

# Effectiveness of Semantic-based Treatment in Persons with Aphasia

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## Abstract

**Background:** Semantic-based treatment is the salient approach used to remediate word retrieval deficits in persons with aphasia (PWAs). It is deemed to improve semantic attributes around the target word, thus aids in restoring word retrieval abilities. Hence, the present study has developed a semantic-based therapy named semantic cueing of verbs and its thematic role (SCVTr). Also, this therapy uses verbs as a core element accompanied by graded levels of semantic cues. **Aim:** The current study Semantic Cueing of Verbs and its Thematic role (SCVTr) aimed to evaluate the effect of word retrieval abilities in PWAs. **Methods and Procedure:** Three participants ( $n = 3$ ) with aphasia were recruited for the study. All the participants in the study received SCVTr therapy, and the responses were analyzed at three distinct time points. That is pre-therapy assessment (before initiation of therapy), mid-therapy assessment (10<sup>th</sup> session), and post-therapy assessment (20<sup>th</sup> session). Nouns, verbs, and discourse abilities of PWAs were evaluated using standardized test batteries. **Outcomes and Results:** The study results have discerned positive gains across trained conditions and discourse genres across all the participants. However, participants exhibited marginal gains with untrained stimuli. In addition, SCVTr therapy aids in modifying the error pattern exhibited by PWAs. Concurrently, researchers noted that all participants showed ameliorated performance on the standardized language test batteries during post-therapy evaluation. **Conclusions:** SCVTr therapy has found to be effective in remediating word retrieval deficits in PWAs. This study extends the knowledge about strengthening the semantic network associated with the target word and its effect on generalization.

**Keywords:** CVA, discourse, nouns, verbs, word retrieval

**Guest editor's notes:** Hypothesis and theory driven, well designed interventions in SLT with single case and single or multiple baseline comparisons are often informative in aphasiology. They provide a sort of 'proof of concept' and pave the way for studies with larger groups, better and more outcome measures, longer follow-up and possibilities of extension of therapeutic benefits in functions which were not part of initial 'methods' (generalization) and persistence of benefits well beyond the duration of study. One of the neglected aspects of aphasia, the discourse, has also been addressed to in this paper.

## INTRODUCTION

Word retrieval deficits are one of the common characteristics exhibited across different variant of persons with aphasia (PWAs). Words have a pivotal role in everyday conversation to convey ideas, thoughts, and feelings. Hence, PWAs have difficulty communicating in their daily activities.<sup>[1]</sup> There are various therapeutic approaches remediated to treat word retrieval deficits in PWAs. Exclusively, semantic-based therapies are streamlined over other therapy approaches based on the outcome of the previous studies.<sup>[1-5]</sup> Semantic-based therapy is a salient approach to train word retrieval deficits in PWAs because this approach has the virtue of improving words beyond trained conditions. Also, the application of semantic therapy yields improved performance in processing words and naming the desired objects in PWAs.<sup>[3]</sup> These approaches also discerned robust effects when treating nouns and verbs.<sup>[6-8]</sup>

Semantic-based therapy is employed using different treatment paradigms. For instance, researchers have used word-picture

matching and yes-no questions on semantic attributes of the objects, and semantic sorting of objects. These paradigms confounded improvement merely to the trained stimuli; this, in turn, makes PWA deprived of generalization. Meanwhile, over the years, semantic-based therapies such as semantic feature analysis (SFA)

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and verb network strengthening treatment (VNeST) have inculcated few variations in the traditional paradigms of semantic therapies to glean generalization effect. The paradigms pertinent to SFA and VNeST are seminal among the various semantic therapies. SFA utilizes the semantic features related to the target word and, thus, results in systematic retrieval of target words, which aids in reinforcing word retrieval per se.<sup>[1]</sup> Also, SFA has found to exert a profound effect in facilitating generalization to functional communication. VNeST deploys verbs as the central element for training and their related thematic roles (agents and patients) to train word retrieval deficits.

