^{h}e ?
Paul this.Q he who Mary.DAT gift give.PRS.PROG
'Is this Paul who is giving a gift to Mary?'

e. Mary-ke dicc^{h}e upohar je Paul ki ʃe ?
Mary.DAT give.PRS.PROG gift who Paul this.Q he
'Is this Paul who is giving a gift to Mary?'

f. dicc^{h}e upohar je Mary-ke ʃe ki Paul ?
give.PRS.PROG gift who Mary.DAT he this.Q Paul
'Is this Paul who is giving a gift to Mary?'

The examples in (15) are showing the patterns of yes/no questions in three different word orders. Examples from (15a-c) are declaring a definite question about the statement as stated in the (13a). On the other hand, examples (15d–f) show questions about the relative statement. The use of relative pronoun in the questions creates a doubt about the action of the subject. Sentence (15d) requires a clarification between the pronoun /ʃe/ and 'Paul', because the relation between the pronoun /ʃe/ 'he/she' and 'Paul' may be unclear. For the reverse word order, this task might be more difficult for the language-impaired individuals. In (15e) the indirect object 'Mary' comes in sentence initial position and the pronoun /ʃe/ has taken

the final position in the sentence. Also here, the relation is unclear since /ʃe/ 'he/she' may be taken to refer to the indirect object 'Mary' instead of to 'Paul'. In (15f), the verb has taken the first position in the sentence and the subject is shifted to the final position of the sentence. The indirect object 'Mary' is closer to the pronoun /ʃe / and this proximity also could prevent the correct response from the speakers.

A concise overview of Bengali sentence construction and alternative word orders has been given in the above discussion. In the context of the present research paper, yes/no questions with reversible orders are of importance. Declarative sentences, relative clauses and Wh-questions have been discussed to make the basics of Bengali sentence structures more understandable.

1.8 Language and the human brain

Language and brain have a vital connection with each other. The functioning and processing of language is performed by the human brain. The central nervous system provides a context to understand the brain functions for language. In this section, the parts and functions of the central nervous system will be discussed briefly, mostly focusing on the language function.

The cerebrum is the part of central nervous system that is most important for speech and language. The cerebrum is divided into two hemispheres, which are called right and left hemisphere. Fiber bundles connect these two hemispheres; the corpus callosum is the important one of the fiber bundles. The surface of the cerebral hemisphere is the cortex. The 'hills' are known as *gyri* and the 'valleys' known as *sulci*. The gyri and sulci draw up the boundaries of the lobes. The four lobes are the temporal, occipital, parietal and frontal lobes. There are two types of fissures, which are called Rolandic and Sylvian fissures, that divide the lobes of the brain. The Rolandic fissure divides the frontal and parietal lobe. The Sylvian fissure cuts through the language area that parts the temporal lobe below and the parietal and frontal lobes above. The frontal lobe is referred to as the anterior region of the brain. The parietal and occipital lobe are in posterior region and the temporal lobe runs in both anterior and posterior sections. The outer layer cortex consists of nerve cell bodies, called 'gray matter'. The sub-cortical regions are below the gray matter which is called 'white matter' that consists of nerve cell fibers (Obler & Gjerlow, 1999).

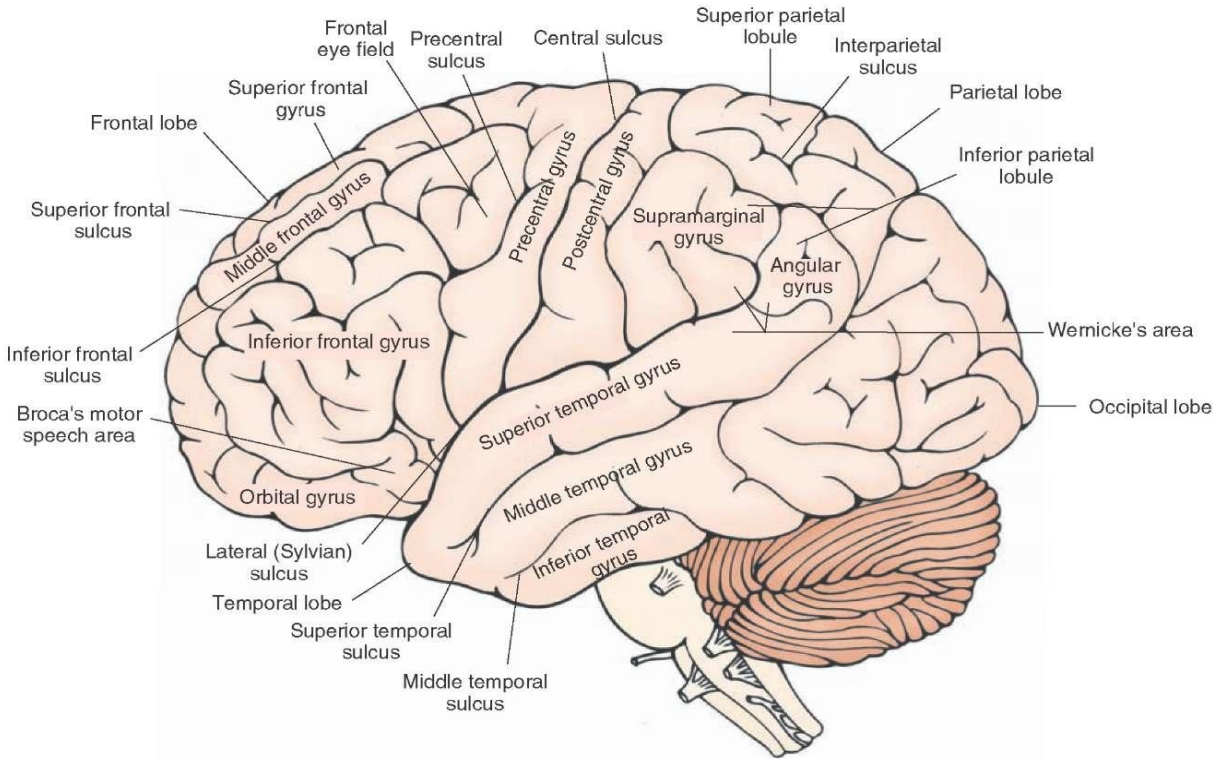


Figure 1.2: A view of lobes, fissures, gyrus and sulcus.(source:https://s-media-cache-ak0.pinimg.com/originals/67/d8/ed/67d8ed4f405baa443492507f63382e5f.jpg)

Damage in the anterior language zone in the left hemisphere may cause language impairment. The left hemisphere is important for speech and language. Any kind of damage in this area can cause different types of language impairment. The anterior language zone in the frontal lobe takes part in expressive language action such as speech and writing. It helps to plan and process language utterances. The posterior language zone in the left temporal and parietal lobes are important for comprehending, recalling and formulating linguistic messages by using appropriate syntactic and semantic content. The posterior inferior frontal lobe in the anterior area is called Broca's area. This area covers the lower part of premotor cortex, which is a strip of cortex in front of the primary motor cortex. The premotor cortex is responsible for volitional movements for the primary motor cortex. Broca's area is a closest area of primary motor cortex for the speech muscles, which is important for the planning of speech movements (Brookshire, 2003).

The posterior superior left temporal lobe is called Wernicke's area. This area is thought to be important for the storage and retrieval of mental representations of words, word meanings, and use of grammatic and linguistic rules. The speech production process starts with the preparation of words from a meaning representation. A speaker needs to perform lexical access through some preparing stages that access the mental lexicon and lead to the selection of lexical item. The lexical selection process has been discussed by Levelt (2001). He introduced a model for the flow of lexical selection to form encoding, ultimately leading to articulation through the phonetic encoding. The language model of Levelt is presented in Figure 1.3.

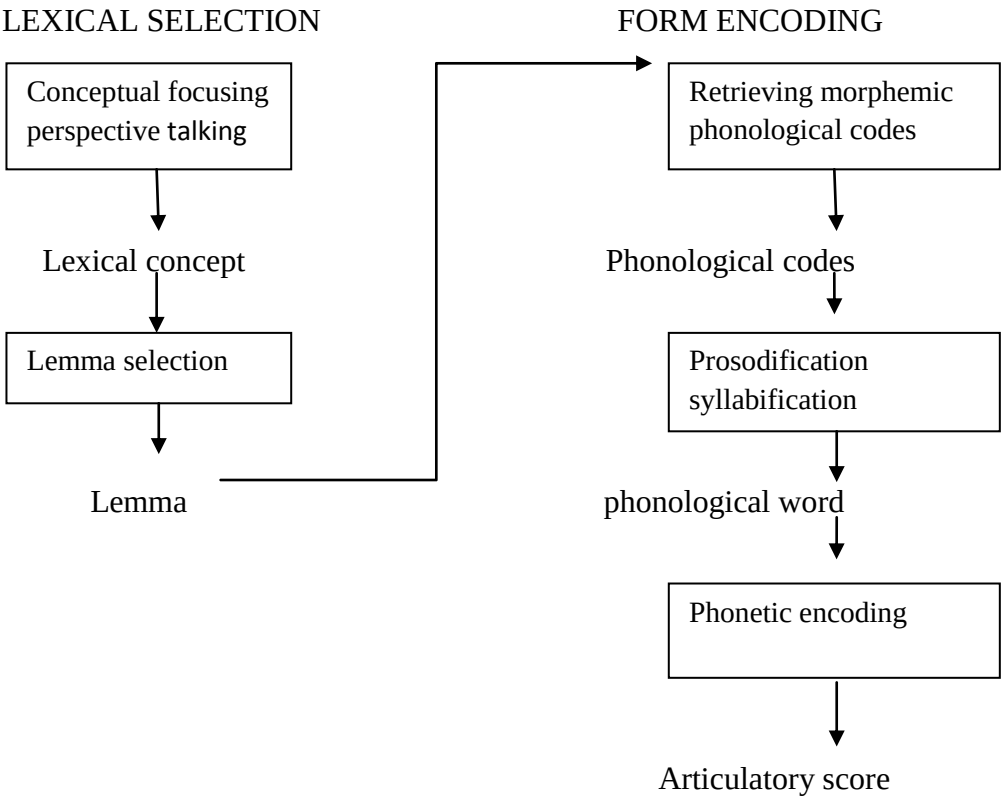


Figure 1.3: Two stages of lexical selection followed by three stages of form encoding (Levelt, 2001).

In the production of a content word, a speaker will first select the appropriate item form the mental lexicon. This is called 'Lexical selection'. The selected lexical item's articulatory shape will be prepared through the 'Form encoding'. For example, a subject is shown a picture of a horse. Then he is asked to name the picture. There is a possibility that the subject might say 'stallion' or 'animal' instead of 'horse'. Speakers may have different words in their minds that are semantically related to the same concept. A specific picture or any question,

which is presented to a speaker causes a need to provide the appropriate word that could convey the meaning. At this point, 'perspective talking' should be introduced to reach the particular communicative goal. Perspective talking denotes the feature that the discussions about relevant ideas drives the speakers towards the level of 'lexical concept'. To initiate the lexical selection the subject need to concentrate on the lexical concept. Relevant lexical concepts may be, for instance, the words 'stallion', 'animal' and 'horse' that trigger the reactivation of related concepts during perspective talking. The corresponding lexical item in the speaker's mental lexicon is called the 'lemma'. Lexical selection is completed when the speaker has reached the target lemma. The selected lemma spreads the activation to the phonological codes. Phonological codes are accessed as an ordered set of phonological segments. The process of prosodification and syllabification is inserted in this point. The phonological segment completes the process of syllabification by forming a phonological word. The phonological words enter into the final step of phonetic encoding. The final output of form encoding is an articulatory score (Levelt, 2001).

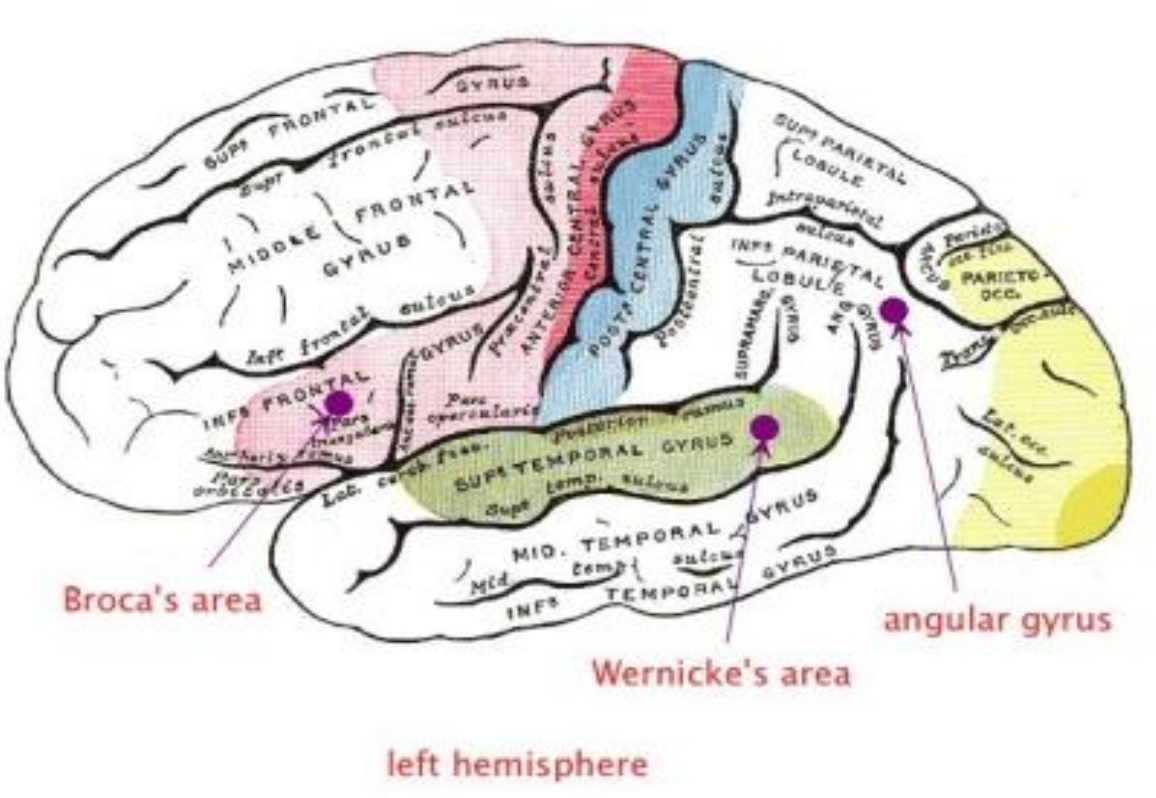


Figure 1.4: Language areas of brain (Source: http://webspace.ship.edu/cgboer/speechbrain.html)

The posterior superior left temporal lobe of the brain sustains the whole process of lexical selection. Wernicke's area communicates with Broca's area and other frontal regions of the brain with the help of banded nerve fibers called *arcuate fasciculus*. The *arcuate fasciculus* goes through the mid temporal lobe and the lower regions of the frontal lobe in a connection with the parietal lobe that is considered as a primary route to transfer linguistic messages from Wernicke's area to Broca's area. The process of reading and writing is executed in and around the area of angular gyrus at a junction of the temporal, parietal and occipital lobes (Brookshire, 2003).

1.9 Aphasia

The human brain has two specific areas that control the language production and comprehension tasks. These two language areas can be damaged by many factors such as stroke, tumor, head injury or progressive degenerative disease that can interrupt the total processing system of language. There are different types of language disorders that can be caused by a disruption in the language areas. Aphasia is one kind of language disorder that results from damage to the brain. Aphasia is an acquired disorder that can hamper an individual's language abilities (Nikolova, Boyd-Graber & Fellbaum, 2011). Aphasia is an impairment of the ability to produce, comprehend, or repeat language due to brain injury. Aphasic patients have difficulty retrieving words for objects and actions during the production of language. Aphasic patients also have impairments in phoneme perception, word recognition, and syntactic parsing during the comprehension of language (Kemmerer, 2015).

The scientific investigation of aphasia began in the middle of the 19th century. In 1861, Paul Broca first pointed out that a portion of the brain, more specifically the left hemisphere, is related to the output of language. He mentioned a particular type of aphasia that is called by his name as Broca's aphasia. In the late 1800s, other scientists followed the path of Paul Broca and discovered many other forms of aphasia. One of them, Carl Wernicke, drew attention to a new type of aphasia, which has become known as Wernicke's aphasia (Kemmerer, 2015).

