Development of Bedside Aphasia Battery in Tamil (BAB-T)

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Abstract

Bedside Aphasia Battery in Tamil (BAB-T) was developed for assessing the linguistic abilities of Tamil-speaking individuals following an acquired brain injury. **Method:** The conception of the test took place in two phases: Phase 1 was the development of the Bedside Aphasia Battery in Tamil (BAB-T) and phase 2 administration of the test battery in neurotypical adults and patients with aphasia. A Delphi panel was constructed based on selected experts from the field of neuro-communication disorders and linguistics majors in the Tamil language. Recruited participants were surveyed using a modified Delphi method to establish opinions. A three-round Delphi process-derived consensus among the experts regarding the components and subdomains employed in the construction of BAB in Tamil. A pilot study was also conducted on nine participants (six neurotypical and three patients with stroke) to content validate the constructed BAB in Tamil. **Outcomes and Results:** BAB-T and its subdomains were identified to have excellent internal consistency, test retest and interrater reliability. BAB-T takes approximately 15–20 min to administer and can be employed in busy wards. This tool is especially useful in low-resource countries like India, where professional specialized speech and language services are scarce. The BAB-T significantly differentiates performance between neurotypical adults and patients with aphasia. Additionally, differences among the patient group also reflect the type of fluent and non-fluent aphasia.

Keywords: Aphasia, Assessment, Bedside Aphasia Battery in Tamil, Screening, Reliability, Validity

INTRODUCTION

Aphasia is an impairment of comprehension or formulation of language caused by damage to the cortical center for language. It is a multimodality disorder represented by a variety of impairments in auditory comprehension, reading, oral-expressive language, and writing. The disrupted language may be influenced by physiological inefficiency or impaired cognition, but it cannot be explained by dementia, sensory loss, or motor dysfunction".[1] At the same time, aphasia also affects the memory, attention, and other functions of patients.[2] Aphasia persists as a disability in 21%–38% of stroke survivors. Engelter *et al.*[3] identify the community incidence as 43/100,000/year, and the prevalence is 3000 per million. Given the cultural, linguistic, and educational variety in India, screening and diagnosing language and communication impairment following neurological illnesses requires the availability of instruments that are tailored to various communities.[4] Tests developed for the Western population are inappropriate to assess linguistic skills in the Indian context as they might result in several linguistic and ethnocultural interpretations, especially in neuro-communication disorders like aphasia, apraxia of speech, etc. Thus, to improve the quality of assessment of aphasia and for a better understanding of a person's communication strengths and weaknesses, there is a demand for developing test materials in the native language. Table 1 identifies several diagnostic tests of aphasia that were adapted to assess aphasia and related neurogenic communication disorders in Indian languages. Only two tools, the Revised Token Test[5,6] and the Bilingual Aphasia Test,[7] have been developed specifically to test the linguistic abilities of the Tamil-speaking population.

The comprehensive aphasia language batteries are time-consuming and difficult to complete for stroke patients in the acute phase. Knowing this, patients in the acute stage would benefit from a short instrument (within 15–20 minutes) that assesses a wide range of language and communication skills.

Due to the limited availability of test tools in the Indian language and the lack of standardized test batteries available for bedside evaluation for aphasics in the Tamil language, there arises a need for an indigenous tool to assess linguistic abilities in individuals in India with aphasia. Also for clinical use, the Bedside Aphasia Battery in Tamil (BAB-T) has to be designed by combining the screening and diagnostic versions, with a

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Table 1: Indian tools for aphasia

