Semantic Comprehension Deficits in Hindi Speaking Persons with Aphasia: A Preliminary Report

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Abstract

The study was carried out with the aim of to develop a protocol of semantic comprehension in Hindi language. The objective of the study was to conduct a relative study between neuro-typical adults and persons with aphasia with respect to auditory, picture, and orthographic modes. The present study was done in two phases. First phase included development of protocol material and in the second phase, the protocol battery was administered on neuro-typical adults and persons with aphasia. The developed material consisted of seven sections viz. noun, polar questions, semantic anomaly, syntagmatic relations, paradigmatic relations, semantic contiguity, and semantic similarity. Further, noun section of the semantic protocol was categorized into five sub-sections like body parts, common objects, colors, geometric forms, and numbers. Each sections and/or sub-sections consisted of 10 items in auditory, picture, and orthographic mode. The material was administered on 56 neuro-typical adults and 11 persons with aphasia aged 18 to 65 years. It was observed that there was a significant difference between the mean scores across the neuro-typical adults and persons with aphasia on the entire task in all the modalities. Based on this finding it is recommended that the developed protocol can be used for assessment of semantic comprehension for persons with aphasia.

Key words: *Modality, Hindi, Semantics, Neuro-typical*

Aphasia refers to loss of language following an insult to the anatomical basis of language areas in the brain (Goodglass & Kaplan, 1972). There have been several definitions given by various scholars based on their background. But almost all agree that it is an acquired neurogenic condition "Aphasia refers to the disturbance of any or all of the skills, associations and habits of spoken and written language produced by injury to certain brain areas that are specialized for these functions. " (Goodglass & Kaplan, 2001; p.5). Causes of brain attack vary from cerebral vascular accidents (stroke), tumor, penetrating wounds, and other diseases. Stroke is the most common cause of aphasia (Tonkonogy, 1986). Aphasia may affect all modes of expressive and receptive communication including speaking, reading, writing, understanding and gesturing. The extent to which each of these is affected depends on the location in the brain where the stroke has occurred (Longerich & Bordeaux, 1954).

Aphasia may impair the ability to select words to express one's thoughts and also impair the recognition of words for the comprehension of phrases and paragraphs. If comprehension is affected, reading and listening will also be impaired on the same level (Musso, Weiller, Kiebel, Muller, Bulau, & Rijntjes, 1999). Comprehension may be compromised while reading sentences and texts which have semantic and morphological alterations of the spoken words (Radanovic, Senaha, & Mansur, 2001). The semantic system is thought to be central to all aspects of language and is involved in the comprehension and production, either spoken or written (Patterson & Shewell, 1987). Hart and Gordon (1990), who found a selective disorder in 'receptive' semantics in three cases, suggested that the semantic mechanisms for comprehension and production are separable. A "vertical" fractionation of semantic processing in input and output was also postulated by Raymer and Rothi (2000), along with the "horizontal" fractionation that is indicated by category- and modality-specific deficits.

Several researchers have studied comprehension at semantic level in persons with aphasia. Stachowiak, Huber, Poeck, and Klerschensteiner (1977) compared semantic comprehension among persons with aphasia, persons with non-aphasia and neuro-typical adults. The test material consisted of 26 stories. Each story was an everyday event or situation. The story was read to the participants. They were required to choose the picture from a multiple choice set of five, which was appropriate to the story. Out of five pictures, one picture depicted the literal sense of a metaphorical comment and the other pictures misrepresented semantic functions expressed in the text. The persons with aphasia and control group gave the same pattern of response. It was concluded that persons with aphasia experienced difficulties in comprehending isolated words and sentences due to the redundancy of the text.

Pierce, Jarecki, and Cannito (1990) studied eleven

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persons with aphasia to evaluate the influence of three variables on single word comprehension. The variables were the number of pictures displayed, pictures relatedness and the presence of a situational context. The task given to the participants was to point to the pictures. They found significant interaction among their effects. When unrelated pictures were displayed, increasing the number of pictures did not affect accuracy until eight pictures were presented, whereas performance deteriorated when six related pictures were displayed. When the pictures were related based on a common situational context, performance deteriorated for four or more pictures. Persons with aphasia had more difficulty in choosing one of five printed related words than one of five printed unrelated words (Grogan & Pierce, 1994). In a similar study by Howland and Pierce (2004), the performance was found to be significantly poor for all array sizes.

Breese and Hillis (2004), compared the auditory comprehension performance of 122 persons with aphasia on multiple-choice tasks to an alternate word/picture verification tasks. The results of the study revealed that word/picture verification tasks were significantly more sensitive than the multiple choice task in identifying deficits in auditory comprehension than the more commonly used multiple choice tasks using the same item. They also stated that the sensitivity of these tasks in identifying deficits is limited due to the credit given for correct guess by forced choice.

Semantic comprehension is commonly tested by asking the patient to point to named object or word (Goodglass, 1993). Jodzio, Biechowska, Leszniewska-Jodzio (2008) studied 26 persons with aphasia (11 women and 15 men) to investigate the deficits of auditory comprehension on semantic task in Polish language. Semantic categories chosen were colors, body parts, animals, food, objects, and means of transportation. Results revealed significant discrepancies among these categories in persons with aphasia.

To assess comprehension in persons with aphasia several tests have been used such as Minnesota Test for Differential Diagnosis of Aphasia (MTDDA) (Schuell, 1955, 1973), Boston Diagnostic Aphasia Examination (BDAE) (Goodglass & Kaplan, 1972), Reading Comprehension Battery for Aphasia (LaPointe & Horner, 1979), Auditory comprehension test for sentences (Shewan, 1980), Token Test (De Renzi & Vignolo, 1962), and Western Aphasia Battery (WAB) (Kertesz, 1979; 1982; 2006).

The Minnesota Test for Differential Diagnosis of Aphasia (MTDDA) consists of five sections; auditory disturbances (9 sub-tests), visual and reading disturbances (9 subtests), speech and language disturbances (15 subtests), visuomotor and writing disturbances (10 subtests), and numerical relations and arithmetic processes (4 subtests). Within each section, the order of the subtest is from simple to complex. Differential diagnosis using the MTDDA identifies five aphasia syndromes; simple aphasia, aphasia with visual involvement, aphasia with sensory motor involvement, aphasia with scattered findings compatible with generalized brain damage, and an irreversible aphasia syndrome (Schuell, 1974). MTDDA is an extensive, time consuming examination. The test measures language recovery after stroke and head trauma, and show that language recovery is relatively independent from intelligence (Bailey, Powell, & Clark, 1981; David and Skilbeck, 1984).