Edmonds *et al.*<sup>[4]</sup> developed VNeST therapy, which helps to generate thematic roles around the targeted verb. Also, it activates the semantic knowledge of the targeted word. The thematic role is activated based on the event schemas that he/she is exposed to. Concurrently, PWAs evoke multiple pairs of thematic roles through probes. To illustrate, for the verb/akalisu/(yawn), multiple pairs of thematic roles generated could be/magu/(baby)-/hasige/(bed) and/huduga/(boy)-/saleyalli/(school). Further, participants answer “who,” “where,” “why,” and “when” probes related to each pair. Followed by semantic judgement, task was carried out via auditory mode. Then, the retrieval of the verb with prompting is conducted. Finally, verbs and thematic roles are retrieved without prompting (For an extensive review refer).<sup>[4]</sup>

Edmonds *et al.*<sup>[4]</sup> examined the effect of VNeST on lexical retrieval of words in sentence context. Four PWAs participated in the study (two transcortical motor aphasia and two conduction aphasia). The study design entailed training of verbs with probing PWAs to generate related agents and patients for the targeted verbs. Therapy was delivered twice a week with each session lasting for 2 h. Researchers used a multiple baseline design in the study. Their results manifested positive gains for word retrieval skills. Also, it supported the contention that VNeST aids in proliferating the performance beyond trained conditions. On similar lines, Edmonds and Babb<sup>[5]</sup> conducted a study to see the effect of VNeST in moderate-severe PWAs with similar methodology, and study design as mentioned in the previous study. Out of two PWAs, one subject improved beyond trained conditions, and the other subject confounded the performance solely to trained conditions.

On the other hand, some works of the literature have explored assessing discourse skills in PWAs followed by word retrieval training. In this line, authors have manifested modest improvement in discourse genre following word retrieval training.<sup>[9-11]</sup> Conversely, Antonucci<sup>[12]</sup> utilized SFA approach to improve discourse, by introducing semantic self-cueing and semantic appropriate circumlocution during discourse training in group treatment setting. Overall, the results of the study gleaned improved discourse skills in group therapy setup in two PWAs participated in the study.

### The rationale for the conception of the current study

Retaining the basic principles and steps of VNeST, researchers of the present study designed a slightly distinct protocol titled

“Semantic Cueing for Verb and its Thematic Roles” (SCVTr), where the study implemented steps pertinent to VNeST. SCVTr is the name given to the approach in the present study, secondary to modifications made in terms of procedures of VNeST. Hence, the study pertaining to VNeST serves as the foundation for SCVTr study. Also, it was noted from a review of literature of the present study that VNeST was only carried out in English Language.

SCVTr therapy uses verbs as a core element in training, and generally, verbs are predicative components, and nouns are adjectival components. For example, for the word “cat” whining, drinking, and running are the predicative components. Likewise, tail, colored eyes, and small can be adjectival components. Also, verbs play an imperative role during sentence formation because they carry a critical meaning in the sentence. Researchers have argued that when a verb is heard/read, it activates generalized situation knowledge,<sup>[13]</sup> thus enabling participants to activate the corresponding thematic roles. Studies have even noted positive gains in functional communication, connected speech, and discourse genre with the application of verb-based therapies.<sup>[4,5]</sup> Verbs comprise semantic and syntactic information which serves as the important element for sentence construction. For instance, if PWAs exhibit alleviated performance in retrieving verb, then one manifests impairment in constructing sentence per se.<sup>[14]</sup> Hence, targeting verb in therapy plays a pivotal role in order to enhance sentence construction abilities in PWAs.

The present study has a crucial role in remediating word retrieval deficits. Wherein, the study inculcated graded levels of semantic cueing, i.e., moving from a broad range of semantic cues to more specific cues. Thus, the cueing strategy facilitates an extensive semantic network around the target verb. A similar cueing strategy is used to generate thematic roles. Furthermore, SCVTr employs a multimodal cueing strategy. Both visual and orthographic cues are presented through flashcards to train targeted verbs and their thematic roles. Hence, it may facilitate word retrieval with ease. This modification in SCVTr approach stands distinct from VNeST approach.

Word retrieval processes may vary across different languages. That is, the English language has a S+V+O sentence structure, thus generalizing the results of western studies to the Indian scenario is not a feasible strategy. Hence, there is a need to explore word retrieval abilities across different Indian languages. To the best of our knowledge, the present study remains the first study in the Indian scenario that uses the Kannada language (A Regional Language spoken in Karnataka state) in SCVTr therapy to train word retrieval deficits. In the Kannada language, the sentences have S + O + V structure; this may plausibly modify verb processing and retrieval abilities in PWAs. Also, Kannada language is agglutinative in nature, that is, suffixes added to root words which in turn derive in forming new meaning. Hence, training verbs of Kannada language train person, number, and gender agreement as adjunct components.

