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# Development and Standardization of a Semantic Comprehension Assessment Tool for Dementia in Bengali

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***Abstract:*** *Dementia is a neuro-communication disorder characterized by an impairment of the semantic memory responsible for processing meaning-related knowledge. The effect of dementia on semantic comprehension skill varies based on severity of dementia. In the same context, semantic memory has been described as the form of memory that allows humans to understand the meanings of words, objects, and events; to name and to produce meaningful statements; and to behave in a manner that reflects knowledge about the objects and events that exist in the environment. No standardized test has been documented till date for measuring semantic comprehension in dementia patients in Indian languages. With Bengali being the second widely spoken language in India (Census, 2001), the development and standardization of semantic comprehension test in Bengali was envised.*

*The present study aimed to develop and standardize semantic comprehension test in Bengali and to assess the extent of semantic comprehension deficit across mild, moderate and severe dementia subjects categorized through dementia severity rating scale in Bengali using the developed test.*

*A total of sixty participants (30 dementia patients and 30 normal subjects) participated in the study. The clinical population consisted of 10 mild, 10 moderate and 10 severe degree dementia patients identified with the help of clinical dementia rating scale. The developed semantic comprehension test comprised of seven sections representing noun, polar questions, semantic anomaly, syntagmatic relations, paradigmatic relations, semantic contiguity, and semantic similarity. Noun section of the semantic protocol was categorized into five sub-sections like body parts, common objects, colours, geometric forms, and numbers. Stimulus was given through auditory, picture and orthographic mode. Responses were analyzed and a score of '2'/ '1'/ '0' were given for every correct response without prompt, with prompt, and incorrect/no response even after prompt responses respectively.*

*Results indicated significant difference between the scores obtained by mild, moderate and severe dementia patients on semantic comprehension test. The mild dementia patients performed better than moderate and severe dementia patients in the semantic comprehension test. Results also indicated the developed semantic comprehension test to be valid and to be a reliable tool for assessment of semantic comprehension deficits across different degrees of dementia. The semantic comprehension test was thus validated to be an efficient, reliable and valid tool to be used with native Bengali speakers for evaluating semantic comprehension skills among individuals with neuro-communication disorders.*

***Keywords:*** *Bengali, comprehension, dementia, semantics, , standardization*

## I. Introduction

Semantic comprehension is the most important aspect of language, which helps to perceive the intended message and also helps to get feedback of one's own speech. Semantic comprehension is one of the basic needs of reading and listening. It enables one to acquire information, to experience and be aware of events, to communicate successfully, and to achieve academic success. The goal of listening or reading a discourse or text is usually to derive an overall interpretation rather than simply to retrieve the meanings of individual words or sentences. An extent of deficit in semantic comprehension provides important information about the language efficiency of the client (Paul, 2007). Therefore, understanding and measurement of semantic comprehension is needed in all language disordered population. Semantic comprehension is one of the major language aspects affected due to aging as has been attributed to be due to loss of auditory or semantic memory span. Impairments of semantic cognition are highly debilitating and can arise in a range of disorders including aphasia following a stroke and in dementia.

Signs of dementia include decrease in the speed of performing mental operations and limited working memory processes, such as retrieving and storing information. Apart from these features, some people may have

problem in finding words and retrieving names of people and places, as well as remembering details belonging to past episodes (Craik, 2000). Language disorders especially naming deficits and deficits in planning and visuo-spatial abilities increases with increase in the severity of dementia and has been mostly reported in cortical dementias. In Alzheimer's disease and other cortical dementias, marked deterioration of semantic knowledge and cognitive ability has also been correlated in literature and has been found to increase with increase in the severity of dementia. However, in some cases of semantic dementias, selective and progressive impairment of semantic memory associated with bilateral atrophy of the anterior temporal lobes (Hodges et al., 1992a; Mummery et al., 2000; Snowden et al., 1989) have also been reported. Other cognitive functions, including phonology, syntax, executive skills and episodic memory, remain relatively intact in dementia. Dementia patients show a highly predictable pattern of errors on a number of tasks which are "pre-semantic", including reading single words aloud (Funnell, 1996; Patterson and Hodges, 1992; Woollams et al., 2007); spelling to dictation (Graham et al., 2000; Parkin, 1993); producing the past tense form of verbs from the present tense (Cortese et al., 2006; Patterson et al., 2001); lexical decision (Moss et al., 1995; Rogers et al., 2004b); immediate serial recall of short lists of words (Jefferies et al., 2004; Jefferies et al., 2005; Knott et al., 1997; Knott et al., 2000); object decision, i.e. deciding if line drawings represent real objects (Breedin et al., 1994; Hovius et al., 2003; Rogers et al., 2003; Rogers et al., 2004b) and copying drawings of objects after a brief delay (Bozeat et al., 2003; Lambon Ralph and Howard, 2000).