In neurolinguistics, two viewpoints have been put forward regarding the functional processes of language. These are called the localizationist view and the connectionist view. The localization of language production and comprehension in the two hemispheres is the

localizationists view. This view is associated with the 'Boston school' and the scholars Norman Geschwind, Harold Goodglass and Edith Caplan followed the techniques stated by Obler & Gjerlow (1999). On the other hand, the connectionists emphasized that the parts of the brain are interconnected in the processing of language.

In the 1880s, Wernicke and Lichtheim proposed a localizationalist model, referred to by Kemmerer (2015) as the 'house' model of the neural architecture of language. Geschwind elaborated this model in the 1960s.

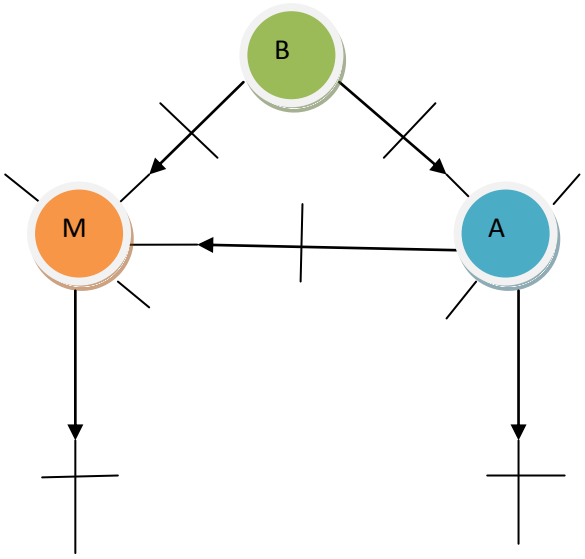


Figure 1.5: House model of the neural architecture of language (Kemmerer 2015).

The sign 'M' represents the center for speech planning and production that is Broca's area. The sign 'A' represents the center that stores the word sounds, which is Wernicke's area. The sign 'B' represents the center that contains the meaning of words. The direction of the information flow is indicating by the arrows. Lesion sites are indicating by the line segments transecting the centers and the connections between centers. The above model illustrates that damage in the motor center (M) that subserves spoken language production results in Broca's aphasia. Damage in the auditory center (A) that stores the 'sound images' of words results in Wernicke's aphasia. An interruption in the pathway that projects from the auditory center to the motor center results in conduction aphasia. Disruption of the pathway between the concept center (B) and motor center results in Transcortical motor aphasia. An interruption of the pathway from auditory center to the concept center results in Transcortical sensory

aphasia. An interruption of both pathways connecting the auditory and motor centers with the concept center results mixed Transcortical aphasia and damage to the whole system results in global aphasia (Kemmerer, 2015).

The general view on the neurological basis of language is that Broca's area and Wernicke's area in the left hemisphere have crucial functions in processing language. In recent years, the discussion on the neurological aspect of language has changed and new ideas have come up regarding the functions of language. Stowe, Haverkort, & Zwarts (2005) discussed that the function of production and comprehension cannot be split up in a way that Broca's area is only handling production and Wernicke's area is handling comprehension. There is a connection between these two areas. The activation of language processes in one area leads to the activation of other areas. The classical model of language processing where the functions of language are completely different from each other has thus been challenged. The model of language production and comprehension has shown that Wernicke's area is giving support for the comprehension of language. Conversely, several studies showed that Broca's aphasics with severe impairment in language production also suffered in the understanding of complex syntactic structures. Stowe, Haverkort, & Zwarts (2005) also argued that Broca's area is not only related to syntactic processing but also have function in the phonological and semantic tasks. Some studies have claimed that the most inferior part of the inferior frontal gyrus in Broadman's area 47 is involved in the activation of semantic elements. Moreover, Broadman's area 44 tends to activate the syntactic functions and the Broadman's area 45 activates phonological tasks. The conception of the functions of Broca's area and Wernicke's area has turned into a new phase in the above discussion. The idea is here that all the parts of language areas in the brain are interconnected. Therefore, the functional language areas of the brain cannot be labeled with specific tasks. Several different studies have been done and theories have been developed about the functional role of language according to the neurological basis of language. Thus, it is still a matter of argument to which extent the language areas of brain are interconnected with each other or are separate from each other based on their functions in the processing of language.

1.9.1 Types of aphasia

There are different types of aphasia based on the damaged language areas of the brain. The eight types of aphasia are most common, which are briefly described here.

1. Broca's aphasia

Damage in Broca's area causes Broca's aphasia. In Broca's aphasia, speech is disrupted and limited to broken words. Paul Broca examined a patient named Leoborgne who was incapable of speech for many years. Leoborgne was able to produce a single word 'tan'. Paul Broca found another patient named Lelong who was able to produce five words only. Paul Broca did an autopsy of both patients and found that they have a damage are in the left hemisphere (Kemmerer, 2015). Broca's area lies in the third frontal gyrus of the cerebral cortex (Geschwind, 1972). People who suffer from Broca's aphasia are called Broca's aphasics. Broca's aphasia is also called agrammatic aphasia or non-fluent aphasia. Hillis (2007) states that nonfluency includes reduced phrase length, impaired melody and articulatory agility and reduced speed (in terms of words per minute). The speech of Broca's aphasics may be described as 'telegraphic' speech. Their speech is slow, effortful and halting. It is stressful for a patient with agrammatic aphasia to complete a whole sentence. Broca's aphasics take a long time and pause during their utterance of sentences. Broca's aphasics have difficulty in producing morphemes with a grammatical function. Agrammatism, a distinctive characteristic of Broca's aphasia, denotes the impaired production of closed-class elements. This results in ungrammatical utterances as well as the lack of comprehension of certain grammatical constructions (Avrutin, 2001). The speech of agrammatic patients has a clear indication of the lack of markers in the organization of sentences and relatively small use of closed-class items (Szczegielniak, 2007). In Broca's aphasia, the ability of language production is impaired but the ability of understanding language is relatively intact. They could face problems in processing some types of syntactically complex grammatical constructions like the distinction between active and passive sentences. The changing position of object and action in a sentence could present difficulties to Broca's aphasics. The repetition capacity of Broca's aphasics is relatively better with little omissions and substitutions (Kemmerer, 2015).

2. Wernicke's aphasia

Wernicke's aphasia is a kind of aphasia where the production of language is relatively better than the comprehension of language. It is in a sense the opposite of Broca's aphasia. Wernicke's aphasics' speech is fluent but it contains some unusual semantic features. The patient's use of elaborated descriptions instead of using simple words and the creation of new

words (neologisms) that carry little specific meaning is characteristic. Patients with Wernicke's area have damage in the posterior superior left temporal lobe of brain.

3. Conduction aphasia

Conduction aphasics are unable to repeat spoken language because of a disconnection between Broca's and Wernicke's area. The damaged area could be the upper temporal lobe, lower parietal lobe or insula that damage the arcuate fasciculus that is responsible for conduction aphasia. In this category of aphasia, patients also could have some problems in the production and comprehension of language. Repetition capacity is highly impaired in conduction aphasia.

4. Global aphasia

The occlusion of the trunk of the middle cerebral artery causes damage in the perisylvian region that leads to the global aphasia. Global aphasics suffered from subcortical damage in the thalamus and basal ganglia. They have severe impairments in almost every aspect of language.

5. Anomic aphasia

The problem of remembering the names of things is called anomic aphasia. Anomic aphasics only have problems in producing names. Their production and comprehension of speech is relatively intact in contrast with the other types of aphasia. The brain damage in anomic aphasia seems to be at the convergence of the parietal-temporal-occipital cortex (Owens, Metz, & Haas, 2014).

6. Transcortical motor aphasia

Transcortical motor aphasia is similar to Broca's aphasia. The damage in the anterior superior frontal lobe of the language-dominant hemisphere is the reason behind Transcortical motor aphasia. Transcortical motor aphasics have problems in language production, somewhat similar to Broca's aphasics but they are not typically agrammatic. They talk using fragmented sentences instead of a full and complete sentence. Repetition capacity is intact for the Transcortical motor aphasics.

7. Transcortical sensory aphasia

Transcortical motor aphasia is similar to Wernicke's aphasia. The watershed area of the middle cerebral artery in the high parietal lobe of the language-dominant hemisphere is responsible for the transcortical sensory aphasia. Transcortical sensory aphasics have fluency with poor comprehension of language but their speech is semantically not balanced. Repetition capacity is also intact for the transcortical sensory aphasics.

8. Mixed Transcortical

Mixed transcortical aphasia is caused at the internal carotid artery, which compromises blood flow throughout the watershed area of the language-dominant hemisphere. Mixed transcortical aphasics are suffering from a lack of speech, comprehension of spoken language, problems in naming, reading and writing, but have intact repeating capability (Brookshire, 2003).

1.10 Previous work

Much experimental research has been done on Broca's aphasia in different languages, although little work has been done on aphasia in the Bengali language. The nature of agrammatism is not the same for all languages. Broca's aphasics do not show impairment in every grammatical category. They may not be able to produce a tense, verb inflection, subject-pronoun relation, relative sentence, conjunction, Wh-questions, yes/no questions and many other functional categories (Friedmann, 2006). Agrammatic aphasics have impairments in different types of sentences such as passives, objective relations, yes-no questions, Wh-questions etc. (Thompson, Tait, Ballard & Fix, 1999). Phenomena vary from language to language.

1.10.1 Research in other languages

Naama Friedmann (2006) worked on Hebrew and Palestinian Arabic speaking Broca's aphasics to study the use of verb inflections and Wh-questions according to their positions in the syntactic tree. The result showed that the higher parts of the syntactic tree are more impaired than the lower parts. Havik & Bastiaanse (2004) analyzed the omission of definite and indefinite articles in the spontaneous speech of eight Dutch agrammatic speakers with Broca's aphasia. The result showed that the Dutch agrammatic speakers have difficulty in

producing articles. They found no significant difference between definite and indefinite articles. The outcome of this research showed a trend of impairment in definite articles but not in indefinite articles. Bleser & Bayer (1988) examined the morpho-syntactic capacity of German agrammatic aphasics. The experimental tasks showed surprisingly good command of inflected forms in the face of a relatively poor syntax. Wenzlaff & Clahsen (2004) also did a study with German agrammatic aphasics. They examined the use of tense and subject-verb agreement marking. They found high correctness for agreement but severely impaired tense marking. Benedet, Christiansen, & Goodglass (1998) experimented on Spanish and English speaking agrammatic speakers. They found that the relative order of difficulty in both production and comprehension of various grammatical morphemes are same in these two languages. Spanish differs in two respects, i.e. they are relatively better in subject-verb agreement and worse in active and passive voice sentences.

Choy & Thompson (2010) conducted a study with nine Broca's aphasics. They were native speakers of English. This study concentrated on the lexical processing deficit of Broca's aphasia in lexical access or lexical integration and the effect of this deficit on the sentence comprehension capacity. The result of this study showed the comprehension problems in Broca's aphasics are not due to a deficit in syntactic processing, but seem only affected by a possible deficit in lexical integration. Mack, Ji & Thompson (2013) examined agrammatic aphasics with a visual-world eye tracking test to predict and facilitate the integration of a subsequent noun argument by using the verb meaning. They found that the agrammatic aphasics are able to use verb information to facilitate the integration of overt arguments, but their prediction of upcoming arguments is impaired. Friedmann, Gvion, Biran & Novogrodsky (2006) have done an experiment with Hebrew speaking agrammatic aphasics to see the impairment in the comprehension of sentences derived by the verb movement of phrases. The individuals with agrammatic aphasia showed disruption in their comprehension of sentences with verb movement in this study. Peristeri, Tsimpli & Tsapkini (2013) investigated the on-line processing of unaccusative and unergative sentences with eight Greek-speaking Broca's aphasics. Unaccusativity is a process that involves the reactivation of the postverbal trace by retrieving the antecedent provided in the early part of the sentence. The result showed that Broca's aphasics have selective reactivation of the antecedents for the unaccusatives.

Friedmann & Shapiro (2003) examined seven individuals with agrammatic aphasia, seven individuals with conduction aphasia and seven individuals without language impairment and all the participants were a native speaker of Hebrew. The focus of this study was to see the comprehension capacity of agrammatic aphasics in a comparative task between OSV and OVS sentences with SVO sentences and to subject and object relatives. Agrammatic aphasics showed a poor response in the structures that involve movement of noun phrases not only in passive sentences but also in active sentences. Hickok & Avrutin (1996) investigated the comprehension of Wh-questions with Broca's aphasics. They took questions headed by 'which' and 'who'. They have raised two types of syntactic chains that presented in the both subject and object gap version. The experiment was done with a sentence-picture matching task. From this investigation it appeared that the comprehension ability of agrammatic aphasics was in need of more clarification in the attempt to match pictures with sentence constructions. The pictures could demonstrate a judgment about the authenticity of the argument that asymmetric syntactic chains might disrupt the comprehension.

Berndt, Mitchum & Haendiges (1996) tested the difficulty of comprehending semantically reversible active and passive sentences with a sentence-picture matching task. They found that the comprehension of active sentences is better than the comprehension of passive sentences. The roles of agent and patient could be found out during the task where the pictures are relevant to the sentence structure. In some cases, distractor pictures are added in the paradigm to provide an extra effort for the participants. The inconsistency between the sentence constructions and the distractor pictures confirms the comprehension inadequacy. Burchert, Meißner & De Bleser (2008) worked with German agrammatic aphasics. They stated that German has relatively free word order that can result in 'scrambled' sentences. They worked on German agrammatic aphasics with canonical sentences without object movement and noncanonical scrambles sentences with object movement. The result of the study showed that noncanonical constructions are harder to produce for the agrammatic aphasics. The canonicity and movement in the sentence construction can obstruct the production and probably the comprehension of agrammatic aphasics.

Berndt, Mitchum & Wayland (1997) have done a comparative experiment in English, German and Italian language with Broca's aphasics. The SOV sentence construction in English is more static than in German or Italian. German and Italian are more flexible in their word order variations. They tested the declarative sentences in active and passive voice and

in sentences with center-embedded relative clauses. The result of this work failed to obtain any specific pattern in the comprehension deficit of Broca's aphasics but showed relevance with the methodological and theoretical aspect for future research. Salis & Edwards (2005) have examined a single case to find the comprehension deficit in Wh-questions. They took various types of Wh-question in canonical and noncanonical word order. The agrammatic patient was able to understand the canonical questions but showed difficulty in the noncanonical questions. They argued that the deficit of understanding the Wh- questions in aphasia is related to the syntactic aspect rather than the discourse. Yağız & Aydın (2014) worked with Turkish Broca's aphasics to find out the status of the comprehension in lexical processing. They examined the participants through a visual lexical decision task and passive sentence comprehension task. The passive sentence comprehension task contained both active and passive sentences in order to examine whether the participants could comprehend the selective expressions. The result showed that the Turkish Broca's aphasics have difficulty in the passive sentences where the word order is in a theme-agent order. The Broca's aphasics showed no difficulty in the comprehension of active sentences in Turkish because the agent is the first element in the active sentences.

There are many discussions have found in the aspect of active and passive sentences that the Broca's aphasics are more impaired in the passive constructions than the active. In this type of investigations, Druks & Marshall (1995) have discovered a new dimension in the comprehension incompatibility of agrammatic aphasics. They compared the results between two participants that were focused on the active and passive sentences. One participant performed better in the simple actives, active questions, and active essentials and showed less compatibility with passives. On the other hand, the second participant performed better in the simple passives, passive questions and passive essentials, with less compatibility in actives. They have interpreted the response in terms of the distinction made by case theory between structural or inherent case. The first participant's problem of understanding was related to either structural or inherent case followed by a non-linguistic linear strategy to assign thematic roles in all sentences. The second participant had a specific impairment of structural case. He could not interpret actives but could interpret passives because the case in active sentences is assigned configurationally and in passive sentences it is assigned lexically.