## Aim of the study

The study aimed to analyze the effect of semantic cueing of verbs and its thematic role (SCVTr) in PWAs.

## Objectives of the study

1. To investigate the effect of the SCVTr therapy by evaluating word retrieval abilities (agents, patients, and verbs) in trained and untrained stimuli across pre-therapy, mid-therapy, and post-therapy condition in patient 1 (P1), patient 2 (P2), and patient 3 (P3).
2. To assess the discourse abilities during pre-therapy, mid-therapy, and post-therapy conditions in P1, P2, and P3.
3. To understand the evolution of error patterns during pre-therapy and post-therapy conditions in P1, P2, and P3.

## METHODS

### Participant characteristics

The present study was conducted in Mysuru (Karnataka state, India). The participants were native speakers of Kannada, and these participants were from in and around the Mysuru district. Informed consent for willingness to participate in the study was taken from all participants before enrollment to the study. The study was ethically approved by AIISH ethical committee. The authors of the study employed a convenient sampling method with a single subject design. The recruited participants were diagnosed with aphasia due to stroke, and all were right-handed pre-morbidly. A detailed history of subjects' pre-morbid activities, handedness, and detailed medical history was taken to rule out any psychological, neurological, or visual impairment. Also, participants were screened for apraxia (using the section of Western aphasia battery in Kannada, WAB-K). Cognitive impairment was ruled out using a mini-mental state examination.<sup>[15]</sup>

A total of five subjects were recruited for the study ( $n = 5$ ). Two participants were excluded for the study as they scored above 90% on training stimuli during the pre-therapy

assessment. Hence, after the initial pre-therapy assessment, three participants were recruited for the study [See Table 1].

### Materials

Standardized test batteries were used to assess the type of aphasia and word retrieval deficits; WAB-K Chengappa *et al.*<sup>[16]</sup> test was used to diagnose aphasia and classify the type of aphasia. Western aphasic battery-revised was used to estimate severity.<sup>[17]</sup> Further to assess word retrieval deficits on nouns and verbs, the Boston naming test by Chengappa *et al.*<sup>[18]</sup> and Action naming test by Girish and Chengappa<sup>[19]</sup> were administered, respectively. Also, the discourse analysis scale Hema and Chengappa<sup>[20]</sup> was used to assess discourse skills [See Table 2].

### Stimuli development and validation

In the present study, nouns and verbs of Kannada were selected from different resources, such as Manual for Fluent Aphasia in Kannada by Chaitra and Goswami,<sup>[21]</sup> Mental lexicon of nouns and verbs in the adult speaker of Kannada by Prathana and Prema,<sup>[22]</sup> and PASLD-K manual by Priyadarshi and Chengappa.<sup>[23]</sup>

Further, verbs and nouns selected for the study were validated by five native speakers of Kannada speech-language pathologists (SLPs) and five nonprofessionals who were native speakers of Kannada. These stimuli were validated based on frequency, imageability, and familiarity based on a 3-point rating scale with 0 being least score and 2 being maximum score, and the words that received a score of 2 were considered for the study. Overall, 20 verbs and 60 nouns were used for the study [see Appendix A]. Out of which, ten verbs served as the training verbs, and remaining verbs served as the untrained verbs. Further, the researcher developed agent + patient (nouns) pair for each training verbs.

### Procedure

All participants were gauged for noun retrieval, verb retrieval, discourse quotient across the pre-therapy assessment, mid-therapy assessment (10<sup>th</sup> session), and post-therapy

**Table 1: Demographic details of subjects who participated in the study**

SI NO	Age/G	Education	Occupation	SPO	Aphasia type	Severity	AQ
P1	64/M	Graduation	Panchyat secretary	5yrs	Broca's aphasia	Moderate	52.9
P2	42/M	Matriculation	Real estate	4yrs	Broca's aphasia	Severe	46.7
P3	31/M	Post-graduation	Private employee	3M	Broca's aphasia	Severe	30.6

P1=participant 1, P2=participant 2, P3=participant 3, G=Gender, SPO=Stroke post onset, AQ=Aphasia quotient