The first edition of Boston Diagnostic Aphasia Examination (BDAE) was published by Goodglass and Kaplan in 1972. The BDAE-3 (Goodglass & Kaplan, 2001) has three versions: standard, short, and extended. BDAE-3 short form takes less administration time. The extended version of BDAE-3 provides an extensive examination than the standard version. The standard BDAE-3 is divided into five language related sections. These are conversational and expository speech, auditory comprehension, oral expression, reading and writing. The extended version includes a sixth section: praxis. The test provides profiles for classic and rarer aphasic subtypes. The performance of the person is rated on a seven point rating scale. This test predicts progress in therapy (Davidoff & Katz, 1985; Helm-Estabrooks, & Ramsberger, 1986). BDAE is more useful for assessments during detailed studies of aphasia and aphasia rehabilitation.

The first edition of Reading Comprehension Battery for Aphasia (RCBA) was developed by LaPointe and Horner, 1979 and revised RCBA-2 by LaPointe and Horner, 1999. The RCBA-2 is designed to provide systematic evaluation of the nature and degree of reading impairment in adolescents and adults with aphasia. The test is described by authors as a criterion referenced measure with no normative basis. It takes about one hour to administer the test. The test includes ten core subtests, each one containing ten tests items, and seven supplemental subtests of variable lengths. Core subtests include measures of single word comprehension, functional reading of short passages, synonyms, sentence and paragraph length comprehension, and syntax. Supplementary tasks examine single letter recognition, identification of real versus nonsense consonant-vowel-consonant trigrams, and oral reading of words and sentences. Items are scored on being correct or incorrect and the time to complete each subtest is recorded.

Flanagan and Jackson (1997) examined test-retest reliability of the original RCBA in a small sample of non-brain-damaged adults and reported reasonable levels of reliability. A study checked for the aphasic performances on the original RCBA which examined aphasia treatment modalities (Wertz et al., 1986)

Auditory comprehension test for sentences (ACTS) examines the comprehension for sentence-length material (Shewan, 1980). The test consists of 21 tests items, varying in sentence length, difficulty level of the vocabulary and syntactic complexity. It involves a pass fail scoring and qualitative error analysis. It takes around 10-15 minutes for the test administration. Shewan and Kertesz (1984) used ACTS together with WAB to examine recovery and the differential impact of treatment in a sample of 100 persons with aphasia grouped by subtype; improvements over time were similar for treated and untreated persons with aphasia. Flanagan and Jackson (1997) confirmed the tests-retest stability of the measure in a sample of neurologically intact 50 to 76 year-old individuals. Cautions about evaluating the obtained performance, such as differences between the ACTS standardization sample and the clinician's referral, as well as about educational and cultural influences on test performance are the weaknesses of the test.

The first edition of the Token Test (TT) was developed by De Renzi and Vignolo (1962). The TT is a measure to examine auditory comprehension deficits in persons with aphasia. Revised Token Test (RTT) with an expanded linguistic examination was developed by McNeil and Prescott, 1978). The Indian version, Revised Token Test in Kannada (RTT-K; Veena, 1982), Revised Token Test in Malayalam (RTT-M; Lincy & Goswami, 2010), and Revised Token Test in Oriya (RTT-O; Bijoya & Goswami, 2010) is based on the principles of RTT of English (Mc Neil & Prescott, 1978) and concrete object form of Token Test (Martino et al, 1976). The test includes 10 subtests which comprehensively assesses different command lengths and different sentence types involving the 20 test stimuli. Each subtest further included 10 homogeneous items ranging in difficulty and linguistic construction.

The Western Aphasia Battery (WAB) was designed to evaluate the main clinical aspect of language function in person with aphasia. This test classifies aphasia sub-types and rates the severity of the aphasic impairment. The test is designed for both clinical and research use. Aphasia quotient (AQ) is determined by the performance on the four language subtests, which assess spontaneous speech, comprehension, repetition, and naming. The performance quotient (PQ) is determined by the performance on the reading and writing, praxis, construction, and Raven's Colored Progressive Matrices. The AQ and the PQ are summed to form a cortical quotient (CQ). Language quotient (LQ) is the most recent score developed for this test (Shewan & Kertesz, 1984). The LQ is a composite of all language sections, including reading and writing. The revised version of this test is Western Aphasia Battery-Revised (WAB-R; Kertesz, 2006). It assesses both linguistic and non-linguistic skills. It also includes bedside evaluation which provides a quick look at the person's functioning. WAB is among the top five language tests used by speech-language pathologists providing services in treatment settings for traumatic brain injury (Frank & Barrineau, 1996). Auditory-verbal comprehension measured on the WAB is strongly related to outcome (Mark and Thomas, 1992). Adaptations of WAB in Indian languages include WAB-Hindi (Karanth, 1980a), WAB- Kannada (Shymala & Vijayashree, 2008), and WAB-Telugu (Sripallavi & Shyamala, 2010). As reviewed above, the quoted tests vastly cover all the domains but not much emphasis has been provided towards assessment of semantics across modes. This is more so in Indian context. Hence, the need to develop a semantic comprehension protocol for persons with aphasia arises.

There are many aphasia test batteries which are commonly used in both clinical and research settings. However, assessment of persons from diverse ethnic, cultural, and linguistic backgrounds present significant challenges for clinicians as most tests may not have included a representative number of people from diverse backgrounds in their standardization (Screen & Anderson, 1994; Horner, Swanson, Bosworth, & Matchar, 2003; Munoz & Marquardt, 2003; Edwards & Bastiannse, 2007; Penn, 2007). There are limited tests to assess the comprehension abilities of the persons with aphasia in Indian context. The available Western assessment tests have limitations to be used in Indian context due to the linguistic and ethno-cultural diversity. However, there is growing evidence that a diagnosis in terms of affected linguistic levels -semantics (word meaning), phonology (word sound), and syntax (grammatical structure) - is more useful than aphasia type (Howard & Patterson, 1989). For the assessment of aphasia in the Indian context, it is necessary to have a culturally standardized test to identify the problem and classify the problem into various groups for the purpose of diagnosis, therapy and prognosis. Thus, the aim of the present study was to develop a protocol of semantic comprehension in Hindi language.

Method

The present study was done in two phases. First phase included development of protocol material and

in the second phase, the protocol was administered on neuro-typical adults and persons with aphasia.