Schwartz, Saffran & Marin (1980) tested agrammatic aphasics comprehension ability with the picture-pointing task. Agrammatic patients showed poor performance on reversible

constructions involving spatial prepositions and verbs. The disassociation between meaning and syntactic structure can hamper the comprehension aptitude. It emerged in the discussion of comprehension deficit that change or reconstruction in the major lexical items does not disrupt the comprehension. The comprehension of agrammatic aphasics is highly hampered in the syntactic nodes that are mostly observed in the languages. Friedmann, Reznick, Dolinski-Nuger & Soboleva (2010) worked with Russian-speaking agrammatic aphasics. They explored the understanding of movement-derived sentences to see whether the patients used the morpho-syntactic cues to assist their comprehension. Russian has relatively free word order with inflection and case morphology. The study included the topicalization structures, relative clauses, and SVO sentences. The performance of agrammatic aphasics was better in the SVO and subject-relative sentences than the topicalization structures and object relative sentences.

1.10.2 Bengali aphasia research

The above discussions give good grounds to investigate the comprehension deficits in the Bengali sentential word orders. Imtiaz (2013) has worked on the comprehension deficit of Bengali speaking Broca's aphasics. He tested the trace deletion hypothesis (TDH) to verify the actual state of syntactic agrammatism of Bengali speaking Broca's aphasics. Five sentence types were taken for this research; these are active (SOV), scrambled (OSV), passive, object relative clause and subject relative clause. Each type of sentence was constructed with 3 different semantically reversible verbs and also had picture-matching task. The results of this research have revealed that the canonical active sentence comprehension of Bengali aphasics is intact compared to the other sentences structures.

There is another study by Tamanna (2015) in Bengali which focused on agrammatism in Bengali speaking Broca's aphasic patients. This study has mainly focused on the production task of Bengali speaking agrammatic aphasics. The research of Tamanna (2015) investigated two aspects. The first goal was to find the characteristics of Bengali speaking Broca's aphasics, specifically agrammatism. The second goal was to find the affected grammatical categories in agrammatism. The null hypothesis is that Bengali speaking Broca's aphasic patients show impairment in grammatical categories, which means they have agrammatism, while the alternative hypothesis is that Broca's aphasic patients do not show impairment in grammatical categories. The research was conducted with seven Broca's aphasic patients and

seven normal language users of Bengali. Broca's aphasics were selected according to their medical history of illness. Six grammatical categories of Bengali language have been included in the research. These categories have been taken from the previous works in other languages. It has been an assumption that these categories may also be impaired in Bengali. The six categories are the following.

1. Copula.
2. Postposition.
3. Adverb.
4. Complex sentence.
5. Compound sentence.
6. Subject-verb agreement.

The responses collected from the participants were classified into four categories. The four categories are the following.

1. Correct
2. Incorrect
3. No
4. Replaced with another grammatical category

The result of the research showed that Broca's aphasics have more impairment in producing grammatical categories than the normal speakers could produce. A comparative discussion follows.

Copula: The task was carried out with gap filling sentences. The target word is /hoy/ 'is'. Usually, a Bengali sentence is grammatical without including the copula. Bengali has limited use of such verbs, which can be found in some literary texts.

(16) ʃe (hoy) bʰalo.

He is good.

'He is good'

In example (16), /ʃe bʰalo/ 'He is good' and /ʃe hoy bʰalo/ 'He is good' both express the same meaning. /ʃe bʰalo/ is the usual form. Broca's aphasics produced 11% correct responses and

normal speakers produced 25% correct responses. The correct responses have been taken in order to their understanding of filling the gap with a copula. This grammatical category is affected in both groups of participants. However, it cannot be said that Broca's aphasics showed significant impairment in this category because the percentage of correct responses for the normal speakers is not so high either. Still, it can be stated that Broca's aphasics showed more impairment than the normal speakers did.

Compound sentence: The task was carried out with gap filling sentences. The target word is /ʈai/ 'therefore', which is used to join two clauses in the Bengali language.

(17) ʃoʈʈo koʈʰa boli-ni (ʈai) bipoɖ-e porecʰi.

Truth speak tell-NEG therefore trouble-LOC fall.PRS

'I have not told the truth and therefore I am in trouble.'

In example (17), Broca's aphasics produced 93% correct responses whereas normal speakers produced 100% correct responses. Broca's aphasics changed the grammatical category and showed impairment in the compound sentences.

Postposition: The task was carried out with gap filling sentences. The target word is /por/ 'after'.

(18) griʃʃo-er (por) borʃa aʃe.

Summer-ABL after monsoon come.

'Monsoon comes after summer.'

In example (18), Broca's aphasics produced 36% correct responses whereas normal speakers produced 57% correct responses. Broca's aphasics used nouns in the place of postpositions. Broca's aphasics showed more impairment than normal speakers did.

Adverb: The task was carried out with gap filling sentences . The target word is /proʈidin/, which means 'regularly'.

(19) Ratul-er ʃaʈʰe amar (proʈidin) ɖekʰa hoy

Ratul-ABL with my regularly meet is.

‘I meet Ratul regularly.’

In example (19), Broca’s aphasics produced 64% correct responses whereas normal speakers produced 86% correct responses. Both groups of participants replaced the adverbs with adverbials of time or place. Broca’s aphasics showed more impairment than normal speakers did.

Complex sentence: The task was carried out with a complex sentence. The target is to understand that /je/ and /ʃe/ is referring to /Lokti/.

(20) Lok-ti je goṯokal aʃecʰilo ʃe ɔʃusṯʰo hoye porecʰe .

Man-DET who yesterday come.PST he sick is fall.PRS.

‘The man who came yesterday is sick.’

In example (20), Broca’s aphasics produced 71% correct responses whereas normal speakers produced 100% correct responses. Broca’s aphasics showed impairment in complex sentences.

Subject-verb agreement: The task carried out with four pictures. The target is to understand the action of the noun phrase and produce a sentence with target verbs. As mentioned before that, Bengali does not have any number agreement but it has person agreement with noun and pronoun.

Figure 1.6: Picture regarding subject-verb agreement

(21) a. Kukur-ti cʰele-ti-ke ador korcʰe.

Dog-DET boy-DET-DAT cuddles do.PRS

'The dog is cuddling the boy.'

b. kukur-ti cʰele-ti-r ʃaṯʰe kʰela korcʰe.

Dog-DET boy-DET-GEN with play do.PRS.PROG

'The dog is playing with the boy.'

The figure 1.3 shows that 'The dog is biting the boy.' Here, the target response of verb is /kamracʰe/ 'Biting'. The examples in (21) are the responses given by the aphasics. Broca's aphasics produced 61% correct responses whereas normal speakers produced 82% correct responses. Broca's aphasics showed more impairment in this task. It must be added that the responses in (21) do not necessarily point to a lexical choice problem, but could also be explained by different perceptions of the depicted situation in Figure 1.6.

The outcomes of copula and subject-verb agreement task are not significant because these tasks are not representative for Bengali. The overall conclusion was, however, that the Bengali speaking Broca's aphasics showed more impairment in all grammatical categories than the normal speakers. However, the results are not highly significant. Further studies can be performed to study effects in different grammatical categories.

The discussions in this chapter were meant to give a logical theoretical base for the research presented in the remainder of this work. Deficits in language production as well as in comprehension in Broca's aphasics have been shown. Therefore, the following research will be presented as an important addition in the perspective of our knowledge of Broca's aphasia in Bengali.

Chapter 2: Method

To test the impairment of Broca's aphasics in comparison with normal speakers of the Bengali language, two experiments have been performed. Experiment 1 has focused on a specific grammatical category, which is postposition. The main concern of this task is to investigate the production capacity of agrammatic aphasics. Experiment 2 has been done with alternative word orders and was aimed at checking comprehension deficits.

2.1 Experiment 1

2.1.1 Participants

The total number of participant for this experiment was 30. Two groups of participant have participated in this experiment. The first group consisted of Bengali-speaking individuals with Broca's aphasia and the second group had normal speakers of Bengali language. The number of Broca's aphasics was 20 and the number of normal speakers was 10. Broca's aphasics were from three different hospitals: the National institute of neurosciences hospital, Bangabandhu sheikh mujib medical university and Uttara adhunik medical college, all located in Dhaka, Bangladesh. The research was done with Broca's aphasics in the age range of 40-70 with age matched normal speakers. There were 26 male and 4 female participants. Broca's aphasics took approximately 10-15 minutes and normal speakers took approximately 5-7 minutes for this experiment. The details of the patients are attached in Appendix 3.

2.1.2 Materials

The experiment has done with picture and sentence stimuli. Five questions, each related to a picture, were presented to the participants for this experiment. The pictures that took in the main experiment expressed the spatial and temporal situations. A practice trial was conducted to introduce the experiment to the subjects. Two separate questions and pictures were presented to the participants for the practice trial. The pictures that took in the practice trial, one expressed the spatial or temporal situation and the other one expressed a causal situation. A set of expected answers was set for all the sentences. The sentences and pictures regarding this experiment are attached in Appendix 1. The pictures were made in way that the participants could differentiate all the elements and could give the right response. As

mentioned before, the sentences in Bengali could be produced with or without postpositions. Sentences could be produced with a locative case marker instead of a postposition if the situation in the sentence demands it. Therefore, the pictures and questions were designed so as to make sure that the only appropriate responses were sentences with postpositions. The pictures included animate and inanimate elements. Animate elements were 'cat', 'boy', 'girl', 'man' and inanimate elements were 'table', 'chair', 'almirah', 'bed', 'hammer', 'sofa' etc. The animate and inanimate elements in all the stimuli were distributed in same way to make the task more comprehensible for the participants.

2.1.3 Procedure

This experiment was the same for both groups of participants. This experiment started with the instructions. Participants were instructed to participate firstly in the practice sessions and then they begun the main experiment. Every session started with the presentation of a picture. A question regarding the picture was presented to reach the target answer.

Figure 2.1: A Picture stimulus regarding Postposition.

Figure 2.1 is showing a chair, two books and one football. The question for this picture is 'Where is the football?' and the expected answer is 'The football is on the book.' If subjects are able to produce the target sentence with the correct postposition then it was considered as a correct response. As discussed before, the picture materials were prepared in a way to avoid

the production of locative markers instead of postpositions. This picture will only trigger the production of a postposition, as in (22a).

Figure 2.2: Picture stimulus regarding locative marker.

(22) a. Football-ti boi-er upore rak^{h}a ac^{h}e.

Football.DET book.GEN on.POST keep be

'The football is on the book.'

* b. Football-ti boi-e rak^{h}a ac^{h}e.

Football.DET book.LOC keep be

'The football is on the book.'

The example (22a) is the correct response for this task. On the other hand, example (22b) is incorrect. The use of locative marker in (22b) makes the meaning incomprehensible.

In contrast to Figure 2.1, which has three objects, 'chair', 'book' and 'football', Figure 2.2 shows a picture with only two elements, 'chair' and 'football'. In the latter case, the question 'Where is the football?' may lead to two different correct answers, one with a postposition and the other one with a locative marker, as shown in (23).

(23) a. Football-ti ceyar-e rak^{h}a ac^{h}e.

Football.DET chair.LOC keep be

'The football is on the chair.'

b. Football-ti ceyare-er upore rak^{h}a ac^{h}e.

Football.DET chair.ABL on.POST keep be

'The football is on the chair.'

The examples in (23) are both correct in Bengali. The target of this experiment is to test the production of postpositions. Therefore, the pictures were prepared with three elements to make sure the production of postpositions was intended.

All the materials for this experiment including sentences and pictures both are prepared to keep those facts in mind so that the outcome of this research can get a valid ground.

2.2 Experiment 2

The second experiment tested canonical and alternative word orders. The materials were pictures and yes/no questions. The word order of these yes/no questions was changed in different ways to test the comprehension ability of agrammatic aphasics.

2.2.1 Participants

The participants were the same as in experiment 1 for this task. The time of the experiment was different from experiment 1. Broca's aphasics took approximately 20-30 minutes and normal speakers took approximately 15-20 minutes for this experiment.

2.2.2 Materials

A sentence-picture matching task has set for this experiment. Five yes/no questions from Bengali language have been constructed for this experiment. Three pictures were included with each question, one of which was to be selected by the subjects. This test was designed to observe the comprehension ability of the participants. Practice sessions were also part of this experiment, which was formed with another two yes/no questions and three pictures regarding these questions. As stated before, the basic sentence construction of Bengali is

SOV. Due to the relatively free word order, this construction could be shuffled in many ways. Each sentence was altered into three different word orders, as presented in (24a-c).

(24) a. SOV – Subject+Object+Verb

b. OVS – Object+Verb+Subject

c. VOS – Verb+Object+Subject

Pictures were tagged as R means ‘Related, O means ‘Opposite’ and UR means ‘Unrelated’. Three picture orders made for this experiment. Picture orders are presented in (25a-c).

(25) a. UR+O+R – unrelated+opposite+related

b. O+R+UR – opposite+related+unrelated

c. R+UR+O – related+unrelated+opposite

The picture materials have been developed for this experiment to give a proper stimulus leading to the right responses. Each picture contains animate and inanimate elements.

(26)

a. b. c.

Example (26) shows three different pictures where each picture contains an agent, a patient and an instrument. Example (26a) shows a boy hitting a girl with a stick and both are sitting on a bench. Example (26b) shows the inverse: a girl is hitting a boy with a stick. Example

(26c) shows a boy and a girl is sitting together on a bench and eating ice cream. The 'boy' and the 'girl' act as an agent and patient in alternate pictures and a 'stick' or 'icecream' act as an instrument in the pictures. A common ground 'bench' was put in all the pictures. There are lot of similarities between the pictures to keep conditions constant. Other pictures included in this experiment had animate items such as 'boy', 'girl', 'child', 'dog' and inanimate items such as 'stick', 'ice-cream', 'chocolate', 'biscuit', 'flower', 'book', 'gift', 'bench' etc.

Each sentence was randomized with different word orders and picture orders. All the randomized sentences were equally distributed among the participants to check if different orders of pictures with each sentence have any effect in the results or not. Three different sets of trials were made for this experiment. Each trial contained 15 randomized sentences. All the stimulus material is attached in Appendix 2. The distribution of Randomized sentences with pictures is in Table 2.1.

Number of participants	Word order	Picture order
4	SOV	UR+O+R
3	SOV	O+R+UR
3	SOV	R+UR+O
4	OVS	UR+O+R
3	OVS	O+R+UR
3	OVS	R+UR+O
4	VOS	UR+O+R
3	VOS	O+R+UR
3	VOS	R+UR+O
Total = 30		

Table 2.1: Randomization of sentences and pictures.

The overall situation is here that each sentence order is randomized with every picture order. All the picture orders are mixed with all the sentence orders to see the difference in the response whether it is affected by the distribution of picture order and sentence order.

2.2.3 Procedure

This experiment was conducted in the same way for both groups of participants. This experiment started with the basic instructions as in experiment 1. Participants were instructed to participate firstly in the practice sessions and then they begun the main experiment. Each

trial of 15 sentences was presented to them. They were asked to listen to each sentence first and then point out the picture which they think is related to that sentence. This experiment was a test for the comprehension ability of Broca's aphasics. Speech production was not included in the procedure. Listening to the sentences and pointing out on the picture was sufficient for this task. Pictures were sequenced as 1, 2 and 3. This sequence helped to make the response faster.

27)	John ki ʃe je Mary-ke marc^{h}e ? John this.Q he who Mary.DAT hit.PRS.PROG 'Is this John who is hitting Mary?'	UR+O+R	SOV

a. b. c.

Example (27) shows the sentence 'Is this John who is hitting Mary?' Three pictures were put in sequence: one with unrelated meaning, one with opposite meaning and one that corresponds to the sentence. The right response for this sentence is picture number (27c) which represents a situation that would give an affirmative answer to the question 'Is this John who is hitting Mary?'. This picture is showing the action of 'hitting' has done by the agent John. On the other hand, picture (27b) is showing opposite action, i.e. the actor and patient have switched roles: the action of 'hitting' is done by Mary. Picture number (27a) is unrelated to the sentence and is therefore considered as the distractor for the participant.

2.3 Challenges and limitations

This work is primarily an investigation into the language production and comprehension capability of Bengali speaking Broca's aphasics. I faced some problems during the execution of this research. It is always difficult to work with the patients. These kinds of experiments

tend to be tiring for them. Two patients quit the experiment before completion. Their data was not included in the analysis. These patients were confused, tired and a bit stubborn. The attendants of the patients were reluctant to see their patients take part in the experiments as they felt it would be too tough for the patients. As the population rate of Bangladesh is high, the hospitals are overcrowded all the time. It was not possible to do a repetition of the tasks with the same patients. The time for the execution of the experiments was also limited as the hospitals took a long time before giving permission for the data collection. Therefore, the data collection process needed to be completed in a short period. Summing up, the present research faced several obstacles in its execution, although I believe the collected data is valid and the present work has laid solid ground for further research on the Bengali speaking Broca's aphasics.