**Table 2: Performance of subjects across standardized test battery during pre- therapy and post- therapy conditions**

Tests	P1		P2		P3	
	Pre-therapy	Post-therapy	Pre-therapy	Post-therapy	Pre- therapy	Post-therapy
ANT	26	55	39	51	12	26
BNT	64	96	51	60	15	32
DAS	9.25%	25.92%	5.55%	12.96%	5.55%	12.96%
WAB-AQ	52.9	61.2	46.7	51.9	30.6	41.2

ANT=Action Naming test, BNT=Boston Naming test, DAB=Discourse analysis scale and WAB-AQ=Western Aphasic battery -Aphasic quotient

assessment (20<sup>th</sup> session). SCVTr therapy entailed a series of steps. In step 1, PWAs were asked to retrieve the verbs with semantic cues presented in auditory mode (broader cues to more specific cues) known as minimal cueing. If PWAs fail to retrieve, a visual cue (flashcards) along with a written cue was presented. If participant fail to retrieve the target word, then maximum cues were presented. That is, authors presented target word along with three foils. Followed by, PWAs should identify one among the choices was presented. PWAs were subsequently encouraged to retrieve 2-3 pairs of agents and patients related to the target verb. Meanwhile, the cueing strategy was used similar to verb training for agents and patients training. In step 2, reading aloud the generated agent + patient + verb pairs was carried out. In step 3 (“who,” “where,” “why,” and “when,”) questions were asked pertinent to the generated agent + patient + verb pairs. If the participant was unable to answer the probes, then forced choices were presented. Forced choices comprised the target word and foil; here, participants had to point to one of the choices displayed. In step 4, the semantic judgment of the sentence was carried out in auditory mode by presenting sentences with the inappropriate agent, followed by inappropriate patient, sentence reversal, and the correct pair; here participant should respond “YES” or “NO” for the following sentences. In step 5, the trained verb was retrieved with/without prompting. In step 6, all the steps were carried out without prompting (Illustration of SCVTr therapy procedure provided in Appendix B).

The study trained only one new verb in each session. Authors considered successful word retrieval when PWAs could retrieve the agent, patient, and verb pair in no cue condition or in minimal cue condition. Each session’s responses were recorded and transcribed using the session report [See Appendix C]. Overall, 20 therapy sessions were rendered and they were given for 6-7 weeks, with each session of 60–80 min duration. The first author of the present study rendered all the sessions. Participants were discharged from therapy after attending 20 intensive SCVTr therapy sessions, irrespective of their prognosis.

Discourse analysis of the participants was carried out using picture description task, which comprises pictures such as cat rescue picture, broken window, refused umbrella,<sup>[24]</sup> and conversation and narration task (topic of participant’s interest); this was used to gauge PWAs propositional and nonpropositional skills during assessing discourse. Based on this performance, scores were assigned to each task and discourse quotient (DQ) was calculated. For instance, if PWA gets a score of 25 in propositional section and a score of 10 in nonpropositional section, then both sections scores will be computed. Further, it will be divided by the maximum score in both section and finally it is multiplied by 100.  $(DQ) = 35/78 \times 100 = 44.87\%$ .

### Scoring

Each participant was evaluated on standardized test batteries across pre-therapy, mid-therapy, and post-therapy, and scored

based on the guidelines of the respective manuals. Scoring for trained and untrained stimuli was based on the 4-point rating scale. Where 0 = No response, perseveratory error, empty speech, and semantic error, 1 = word retrieval based on phonemic cue, 2 = word retrieval based on semantic cue and unintelligible response, 3 = word retrieval with no cues, minor articulator error, and morphological error. In this scoring system, a participant could get a maximum score of 270 for both trained and untrained stimuli. This included the cumulative scoring of responses of the agent, patient, and verb retrieval. For example, if a PWA gets a score of 3, 2, and 2 for agent, patient, and verb, respectively, then the PWA’s cumulative score will be 7.