Test tool	Author	Language
All India Institute of Medical Sciences Diagnostic Test of Aphasia in Hindi	Bhatnagar, n.d.[8]	Hindi
Bilingual Aphasia Test in Hindi	Paradis and Vaid,[9]	Hindi
Boston Diagnostic Aphasia Examination in Hindi	Kacker *et al*.[10]	Hindi
Modified Communicative Abilities of Daily Living (CADL-2) in Hindi	Mahendra, *et al*.,[11]	Hindi
Western Aphasia Battery in Hindi	Karanth *et al*.[12]	Hindi
Adaptation of the Western Aphasia Battery in Bangla	Keshree *et al*.[13]	Bangla
Bilingual Aphasia Test in Tamil	Paradis and Devanathan[7]	Tamil
Revised Token Test in Tamil	Sreedevi[5] and Chengappa[6]	Tamil
Bilingual Aphasia Test in Urdu	Paradis and Janjua[14]	Urdu
Bedside Screening Test for Aphasics in Kannada (BST-K)	Ramya *et al*.[15]	Kannada
Bedside Screening Test for Aphasics in Malayalam (BST-M)	Kanthima *et al*.[16]	Malayalam
Bedside Screening Test for Aphasics in Odiya (BST-O)	Jati *et al*.[17]	Odiya
Bedside Screening Test for Aphasics in Telugu (BST-T)	Santhosh *et al*.[18]	Telugu
Mississippi Aphasia Screening Test in Telugu	Nagendar and Ravindra[19]	Telugu

focus on evaluating patients with neurogenic communication impairments at the bedside in an acute-care setting. Thus, BAB-T has been conceptualized to be comprehensive yet quick and easy to administer. Hence, the present study aims to develop the BAB-T for assessing the linguistic abilities of Tamil-speaking individuals following a stroke.

MATERIALS AND METHODS

Phase I: Development of the test BAB-T:

Baseline phase: The BAB-T test components were initially developed after reviewing a variety of aphasiology-related literature, including various clinical symptoms, language profile components, and various Western and available Indian assessment tools. The review revealed the availability of only two Tamil test tools[5-7] (Bilingual Aphasia Test in Tamil and the Revised Token Test in Tamil). Upon identifying the need for developing a test tool in the Tamil language for assessing language components in persons with aphasia, a panel of experts was identified. Based on a literature review, analysis of clinical practice recommendations, and consultation with subject-matter experts, a list of potential linguistic assessment components for aphasia was developed, paying particular attention to bedside assessment.

Step 1: For the first round of the Delphi method, an online survey was conducted seeking expert opinion on current practices in the assessment of Aphasia in the Tamil-speaking population concerning available tools, reliability, validity, norms, scoring, and interpretation, literacy, etiological considerations, etc. All panelists who were contacted for the above-mentioned survey were asked to respond to a series of questions related to the need and construction of tools for aphasia assessment and its goals and components. Participants were sent an invitation email with a link to the questionnaires. Panelists included were native Tamil speakers with good proficiency in reading and writing as well as knowledge and experience in neurological and neuro-communication disorders. Speech Language Pathologists (SLPs) currently practicing in neuro-communication disorders with a minimum of 5 years

of experience and two neurologists working in multispecialty facilities, that is, hospitals and centers, were included for Delphi rounds in the initial tool development process. The panel also included two graduate Tamil teachers from a literature background for their expert input on semantically and syntactically appropriate stimuli for the construction of the test material. The test items considered during the development of BAB-T were based on the factors such as word frequency, familiarity, imageability, concreteness/abstractness, word, phrase, sentence length, phonemic complexity, grammatical complexity, and plausibility of content. The picture cards were rated concerning the size of the picture, color, appearance, arrangement, and iconicity. Based on the responses obtained, the research team prepared the first round of the Delphi survey. In the first round of the survey, six identifiable components with questions relating to language assessment in persons with aphasia were posed with an individual comment box session for each section. At the end of the survey, there was an option for participants to identify additional aspects and provide any other additional comments or suggestions. The initial round of the survey aimed to collate expert opinions on the development of a tool for the aphasia Tamil-speaking speaking population.

Step 2: Based on the feedback from round 1, the responses were collected and analyzed over the following week by the research team. The initial draft version of the enteral was designed in 2 weeks incorporating the input obtained from round 1. The second round of the survey was then sent out to 20 SLPs working in neuro-communication rehabilitation. The newly constructed "BAB-T" was validated (content and face validation) based on the feedback by the expert committee obtained in the first phase. Comments and feedback from the second round of the survey were then incorporated in the final "BAB-T" for administration in round 3. The third round of the survey was sent out to the same 18 SLPs and two Tamil linguists for semantic and syntactic relevance to identify consensus for each part of the subdomains of the test tool. The final round of the form used in round 3 also asked

whether experts would recommend using the "BAB-T" in their clinical practice for assessing language for individuals with aphasia on a rating scale from 1–10 recommended for face validation.