The discussions in this chapter have showed the method and procedure that has been followed to conduct the experiments and collect the data for this research. The experimental stimuli were carefully prepared, as explained above, and are further documented in the appendices.

Chapter 3: Results

This chapter will discuss the findings of these two experiments and the statistical data analysis.

3.1 Experiment 1

As per the previous discussion, the primary assumption of experiment 1 was that the aphasics make more mistakes than the normal speakers of Bengali in producing the postpositions. The data collected in this experiment has been analyzed and interpreted in the light of different research questions. The outcomes will be presented one by one. The null and alternative hypothesizes for this analysis are the following:

H0: Aphasic and normal participants do not show any difference in their responses.

H1: Aphasic and normal participants show differences in their responses.

The target postpositions set for this task are listed in (28)

(28) a. /upore/ ‘on’

b. /nice/ ‘under’

c. /pec^{h}one/ ‘behind’

d. /ʃamne/ ‘front’

e. /maɲ^{h}k^{h}ane/ ‘middle’

Based on the target responses that has presented in (28a–e) the task has been designed and executed. The responses that have been collected from the both group of participants are shown in tabular form in Appendix 4. That table shows the variations in the responses of two groups of participants. A noteworthy part of these responses is item number five, which comes with three different types of responses that represent the same meaning in Bengali.

(29) a. kalo cek-er baliʃ-ti kot̪ʰay rakʰa acʰe?

Black striped.ABL pillow.DET where keep be

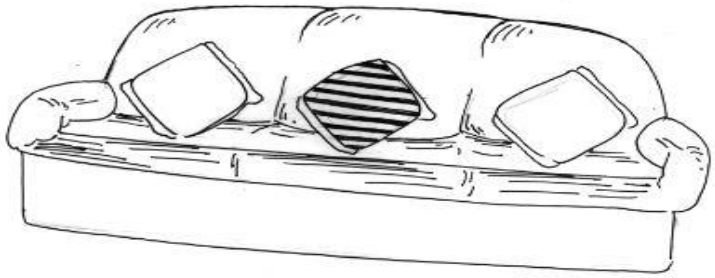
'Where is the black striped pillow?'

b. kalo cek-er baliʃ-ti sofa-r maɟʰkʰane rakʰa acʰe.

Black striped.ABL pillow.DET sofa.ABL middle.POST keep be

'The black striped pillow is in the middle of sofa.'

c.



Example (29a) shows the question, (29b) shows the expected answer and (29c) shows the picture for item number 5. The target postposition for this sentence is /maɟʰkʰane/ 'in the middle'. The collected responses contain three different postpositional words, which are /maɟʰkʰane/ 'in the middle', /maɟʰe/ 'middle' and /mod̪d̪ʰe/ 'between' that carry similar meanings in Bengali. Therefore, these three responses have been taken as equivalent and are considered correct responses for the two groups of participants.

The analysis of this experiment has been done with different assumptions. The outcomes of these assumptions is discussed below-

Question 1: Are response categories different according to the types of responses?

Type	**Correct**	
	Yes	**No**
Aphasic	73	27
Normal	45	5

Table 3.1: Analysis of responses by participant type (normal vs. aphasic)

Table 3.1 shows the response data in terms of correctness according to the type of participants. These are also graphically presented in Figure 3.1, in which the dotted lines represent the average for both groups.

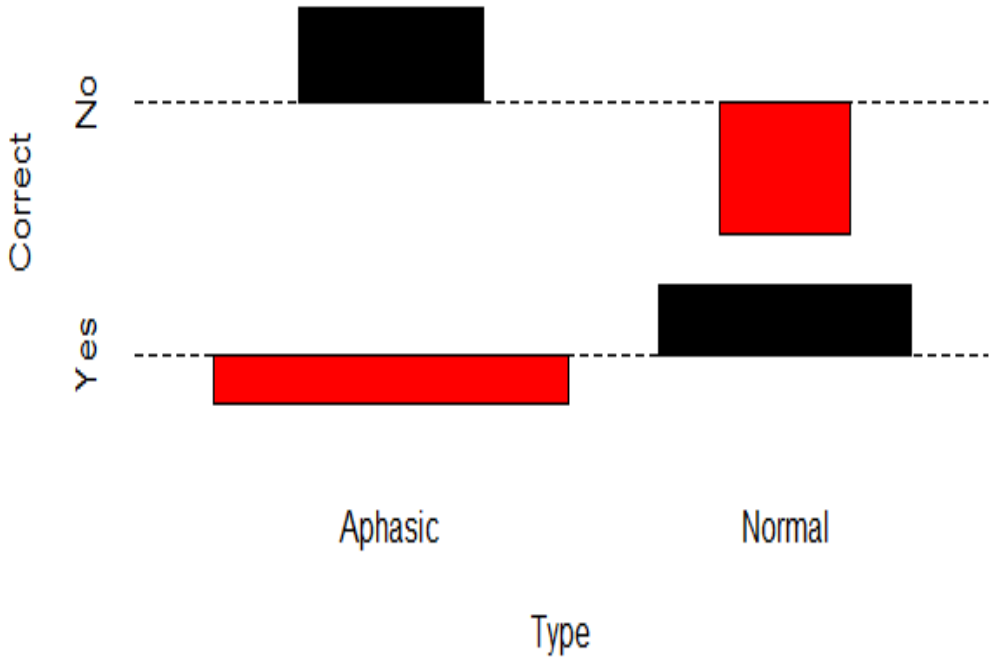


Figure 3.1: Analysis of responses by participant type

Figure 3.1 shows that there is an association between the responses 'No', which is the incorrect answers and the participant group 'Aphasic'. The number of observations is higher in the category 'No' for the aphasics, which means that they have faced difficulty to produce postpositions. On the other hand, the number of observations in the category 'Yes', which is the correct responses for the normal speakers means that they did not show difficulty in the production of postpositions.

A Pearson's Chi-squared test was performed and its results are shown in Figure 3.2. The significance level was $p<0.05$, which is-$\chi^2_{(df=1)}$ =4.8, p= 0.03. This suggests that there is a significant difference between aphasics and normal speakers with respect to mistakes in producing postpositions. Aphasia patients and normal participants react to the test in significantly different ways. The analysis of this experiment suggest that we reject the null hypothesis and accept the alternative hypothesis that the Broca's aphasics show a difference in the response categories of correct and incorrect answers.

The Phi test, which is a measure of effect size shows a small to medium effect of $\phi = 0.18$. A value of 0.1 is considered a small effect in Phi. The effect size, which is between small and medium, suggests that the questions need to repeat many times for reliable answers. Here, the significance of the experiment has detected with only five items due to the impossibility to do a repetition task although it shows a representative output for this study.

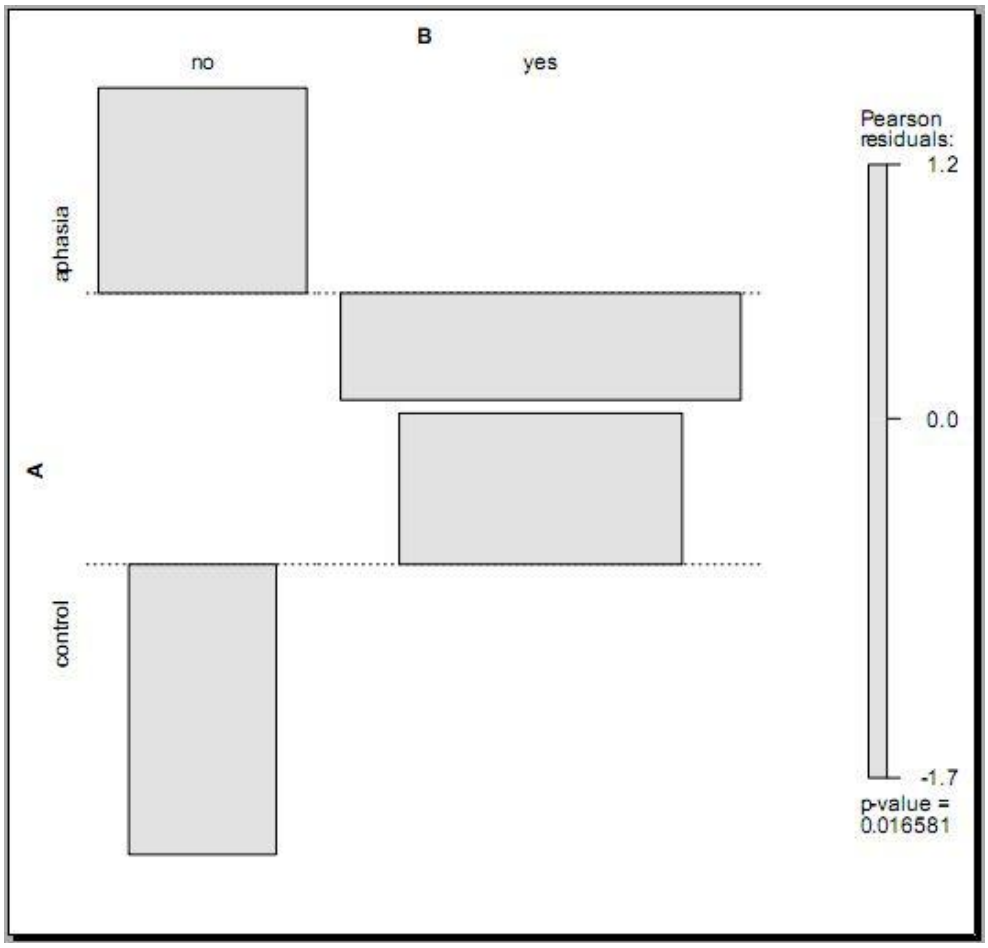


Figure 3.2: Analysis of responses by correctness of answer (yes=correct, no=incorrect)

Figure 3.2 shows that the significance is not from any specific cell, but it has an overall crossover effect. Aphasics show relatively more errors and less correct responses than average and the reverse for the normal group, which show less errors and more correct responses than average.

Question 2: Are response categories different according to the items of responses?

Type	**Item**					**Correct**	**Type**	**Item**					**Correct**
	1	2	3	4	5			1	2	3	4	5	
Aphasic	14	17	9	14	19	Yes	**Aphasic**	6	3	11	6	1	No
Normal	8	10	9	9	9	Yes	**Normal**	2	0	1	1	1	No

Table 3.2: Analysis of responses by items

Table 3.2 shows the data per item with 'Correct' and 'Incorrect' answers for both types of participant groups. The number of correct answers of normal participants is higher than the answers of the aphasic group of participants. The correctness of answers per group does not show any significant difference between items. The correct answers are independent of the items. The aphasic patients also give correct answers. In some cases, aphasics performed as the normal participants. The item number 3 and 5 looks stand out in the incorrect responses. The item number 3 where the aphasics gave most incorrect answers. On the other hand, the item number 5 does not have much distinguishing value because participants from both groups have given different types of answer which are also taken as a correct response. They have used different postpositional words which have same in the meaning. Therefore, all these postpositional words have taken as correct responses. Figure 3.3 is the graphical representation of Table 3.2.

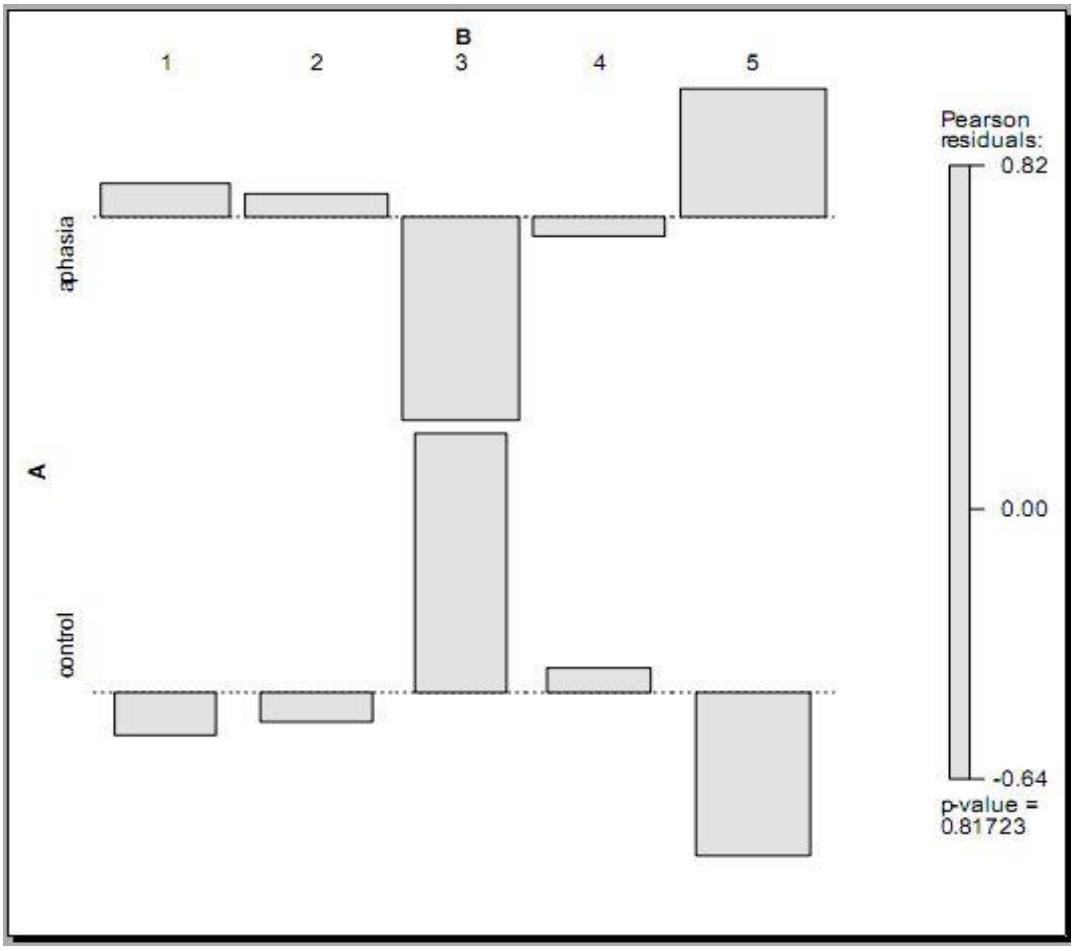


Figure 3.3: Analysis of correct responses by the items (normal vs. aphasic)

In Figure 3.3, the Pearson's Chi-squared test shows $\chi^2_{(df=4)}$ =1.55, p= 0.8, so the effect for items are not significant. The notable part of this test is that item 3 has *less* correct answers and item 5 has *more* correct answers than expected from the aphasics. The Phi test of effect size is shown below-

Participant groups	**Items**				
	1	**2**	**3**	**4**	**5**
Aphasic	0.50	0.47	-2.29	-0.47	1.18
Normal	-0.53	-0.49	3.43	0.48	-1.63

Table 3.3: Phi test of the Effect size

Table 3.3 shows the effect size per cell or serendipity (Johansson, 2017). Each number of the above table shows the signed effect size *multiplied* by 100, if distributed by each cells contribution to χ^2(significance), to test the effect of each item. For example, in item 1, the

number for the aphasic group is 0.50/100 = 0.005, which is close to no effect for this item. The other numbers also can be divided like this to testify the significance of each item in this study. Item 3 has an effect size of at most 0.03, which is negligible.

Question 3: Are response categories different according to the subjects?

Response	**Subjects**									
	NE	**SA**	**BH**	**AA**	**KMA**	**AH**	**MKM**	**DR**	**KB**	**MS**
Yes	4	4	3	3	5	4	3	3	2	5
No	1	1	2	2	0	1	2	2	3	0
Response	**Subjects**									
	AH2	**JH**	**SA2**	**AJ**	**AK**	**FA**	**MR**	**PCM**	**TH**	**SB**
Yes	1	4	3	4	5	4	3	5	5	3
No	4	1	2	1	0	1	2	0	0	2

Table 3.4: Analysis of the responses by the aphasic subjects

In Table 3.4, the response of the aphasic subjects is presented. The participants 'KMA', 'MS', 'AK', 'PCM' and 'TH' show the perfect score. The participant 'AH2' is showing less number of correct answers.