Phase- I: Development and description of protocol

The first phase involved the development of the protocol. All the items of the protocol were selected on the basis of the linguistic background of the target population. The semantic comprehension protocol consisted of seven sections viz. noun, polar questions, semantic anomaly, syntagmatic relations, paradigmatic relations, semantic contiguity, and semantic similarity. Further, noun section of the semantic protocol was categorized into five sub-sections like body parts, common objects, colors, geometric forms, and numbers (See Figure. 1). These sections and sub-sections assist in assessing semantic comprehension and have been most widely used in the tools documented in the literature like Linguistic Profile Test (Karanth, 1980b). In each section/sub-section, 20 items were selected from newspaper or day to day materials. Twenty Speech Language Pathologists (SLPs), who were proficient in speaking, reading, and writing Hindi language and who had at least two years of clinical experience, were asked to rate the items on appropriateness for assessing semantic comprehension in persons with aphasia. A three point rating scale was applied to rate the stimuli on the basis of inappropriate, appropriate and most appropriate by the SLPs. The final set of stimuli consisted of the items which were rated 90% appropriate by SLPs. SLPs were also asked to arrange the items in a hierarchical manner.

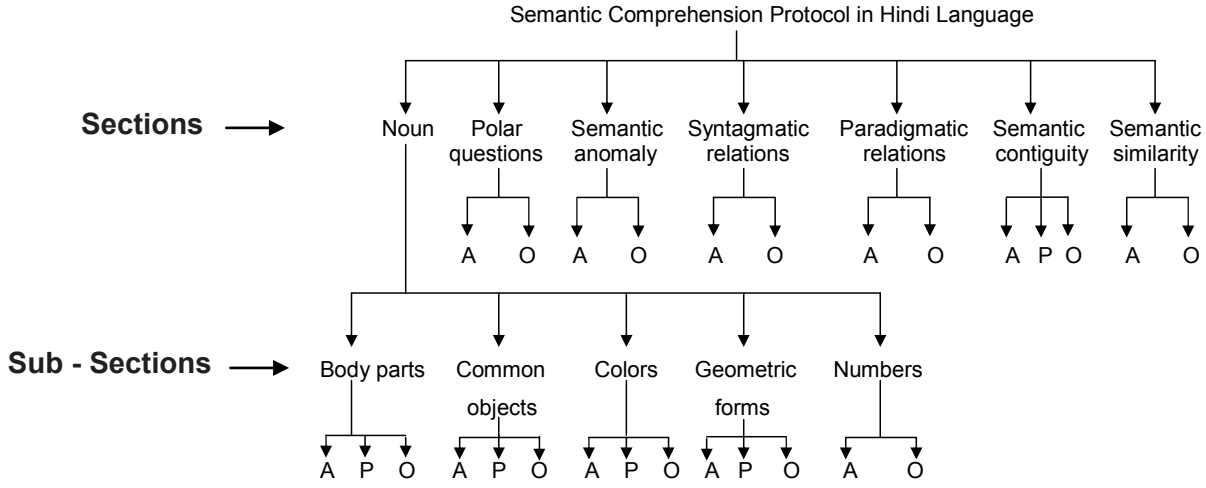

Fig. 1. Schematic representation of the protocol.

The finalized protocol, semantic comprehension protocol in Hindi language, consists of 10 items in each sections and/or sub-sections. A total of 110 stimuli in auditory mode, 50 stimuli in picture mode, and 110 stimuli in orthographic mode were considered for the final protocol. Culturally appropriate picture stimuli were provided wherever necessary, which were drawn by a professional artist. The stimuli were presented in auditory, picture, and orthographic mode separately and randomly. The noun section and semantic contiguity was tested through auditory, picture, and orthographic modes while the other sections were tested in auditory and orthographic mode only.

The response sheet for the noun section consisted of four pictures out of which one was the target picture and other three were the distracters. Different distracters were provided for different stimuli. In semantic contiguity section, there were two pictures present under each item. Person has to point to the target picture. Responses for other sections can be either verbal, gestural or pointing cards having 'yes' and 'no' written. Scoring pattern followed a three point rating scale as described in the following Table 1.

Table 1. *Scoring pattern.*

Score	Response
2	Correct without prompt
1	Correct with prompt
0	Incorrect even with prompt

Different sections have different instruction. Stimulus repetition was allowed once, if the person did not respond or if he/she asked for repetition. While responding, if the person self-corrects then it was considered the last answer as the final response. The details of the instructions given to participants have been provided in Appendix-1

Table 2. *Responses of the raters regarding the testprotocol material.*

Sl. No.		Very Poor	Poor	Fair	Good	Excellent
1	Simplicity				11	13
2	Familiarity			1	9	14
3	Size of the picture			2	9	13
4	Color and appearance				11	13
5	Arrangement			1	9	14
6	Presentation				10	14
7	Volume			5	10	9
8	Relevancy			2	8	14
9	Complexity			1	8	15
10	Iconicity			1	12	11
11	Accessible			2	10	12
12	Flexibility			2	10	12
13	Trainability			2	12	10
14	Stimulability			1	10	13
15	Feasibility			2	10	12
16	Generalization			1	8	15
17	Scope of practice			3	8	13
18	Scoring Pattern			1	10	13
19	Publications, Outcomes and Developers (professional background)*	Yes	2			
		No	22			
20	Coverage of parameters (Reception & expression)**				8	16
	Total			27	183	246
	Total %			5.92	40.13	53.95

**The SLPs were asked to rate this parameter in terms of "Yes" or "No"*
***The SLPs were asked to rate this parameter in terms of reception only*

Feedback about protocol

The protocol was given for feedback rating to 24 SLPs, who were native speakers of Hindi with at least three years of clinical experience. The SLPs were asked to judge the protocol based on feedback rating questionnaire adopted from "Feedback Questionnaire for Aphasia Treatment Manuals" (Field Testing of Manual for Adult Non-fluent Aphasia Therapy in Kannada, MANAT-K; Goswami, Shanbal, Samasthitha, & Navitha, 2010) (Table 2). The feedback rating questionnaire needed the rater to judge the protocol on various parameters such as simplicity, familiarity, complexity, iconicity, arrangement etc., while keeping in mind the abilities and performance of a person with aphasia.

Phase- II: Administration of protocol

Neuro-typical participants between the age group of 18-65 years were tested to establish a baseline, which was considered as normative for this protocol. The participants were seated comfortably in a quiet environment. The protocol materials were arranged according to the demands of the task of each section, subsection, and order of mode of administration of the protocol. The instructions to the participants were given verbally.

Participants

A total of 67 participants participated in the study. The participants were divided into two groups: Group- 1 consisted of neuro-typical adults and

Table 3. *Details of the participants of the study.*

Participants	Age range	Male	Female
Neuro-typical adults	18-33	10	10
	34-49	10	10
	50-65	6	10
Persons with aphasia	18-65	7	4

Group- 2 consisted of persons with aphasia who were classified based on their performance on WAB. The nomenclature used was as given by Kertesz (1979). In group-1, 26 Males and 30 Females, and in group-2, 4 Global aphasia (2 Males and 2 Females) and 7 Broca's aphasia (5 Males and 2 Females) participated in the study. Table 3 and Table 4 provide the demographic details of the participants:

Initially a total of 60 neuro-typical adults and 16 persons with aphasia were recruited for the study. But there was attrition of four neuro-typical adults and five persons with aphasia which resulted in the final count of 56 neuro-typical adults and 11 persons with aphasia for the study.