At present, no tool is available for measuring overall semantic comprehension in dementia patients in Indian languages. A very few available standardized tests in Indian languages assess either listening skills, reading comprehension skills or auditory comprehension skills with semantic comprehension being relied to be tested using other English language tests. With Bengali being the second widely spoken language in India (Census, 2001), the development and standardization of a semantic comprehension tool in Bengali was conceptualized for assessment of semantic comprehension skills in native Bengali speaking dementia patients. As semantic comprehension is commonly tested by asking the patient to point to named object or word (Goodglass, 1993), the development of an audition, orthographic and picture based semantic comprehension tool was envisioned.

The aim of the study was to develop and standardize a semantic comprehension test in Bengali and to analyze semantic comprehension deficits across mild, moderate and severe degree of dementia as measured through dementia severity rating scale in native Bengali speaking dementia subjects.

It was hypothesized that there will be a significant difference between performance scores of semantic comprehension test in Bangla across mild, moderate and severe patients with dementia with mild dementia patients to be scoring better than moderate and severe dementia patients and severe dementia patients to be having comparatively poor scores in the semantic comprehension tool.

## II. Methodology

***Participants***

A total of sixty participants (30 dementia patients and 30 normals) having native language exposure as Bengali and within the age group of 60 – 80 years (mean age of 74.8 years) participated in the study. The participants diagnosed with dementia constituted the clinical group and the normal participants constituted the control group. Written family or self consent for participating in the study was obtained from all the participants.

**Control group:**

The participants of the control group were recruited amongst the pool of patients who had reported at AYJNIHH, ERC during the year 2014 – 2015 for availing speech and language therapy services.

**Clinical group:**

The participants of the clinical group were drawn amongst the patients who had reported at the Alzheimer's and Related Disorders Society of India (ARDSI), Kolkata chapter at Kolkata and had been diagnosed to be having cortical dementia. The Clinical Dementia Rating Scale () was administered on the patients diagnosed with cortical dementia at ARDSI, Kolkata and 10 mild, 10 moderate and 10 severe degree dementia patients were finally selected for the study.

**Inclusion criteria:**

1. The normal participants without any history of pre-morbid neurological illness, psychological disorders, and other significant sensory and/or cognitive deficits were included in the study.
2. All the participants were able to read and write the Bengali orthographic.

**Exclusion Criteria:**

1. Participants having any hearing, and/or vision problem.
2. Participants who were not physically fit to endure the test.

**Procedure:**

In order to answer the questions posed in the objectives, a procedure consisting of six stages was devised.

***Phase 1: Development of the semantic comprehension test in Bangla***

The developed semantic comprehension protocol consisted of seven sections- noun, polar questions, semantic anomaly, syntagmatic relations, paradigmatic relations, semantic contiguity, and semantic similarity. Noun section of the semantic protocol was categorized into five sub-sections like body parts, common objects, colours, geometric forms, and numbers. In each section/sub-section, 20 items were selected from newspaper and Bengali literature books of senior high school prescribed by West Bengal Board of Secondary Education. The selected test items were given to five native Bengali speech language pathologists and five linguists to rate for familiarity. A three point likert rating scale was used for rating and included the scores "0" as inappropriate, "1" as appropriate and "2" as most appropriate.

The items rated as appropriate and most appropriate were selected for further analysis and the items rated as inappropriate were corrected and were again given to five native Bengali speech language pathologists and five linguists to rate for familiarity till no significant statistical differences were obtained. For the final tool, 10 test items were randomly selected from the 20 items of each section and sub section. Finally**,** the developed tool in Bengali was given for face validity and content validity rating to a psychologist to be rated on content validity and face validity so as to be approved as valid for the purpose of the present study.