3.2 Experiment 2

This experiment investigated the effect of alternative word orders in Bengali on the comprehension capability of Bengali speaking Broca's aphasics.. The null and alternative hypotheses of this test are the following.

H0: Aphasic and normal participants do not show any difference according to the different word orders.

H1: Aphasic and normal participants show differences in their responses to the different word orders.

Question 4: Are response categories different according to the participant groups?

	Response		
Group	**Correct**	**Distractor**	**Opposite**
Aphasic	206	20	74
Normal	148	0	2

Table 3.5: Analysis of all responses by groups (normal vs. aphasic)

Table 3.5 shows the responses according to the groups of participants, i.e. the Broca's aphasics and normal speakers of Bengali. The tag 'Response' has three categories 'Correct', 'Distractor', and 'Opposite' which refer to the choice of pictures that were used as stimuli for this experiment. A Chi-squared test showed that the 'Opposite' category suggests a significant difference between the two groups of participants. Aphasic patients significantly more often chose the opposite picture. Another notable output is that the normal speakers never chose the category 'Distractor'. The Pearson's Chi-squared test shows significance at the level of $p<0.001$, which is- $\chi^2_{(df=2)=}53.6$, p=2.2084e-12. Figure 3.4 is a graphical representation of the data in Table 3.5.

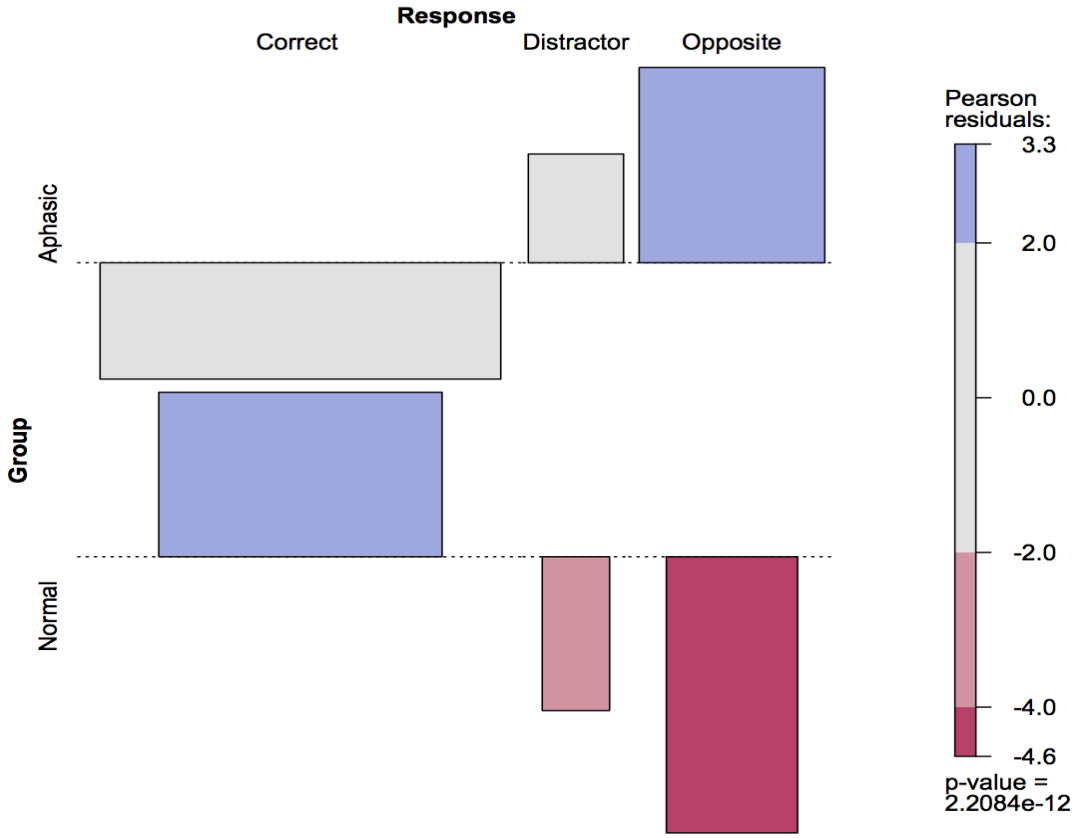


Figure 3.4: Analysis of responses by group for (normal vs. aphasic).

Figure 3.4 shows that the aphasic group has a very significantly higher frequency of opposite responses. Additionally, it also shows that the normal group hardly ever chose the distractor. The bar length of the graph represents the number of observations and the height of the bars represents the response of the participants. The colors show the p-values. The aphasics have not shown good response in comparison with the normal speakers of Bengali language in any of the response categories.

Question 5: Are response categories different according to the word orders?

	Response		
Condition	**Correct**	**Distractor**	**Opposite**
OVS	111	10	29
SOV	121	5	24
VOS	122	5	23

Table 3.6: Analysis of responses by word orders

Table 3.6 shows the responses according to the different word orders. There are no significant differences but the OVS construction of the sentence seems to be marginally more difficult with Distractor and Opposite pictures.

Question 6: Are response categories different according to the individual subjects?

Response	**Subjects**									
	NE	**SA**	**BH**	**AA**	**KMA**	**AH**	**MKM**	**DR**	**KB**	**MS**
Correct	11	15	13	9	15	15	12	8	11	9
Distractor	3	0	0	0	0	0	0	0	1	0
Opposite	1	0	2	6	0	0	3	7	3	6
Response	**Subjects**									
	AH2	**JH**	**SA2**	**AJ**	**AK**	**FA**	**MR**	**PCM**	**TH**	**SB**
Correct	6	11	6	7	12	15	6	9	6	10
Distractor	1	0	1	0	0	0	5	2	6	1
Opposite	8	4	8	8	3	0	4	4	3	4

Table 3.7: Analysis of responses for the aphasic subjects

Table 3.7 shows the responses by subject in three categories, which is ‘Correct’, ‘Distractor’ and ‘Opposite’. The ‘Distractor’ and ‘Opposite’ responses are both incorrect answers, and

only two or three aphasic subjects chose mostly distractor images. More reliable statistics might be obtained by conflating distractor and opposite responses to "incorrect" choices. In Table 3.7, SA, AH and FA show a perfect score for this test, which is somewhat unexpected. There are 2 subjects, MR and TH, which stand out as choosing more distractors, which is different from the profile of the others. Participants AH2, SA2 and AJ stand out with more errors toward the 'opposite' response. Figure 3.5 shows the graphical representation of Table 3.7. Significance is color coded.

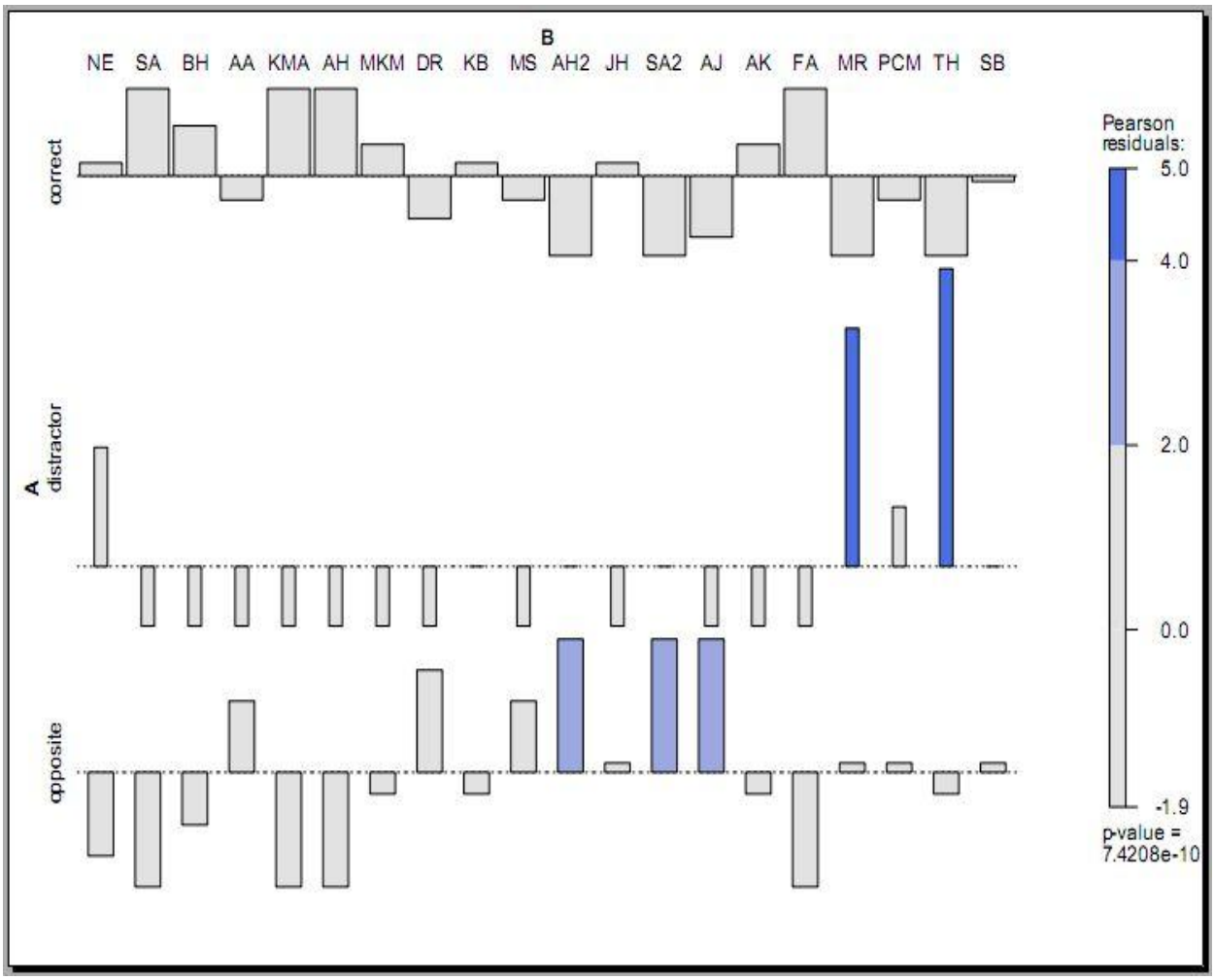


Figure 3.5: Analysis of responses by aphasic subjects

In Figure 3.5, there are 5 subjects that seem to be more severely affected than the others; these are AH2, SA2, AJ, MR, and TH. The notable part of this graph is the choice of 'Distractor'. The participants 'MR' and 'TH' took the response 'Distractor' significantly more often than other participants. The participants 'AH2', 'SA2' and 'AJ' took the response 'Opposite' significantly more often than the other participants.

An analysis was also performed with only two categories by conflating 'Distractor' and 'Opposite' into the new category 'Incorrect'. The correct and incorrect responses from individual aphasic patients are shown in Figure 3.6. From this analysis, it can be seen that there are 4 subjects, SA, KMA, AH and FA, who stand out with a perfect score. They have performed just like the normal participants, which is different from the expected. The Pearson's Chi-squared is highly significant: $p<0.001$, $\chi^2_{(df=19)}=61.4$, $p<<0.001$, which means that some subjects are significantly different in their responses. From the previous tests, MR and TH, and to some extent NE, have been pointed out as choosing the distractor more often, while SA, KMA, AH, and FA have scores that would place them in the normal group.

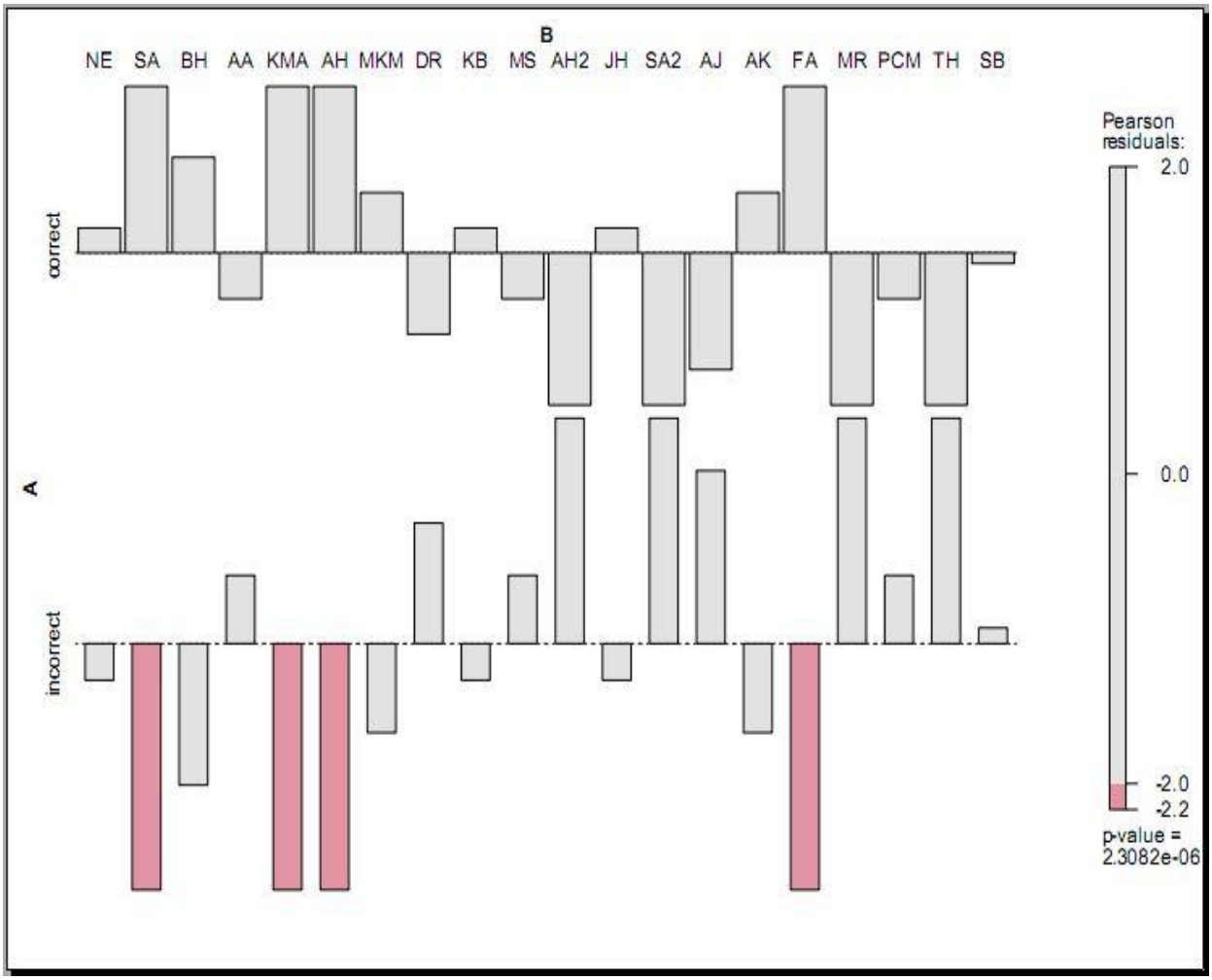


Figure 3.6: Analysis of responses for the aphasic subjects (Correct vs. incorrect)

3.3 Discussion

The results show that in both experiments the null hypothesis has been rejected. Experiment 1 has limited effect size for the aphasics but the outcome has given a platform to do further research, especially a repetition of the tasks. Of particular interest are the participants who showed correct responses, which would place them in the normal group. Four participants, SA, KMA, AH and FA have shown perfect scores in experiment 2. These participants were tested with different trials for experiment 2. The reason behind the perfect score might be in the difference between the trials. Trial set 1 was given to the participants 'KMA', 'AH' and 'SA', while trial set 3 was given to participant 'FA'. The noteworthy part is that there is no perfect score for trial set 2. The design with different trial sets, which was intended to check whether the difference in the randomization of pictures and sentences has any effect on the responses, has resulted in different sets which may have different levels of difficulty, so that the trials 1 and 3 were more comprehensible for aphasics than the trial 2. The randomized trial sets are included in Appendix 2.