Inclusion Criteria: Ethical standards and considerations were maintained and adhered to while selecting the participants for the study. The participants (or family members/care takers in case of persons with aphasia) were explained the purpose and procedure of the study and written consent was acquired. They were selected based on the following inclusionary criteria. The age of the participants were between 18-65 years (It has been well documented in the literature that incidence of dementia is more in persons with above 65 years of age, hence the upper age was restricted to 65 Years). All the participants under consideration were the native speakers of Hindi (For development of a new protocol it is preferred to use native speakers than the proficient speakers) and Pre-morbidly all participants have been right handed. No known history of pre-morbid neurological illness, psychological disorders, and no other significant sensory and/or cognitive deficits. Mini-Mental State Exam (Folstein, Folstein & McHaugh, 1975) was administered on neuro-typical adults to rule out any cognitive-linguistic deficits. The persons with aphasia were identified through hospitals, neurological clinics and/or speech and hearing centers. The participants have been diagnosed as having Ischemic stroke by a Neurologist/Physician. Western Aphasia Battery test in Hindi (Karanth, 1980a) was administered to assess the type of aphasia.

Procedure

The protocol materials were presented and the order of stimuli presentation was random in all modes for all groups of participants. Each participant was seated in front of a table at a comfortable distance from where it was easy for him/her to reach and point to the protocol material. The administration of the protocol was recorded on a digital video camera recorder (Sony Handycam, model no. DCR-SR88).

Pretest Instructions: Pretest instructions were given to the participant to make sure that he/she has understood the task. The pretest instructions were given as follows:

"I am going to administer a test on you. I will be asking you to point to or show pictures or you can respond orally or gesturaly. The instructions for responding for each section will differ. Whenever you feel that you have not understood what I have told then please stop me and ask me to repeat. I will repeat the instructions again."

Table 4. *Details of persons with aphasia.*

Sl. No.	Age	Gender	Provisional Diagnosis	Education
1	49 years	Male	Global Aphasia	Graduate
2	65 years	Male	Global Aphasia	Graduate
3	58 years	Female	Global Aphasia	10+2
4	62 years	Female	Global Aphasia	Graduate
5	42 years	Male	Broca's Aphasia	Graduate
6	48 years	Male	Broca's Aphasia	Dip. in electronic communication
7	43 years	Female	Broca's Aphasia	Graduate
8	57 years	Male	Broca's Aphasia	Graduate
9	65 years	Male	Broca's Aphasia	Graduate
10	65 years	Male	Broca's Aphasia	Graduate
11	55 years	Female	Broca's Aphasia	10+2

Table 5. *Scoring Sheet*

Section	Sub-section	Auditory	Visual	
			Picture	Orthographic
Noun	Body parts			
	Common objects			
	Colours			
	Geometric forms			
	Numbers			
Polar question				
Semantic anomaly				
Syntagmatic relation				
Paradigmatic relation				
Semantic contiguity				
Semantic similarity				
Total				

In case of unsuccessful trial performance, if the participants did not respond or ask for repetition, the instructions were repeated to the participants.

Scoring: All the sessions were video recorded. Participant's responses were analyzed and a score of '2', '1', and '0' was given for every correct without prompt, correct with prompt, and incorrect/no response even after prompt (see table 1) respectively. The details of the scoring are shown in Table 5.

Time duration: The administration time taken of the protocol for neuro-typical participants was approximately 20 minutes and around one hour for the persons with aphasia.

Statistical Analysis

The normative values for each group were calculated separately and the mean scores were compared in all the age groups and between neuro-typical adults and the persons with aphasia groups across all section and/or sub-section. Statistical analysis was done using SPSS software (Statistical Package for the Social Sciences version 17.0). The tabulated scores were used for obtaining the mean (M) and standard deviation (SD). Non-parametric measures were utilized to obtain the significant difference measures. Mann- Whitney U-test was used to compare the performances of neuro-typical adults and persons with aphasia.

Results

Performance on nouns:

Body part

Mean and standard deviations were extracted for the groups of neuro-typical adults and persons with aphasia. Scores for the body parts tasks in auditory, picture, and orthographic mode are shown in Table-6. It is apparent from Table-6 and Figure 2 that persons with aphasia obtained a lower mean score than the neuro-typical participants for body part in auditory, picture, and orthographic modes.

Performance of persons with aphasia on body part task was better in picture mode than the auditory mode and it was less in orthographic mode. It is evident from the mean values that person with aphasia, comprehend body part better in picture mode than the auditory and orthographic mode. Results reveal a significant difference in auditory ($Z=-7.20$, $p < 0.001$), picture ($Z=-4.62$, $p<0.001$), and orthographic ($Z=-7.65$, $p< 0.001$) modes on Mann-Whitney U test between the neuro-typical adults and persons with aphasia.

Common objects

It can be inferred from Table 6 and Figure. 2 that persons with aphasia have performed better in picture mode than the other two modalities for common object task, which is comparatively less than their neuro-typical adults counter parts. Mann-Whitney U test was carried out and the results reveal a significant difference in auditory ($Z=-7.65$, $p < 0.001$), picture ($Z=-4.62$, $p<0.001$), and orthographic ($Z=-7.65$, $p< 0.001$) modes between the neuro-typical adults and persons with aphasia.