All participants' informed consent was obtained before to the pilot testing and during the administration of the BAB-T phase of the trial.

Pilot study: A pilot study consisted of BAB-T administration on nine participants (six neurotypical and three patients with stroke). After content validation and a pilot study, various modifications were made to the test battery. These modifications were in the form of modifying test items, changing the sentence formulation, and altering a few response criteria. Thus, the final test battery, Bedside Aphasia Battery (BAB-T) was developed in Tamil.

Test description: BAB-T: at the end of round three including expert interviews and the pilot study, there were a total of six domains and 16 subdomains identified. The stimuli were placed in a hierarchy of increasing complexity. The instructions for administering the test tool have been provided for each subdomain. Appropriate scoring has been assigned. The various subdomains have appropriate test material for administrating such objects and/or graphic cards. Each domain and subdomain and its scoring are presented in Table 2.

The study was approved by the ethical committee of the Madras ENT Research Foundation (P) Limited and MERF – Institute of Speech and Hearing, Chennai.

Phase II: Administration of the test battery

Participants: The participants in the present study were divided into two: the neurotypical group (*n* = 60) and the persons with aphasia group (*n* = 45) [Table 3].

Inclusion and exclusion criteria: Neurotypical individuals above the age of 18 years with no history of premorbid neurological illness, psychological disorders, and no other significant speech, language, cognition, and sensory deficits (screened by an experienced SLP) were included. Neurotypical adults were further subdivided based on their ages into three groups: group I (G I) 18–40 years, group II (G II) 41–60 years, and group III (G III) 60+ years. The study group included individuals diagnosed with stroke by a neurologist within 2 years of onset and who did not have any known associated premorbid disability or medical conditions contributing to language deficits. All participants were native speakers of Tamil and were above 18 years with no known sensory deficits (visual or hearing impairment or agnosia). Language history was obtained by interviewing a reliable family member.

Language evaluation using BAB-T: Two qualified native Tamil SLPs administered the subtests of BAB-T. BAB-T was used to evaluate language functions, especially in patients, to determine the presence, type, and severity of aphasia.

Table 2: Domains, subdomains, and scoring of BAB-T

Domain	Subtest	Maximum Score	Maximum Score of the domain
Spontaneous Speech	Content	10	60
	Fluency	10	
	Automatic Speech	10	
	Describing Objects	10	
	Verbal Reasoning	10	
	Sequencing	10	
Auditory Verbal Comprehension	Yes–No Questions	10	40
	Pointing Task	10	
	Auditory Word Recognition	10	
	Sequential Commands	10	
Repetition	Word	10	30
	Phrase	10	
	Sentence	10	
Naming	Confrontation Naming	10	30
	Responsive Naming	10	
	Lexical Generative Naming	10	
Reading		10	10
Writing		10	10

Table 3: Demographic details of participants in both groups

	Neurotypical adults (*n* = 60)	Persons with aphasia (*n* = 45)
Age (year)	Mean (SD): 49.1 Range: 20-82	Mean (SD): 60.9 Range: 32-85
Gender	Male: 23 Female: 37	Male: 31 Female: 14
Site of lesion	-	Left MCA (middle cerebral artery) infarct associated with other lesion sites - 25 Left MCA infarct - 7 Frontal, parietal, or temporal lobes infarct - 7 Subcortical stroke - 6
Person with aphasia	-	Aphasia: 34 Aphasia with dysarthria: 11
Types of aphasia	-	Global - 9 Broca`s - 8 Wernicke - 4 Anomic - 5 Transcortical sensory - 2 Transcortical motor - 2 Recovering Broca - 13 Recovering anomic - 2

Informed consent was obtained from all the participants and their caregivers. Instructions were given verbally, and picture cards or objects used during the stimuli were presented for the various tasks. The administration and scoring of the short versions of the test were performed as per the guidelines.