The two participants 'MR' and 'TH' who frequently chose the 'Distractor' might be confused by the verb, which is perhaps why they do not choose the 'Opposite' one. Another possibility is that participants with perfect scores or choosing the 'Distractor' might have improved their language capability. The participants 'AH2', 'SA2' and 'AJ' who took the response 'Opposite' might have difficulty to understand the role of agent and patient as well as the verb. In the opposite pictures, the role of the agent and patient has showed in reversed way. The reversed action in the opposite pictures was more difficult for the participants 'AH2', 'SA2' and 'AJ'.

In experiment 1, the participants 'KMA', 'MS', 'AK', 'PCM' and 'TH' had perfect scores. The reason behind these perfect scores may be that for the item number 5 three different answers were accepted as correct responses. If the answers of these five participants were not the same as the originally expected answer then there had been no chance to get a perfect score in this task. The participant 'AH2' is showing less correct answers. 'AH2' showed the highest number of errors among all the aphasic patients.

In both experiments, the subject 'KMA' showed a perfect score and should therefore perhaps be considered to belong in the 'normal' group. In contrast, the subject 'AH2' showed severe impairment in both tasks. 'AH2' was not able to perform not only the production task but

also the comprehension task. The other subjects showed more or less impairment in the both tasks. It therefore seems that the experiment could lay the grounds for developing tests that assess the level of severity of the impairment.

The above discussion on the results of the experiments, which have been done for this research, shows that the Broca's aphasics showed both production and comprehension deficit. One another idea is here that not necessarily who have problem with production must have problem with the comprehension and vice versa. It is possible that some participants could have problem with production with intact comprehension ability and some other participants have problems with comprehension with intact production ability. The patients with agrammatic aphasia have problems in producing and comprehending grammatical categories that may be language dependent. The experiment on the production of postpositions does not show results that are conclusive enough to establish that the Bengali speaking Broca's aphasics have difficulty in this category. It only shows a tendency of deficit that needs to be in further examination. The comprehension deficit with the alternative orders of the sentences seems to clearly indicate that the Bengali speaking Broca's aphasics have difficulty in this area.

Chapter 4: Further research and Conclusion

4.1 Research outcomes

This chapter will discuss the findings and future prospects of this research. The deficit and inability of using grammatical components in aphasia is a situation that affects the whole language system of a person. The specific pattern of the deficit differs from language to language. The outcome of this research has found evidence to production as well as comprehension deficits in Bengali speaking Broca's aphasics. Broca's aphasia focuses on the production deficit due to the damage of language area in the brain. There are however also many examples in different languages that suggest that the comprehension capability of Broca's also can be hampered.

4.1.1 Production problem

Experiment 1 has dealt with the production deficit of postpositions. The result of this experiment has drawn attention to the trend but does not give definitive evidence about the production deficit regarding postpositions. There is a chance that errors of items are correlated, but the amount of the data of this experiment was not sufficient to establish the correlations. Repetition of the same task would be a way of strengthening the evidence. The overall view of this experiment is that the Broca's aphasics have shown difficulty in the production of the postpositions.

4.1.2 Comprehension problem

Experiment 2 has dealt with the comprehension deficit regarding canonical (SOV) and noncanonical (OVS and VOS) sentence structures. The results of this experiment are stronger than those of experiment 1. As expected the normal speakers have shown good performance in all categories of sentences. The Broca's aphasics showed impairment in every category. The most interesting outcome is that they faced a problem with the 'Opposite' category of the pictures in all categories of sentences. Moreover, the 'OVS' construction of sentence has showed more impairment in association with the 'distractor' and 'opposite' pictures. The result indicates a pattern of impairment in 'OVS' constructions for the Bengali speaking Broca's aphasics. When the object moved into the first position of a sentence and subject

goes to the end of the sentence, the correct interpretation of all sentence constituents seems to need an intact language capability, which is not present in the Broca's aphasics. Their damaged language area of the brain obstructs the comprehension ability and made the task difficult.

4.2 Further research

This research has great opportunities to do further investigations on the production and comprehension complexity of Bengali speaking Broca's aphasics.

4.2.1 Experiment 1

This experiment only focuses the production task of postpositions. There is a larger scope of function words that we can examine in addition to postpositions, and we can also design a comprehension task for them, as what we did in experiment 2. Postpositions which are opposite in meaning can be presented with related and opposite pictures to further investigate the comprehension deficit of Broca's aphasics.

4.2.2 Experiment 2

The comprehension capability has been tested in this experiment. The testing material was yes/no questions. Bengali has different categories of sentence structures that can be used in testing both the production and comprehension capabilities. We could examine the comprehension deficit along with some production task. The relative clauses in Bengali language construction would be a potential area. The syntactic movement of relative clauses could be difficult to parse for the Broca's aphasics because it requires understanding the connection between the relative pronoun and its antecedent. On the other hand, the complex construction of relative clauses could be difficult in production tasks. Therefore, relative clauses could be included in both production and comprehension tasks for Bengali speaking Broca's aphasics.

4.3 The application of results

The results of this research have important implications for the further development of aphasia related research and development in the Bengali language. Some aspects of applications are discussed below-

4.3.1 Development of the tests

The results of this research could be applied to the development and implementation of tests that assess the level of impairment in Bengali aphasics. In Bengali, previous research on aphasia tests is very limited due to the lack of proper instructions about the procedures of experimental tests. The outcome of this research has indicated that time is a very important factor for tests. It is difficult to do repetition tasks in the context of Bangladesh because people come from different parts of Bangladesh to the hospitals. Therefore, the materials should be constructed in a way that further research, as well as developed tests, could be done in the available time. In this regard, the present research gives a good indication about the test procedures to make sure valid results are obtained.

4.3.2 Development of the research tools

In the context of Bangladesh, the availability and set-up of research tools in the hospitals is not easy. The population growth is very high in Bangladesh and the number of hospitals is insufficient for this population. Therefore, the hospitals are very busy and overcrowded all the time. The materials of this research should be applied in a way that it could be performed under any circumstances. The outcome of this research shows that the nature of production and comprehension deficit of Broca's aphasics can be diagnosed by the manual way of presenting data and collecting the responses. It does not per se need digital equipment. However, with the support of testing software and devices, time could be saved and in the same time period, more participants could be examined in a more efficient way. Moreover, a large scale study and in-depth study could explore new spheres on the study of language production and comprehension deficit among Bengali Broca's aphasics.

4.4 Conclusion

This thesis has resulted in new knowledge about the Bengali speaking Broca's aphasics. In summary, this work has shown more errors than the normal speakers in specific categories of the Bengali language. Experiment 2 has shown that the aphasics make more mistakes in the OVS construction of the sentences with 'distractor' and 'opposite' pictures. Experiment 1 has remarked an overall effect of the test on the aphasics but it does not draw attention to any specific characteristics. The effects on the production of postpositions have a scope that could be extended and examined more closely in further research. The test on the comprehension capacity of Broca's aphasics with the reversible word orders of Bengali have portrayed clearly that the Broca's aphasics not only suffered with language production but they could also suffer with comprehension and the link between syntactic and semantic processing. Their understanding of the sentences is hampered due to the injury in the language area of brain.

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Appendix 1: Stimulus material for Experiment 1

1.

QUESTION: Football-ti koʈʰay rakʰa acʰe ?

Football.DET where keep be ?

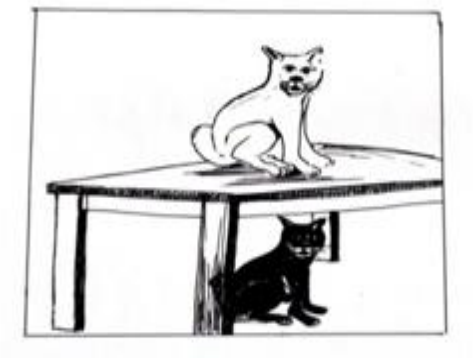
‘Where is the football?’

TARGET: Football-ti boi-er upore rakʰa acʰe.

Football.DET book.ABL on.POST keep be

‘The football is on the book.’

2.



QUESTION: kalo biɽal-ti kot̪ʰay boʃe acʰe ?

Black cat.DET where sit be

‘Where is the black cat?’

TARGET: kalo biɽal-ti tebil-er nice boʃe acʰe.

Black cat.DET table.ABL under.POST sit be

‘The black cat is sitting under the table.’

3.

QUESTION: cʰele-ti kot̪ʰay ɖariye acʰe?

Boy.DET where stand be

‘Where is the boy standing?’

TARGET: cʰele-ti almari-r pecʰone ɖariye acʰe.

Boy.DET Almira.ABL behind.POST stand be

‘The boy is standing behind the almira.’

4.

QUESTION: meye-ti koʈʰay ɖariye acʰe ?

Girl.DET where stand be

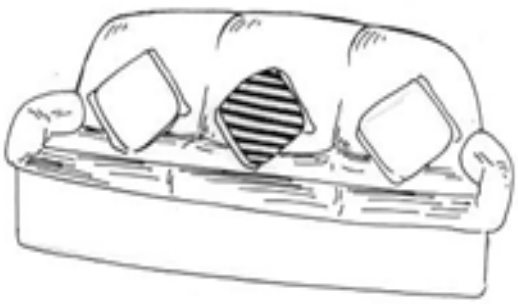
‘Where is the girl standing?’

TARGET: Meye-ti gaɽi-r ʃamne ɖariye acʰe.

Girl.DET car.ABL front stand be

‘The girl is standing in front of the car.’

5.



QUESTION: 1. kalo cek-er baliʃ-ti koʈʰay rakʰa acʰe ?

Black striped.ABL pillow.DET where keep be

‘Where is the black striped pillow?’

TARGET: kalo cek-er baliʃ-ti sofa-r maɟʰkʰane rakʰa acʰe.

Black striped.ABL pillow.DET sofa.ABL middle.POST keep be

‘The black striped pillow is in the middle of sofa.’

Practice trials:

6.

QUESTION: lok-ti ki korcʰe?

Man.DET what do.PRS.PROG?

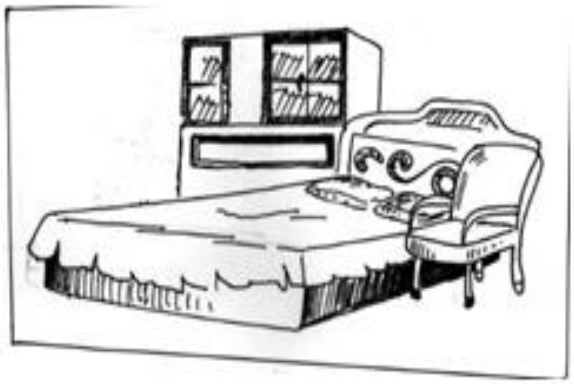
‘What is the man doing?’

TARGET: lok-ti haʈuri ɖiye it vaŋcʰe.

Man.DET hammer.INST with.POST brick break.PRS.PROG

‘The man is breaking bricks with hammer.’

7.



QUESTION: ceyar-ti koʈʰay rakʰa acʰe ?

chair.DET where keep be

‘Where is the chair?’

TARGET: ceyar-ti kʰat-er paʃe rakʰa acʰe.

chair.DET bed.ABL beside.POST keep be

‘The chair is keeping beside the bed.’

Appendix 2: Stimulus material for Experiment 2

Trial 1:

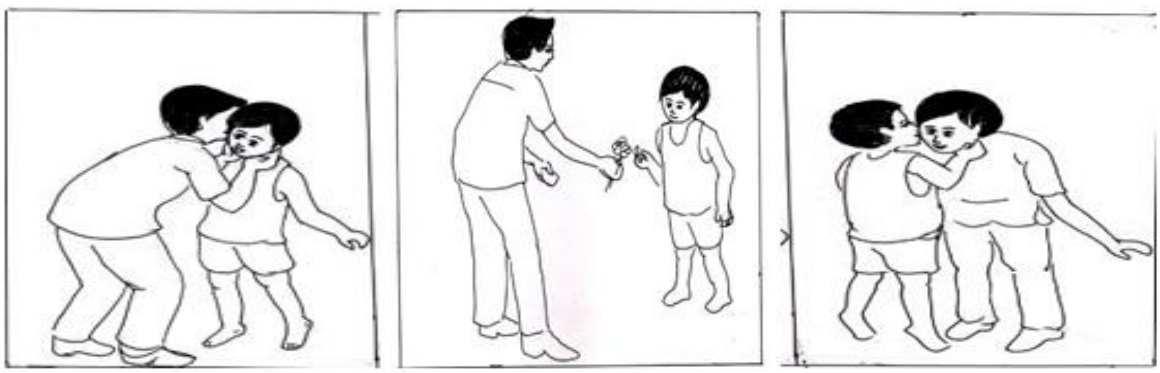
SOV	UR+O+R	John ki ʃe je Mary-ke marcʰe ? John this.Q he who Mary.DAT hit.PRS.PROG 'Is this John who is hitting Mary?'	1.a.1

OVS	O+R+UR	ʃiʃu-ti-ke diccʰe cɔklet je John ki ʃe ? child-DET-DAT give.PRS.PROG chocolate who John this.Q he 'Is this John who is giving chocolate to the child?'	2.b.1

VOS	R+UR+O	diccʰe ful je Mary-ke ʃe ki Paul ? give.PRS.PROG flower who Mary.DAT he this.Q Paul 'Is this Paul who is giving flower to Mary?'	3.c.1

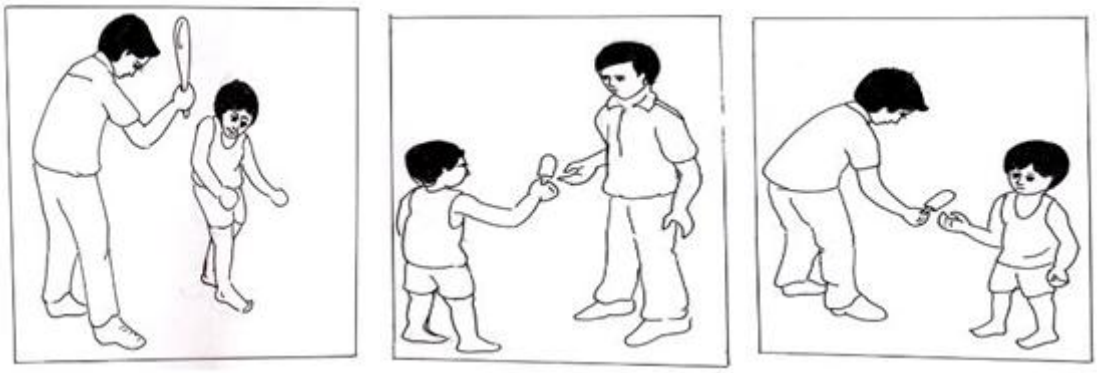
SOV	UR+O+R	Rina ki ʃe je kukur-ti-ke kʰaoyaccʰe? Rina this.Q she who dog.DET.ACC feed. PRS.PROG 'Is this Rina who is feeding the dog?'	4.a.1

OVS	R+UR+O	ʃiʃu-ti-ke diccʰe cumu je John ki ʃe ? child-DET-DAT give.PRS.PROG kiss who John this.Q he 'Is this John who is kissing the child?'	5.b.2



VOS	O+R+UR	marcʰe je Mary-ke ʃe ki John ? hit.PRS.PROG who Mary.DAT he this.Q John 'Is this John who is hitting Mary?	1.c.3

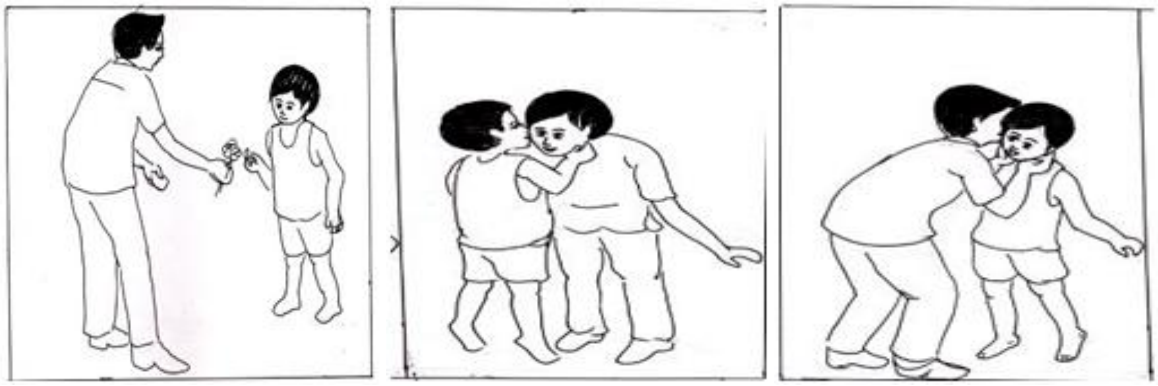
SOV	UR+O+R	John ki ʃe je ʃiʃu-ti-ke cɔklet diccʰe? John this.Q he who child-DET-DAT chocolate give.PRS.PROG 'Is this John who is giving chocolate to the child?'	2.a.1