Table 6. *Mean and SD values for neuro-typical adults and persons with aphasia in auditory, picture, and orthographic modes.*

Section	Sub-section	Mode	Neuro-typical adults		Persons with Aphasia	
			Mean (%)	SD (%)	Mean (%)	SD (%)
Noun	Body parts	Auditory	100.00	0.00	74.55	24.23
		Picture	100.00	0.00	82.73	24.53
		Orthographic	100.00	0.00	65.00	34.13
	Common objects	Auditory	100.00	0.00	69.10	22.56
		Picture	100.00	0.00	82.73	24.53
		Orthographic	100.00	0.00	60.91	31.45
	Colors	Auditory	100.00	0.00	61.82	34.01
		Picture	100.00	0.00	83.64	22.92
		Orthographic	100.00	0.00	60.91	35.34
	Geometric forms	Auditory	100.00	0.00	60.00	31.94
		Picture	100.00	0.00	80.00	27.93
		Orthographic	100.00	0.00	58.18	35.73
	Numbers	Auditory	100.00	0.00	63.18	31.33
		Orthographic	100.00	0.00	61.36	33.47

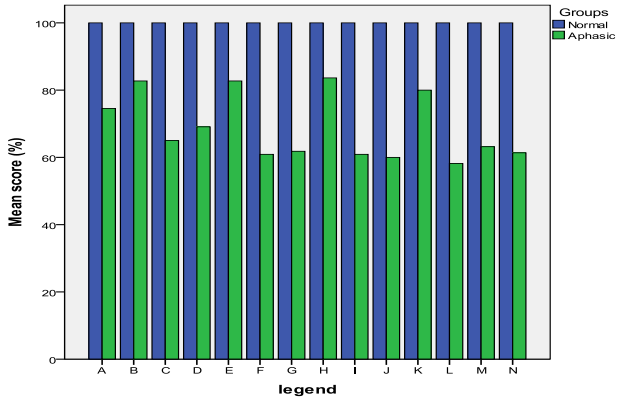

Fig. 2. Response of participants on different task in auditory, picture, and orthographic mode.

Whereas
A- Scores of body parts in auditory mode
B- Scores of body parts in picture mode
C- Scores of body parts in orthographic mode
D- Scores of common object in auditory mode
E- Scores of common object in picture mode
F- Scores of common object in orthographic mode
G- Scores of colour in auditory mode
H- Scores of colour in picture mode
I- Scores of colour in orthographic mode
J- Scores of geometric form in auditory mode
K- Scores of geometric form in picture mode
L- Scores of geometric form in orthographic mode
M- Scores of number in auditory mode
N- Scores of number in orthographic mode

Colors

Mean and standard deviation of color task for persons with aphasia and neuro-typical adults are shown in Table 6. It can be observed from Table 6 and Figure. 2 that performance of neuro-typical adults on color task is higher than the performance of persons with aphasia in all modalities. Comprehension of color is better in picture mode than the auditory followed by orthographic mode for persons with aphasia whereas neuro-typical adults have comprehended well in all modes. A Mann-Whitney U test was carried out to examine for statistical significance and the results reveal a significant difference in auditory ($Z=-8.09$, $p < 0.001$), picture ($Z=-4.62$, $p<0.001$), and orthographic ($Z=-8.09$, $p< 0.001$) modes between the neuro-typical adults and persons with aphasia.

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Geometric form

The performance of persons with aphasia and neuro-typical adults on geometric form task is represented in Table 6. It is indicated from Table 6 and Figure. 2 that the mean score of geometric forms task in auditory, picture, and orthographic mode for persons with aphasia is comparatively less than their neuro-typical counter parts. Persons with aphasia have performed better on geometric form task in picture mode and comparatively less in auditory and orthographic modes. To know the statistical significance, Mann-Whitney U test was carried out and the results reveal a significant difference in auditory ($Z=-7.65$, $p <$

Table 7. *Mean and SD values for noun for neuro-typical adults and persons with aphasia in auditory, picture, and orthographic modes.*

	Modes	Neuro-typical adults		Persons with Aphasia	
		Mean(%)	SD(%)	Mean(%)	SD(%)
Noun	Auditory	100.00	0.00	65.73	28.32
	Picture	100.00	0.00	82.27	24.81
	Orthographic	100.00	0.00	61.27	33.59

0.001), picture (Z=-4.62, p<0.001), and orthographic (Z=-8.08, p< 0.001) modes between the neuro-typical adults and persons with aphasia.

Number

Table 6 and Figure 2 indicate the mean score of number task in auditory and orthographic mode for persons with aphasia is comparatively less than their neuro-typical counter parts. Comprehension of number is better in auditory mode than the orthographic mode for the persons with aphasia whereas neuro-typical adults have performed better in both modes. On the Mann-Whitney U test, it was observed that there was a significant difference in auditory (Z=-8.08, p < 0.001) and orthographic (Z=-8.08, p< 0.001) modes between the neuro-typical adults and persons with aphasia.

Overall Performance on nouns

The overall total scores for noun were summed up for all modalities. The mean and standard deviation for auditory, picture, and orthographic modes were calculated. It is apparent from Table 7 and Figure 3 that the comprehension of noun was better in picture mode than in auditory mode and then followed by orthographic mode for persons with aphasia. It also shows that performance of neuro-typical adults on noun task is higher than the performance of persons with aphasia in all modalities. A Mann-Whitney test result showed that there was a significant difference of the performances in noun task in auditory (Z=-8.08, p<0.001), picture (Z=-4.62, p<.001), and orthographic (Z=-8.08, p<0.001) modes across neuro-typical adults and persons with aphasia.

Comprehension of noun in all the auditory, picture, and orthographic input modalities was impaired for persons with aphasia compare to neuro-typical adults.

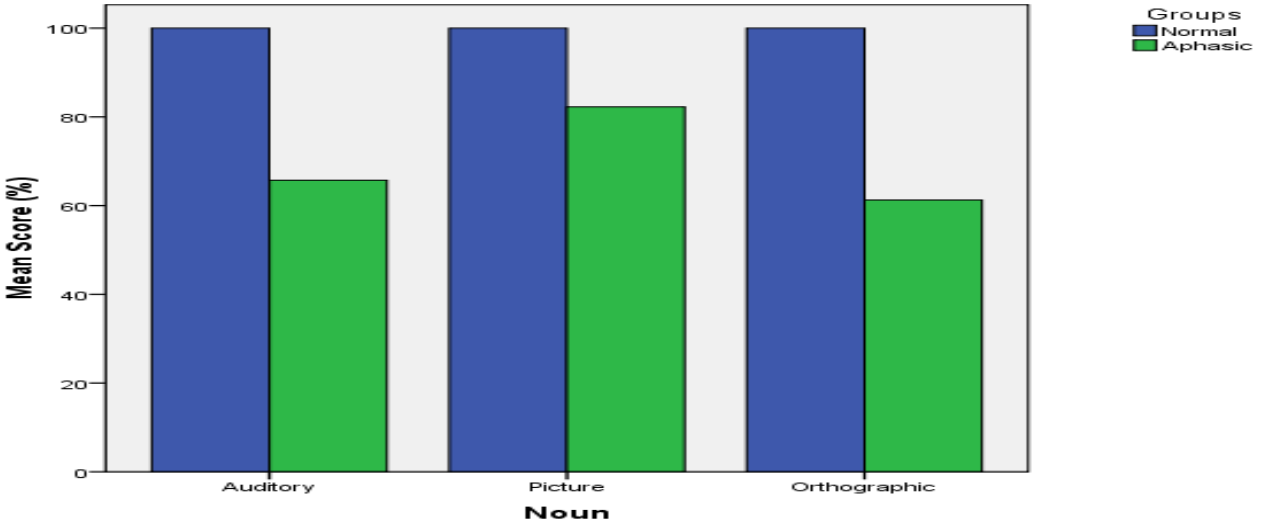

Fig. 3. Response of noun task in auditory, picture, and orthographic mode of neuro-typical adults and persons with aphasia.