### Error analysis

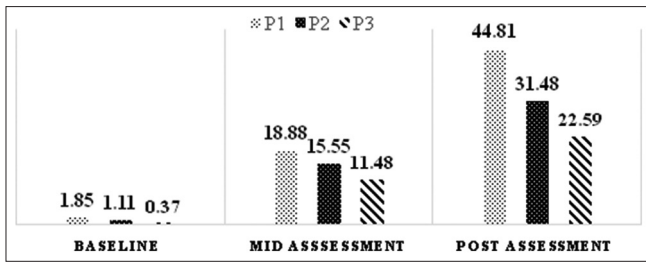
The verbatim of the participants was recorded and subjected to error analysis. The study adopted the protocol of Edmonds and Babb<sup>[5]</sup> for error analysis. The response was categorized as a semantic error, >50% of phonemes correct, mixed error (involves both semantic and phonemic error), unrelated, neologisms, I don’t know (IDK)/No response, perseveratory error.

### RESULTS

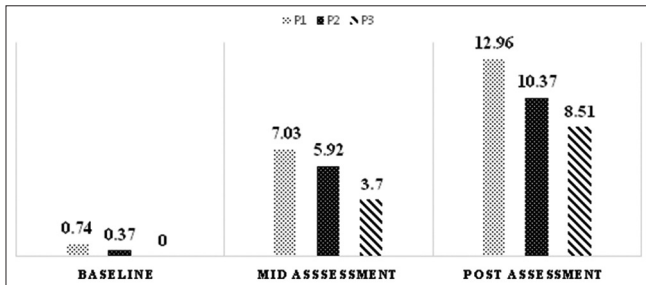
To evaluate the magnitude of improvement during pre-therapy, mid-therapy, and post-therapy assessment, researchers relied on descriptive analysis because of the paucity of sample size. Further, when estimating word retrieval abilities, agent, patient, and verb scores were summed up. Each participant’s results discussed individually as per the objectives of the study.

Objective 1 was to investigate the effect of the SCVTr therapy through word retrieval abilities (agent, patient, and verbs) in trained and untrained stimuli across pre-therapy, mid-therapy, and post-therapy. Results revealed enhanced performance scores on trained stimuli for P1. That is, scores of P1 were 1.85%, 18.88%, and 44.81% across pre-therapy, mid-therapy, and post-therapy conditions [See Figure 1], whereas a marginal increase in the slope of performance was noted for P1 across pre-therapy, mid therapy, and post-therapy conditions and scores were 0.74%, 7.03%, and 12.96%, respectively [See Figure 2]. Objective 2 was to determine changes in discourse genre over pre-therapy, mid therapy, and post-therapy conditions. Results manifested enhanced performance in discourse for P1 across pre-therapy, mid-therapy, and post-therapy conditions and scores were 9.25%, 12.96%, and 25.96%, respectively [See Figure 3].

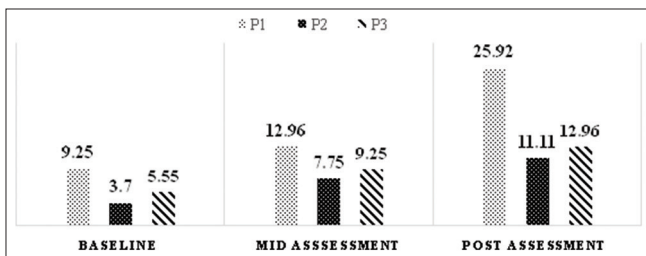
On addressing the performance of P2 on objective 1, results gleaned a robust effect for trained stimuli. Performance scores were 1.11%, 15.55%, and 31.48% across pre-therapy, mid-therapy, and post-therapy conditions, respectively [See Figure 1]. Suboptimal improvement noted for untrained stimuli. Performance scores were 0.37%, 5.92%, and 10.37% across the conditions [See Figure 2]. The performance of P2 showed ameliorated scores on discourse measures. The scores were 3.7%, 7.75%, and 11.11% across conditions [See Figure 3].



**Figure 1:** Illustration of response score of agent, patient, and verbs for trained stimuli across baseline, mid, and post assessment of all the participants



**Figure 2:** Illustration of response score of untrained stimuli for all the participants



**Figure 3:** Illustration of discourse quotient of all the participants across different sessions

The results for P3 showed a nominal increment of performance in trained and untrained stimuli across pre-therapy, mid-therapy, and post-therapy conditions (scores are as depicted in Figures 1 and 2), whereas P3 performed better on discourse measures across pre-therapy, mid therapy, and post-therapy conditions. The scores were as follows 5.55%, 9.25%, and 12.96%, respectively [See Figure 3].