Statistical analysis

The scores that were obtained from both groups were tabulated in Statistical Package for Social Sciences (SPSS) version 21 with the statistical significance set at p < 0.05. The internal consistency of BAB-T was tested using Cronbach's alpha test. An independent sample t-test was used to compare various language domains across groups and between fluent vs non-fluent aphasics using BAB-T. Finally, the test–retest and inter-rater reliability of BAB-T was assessed using Pearson's correlation coefficient

RESULTS

Overall, the study consisted of a total sample of 105 participants: 60 neurotypical adults and 45 patients with aphasia. On average, the participants completed the BAB-T in 15–20 mins.

Internal consistency: Cronbach's alpha test was used to determine the test's internal consistency for each domain and across the overall tool [Table 4]. The full-scale Cronbach's alpha measured for all six domains together was 0.994, indicating excellent internal consistency.

Comparison of BAB-T scores across domains: The ratings of each domain were compared using an independent sample t-test between neurotypical adults and patients with aphasia and between the fluent and non-fluent aphasia subgroups. BAB-T showed statistical significance at *P* < 0.05 between neurotypical adults and patients with aphasia across all domains. Patients with aphasia were further grouped as non-fluent and fluent aphasics based on the clinical evaluations according to the Boston classification. The distribution of fluent and non-fluent aphasics has been depicted in Figure 1.

Domain I – Spontaneous speech

The term "spontaneous speech" refers to utterances with well-formed phrases that occur without prompting or during an unstructured discourse. This domain comprised fluency, content, automatic speaking, describing objects, verbal reasoning, and sequencing.

Between neurotypical and patients with aphasia group: The neurotypical group had a mean of 59.82, whereas the study group had a mean of 26.33, demonstrating that those who had a stroke performed poorly in all subdomains of spontaneous speech [Table 5].

Non-fluent and fluent subgroups: Within the study group, patients were divided into non-fluent and fluent types of aphasia [Table 6]. The mean scores between the non-fluent and the fluent aphasia groups were 13.38 and 27.30, respectively, indicating greater impairment in spontaneous production for the non-fluent group when compared to the fluent group.

Age effect: The language performance across different ages was compared within neurotypical groups [Table 7]. Minimal age-related changes were recorded in group III (>60 years) when compared to other ages of <60 years groups I and II).

Domain II – Auditory verbal comprehension

Yes - No questions, pointing, auditory word recognition, and sequential command tasks were included to evaluate the auditory verbal comprehension abilities.

Between neurotypical and patients with aphasia groups: The neurotypical group had a higher mean of 39.93 than the aphasia group, which had a mean of 27.27, with statistical significance obtained for all subdomains (*P*-value > 0.001) [Table 5].

Non-fluent and fluent subgroups: This was also observed in the current study [Table 6] when analyzing the performance of auditory comprehension using BAB-T, with non-fluent aphasics having a higher total mean score of 24.88 than fluent aphasics (9.90).

Age effect: For group III (60+ years) of the neurotypical group, the following commands produced a mean score of 9.8, whereas a full score of 10 was documented in all other subdomains [Table 7].

Domain III – Repetition

Repetition skills were assessed at word, phrase, and sentence levels.

Between neurotypical and patients with aphasia: A comparison of scores between the control and study groups was performed and has been tabulated in Table 5. Individuals with stroke

Table 4: Reliability of the tool–Internal consistency using Cronbach's alpha test

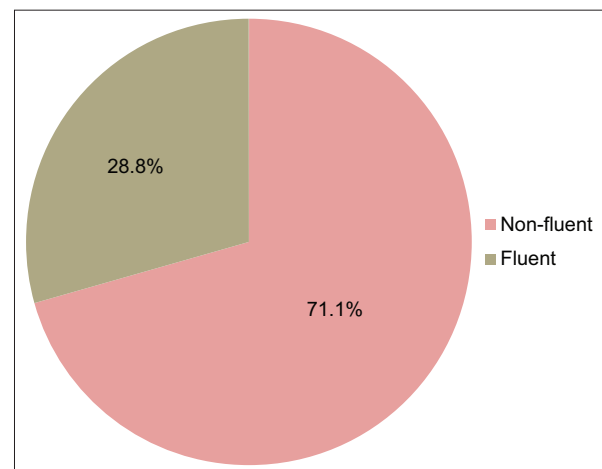| Domains	No. of items	α value	Internal consistency
Spontaneous speech	25	0.976	Excellent
Auditory verbal comprehension	20	0.987	Excellent
Repetition	15	0.992	Excellent
Naming	15	0.989	Excellent
Reading	5	0.983	Excellent
Writing	5	0.878	Good
Total	85	0.994	Excellent