***Stage 2: Validation of the semantic comprehension test in Bangla***

The semantic comprehension protocol in Bengali language had 10 items in each sections and/or sub-sections. A total of 110 stimuli to be presented in auditory mode, 50 stimuli in picture mode, and 110 stimuli in orthographic mode were finalized. Culturally appropriate picture stimuli were provided wherever necessary and were drawn by a professional artist. The stimuli were presented in each modality separately and randomly. The noun section and semantic contiguity were tested through auditory, picture, and orthographic modes while the other sections were tested in auditory and orthographic mode. The noun section contained four pictures out of which one was a target picture and other three were distracters. Different distracters were provided for different stimuli, and for semantic contiguity section, two pictures were presented under each item.

***Phase- 4: Administration of the semantic comprehension test on participants:***

Prior to the administration of the test all participants were presented with two practice stimulus. This was done to familiarize the participants with the test requirements and to ensure that each participant understood the task. At the beginning of each subtest, the carrier phrases"tell me"/ "Show me" were used before each stimulus item.

Participants were asked to point to the target stimulus. Accepted responses for other sections were through verbal, gestural or through pointing to cards written 'yes' and 'no'. Different sections were followed by different instructions. The stimuli were repeated if the participants did not respond or if he/she asked for repetition.

The developed test materials were presented in a random order across all modes to the participants.

The participant's responses were scored as '2', '1', or '0' for every correct response without prompt, correct response with prompt and incorrect/no response even after prompt respectively.

Statistical analysis of participant's scores was done by using SAS 9.2 version software. Generalized Least square Mean (GLM) method was used for comparing the semantic comprehension scores across the three types of dementia and with the control group.

***Stage 5: Test retest reliability***

The reliability of the semantic comprehension test was examined by measuring the test-retest reliability. Five out of the thirty participants of each group were randomly selected and were re-tested after two weeks. The data thus obtained from these ten participants during the re-test session was compared with the data obtained two week prior to find out if there is any significant difference between the tests and retest scores.

***Stage 6: Validity***

The validity of the test was established by comparing the scores obtained from thirty normal participants against thirty dementia participants to determine whether there is any significant difference in scores between these two populations.

## III. Results And Discussion:

The mean age of the participants was found to be 73.5 yrs (SD 4.8) for mild dementia, 75.4 yrs (SD 4.2) for moderate dementia and 74.2 yrs (SD 2.8) for severe dementia. The mean age of participants in the control group was found to be 72.4 yrs (SD 3.9).

Paired "t" test (shown in TABLE 4.0) was done for computing the level of significance between the performance scores of mild, moderate and severe degree of dementia patients on each section of the semantic comprehension test. Similar p-values (shown in TABLE 3.0) were computed for comparison between dementia and normal subjects across seven sections i.e. noun section, polar question section, semantic anomaly section, syntagmatic relation section, paradigmatic section, semantic contiguity section and semantic similarity section.

Least Square Mean (TABLE 2.0) of semantic comprehension test scores of noun section, polar question section, semantic anomaly section, syntagmatic relation section, paradigmatic section, semantic contiguity section and semantic similarity section across normals and mild, moderate, and severe dementia patients were compared using GLM method. Similarly, Least Square Mean (shown in TABLE 1.0) of semantic comprehension test scores of noun section across normals and mild, moderate, and severe dementia patients were also compared using GLM method.

Least Square Mean scores obtained by GLM method for the normal population in all the seven sections of semantic comprehension test was 20.00. The Least Square Mean scores revealed that performance of normal population in semantic comprehension test was very good compared to the different degrees of dementia patients. Least Square Mean results of dementia patients diagnosed with mild, moderate, and severe dementia across all the seven sections of semantic comprehension test revealed that for each section of semantic comprehension test, mild dementia patients obtained higher scores than the other two groups, moderate dementia patient scores were lower than mild group but higher than severe group, and severe dementia patients scores were lowest among the three groups of dementia patients.

| Least Square Means | | | | | |
|---|---|---|---|---|---|
| Semantic comprehension test score | Body parts section | Colour section | Number section | Geometrical shapes section | Common objects section |
| Normals | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| Mild dementia | 16.30 | 16.50 | 15.80 | 14.90 | 16.70 |
| Moderate dementia | 11.8 | 13.10 | 12.10 | 9.50 | 12.70 |
| Severe dementia | 4.90 | 5.10 | 3.40 | 3.40 | 5.00 |