Table 8. *Mean and SD values for different tasks for neuro-typical adults and persons with aphasia in auditory, picture, and orthographic modes.*

Section	Mode	Neuro-typical adults		Persons with Aphasia	
		Mean(%)	SD(%)	Mean(%)	SD(%)
Polar question	Auditory	100.00	0.00	66.36	26.18
	Orthographic	100.00	0.00	57.27	37.97
Semantic anomaly	Auditory	100.00	0.00	62.73	34.67
	Orthographic	100.00	0.00	50.91	40.61
Syntagmatic relation	Auditory	100.00	0.00	48.18	27.86
	Orthographic	100.00	0.00	41.82	34.01
Paradigmatic relation	Auditory	100.00	0.00	49.09	33.30
	Orthographic	100.00	0.00	42.73	31.01
Semantic contiguity	Auditory	100.00	0.00	51.82	33.41
	Picture	100.00	0.00	51.82	34.01
	Orthographic	100.00	0.00	50.91	36.73
Semantic similarity	Auditory	100.00	0.00	46.36	34.43
	Orthographic	100.00	0.00	48.18	37.63

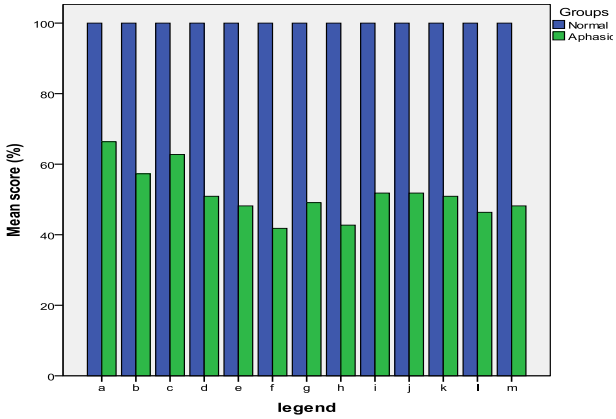

Fig. 4. Response on different task in auditory, picture, and orthographic mode of neuro typical adults and persons with aphasia.

Whereas

a- Scores of polar question in auditory mode
b- Scores of polar question in orthographic mode
c- Scores of semantic anomaly in auditory mode
d- Scores of semantic anomaly in orthographic mode
e- Scores of syntagmatic relation in auditory mode
f- Scores of syntagmatic relation in orthographic mode
g- Scores of paradigmatic relation in auditory mode
h- Scores of paradigmatic relation in orthographic mode
i- Scores of semantic contiguity in auditory mode
j- Scores of semantic contiguity in picture mode
k- Scores of semantic contiguity in orthographic mode
l- Scores of semantic similarity in auditory mode
m- Scores of semantic similarity in orthographic mode

Performance on semantic anomaly

The performance of persons with aphasia and neuro-typical adults on semantic anomaly task is represented in Table 8. Table 8 and Figure 4 indicate that persons with aphasia have performed better in auditory mode than orthographic mode. The performances of Person with aphasia were comparatively lesser than neuro-typical adults in both modalities. To examine for statistical significance, Mann-Whitney U test was carried out and the results reveal a significant difference in auditory ($Z=-8.09$, $p < 0.001$) and orthographic ($Z=-8.09$, $p< 0.001$) modes between the neuro-typical adults and persons with aphasia.

Performance on syntagmatic relation

It can be observed from Table 8 and Figure 4 that the performance of neuro-typical adults on syntagmatic relation task is higher than the performance of persons with aphasia in both modalities. Comprehension of syntagmatic relation is better in auditory mode than orthographic mode for persons with aphasia whereas neuro-typical adults have comprehended well in both modes. Mann-Whitney U test was carried out and the results reveal a significant difference in auditory ($Z=-8.08$, $p < 0.001$) and orthographic ($Z=-8.08$, $p< 0.001$) modes between the neuro-typical adults and persons with aphasia.

Table 9. *Mean and SD values for comprehension of semantic for neuro-typical adults and persons with aphasia in auditory, picture, and orthographic modes..*

	Modes	Neuro-typical adults		Persons with Aphasia	
		Mean(%)	SD(%)	Mean(%)	SD(%)
Semantic	Auditory	100.00	0.00	59.38	29.44
	Picture	100.00	0.00	76.18	26.54
	Orthographic	100.00	0.00	54.38	34.48

Performance on paradigmatic relation

As seen from Table 8 and Figure 4 that comprehension of paradigmatic relation for persons with aphasia is better in auditory mode than orthographic mode which is comparatively less than their neuro-typical counter parts. A Mann-Whitney U test was carried out to examine for statistical significance and the results reveal a significant difference in auditory (Z=-8.08, p < 0.001) and orthographic (Z=-8.08, p< 0.001) modes between the neuro-typical adults and persons with aphasia.

Performance on semantic contiguity

Mean and standard deviation for semantic contiguity task for persons with aphasia and neuro-typical adults are shown in Table 8. It can be inferred from Table 8 and Figure 4 that the mean and standard deviation for semantic contiguity task in auditory, picture, and orthographic mode for persons with aphasia is comparatively less than their neuro-typical counter parts. Persons with aphasia performed equally better in auditory and picture mode than orthographic mode. Mann-Whitney U test was carried out and the results reveal a significant difference in auditory (Z=-8.08, p < 0.001), picture (Z=-8.08, p<0.001), and orthographic (Z=-8.09, p< 0.001) modes between the neuro-typical adults and persons with aphasia.

Performance on semantic similarity

Mean and standard deviations were extracted for the groups of neuro-typical adults and persons with aphasia. Scores for the semantic similarity tasks in auditory and orthographic mode are shown in Table 8. It is apparent from Table 8 and Figure 4 that the neuro-typical participants obtained a higher mean value than the persons with aphasia for semantic similarity in auditory and orthographic modes. Performance of persons with aphasia on semantic similarity task was better in orthographic mode than the auditory mode.

Results reveal a significant difference in auditory (Z=-8.08, p < 0.001) and orthographic (Z=-8.09, p< 0.001) modes on Mann-Whitney U test between the neuro-typical adults and persons with aphasia.