Figure 1: Number and percentage of non-fluent and fluent aphasia group

Table 5: Comparison of scores between neurotypical adults and patients with aphasia

Domains	Subdomains	Neurotypical adults		Patients with aphasia		Significance value (*P*)
		Mean	SD	Mean	SD	
Spontaneous Speech	Fluency	10.00	0.00	4.27	3.68	0.00
	Content	9.83	0.52	4.18	3.55	0.00
	Automatic speech	10.00	0.00	5.24	4.36	0.00
	Describing objects	10.00	0.00	4.22	4.08	0.00
	Verbal reasoning	9.98	0.12	4.27	4.20	0.00
	Sequencing	10.00	0.00	4.16	4.19	0.00
	Total	59.82	0.53	26.33	22.99	0.00
Auditory verbal comprehension	Yes/No questions	10.00	0.00	6.80	4.23	0.00
	Pointing	10.00	0.00	7.47	4.20	0.00
	Auditory word recognition	10.00	0.00	7.24	4.29	0.00
	Following commands	9.93	0.31	5.76	3.61	0.00
	Total	39.93	0.31	27.27	15.98	0.00
Repetition	Word	10.00	0.00	6.53	4.703	0.00
	Phrase	10.00	0.00	5.64	4.360	0.00
	Sentence	10.00	0.00	4.58	4.081	0.00
	Total	30.00	0.00	16.76	12.73	0.00
Naming	Confrontation	10.00	0.00	5.78	4.738	0.00
	Responsive	10.00	0.00	4.80	4.219	0.00
	Lexical Generative	9.97	0.18	3.42	3.467	0.00
	Total	29.97	0.18	14.00	11.930	0.00
Reading	Total	10.00	0.00	4.87	4.630	0.00
Writing	Total	10.00	0.00	3.80	4.015	0.00

Table 6: Comparison of scores between non-fluent and fluent aphasia group

Domains	Subdomains	Non-fluent		Fluent		Significance
		Mean	SD	Mean	SD	
Spontaneous Speech	Fluency	1.75	2.38	5.80	2.89	0.002*
	Content	2.42	2.93	4.10	3.44	0.19
	Automatic speech	3.17	3.77	5.40	4.55	0.19
	Describing objects	2.21	2.65	3.90	4.38	0.27
	Verbal reasoning	2.13	2.77	3.80	4.18	0.26
	Sequencing	1.71	2.23	4.30	4.39	0.10
	Total	13.38	15.74	27.30	22.68	0.10
Auditory verbal comprehension	Yes/No questions	6.17	4.29	5.00	4.92	0.52
	Pointing	7.00	3.60	4.80	2.56	0.19
	Auditory word recognition	6.83	2.41	3.20	2.09	0.19
	Following commands	4.88	3.36	4.90	4.70	0.98
	Total	24.88	11.24	9.90	7.08	0.07
Repetition	Word	4.75	2.901	7.00	2.83	0.23
	Phrase	3.67	1.125	6.30	2.49	0.13
	Sentence	2.25	1.040	5.60	2.30	0.043*
	Total	10.67	7.62	18.90	6.38	0.11
Naming	Confrontation	4.38	4.959	4.50	4.24	0.94
	Responsive	3.25	4.024	3.80	3.79	0.71
	Lexical Generative	2.13	2.909	2.40	3.09	0.81
	Total	9.75	11.46	10.70	10.27	0.81
Reading		3.08	4.272	4.70	4.42	0.34
Writing		2.38	3.437	3.30	3.83	0.51