**Error analysis**

The response of the participants was subjected to error analysis. Authors carried out analysis during pre-therapy and post-therapy conditions. Results for P1 evinced drastic positive changes from pre-therapy to post-therapy conditions. P1 used fewer IDK/NR responses from pre-therapy to post-therapy conditions (10 to 3). Also, there was alleviating usage of unrelated words from pre-therapy to post-therapy conditions (12 to 3). Likewise, P2 reduced the expression of unrelated words (13 to 4) and mixed errors (15 to 4). Conversely, there was an increase in semantic error (2 to 12) in P2. For P3, there was reduction in neologism (14 to 5) and

unrelated words (12 to 4). Alternatively, there were proliferated scores in semantic error (1 to 9).

In summary, the study results evinced positive outcomes for trained stimuli and discourse measures across all the participants. Conversely, results for untrained stimuli should be interpreted with caution because of the nominal improvement in all participants. SCVTr therapy aids in modifying the error patterns exhibited by PWAs. Similarly, the researcher witnessed that all participants showed ameliorated performance in standardized language test batteries [See Table 2]. Also, it was discerned that P1 outperformed P2 and P3 across all the conditions in general.

**DISCUSSION**

The study aimed to see the effectiveness of SCVTr therapy on individuals with aphasia in the Indian scenario. The fundamental ideas of the present study were designed based on the inspiration of the studies of Edmonds *et al.*<sup>[4]</sup> and Edmonds and Babb.<sup>[5]</sup> The present study showed positive gains for trained stimuli across all the participants. However, there were merely slight increments in performance for untrained stimuli for all participants.

In the study, P1, P2, and P3 manifested encouraging findings for trained conditions. This can be attributed to the repeated and systematic training of agents, patients, and verbs, which reinforced lexical retrieval.<sup>[1]</sup> Also, SCVTr therapy uses the verb as the core element in training, which may aid in activating related agents and patients related to the verb. During this activation, verb and related agents and patients induce bi-directional priming effect. Hence, it results in enhanced retrieval of agents, patients, and targeted verbs.<sup>[4,5,25]</sup>

The breadth of generalization was not discerned for the untrained stimuli among P1, P2, and P3. There was a marginal improvement in untrained stimuli, but this finding should be interpreted with caution. The marginal improvement may be attributed to the following: the present study had strict criteria to discharge PWAs from therapy irrespective of their prognosis, and the study recruited participants exhibiting moderate-severe aphasia. Thus, aphasia severity may plausibly interfere with the performance of the participants. Due to the increased severity of the problem, PWAs may likely rely on total communication, but the present study measured outcomes solely in spoken modality. Also, it could be due to fewer sessions provided; hence, PWAs are unable to achieve success as predicted for untrained stimuli. Hence, these factors might have interfered with generalization to untrained stimuli.<sup>[4,5]</sup>

Other factors leading to a limited performance on untrained stimuli could be a detailed cognitive assessment was not carried out in the study and only a screening tool was employed in the study to evaluate cognitive deficits. Hence, the presence or absence of cognitive deficits cannot be ruled out completely. Participants may have had mild apraxia that was not traced during the administration of the section of WAB-K for

assessing apraxia. Hence, a specific test battery for apraxia would be merited. Further, stimuli used for assessing untrained stimuli might not be sufficient to assess the generalization effect. That is, the participant's performance outside the clinical setting would be better, and it was not considered or measured in the study.<sup>[25,26]</sup>

On the other hand, when measuring discourse, there was an inflated slope of performance from pre-therapy to post-therapy conditions across all the participants. Presumably, this may be due to the paradigm used in the study, which may aid in facilitating diverse semantic networks. Hence, this facilitation helps PWAs to foster their performance beyond the trained stimuli.<sup>[1]</sup> The paradigm used in the study increases semantic knowledge of the targeted verb, agent, and patient. Thus, it allows diverse modifications of neural networks underlying cerebral representation for agents, patients, and verbs.<sup>[4]</sup> Also, the verb acts as a predicative component; this concurrently primes related agents and patients (thematic roles) based on the event schemas that he/she is exposed to. Further, thematic roles assigned can prime corresponding verb.<sup>[13,25]</sup> In addition, this could be due to the involvement of strengthening the essential sentence construction element (agent + patient + verb training during the therapy of steps 1 and 2). Hence, it yields in exhibiting positive effects while constructing sentences, and also during connected speech. Enhanced discourse performance could also be due to the less constrained nature of discourse tasks. Thus, performance on discourse was noted to be better.<sup>[4,5,25]</sup> These findings are also in consensus with the study by Davis and Stanton;<sup>[27]</sup> this study applied SFA in PWA who exhibited nonfluent variant of aphasia. This study found to have an intriguing finding, that is, training word retrieval impairment ascribed to inflate the performance of PWA connected speech and also in PWA discourse genre.