OVS	O+R+UR	Mary-ke diccʰe ful je Paul ki ʃe ? Mary.DAT give.PRS.PROG flower who Paul this.Q he 'Is this Paul who is giving flower to Mary?'	3.b.1

VOS	R+UR+O	kʰaoyaccʰe je kukur-ti-ke ʃe ki Rina ? feed.PRS.PROG who dog.DET.ACC she this.Q Rina 'Is this Rina who is feeding the dog?'	4.c.1

SOV	UR+O+R	John ki ʃe je ʃiʃu-ti-ke cumu diccʰe? John this.Q he who child-DET-DAT kiss give.PRS.PROG 'Is this John who is kissing the child?'	5.a.1

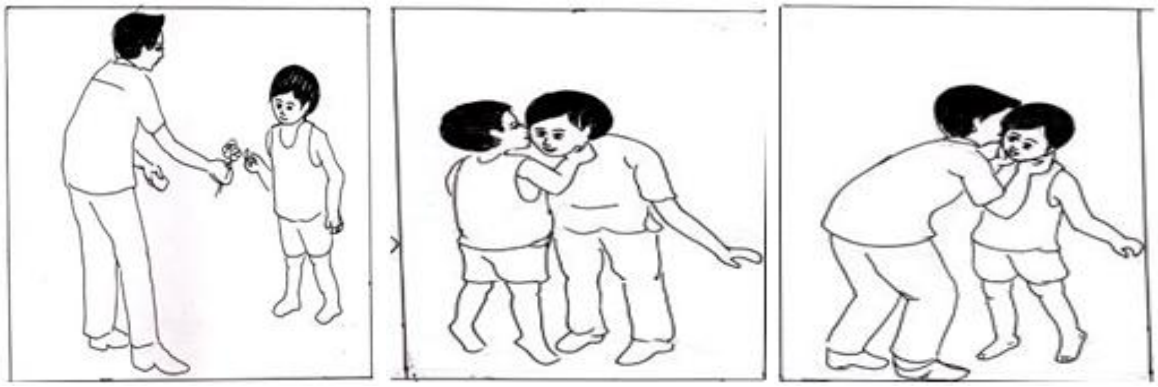


OVS	R+UR+O	Mary-ke marc^{h}e je John ki ʃe ? Mary.DAT hit.PRS.PROG who John this.Q he 'Is this John who is hitting Mary?'	1.b.2

VOS	O+R+UR	dicc^{h}e ful je Mary-ke ʃe ki Paul ? give.PRS.PROG flower who Mary.DAT he this.Q Paul 'Is this Paul who is giving flower to Mary?'	3.c.3

SOV	R+UR+O	Rina ki ʃe je kukur-ti-ke k^{h}aoyacc^{h}e? Rina this.Q she who dog.DET.ACC feed. PRS.PROG 'Is this Rina who is feeding the dog?'	4.a.3

OVS	UR+O+R	ʃiʃu-ti-ke dicc^{h}e cumu je John ki ʃe ? child-DET-DAT give.PRS.PROG kiss who John this.Q he 'Is this John who is kissing the child?'	5.b.3

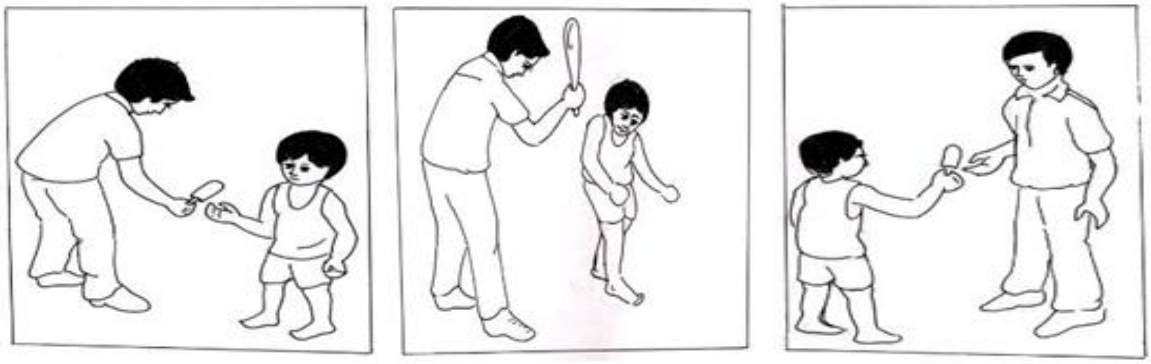


VOS	O+R+UR	k^{h}aoyacc^{h}e je kukur-ti-ke ʃe ki Rina ? feed.PRS.PROG who dog.DET.ACC she this.Q Rina 'Is this Rina who is feeding the dog?'	4.c.3

Trial 2:

SOV	O+R+UR	John ki ʃe je Mary-ke marcʰe ? John this.Q he who Mary.DAT hit.PRS.PROG 'Is this John who is hitting Mary?'	1.a.2

OVS	R+UR+O	ʃiʃu-ti-ke diccʰe cɔklet je John ki ʃe ? child-DET-DAT give.PRS.PROG chocolate who john this.Q he 'Is this John who is giving chocolate to the child?'	2.b.2

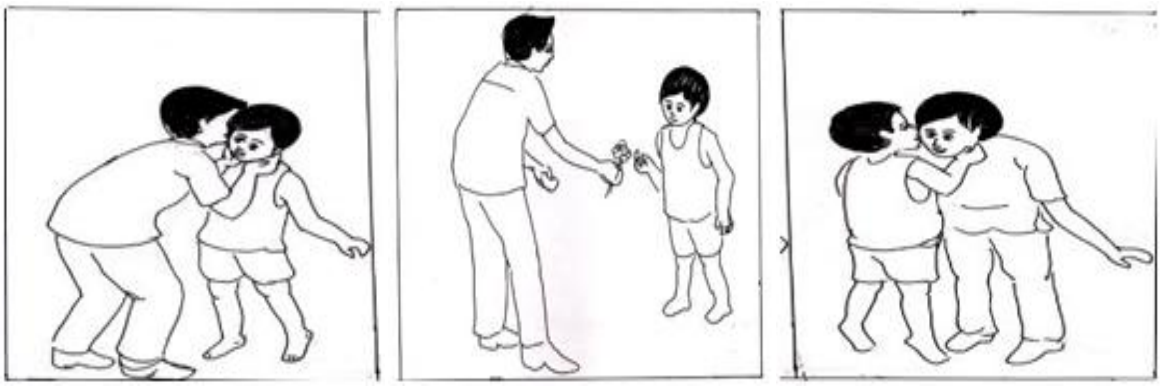


VOS	UR+O+R	diccʰe ful je Mary-ke ʃe ki Paul ? give.PRS.PROG flower who Mary.DAT he this.Q Paul 'Is this Paul who is giving flower to Mary?'	3.c.2

SOV	O+R+UR	Rina ki ʃe je kukur-ti-ke kʰaoyaccʰe? Rina this.Q she who dog.DET.ACC feed. PRS.PROG 'Is this Rina who is feeding the dog?'	4.a.2

OVS	UR+O+R	Mary-ke marcʰe je John ki ʃe ? Mary.DAT hit.PRS.PROG who John this.Q he 'Is this John who is hitting Mary?'	1.b.3

VOS	R+UR+O	dicc^{h}e cumu je ʃiʃu-ti-ke ʃe ki John ? give.PRS.PROG kiss who child-DET-DAT he this.Q John 'Is this John who is kissing the child?'	5.c.1

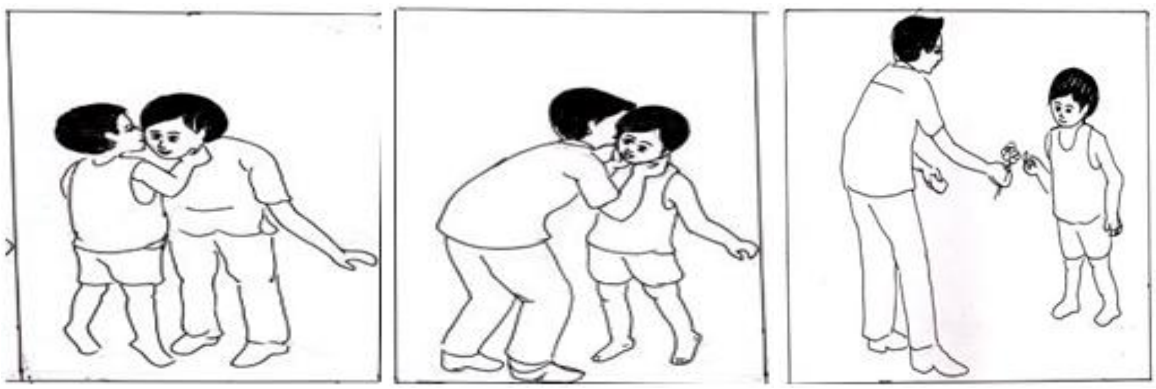


SOV	O+R+UR	John ki ʃe je ʃiʃu-ti-ke cɔklet dicc^{h}e? John this.Q he who child-DET-DAT chocolate give.PRS.PROG 'Is this John who is giving chocolate to the child?'	2.a.2

OVS	R+UR+O	Mary-ke dicc^{h}e ful je Paul ki ʃe ? Mary.DAT give.PRS.PROG flower who Paul this.Q he 'Is this Paul who is giving flower to Mary?'	3.b.2

VOS	UR+O+R	kʰaoyaccʰe je kukur-ti-ke ʃe ki Rina ? feed.PRS.PROG who dog.DET.ACC she this.Q Rina 'Is this Rina who is feeding the dog?'	4.c.2

SOV	O+R+UR	John ki ʃe je ʃiʃu-ti-ke cumu diccʰe? John this.Q he who child-DET-DAT kiss give.PRS.PROG 'Is this John who is kissing the child?'	5.a.2



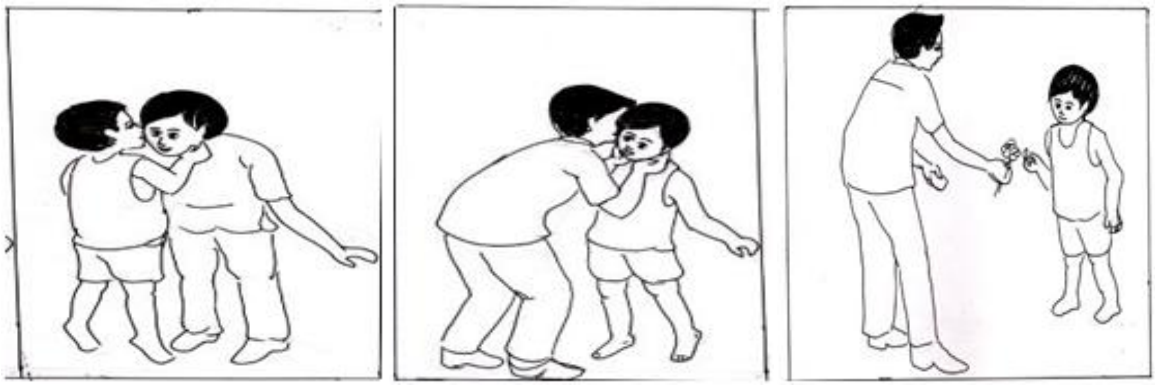
OVS	UR+O+R	Mary-ke dicc^{h}e ful je Paul ki ʃe ? Mary.DAT give.PRS.PROG flower who Paul this.Q he 'Is this Paul who is giving flower to Mary?'	3.b.3

VOS	R+UR+O	dicc^{h}e cɔklet je ʃiʃu-ti-ke ʃe ki John ? give.PRS.PROG chocolate who child-DET-DAT he this.Q John 'Is this John who is giving chocolate to the child?'	2.c.1

SOV	UR+O+R	Paul ki ʃe je Mary-ke ful dicc^{h}e ? Paul this.Q she who Mary.DAT flower give.PRS.PROG 'Is this Paul who is giving flower to Mary?'	3.a.1

OVS	R+UR+O	kukur-ti-ke kʰaoyaccʰe je Rina ki ʃe ? dog.DET.ACC feed. PRS.PROG who Rina this.Q she 'Is this Rina who is feeding the dog?'	4.b.2

VOS	O+R+UR	dicche cumu je ʃiʃu-ti-ke ʃe ki John ? give.PRS.PROG kiss who child-DET-DAT he this.Q John 'Is this John who is kissing the child?'	5.c.3



Trial 3:

SOV	O+R+UR	Paul ki ʃe je Mary-ke ful dicc^{h}e ? Paul this.Q she who Mary.DAT flower give.PRS.PROG 'Is this Paul who is giving flower to Mary?'	3.a.2

OVS	UR+O+R	ʃiʃu-ti-ke dicc^{h}e cɔklet je John ki ʃe ? child-DET-DAT give.PRS.PROG chocolate who John this.Q he 'Is this John who is giving chocolate to the child?'	2.b.3

VOS	R+UR+O	marc^{h}e je Mary-ke ʃe ki John ? hit.PRS.PROG who Mary.DAT he this.Q John 'Is this John who is hitting Mary?	1.c.1

SOV	R+UR+O	John ki ʃe je ʃiʃu-ti-ke cɔklet diccʰe? John this.Q he who child-DET-DAT chocolate give.PRS.PROG 'Is this John who is giving chocolate to the child?'	2.a.3

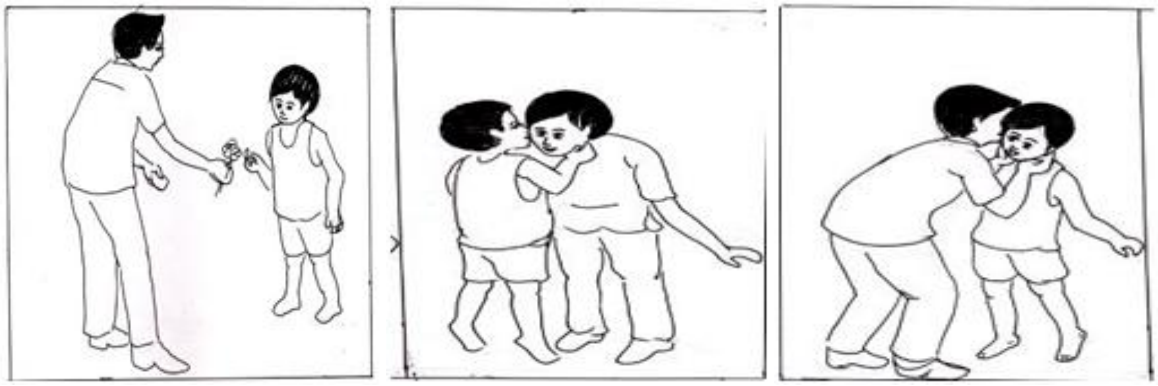
OVS	UR+O+R	kukur-ti-ke kʰaoyaccʰe je Rina ki ʃe ? dog.DET.ACC feed. PRS.PROG who Rina this.Q she 'Is this Rina who is feeding the dog?'	4.b.3

VOS	O+R+UR	dicc^{h}e cɔklet je ʃiʃu-ti-ke ʃe ki John ? give.PRS.PROG chocolate who child-DET-DAT he this.Q John 'Is this John who is giving chocolate to the child?'	2.c.3

SOV	R+UR+O	John ki ʃe je Mary-ke marc^{h}e ? John this.Q he who Mary.DAT hit.PRS.PROG 'Is this John who is hitting Mary?'	1.a.3