Domains	Subdomains	18-40 years *n*=20		41-60 years *n*=20		60+years *n*=20		Total	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Spontaneous Speech	Fluency	10.00	0.00	10.00	0.00	10	0.00	10.00	0.00
	Content	10.00	0.00	10.00	0.00	9.5	0.827	9.83	0.526
	Automatic speech	10.00	0.00	10.00	0.00	10	0.00	10.00	0.00
	Describing objects	10.00.	0.00	10.00.	0.00	10	0.00	10.00	0.00
	Verbal reasoning	10.00	0.00	10.00	0.00	9.95	0.224	9.98	0.129
	Sequencing	10.00	0.00	10.00	0.00	10	0.00	10.00	0.00
	Total	60.00	0.00	60.00	0.00	59.45	0.826	59.82	0.537
Auditory verbal comprehension	Yes/No questions	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Pointing	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Auditory word recognition	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Following commands	10.00	0.00	10.00	0.00	9.8	0.523	9.93	0.312
	Total	40.00	0.00	40.00	0.00	39.8	0.523	39.93	0.312
Repetition	Word	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Phrase	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Sentence	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Total	30.00	0.00	30.00	0.00	30.00	0.00	30.00	0.00
Naming	Confrontation	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Responsive	10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
	Lexical Generative	10.00	0.00	10.00	0.00	9.9	0.308	9.97	0.181
	Total	30.00	0.00	30.00	0.00	29.9	0.308	29.97	0.181
Reading		10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00
Writing		10.00	0.00	10.00	0.00	10.00	0.00	10.00	0.00

Table 7: Comparison of scores of domains and subdomains of BAB-T across the neurotypical adult group

had significant impairment in repetition tasks and had a mean score of 12.73 when compared to a score of 30 obtained by the neurotypical group. As the complexity of repetition tasks increased, the scores showed a downward trend with a mean of 6.53 for word repetition and 4.58 for reference repetition tasks.

Non-fluent and fluent groups: Both the fluent (10.67) and non-fluent aphasic groups (18.90) demonstrated a reduction in mean scores in the performance of the repetition task [Table 6]. On sentence repetition, there was a significant statistical difference seen in fluent aphasics as compared to the non-fluent group with a *P* value of 0.043.

Age effect: No age-related repetition effects were seen here as all three groups obtained a mean of 30.00 [Table 7].

Domain IV – Naming
Naming is one of the most important abilities in linguistic processing. Subdomains of naming included in BAB-T were (a) confrontation naming, (b) responsive naming, and (c) lexical generative naming.

Between neurotypical and patient with aphasia: It is apparent from Table 5 that naming was affected in stroke individuals. In comparison with the neurotypical group, there was a significant difference in all subdomains (*P* > 0.001). Patients with aphasia performed poorer in lexical generative naming with a mean of 3.42 compared to confrontation and responsive naming, which had a mean of 5.78 and 4.80, respectively [Table 5].

Non-fluent and fluent subgroups: The mean score for the non-fluent aphasia group was 9.75 and that for the fluent group was 10.70 [Table 6].

Age effect: Interestingly, within the neurotypical group, confrontation naming and responsive naming did not show any age effect [Table 7]. Hence, all three groups obtained a full score of 10 in both subdomains. However, 9.9 was the mean score for lexical generative naming. It includes predominantly verbal fluency tasks, and the lowering of scores in this domain can be attributed to semantic retrieval deficits.

Domain V – Reading
The test battery (BAB-T) consisted of one question that taps reading comprehension.

Between neurotypical and patients with aphasia: It is evident from Table 5 that there is a significant difference between both neurotypical adults and individuals with stroke, where the study group obtained a mean score of 4.87, whereas the non-fluent group had a full mean score of 10.

Non-fluent and fluent subgroup: Both non-fluent and fluent groups in the current study had reading and writing difficulties, with mean scores of 3.08 and 4.70, respectively [Table 6].

Age effect: The age effect was not observed in the reading domain [Table 7].

Domain VI – Writing
Writing was assessed using tasks like copying, dictation, and asking the person to write his/her demographic details.

Between neurotypical and patients with aphasia: It is evident from Table 5 that there is a significant difference between both neurotypical adults and individuals with stroke where the study group had a mean score of 3.80, whereas the other group had a full mean score of 10. There was a significant difference between both groups in the writing domain.