TABLE 1: Least Square Means values of performance scores of normals and mild, moderate, and severe dementia patients on the noun subtest

| Semantic comprehension test score | Polar question section | Semantic anomaly section | Syntagmatic relation section | Paradigmatic relation section | Semantic contiguity section | Semantic simiarity section |
|---|---|---|---|---|---|---|
| Normals | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| Mild dementia | 15.90 | 16.40 | 15.10 | 12.30 | 15.70 | 16.30 |
| Moderate dementia | 11.30 | 11.90 | 10.80 | 7.90 | 12.00 | 12.20 |
| Severe dementia | 4.90 | 5.50 | 4.80 | 2.20 | 4.40 | 4.60 |

TABLE 2: Least Square Means values of performance scores of normals and mild, moderate, and severe dementia patients on six subtests of developed semantic comprehension test

| Participants | N | Mean | SD | p-value |
|---|---|---|---|---|
| Disorder population | 30 | 115.1 | 52.25 | |
| Normal population | 30 | 220 | 0 | <.0001 |

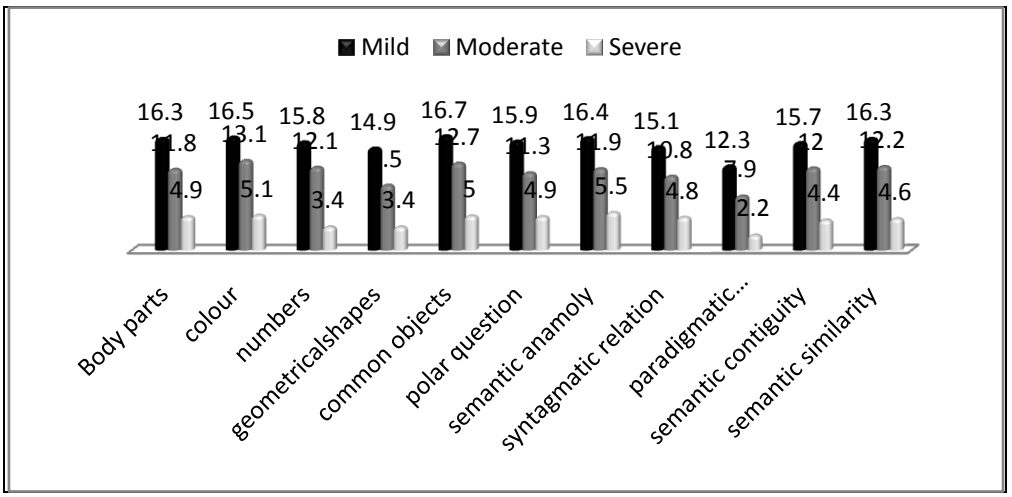
TABLE 3: Paired "t" test results between normal and dementia population.

| Severity rating of dementia | Mild dementia | Moderate dementia | Severe dementia |
|---|---|---|---|
| Mild | | <.0001 | <.0001 |
| Moderate | <.0001 | | <.0001 |
| Severe | <.0001 | <.0001 | |

TABLE 4: Paired "t" test results of all subtests of semantic comprehension test across mild, moderate and severe dementia.

| Participants | Test data | | Retest data | |
|---|---|---|---|---|
| | Mean | S.D | Mean | S.D |
| S1 | 16.18 | 1.53 | 15.90 | 1.64 |
| S2 | 15.72 | 1.61 | 15.81 | 1.40 |
| S3 | 11.27 | 1.73 | 11.63 | 1.43 |
| S4 | 11 | 1.73 | 10.72 | 1.55 |
| S5 | 4 | 1.61 | 4.09 | 1.31 |
| S6 | 20 | 0.00 | 20 | 0.00 |
| S7 | 20 | 0.00 | 20 | 0.00 |
| S8 | 20 | 0.00 | 20 | 0.00 |
| S9 | 20 | 0.00 | 20 | 0.00 |
| S10 | 20 | 0.00 | 20 | 0.00 |

TABLE 5.0: Test retest scores for reliability



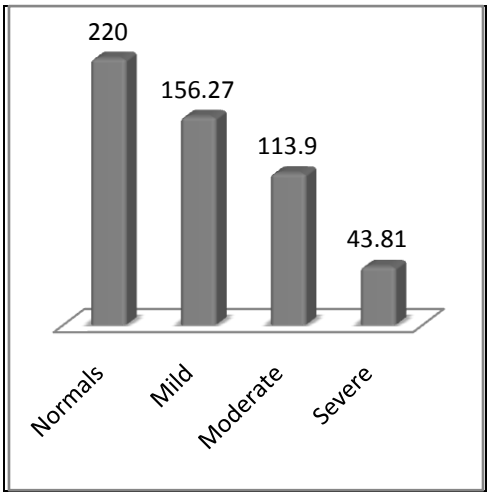




FIGURE 1: (A) Graph showing Least Square Mean values of seven sections of semantic comprehension test for mild, moderate, and severe dementia patients. (B) Graph showing Least Square Mean values of performance scores of normals and mild, moderate, and severe dementia patients on the developed semantic comprehension test.