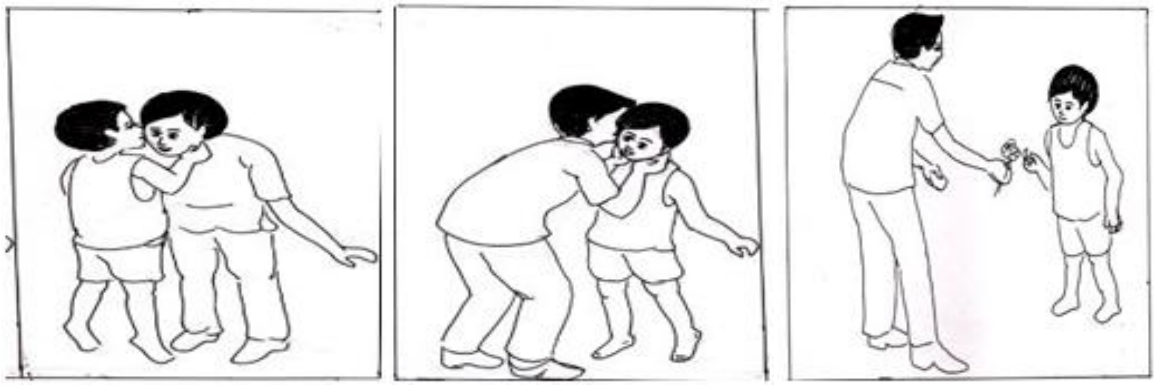
OVS	O+R+UR	kukur-ti-ke k^{h}aoyacc^{h}e je Rina ki ʃe ? dog.DET.ACC feed. PRS.PROG who Rina this.Q she 'Is this Rina who is feeding the dog?'	4.b.1

VOS	UR+O+R	dicc^{h}e cumu je ʃiʃu-ti-ke ʃe ki John ? give.PRS.PROG kiss who child-DET-DAT he this.Q John 'Is this John who is kissing the child?'	5.c.2



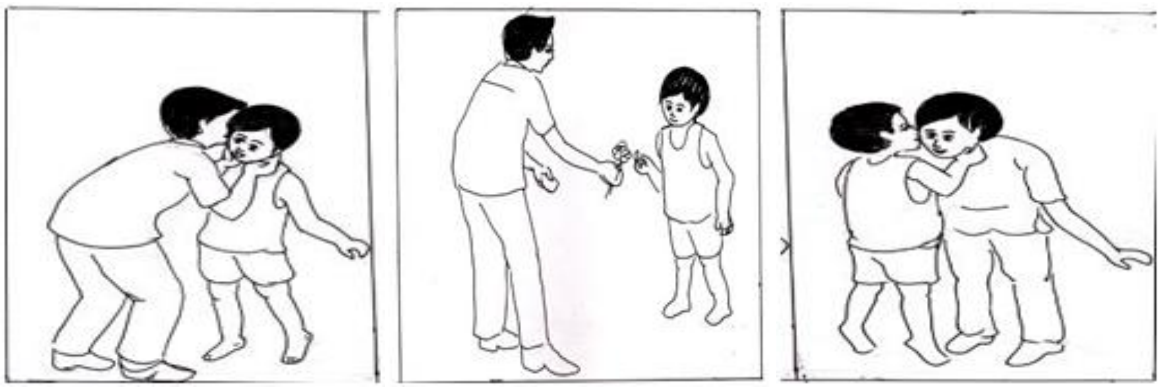
SOV	R+UR+O	Paul ki ʃe je Mary-ke ful dicc^{h}e ? Paul this.Q she who Mary.DAT flower give.PRS.PROG 'Is this Paul who is giving flower to Mary?'	3.a.3

OVS	O+R+UR	ʃiʃu-ti-ke dicc^{h}e cumu je John ki ʃe ? child-DET-DAT give.PRS.PROG kiss who John this.Q he 'Is this John who is kissing the child?'	5.b.1



VOS	UR+O+R	marc^{h}e je Mary-ke ʃe ki John ? hit.PRS.PROG who Mary.DAT he this.Q John 'Is this John who is hitting Mary?	1.c.2

SOV	R+UR+O	John ki ʃe je ʃiʃu-ti-ke cumu dicc^{h}e? John this.Q he who child-DET-DAT kiss give.PRS.PROG 'Is this John who is kissing the child?'	5.a.3



OVS	O+R+UR	Mary-ke marc^{h}e je John ki ʃe ? Mary.DAT hit.PRS.PROG who John this.Q he 'Is this John who is hitting Mary?'	1.b.1

VOS	UR+O+R	dicc^{h}e cɔklet je ʃiʃu-ti-ke ʃe ki John ? give.PRS.PROG chocolate who child-DET-DAT he this.Q John 'Is this John who is giving chocolate to the child?'	2.c.2

Practice Trials:

Set 1:

6.a.1	Mary ki ʃe je John-ke boi-ti dicc^{h}e ? Mary this.Q she who John.DAT book.DET give. PRS.PROG 'Is this Mary who is giving the book to john?'	UR+O+R	SOV



7.b.2	Mary-ke dicc^{h}e upohar je Paul ki ʃe ? Mary.DAT give.PRS.PROG gift who Paul this.Q he 'Is this Paul who is giving a gift to Mary?'	R+UR+O	OVS



6.c.3	dicc^{h}e boi-ti je John-ke ʃe ki Mary ? give.PRS.PROG book.DET who John.DAT he this.Q Mary 'Is this Mary who is giving the book to john?'	O+R+UR	VOS

7.a.1	Paul ki ʃe je Mary-ke upohar dicc^{h}e ? Paul this.Q he who Mary.DAT gift give.PRS.PROG 'Is this Paul who is giving a gift to Mary?'	UR+O+R	SOV

6.b.2	John-ke dicc^{h}e boi-ti je Mary ki ʃe ? John.DAT give. PRS.PROG book.DET who Mary this.Q she 'Is this Mary who is giving the book to john?'	R+UR+O	OVS

7.c.3	dicc^{h}e upohar je Mary-ke ʃe ki Paul ? give.PRS.PROG gift who Mary.DAT he this.Q Paul 'Is this Paul who is giving a gift to Mary?'	O+R+UR	VOS

Set 2 :

6.a.2	Mary ki ʃe je John-ke boi-ti dicc^{h}e ? Mary this.Q she who John.DAT book.DET give. PRS.PROG 'Is this Mary who is giving the book to John?'	O+R+UR	SOV

7.b.3	Mary-ke dicc^{h}e upohar je Paul ki ʃe ? Mary.DAT give.PRS.PROG gift who Paul this.Q he 'Is this Paul who is giving a gift to Mary?'	UR+O+R	OVS



6.c.1	dicc^{h}e boi-ti je John-ke ʃe ki Mary ? give.PRS.PROG book.DET who John.DAT he this.Q Mary 'Is this Mary who is giving the book to John?'	R+UR+O	VOS



7.a.3	Paul ki ʃe je Mary-ke upohar dicc^{h}e ? Paul this.Q he who Mary.DAT gift give.PRS.PROG 'Is this Paul who is giving a gift to Mary?'	R+UR+O	SOV



6.b.1	John-ke dicc^{h}e boi-ti je Mary ki ʃe ? John.DAT give. PRS.PROG book.DET who Mary this.Q she 'Is this Mary who is giving the book to John?'	O+R+UR	OVS

7.c.2	dicc^{h}e upohar je Mary-ke ʃe ki Paul ? give.PRS.PROG gift who Mary.DAT he this.Q Paul 'Is this Paul who is giving a gift to Mary?'	UR+O+R	VOS

Set 3 :

6.a.3	Mary ki ʃe je John-ke boi-ti dicc^{h}e ? Mary this.Q she who John.DAT book.DET give. PRS.PROG 'Is this Mary who is giving the book to John?'	R+UR+O	SOV



7.b.1	Mary-ke dicc^{h}e upohar je Paul ki ʃe ? Mary.DAT give.PRS.PROG gift who Paul this.Q he 'Is this Paul who is giving a gift to Mary?'	O+R+UR	OVS



6.c.2	dicc^{h}e boi-ti je John-ke ʃe ki Mary ? give.PRS.PROG book.DET who John.DAT he this.Q Mary 'Is this Mary who is giving the book to John?'	UR+O+R	VOS



7.a.2	Paul ki ʃe je Mary-ke upohar dicc^{h}e ? Paul this.Q he who Mary.DAT gift give.PRS.PROG 'Is this Paul who is giving a gift to Mary?'	O+R+UR	SOV



6.b.3	John-ke dicc^{h}e boi-ti je Mary ki ʃe ? John.DAT give. PRS.PROG book.DET who Mary this.Q she 'Is this Mary who is giving the book to john?'	UR+O+R	OVS



7.c.1	dicc^{h}e upohar je Mary-ke ʃe ki Paul ? give.PRS.PROG gift who Mary.DAT he this.Q Paul 'Is this Paul who is giving a gift to Mary?'	R+UR+O	VOS



Appendix 3: Information about the participants.

Patient ID	Gender	Age	Patient status
RM	Male	42	Normal
SR	Male	49	Normal
SAL	Male	53	Normal
MIS	Male	48	Normal
MHP	Male	56	Normal
FNA	Female	58	Normal
SS	Male	65	Normal
KKK	Male	62	Normal
MH	Female	55	Normal
AU	Male	62	Normal
NE	Male	55	Aphasic
SA	Male	40	Aphasic
BH	Male	75	Aphasic
AA	Male	35	Aphasic
KMA	Male	63	Aphasic
AH	Male	42	Aphasic
MKM	Male	65	Aphasic
DR	Male	65	Aphasic
KB	Male	60	Aphasic
MS	Female	45	Aphasic
AH	Male	59	Aphasic
JH	Male	57	Aphasic
SA	Male	69	Aphasic
AJ	Male	46	Aphasic
AK	Male	65	Aphasic
FA	Male	45	Aphasic
MR	Male	50	Aphasic
PCM	Male	32	Aphasic
TH	Male	45	Aphasic

SB	Female	55	Aphasic

Appendix 4: Response data from experiment 1.

Participant	Participant type	Item 1	Item 2	Item 3	Item 4	Item 5
RM	Normal	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
SR	Normal	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
SAL	Normal	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/moɖɖʰe/ ‘between’
MIS	Normal	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
MHP	Normal	/maɟʰkʰane/ 'in the middle'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
FNA	Normal	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
SS	Normal	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
KKK	Normal	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/rasʈaʏ/ 'road'	/sopʰaʏ/ 'sofa'
MH	Normal	/upore/	/nice/	/ʃamne/ 'in	/picʰone/	/maɟʰkʰane/

		'on'	'under'	front'	'behind'	'in the middle'
AU	Normal	/maɟʰkʰane/ 'in the middle'	/nice/ 'under'	/maɟʰkʰane/ 'in the middle'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
NE	Aphasic	/maɟʰkʰane/ ‘in the middle’	/nice/ ‘under’	/ʃamne/ ‘in front’	/picʰone/ ‘behind’	/moɖɖʰe/ ‘between’
SA	Aphasic	/maɟʰkʰane/ ‘in the middle’	/nice/ ‘under’	/ʃamne/ ‘in front’	/picʰone/ ‘behind’	/maɟʰkʰane/ ‘in the middle’
BH	Aphasic	/upore/ 'on'	/nice/ 'under'	/paʃe/ ‘beside'	/ʃamne/ 'in front'	/maɟʰkʰane/ 'in the middle'
AA	Aphasic	/ceʏare/ ‘chair’	/nice/ 'under'	/maɟʰkʰane/ 'in the middle'	/picʰone/ 'behind'	/moɖɖʰe/ ‘between’
KMA	Aphasic	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/moɖɖʰe/ ‘between’
AH	Aphasic	/upore/ 'on'	/nice/ 'under'	/upore/ 'on'	/picʰone/ 'behind'	/moɖɖʰe/ ‘between’
MKM	Aphasic	/maɟʰkʰane/ 'in the middle'	/nice/ 'under'	/ʃamne/ 'in front'	/maʈʰaʏ/ ‘head’	/maɟʰkʰane/ 'in the middle'
DR	Aphasic	/upore/ 'on'	/nice/ 'under'	/bahire/ ‘outside’	/ʃamne/ 'in front'	/maɟʰkʰane/ 'in the middle'
KB	Aphasic	/moɖɖʰe/ ‘between’	/konaʏ/ ‘corner’	/moɖɖʰe/ ‘between’	/picʰone/ 'behind'	/moɖɖʰe/ ‘between’

MS	Aphasic	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰe/ ‘middle’
AH	Aphasic	/upore/ 'on'	/paʃe/ ‘beside’	/bahire/ ‘outside’	/ʃamne/ 'in front'	/bʰiʈore/ ‘inside’
JH	Aphasic	/paʃe/ ‘beside’	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
SA	Aphasic	/upore/ 'on'	/nice/ 'under'	/bavɐ/ ‘left’	/ʃamne/ 'in front'	/maɟʰkʰane/ 'in the middle'
AJ	Aphasic	/upore/ 'on'	/nice/ 'under'	/maɟʰkʰane/ 'in the middle'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
AK	Aphasic	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
FA	Aphasic	/upore/ 'on'	/nice/ 'under'	/maɟʰamaɟʰi/ ‘middle’	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
MR	Aphasic	/upore/ 'on'	/paʃe/ ‘beside’	/picʰone/ 'behind'	/picʰone/ 'behind'	/maɟʰkʰane/ 'in the middle'
PCM	Aphasic	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰe/ ‘middle’
TH	Aphasic	/upore/ 'on'	/nice/ 'under'	/ʃamne/ 'in front'	/picʰone/ 'behind'	/maɟʰe/ ‘middle’
SB	Aphasic	/upore/ 'on'	/nice/ 'under'	/bʰiʈore/ ‘inside’	/ʃamne/ 'in front'	/maɟʰe/ ‘middle’

Appendix 5: Response data according to the subjects from experiment 2.

Participant Name	Participant Type	Response to the items		
		Correct	Distractor	Opposite
RM	Normal	15	0	0
SR	Normal	15	0	0
SAL	Normal	15	0	0
MIS	Normal	15	0	0
MHP	Normal	15	0	0
FNA	Normal	15	0	0
SS	Normal	14	0	1
KKK	Normal	15	0	0
MH	Normal	15	0	0
AU	Normal	14	0	1
NE	Aphasic	11	3	1
SA	Aphasic	15	0	0
BH	Aphasic	13	0	2
AA	Aphasic	9	0	6
KMA	Aphasic	15	0	0
AH	Aphasic	15	0	0
MKM	Aphasic	12	0	3
DR	Aphasic	8	0	7
KB	Aphasic	11	1	3
MS	Aphasic	9	0	6
AH	Aphasic	6	1	8
JH	Aphasic	11	0	4
SA	Aphasic	6	1	8
AJ	Aphasic	7	0	8
AK	Aphasic	12	0	3
FA	Aphasic	15	0	0

MR	Aphasic	6	5	4
PCM	Aphasic	9	2	4
TH	Aphasic	6	6	3
SB	Aphasic	10	1	4

Appendix 6: Response data according to the items from experiment 2

Item	**Response**			**Item**	**Response**		
	Correct	**Distractor**	**Opposite**		**Correct**	**Distractor**	**Opposite**
1.a.1	10	0	2	3.b.3	4	0	5
1.a.2	7	0	2	3.c.1	11	0	1
1.a.3	7	1	1	3.c.2	5	0	4
1.b.1	8	0	1	3.c.3	12	0	0
1.b.2	9	1	2	4.a.1	12	0	0
1.b.3	6	1	2	4.a.2	6	0	3
1.c.1	8	1	0	4.a.3	11	0	1
1.c.2	7	0	2	4.b.1	8	0	1
1.c.3	10	1	1	4.b.2	6	0	3
2.a.1	8	0	4	4.b.3	7	0	2
2.a.2	4	0	5	4.c.1	11	0	1
2.a.3	7	2	0	4.c.2	6	0	3
2.b.1	9	0	3	4.c.3	12	0	0
2.b.2	4	2	3	5.a.1	11	0	1
2.b.3	4	3	2	5.a.2	7	0	2
2.c.1	9	0	0	5.a.3	9	0	0
2.c.2	5	0	4	5.b.1	6	2	1
2.c.3	6	1	2	5.b.2	11	1	0
3.a.1	7	0	2	5.b.3	11	0	1
3.a.2	6	2	1	5.c.1	8	0	1
3.a.3	9	0	0	5.c.2	5	2	2

3.b.1	10	0	2	5.c.3	7	0	2
3.b.2	8	0	1				