Non-fluent and fluent subgroup: Both non-fluent and the fluent aphasic group had reduced scores in writing with a mean score of 2.38 and 3.30, respectively, when compared to the neurotypical group [Table 6].

Age effect: Table 7 depicts the effect of age on writing tasks. A 100% response was obtained by all three age groups, and interestingly, all neurotypical adults were able to complete the task in BAB-T.

Test–retest and Inter-rater reliability

Test–retest reliability was studied specifically to estimate the temporal stability of the test. Fifteen patients with stroke were reassessed for the second time with an interval of 2 weeks [Table 8].

The results indicated a positive, significant correlation (r = > 0.9: excellent reliability) between the test date (T1) and retest date (T2) for scores achieved on all subtests and sections. Inter-rating was carried out by videotaping the administration of the test tool on 27 randomly selected patients, and two raters were involved in the rating process [Table 8]. Pearson's correlation showed a strong positive correlation (r = 0.9–1.00) across domains in BAB-T.

DISCUSSION

BAB-T is developed to test for language skills in individuals with aphasia, especially in persons following a stroke. The developed test has been administered on both neurotypical adults and the clinical population. BAB-T was found to have excellent internal consistency and test–retest reliability. The participants who had strokes performed poorly in all subdomains of BAB-T as compared to neurotypical adults.

In the first subdomain, spontaneous speech has been reported to be the most noticeable symptom of stroke patients.[20] Two participants in the aphasia group reported phonemic and semantic paraphasias, two with circumlocutions; and six with pragmatism. The most prevalent errors commonly observed in

picture descriptions are circumlocutions, semantic paraphasias, phonemic paraphasias, neologism, and perseveration.[21] Kohn *et al.*,[21] claimed that the cause of circumlocutions and semantic paraphasias is a lack of access to phonological information for target words. The fluent group outperformed the non-fluent group in the spontaneous speech domain. As a result of a selection disorder, fluent aphasics use sentences that are syntactically intact but semantically compromised. Two fluent aphasics showed perseverance. Perseverance, according to Hudson *et al.*,[22] is the inappropriate repetition or continuation of a previous response when a different response is expected. This is related to the linguistic difficulties associated with aphasia and can happen as a result of the feed-forward input's diminished ability to override residual activity.[23] The fluent group performed well in the spontaneous speech domain compared to the non-fluent group. Few researchers[24] reported that non-fluent aphasia has marked diminished output in spontaneous speech, and there is also a loss of normal grammatical structure. Fluent aphasias are characterized by the relative ease of producing connected speech, yet the speech produced is often error-filled.[25] On the contrary, non-fluent aphasics had poor scores in spontaneous speech (fluency). From the current study, individuals above the age of 60 years demonstrated reduced performance in the content of the spoken message and verbal reasoning ability as supported in the literature.[26]

The neurotypical group performed better when compared to the aphasia group across all subdomains assessed under auditory comprehension. In a study, Goodglass *et al.*[27] suggested that auditory comprehension deficits in brain-damaged individuals may be due to semantic processing difficulties. Three individuals with lesions in the temporal and occipital lobes exhibited comprehension and naming difficulties. This was supported by the findings[28] that damage to the areas of the temporal lobe affects auditory comprehension skills. It was observed in this study that stroke patients exhibited difficulty in following commands as the complexity and length of utterance increased. In contrast, research on stroke aphasia shows that individuals with non-fluent, Broca's aphasia show deficits in grammatical ability that affect both sentence production and comprehension.[29-31] Though non-fluent aphasics have effortful, error-filled speech (both spontaneous production and repetition), they have relatively intact comprehension.[32,33] This was also identified in the current study [Table 6]: while analyzing the performance of auditory comprehension using BAB-T, non-fluent aphasics had better auditory comprehension than fluent aphasics. The elderly group obtained a full score in most of the other subdomains [Table 7].