As shown in Table 1.0, the Least Square Mean scores across the noun section of the developed semantic comprehension test was found to be 16.3 for mild degree of dementia patients which is greater than patients with moderate and severe types of dementia who have scores of 11.8 and 4.9 respectively. This is suggestive of a decrease in semantic comprehension skills as the severity of dementia increases.

Similarly, Least Square Mean values were obtained for mild, moderate and severe degree of dementia patients for every section of developed semantic comprehension test, and it yields the same results. The results (graphically represented in Fig. 1A and 1B) indicated mild dementia patients to have good semantic comprehension than moderate and severe degree of dementia patients.

Statistically significant differences ($p<.0001$ at 95% level of confidence) as shown in table 4.0 were obtained between scores of mild, moderate, and severe degree of dementia patients across all the sections of the developed semantic comprehension test using paired "t" test. This is in line with the evidence from Hodges and Patterson (1995)'s study in which they demonstrated a significant difference in the semantic fluency performance between AD patients with minimal (MMSE = 25.6), mild (MMSE = 20.9), and moderate (MMSE = 10.0) dementia. Hodges and Patterson (1995) found great heterogeneity in the performances of the AD patients, especially in the mildest cases. Significant differences across the different types of dementias on items of the developed semantic comprehension test are also supported by Mickanin et al. (1994) who also found significant group differences in the semantic fluency performance of Alzheimer's disease patients diagnosed with mild (MMSE = 23.7) and moderate (MMSE = 17.5) dementia.

Least Square Mean value of dementia patients and of normal populations were compared with the application of GLM method and pair wise significance test as shown in Table 3.0. Result showed the Mean for different degrees of dementia to be 115.1 with a SD of 52.25 and for age matched normal population it was estimated to be 220. Results of paired t- test ($p <.0001$ at 95% level of significance) indicated significant difference across the total test scores of clinical and control groups.

Computation of least square mean shown in Fig. 1B indicated a mean score of 171.9 for mild degree, 125.3 for moderate degree, and 48.2 for severe degree of dementia patient across all sections of the developed semantic comprehension test. The Least Square Mean of overall sections of semantic comprehension test was 115.1 for dementia patients and for normal was 220.The comparison between the scores obtained by normals and mild, moderate and severe dementia patients indicated significant differences to be present across the control and clinical group. Test retest comparison of means (as shown in TABLE 5.0) of five dementia patients and five normals indicated negligible difference to be present between test and retest scores of five dementia and five normal population, implying the developed test to be a reliable tool to measure semantic comprehension among wide varieties of dementia patients.

## IV. Summary & Conclusion

Progressive deterioration of language in patients with neurodegenerative disease provides an important testing ground for claims about the organization of the language system. The beginning of testing at a point in the progression of the disease when the patient is not too severely impaired, and chart the subsequent deterioration with a view to assessing the relative decline of various aspects of language processing (Hodges, Graham,& Patterson, 1995). The performance of the AD patients on the semantic fluency task appears to be significantly correlated with severity of dementia (Bayles et al. 1993).

Impairment in word comprehension is assumed to be related to the word-finding problems normally displayed by AD patients, and the hypothesis that semantic knowledge is gradually degraded in AD patients (Martin, 1992).

In cases of Dementia, comprehension of semantics is majorly affected, which in turn restricts the communication process. The present study intended to develop and standardize a semantic comprehension test in Bengali for use in patients with dementia as well as tried to explore semantic comprehension deficits across mild, moderate and severe Bengali speaking dementia patients. The result of the study indicated presence of significant differences across the scores of mild, moderate, and severe dementia patients on all the sections of the developed semantic comprehension test with mild dementia patients having better performance scores than moderate and severe degree of dementia patients. It can be concluded that semantic comprehension test can be used to assess semantic comprehension deficits in patients with dementia and also used in managing therapeutic plans.

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