Overall performance on all semantic comprehension tasks

The overall total scores for semantic comprehension were summed up for all modalities separately. The mean and standard deviation for auditory, picture, and orthographic mode were calculated. From Table 9 and Figure 5, it can be seen that performance of persons with aphasia for overall semantic task was better in picture mode than auditory mode and the followed by orthographic mode which was comparatively lesser than the performance of neuro-typical adults. A Mann-Whitney U test was carried out to examine for statistical significance and the results reveal a significant difference in auditory (Z=-8.08, p < 0.001), picture (Z=-8.08, p<0.001), and orthographic (Z=-8.08, p< 0.001) modes between the neuro-typical adults and persons with aphasia.

Result showed that there was a difference in the performances in semantic task between neuro-typical adults and persons with aphasia across the all modalities.

The normatives obtained on the semantic comprehension test in Hindi language, as put forth, have been collected from a group of persons who belong to a part of Northern India, and thus acknowledge the fact that these performances (scores) can be accepted and generalized to the wider dimension of inhabitants residing in this region of the country.

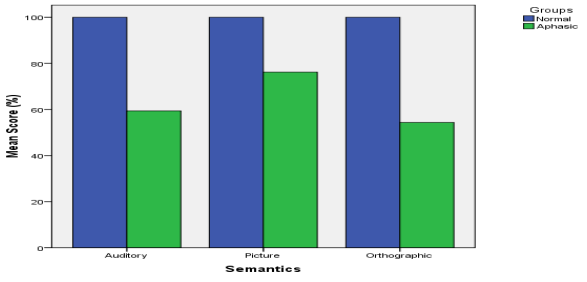

Fig. 5. Response of semantic task in auditory, picture, and orthographic mode of neuro-typical adults and persons with aphasia.

Qualitative analysis of responses about the protocol

The 24 SLPs who rated the protocol based on a feedback questionnaire is shown in Table 2. It is evident from the table 2 that the professionals rated the protocol on overall parameters as 53.95% excellent, 40.13% good, and 5.92% fair. However, none of professional rated the protocol as poor and/ or very poor. Also for the publications, outcomes and developers (professional background) domain, two professionals reported that they were aware of the other materials available which can be used for assessing semantic comprehension, and 22 professionals stated that they were not aware of any other protocol available either in the western or Indian context. Consequently, it can be stated that this protocol grading ranged from excellent or good from most of the judges and the professionals were of the opinion that this protocol can be used effectively on persons with aphasia.

Discussion

In this study, an attempt was made to investigate the semantic comprehension deficits of persons with aphasia in auditory, picture, and orthographic modes. Results reveal that brain damage may cause deficits in comprehension of body-part, common object, color, geometric form and number in auditory, picture, and orthographic modes in persons with aphasia. Comprehension of noun was better in picture mode than the auditory mode than in orthographic mode for persons with aphasia. In the entire semantic task comprehension of color was better in picture mode for persons with aphasia followed by body part, common object, and geometric form. Comprehension of body part was better in auditory mode followed by common objects, number, color, and geometric form. In orthographic mode, comprehension of body part was better followed by common object, color, number, and geometric form. Persons with aphasia have performed poorly on geometric task in all modalities. The poorer comprehension of the aphasics for geometrical shapes could be attributed due to the usage and also indicating category specific deficits in persons with aphasia. This aspect receives support from Dennis (1976), McKenna and Warrington (1978), and Warrington and McCarthy (1983).

These results are suggestive of category specific impairments in semantic comprehension. Category specific impairments have also been reported by Goodglass, Klein, Carey and Jones (1966). They reported of persons who have inappropriate difficulty with particular semantic categories. Objects and actions were easiest to comprehend and letter the most difficult. Dennis (1976), McKenna and Warrington (1978), and Warrington and McCarthy (1983) reported selective impairments in the comprehension of body parts names and inanimate object names. Hillis and Caramazza (1991) also reported of greater impairment in comprehension of the mass noun/count noun distinction as opposed to the proper noun/common noun distinction in Broca's but not in Wernicke's aphasics.

The breakdown in the ability to comprehend noun for persons with aphasia when compared with the neuro-typical adults is in consensus with few other studies (Benedet & Goodglass, 1989; Goodglass & Wingfield, 1993; Jodzio, Biechowska,& Leszniewska-Jodzio, 2008).

Schuell and Jenkins (1961) also reported that persons with aphasia do better on single word comprehension tasks, when written and auditory stimuli are used instead of auditory stimuli alone. Moreover, the repetition of linguistic command also improved the performances of these patients. Further, sub-vocal rehearsals were also noticed in these participants, which is an indication that these participants rely on their auditory feedback and sub-vocal rehearsals also help in retaining the linguistic stimuli for a longer duration. According to Schuell, Jenkins, and Jimenz-Pabon, (1964) and Goswami (2004) virtually all persons with aphasia exhibit retention deficits. Therefore, these sub vocal rehearsals may be used as a compensation mechanism for these deficits. But on the other hand, the responses of Wernicke's and global aphasics were neither clear, nor prompt and did not improve even when the stimuli were presented both in the verbal and graphic modalities, or when the stimuli were repeated. Moreover, no self corrections or sub-vocal rehearsals were noticed. The improvement in comprehension with repetition of the command could be an indication of inattention and/or auditory processing deficits in aphasics.

According to Marshall, Grinnell, Heisel, Newall, and Hunt, (1997), attention deficits in persons with aphasia may result in the individual missing out initial portions of messages or, missing out short messages completely. Thus, the persons with aphasia may be benefited with repetition of command on a single word comprehension task.

Comprehensions of polar question, semantic anomaly, syntagmatic relation, paradigmatic relation were better in auditory mode than orthographic mode for Persons with aphasia. In auditory mode, comprehension of polar question was better than semantic anomaly followed by semantic contiguity, paradigmatic relation, syntagmatic relation, and semantic similarity. In orthographic mode,

comprehension of polar question was better than semantic anomaly followed by semantic contiguity, semantic similarity, paradigmatic relation, and syntagmatic relation. Only on semantic similarity task, persons with aphasia have performed better in orthographic mode than auditory mode. Persons with aphasia have comprehended equally on semantic contiguity task in auditory and picture mode.

The performances of the persons with aphasia however, were not similar across the various sections on semantics exhibited better comprehension on polar questions as compared with semantic anomaly, paradigmatic relations, syntagmatic relations, semantic contiguity, and semantic similarity. The better comprehension on polar question task could be attributed to the relative simplicity of the stimuli and the task in these sections as compared to the semantic anomaly, syntagmatic relations, paradigmatic relations, semantic contiguity, and semantic similarity for persons with aphasia. Moreover, these sections also require intact reasoning skills which may get compromised due to brain damage as is other cognitive processes such as attention and memory which are reported to be impaired in these patients (Martin and Romani 1994; Martin, Shelton, and Yaffee 1994; Freedman and Martin 2001).