Individuals with aphasia had significant impairment in repetition tasks when compared to neurotypicals. Diffuse lesions in many stroke patients support the viewpoint by stating that the stroke group has difficulty performing repetitive tasks, particularly as the complexity increases.[34] Both the fluent and non-fluent aphasic groups demonstrated a reduction in performance of the repetition task. Similarly,

Table 8: Reliability of the tool: test-retest and inter-rater reliability values

Domains	Test-retest r	Inter-rater reliability r
Spontaneous speech	0.999	0.969
Auditory verbal comprehension	0.985	1.000
Repetition	0.971	1.000
Naming	0.998	1.000
Reading	0.994	1.000
Writing	0.992	1.000

it was also reported in the literature[35-37] that both fluent and non-fluent aphasics such as Broca's, Wernicke's, and especially conduction aphasics have deficits in their ability to repeat spoken language, but spared repetition ability is seen in transcortical aphasics.

Patients with aphasia performed poorer in lexical generative naming compared to confrontation and responsive naming. Lesions due to stroke may restrict the individual's ability to access the phonological representation and retrieval of semantic knowledge. Picture-naming skills can be impaired when there are insults to brain regions.[38] Aphasics performed poorly on semantic categories,[39] which is evident in our study. Among the stroke individuals, two exhibited circumlocutions and two had perseverations. One participant exhibited the "tip-of-the-tongue" phenomenon.[40] Here, the person gropes for the desired word, but they may not be able to produce them. These types of difficulties were most commonly noted in discourse production. It was identified from the current study that naming difficulties were common in both aphasics. Similarly, the presence of anomia is identified to be a common characteristic in all types of aphasia.[41] Interestingly, within the neurotypical group, confrontation naming and responsive naming did not show any age effect. However, 9.9 was the mean score for lexical generative naming. It includes predominantly verbal fluency tasks, and the lowering of scores in this domain can be attributed to semantic retrieval deficits.

Many individuals exhibited difficulty in reading comprehension, and they did not perform correctly on this test item. This may be due to the result of phonologic, semantic, lexical, and/or cognitive impairment.[42] It was suggested that working memory is an important factor to consider in reading comprehension abilities and that memory is often disturbed in stroke individuals; this could be attributed to the deficit in the observed reading comprehension abilities. Brain damage disrupts access to orthographic word forms, resulting in difficulties with naming and reading.[43] Hence, in the post-acute stages of recovery after a stroke, the person has difficulties in accessing a stored word and orthography–phonology conversion. Reading difficulties are a common feature of aphasia, including oral reading and reading comprehension problems and reduced reading speed.[44] Both non-fluent and fluent groups in the current study had reading and writing difficulties. Individuals with aphasia not only tend to have impairment of just spoken language but are frequently used to encompass impairments of both written and spoken language.[45-47] Non-fluent aphasia with dysgraphia shows the presence of dissociation between written language and verbal language abilities, and written language may be inferior to verbal language. On the contrary, the fluent aphasia group with dysgraphia characteristically produces a normal quantity of words with normal calligraphy, but the content is nonsensical, and fluent written language skills but semantically incoherent content. All three groups of neurotypical adults interestingly were able to complete the task well in BAB-T. From the current study, it was indicated that BAB-T showed good test–retest reliability with a positive correlation for scores achieved on all subtests and sections. Inter-rater reliability also showed a strong positive correlation across all domains of BAB-T.

SUMMARY AND CONCLUSION

In brief, there are three important inferences from the results of the study. Firstly, given the rising burden of stroke aphasia in India, there was a need to develop indigenous and comprehensive language assessment tools to assess and initiate management for the patients. The developed BAB-T was found to have very high internal consistency and test-retest reliability. Secondly, BAB-T can be employed in busy wards and is especially useful in low-resource countries like India, where professionally qualified specialized speech and language services are scarce. Thirdly, the BAB-T differentiates the performance of neurotypical adults and patients with aphasia as well as subclassifies the patient group which is evidently supported by the existing literature.

There were some limitations to the study. Firstly, the scores of BAB-T have been applied to patients within 1-year post-stroke aphasia but not to individuals with a history of recurrence or chronic aphasia. This study will aid in the future validation of the test in other acquired brain injury Tamil-speaking populations and larger aphasia cohorts.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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