However, the performance of persons with aphasia differs with different modality stimuli presentation for all the sections and/or sub-sections. This highlights an important observation that the benefits of different modality stimuli presentation are also commensurate on the degree of a person's comprehension difficulty on a particular task. Semantic comprehension would have influenced for persons with aphasia such as familiarity, semanticity, speech rate, and stimulus modality.

The persons with aphasia when assessed for the comprehension deficits at semantic level in different modes showed obvious deficits with varying degrees. Several researchers have also demonstrated the existence of semantic deficits in comprehension, additionally; this study also delineated quantitative as well as qualitative differences in semantic comprehension between the various aphasic types. (Goodglass et al, 1976; Coughlan et al., 1978; Warrington et al., 1984; Shapiro et al., 1989; Pierce et al., 1990).

Overall semantic comprehension was better in picture mode than auditory mode and followed by orthographic mode for persons with aphasia. Compared to persons with aphasia, neuro-typical adults seem to comprehend well on all tasks in all modalities.

Deficits in comprehension of linguistic stimuli in persons with aphasia can be attributed to extent and nature of brain damage sustained by the person (Caramazza & Zurif, 1976; Peach, Canter, & Gallaher, 1988). Similar findings of impaired semantic comprehension have been reported in persons with aphasia as compared to the neuro-typical adults (Burchert, Friedmann, & De Blesser, 2003; Goswami, 2004; Wright & Newhoff, 2004.

Thus, this has proved to be a useful protocol for persons with aphasia as implicated by the result. These facts indicate semantic comprehension protocol to be one of the most elaborate clinical tools that help in terms of assessing an individual's auditory, picture, and orthographic mode comprehension and thereby identifying the semantic comprehension deficits in a person with aphasia. Such a comprehensive profile would serve as a necessary baseline/ starting point for management decisions. The particular responses of the person would also guide the clinician in the selection of linguistic timing, and contextual and other facilitators of comprehension. Thus, this study underscores the importance of a thorough assessment of semantic comprehension in different modalities. This study emphasizes that the semantic comprehension deficits in different modalities exhibited by persons with aphasia is not a unitary phenomenon. Person with aphasia individuals exhibit qualitative as well as quantitative differences in their semantic comprehension abilities. Therefore, this study underscores the importance of a thorough assessment of semantic comprehension skills in persons with aphasia in different modalities. This will help in drawing a profile of each person with aphasia in different modes for comprehending the linguistic stimuli.

Conclusion

The present study investigated comprehension deficits in Hindi speaking persons with aphasia at semantic level in different modalities. Result showed that there was a significant difference in the performances on semantic task between neuro-typical adults and persons with aphasia across all modalities. The neuro-typical adults exhibited significantly better comprehension as compared to the persons with aphasia in auditory, picture, and orthographic modes on semantic comprehension in Hindi language. Semantic comprehension was better in picture mode than auditory mode of stimuli presentation on all tasks among persons with aphasia. Category specific deficits in the lexical comprehension were evident in persons with aphasia, with poorer comprehension of particular categories such as numbers and geometric forms. Persons with aphasia showed better comprehension for polar questions as compared to semantic anomaly, syntagmatic anomaly, paradigmatic relations, semantic contiguity

and semantic similarity. Cognitive and / or auditory processing deficits have been implicated from the responses of persons with aphasia. The developed protocol is useful in finding comprehension deficits at semantic level in persons with aphasia in different modalities. Results underscore the fact that research should be orientated at development of language specific material in a multilingual country such as India, to cater to the needs of all the assessors within a broad work culture.

Limitations of the study

The results of the study need to be interpreted with caution as number of the paticpnats was less. Further, the reliability and validity of the stimuli were not taken up, which is one of the major drawbacks of this study. However, the results of the study do provide corroborative evidence for obvious semantic comprehension deficits in persons with aphasia with varying degree in different modalities. This is preliminary stage of work and work is underway to include participants with fluent aphasia.

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Appendix-I

Section	Auditory mode	Picture mode	Orthographic mode
Noun section	"Place the pictures response sheet before the person. Explain to the person that you are going to name some words and he/she has to point to the picture that describes the word."	"Place the pictures response sheet before the person. Give the person a picture, which he/she has to match with the pictures placed before him."	"Place the pictures response sheet before the person. Present the word in orthographic form, the person has to point to the correct picture that describes the word."
Polar questions section	"Explain to the person that you are going to ask some questions and that the answers should be either 'yes' or 'no'. Responses can be either verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."		"Show stimulus written on cards to the person and the person has to carefully read the card before giving a 'yes' or 'no' response. Responses can be either verbal, gestural, or you can also provide cards having 'yes' and 'no' written to encourage pointing responses.
Semantic anomaly section	"Explain to the person that you are going to read some sentences. The person has to listen carefully and tell if the sentence meaning is correct or not. The response can be 'yes' if the sentence is correct or 'no' if the person perceives that the sentence is not correct. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."		"The participant is shown some sentences written on cards. The person has to read carefully and tell whether the sentence is semantically correct or not. The response can be 'yes' if the sentence is correct or 'no' if the person perceives that the sentence is not correct. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."

Syntagmatic relations and Paradigmatic relations sections	"Explain to the person that you are going to read some words. The person has to notify whether the words are related or not. The response can be 'yes' if the words are related or 'no' if the person perceives that the words are not related. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."		"Words written on cards are shown to the participants. The person has to indicate whether the words are related or not. The response can be 'yes' if the words are related or 'no' if the person perceives that the words are not related. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."
Semantic contiguity section	"Explain to the person that you are going to read some words. The person has to indicate whether the words are related or not. The response can be 'yes' if the words are related or 'no' if the person perceives that the words are not related. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."	"Two pictures are shown and the participants have to indicate whether the pictures are related to each other or not. The response can be 'yes' if the words are related or 'no' if the person perceives that the words are not related. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."	"Words written on cards are shown to the participants. The person has to indicate whether the words are related or not. The response can be 'yes' if the words are related or 'no' if the person perceives that the words are not related. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."
Semantic similarity section	"Explain to the person that you are going to read some words. The person has to tell if the meaning of the words is similar or dissimilar. The response can be 'yes' if the words are similar or 'no' if the person feels that the words are dissimilar. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."		"Show some words written on cards. The person has to tell if the meaning of the words is similar or dissimilar. The response can be 'yes' if the words are related or 'no' if the person perceives that the words are not related. Responses may be verbal, gestural or you can also provide cards having 'yes' and 'no' written to encourage pointing responses."