When analyzing error patterns across the participants, the authors noted the evolution of responses. The varied error patterns from pre-therapy to post-therapy conditions can be attributed to the diverse spread of semantic networks. Also, the study's protocol might have aided in the inhibition of unrelated words and facilitate the intended word. Thus, it facilitated PWAs in alleviating the unrelated responses, no response, and neologisms in P1, P2, and P3. In addition, SCVTr therapy embedded semantic aspects, orthographic and phonological aspects of the word in the treatment paradigm. Hence, P1, P2, and P3 showed the marked evolution of responses in reducing mixed errors. In other words, error encompassed both semantic and phonological aspects. However, results manifested increased semantic error in P2. This may be due to the facilitation of a wide array of the semantic network associated with verbs and their agent and patient. This, in turn, may exert difficulty in inhibiting the unrelated words in PWAs. However, this explanation may be true in the case of moderate-severe lexical retrieval impairment.

## CONCLUSIONS

Although preliminary, SCVTr therapy seemed to be viable for treating moderate-severe variant of aphasia. The study also illuminates the knowledge on spreading activation hypothesis, bidirectional priming, and Hebbian learning principles. Wherein, this study sought to be compelling because of the integrations of semantic, orthographic, and phonological aspects of the words in the paradigm. In addition, the therapy trains PWAs at sentence level irrespective of their severity. Thus, it strengthens the basic sentence structure that subsequently helps in establishing good ecological validity in functional communication per se. Overall findings of untrained stimuli need more research and iterations. Future research needs to exploit on understanding the precise intensity and duration of therapy using this therapy. Along with that, upcoming research studies should increase the number of baseline points and the number of participants, to proclaim the effectiveness of SCVTr therapy in remediating word retrieval deficits. The study utilized single subject design to see the effectiveness of therapy; however, for data analysis, authors relied on visual inspection of data and this type of analysis has its own shortcomings. Hence, future studies need to incorporate weighted statistics to gauge degree of change due to intervention. Overall, considering the shortcomings of the present study, future studies are warranted to conduct a study using SCVTr approach.

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## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for 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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Nil.

## Conflicts of interest

There are no conflicts of interest.

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**APPENDIX A (Examples of agent patient and verb stimuli)**

<b>SI No</b>	<b>Agent</b>	<b>patient</b>	<b>Verbs /akalisu/(yawning)</b>
1	/magu/(baby)	/Hasige/(Bed)	/akalisu/(yawning)
	/huduga/(Boy)	/maneyalli/(house)	/akalisu/(yawning)
	/hudugi/(girl)	/saleyalli/(school)	/toli/(wash)
2	/batta/(shelf)	/patre/(utensils)	/toli/(wash)
	/dhobi/(laundry)	/batte(cloth)	/toli/(wash)
	/driver/(driver)	/karu/(car)	/pujisu/(praying)
3	/pujari/(priest)	/devaranu/(god)	/pujisu/(praying)
	/raitha/(farmer)	/negilanu/(plough)	/pujisu/(praying)
	/rushhi/(saint)	/maravanu/(tree)	/pujisu/(praying)



**Appendix B (Procedure of SCVTr)**

Steps	Objective	Procedure
1	Retrieval of verb and corresponding agent and patient	Semantic cue for verb /akalisu/(Yawning) was introduced through auditory mode, if subject fails to respond than visual cue(Flash card of /akalisu/) and written cue was introduced simultaneously. Even after introducing visual and written cue, if subject still fails then, maximum cueing strategies were provided I.e. /akalisu/(Yawning)/yeddelu/(Wake up)/toli/(washing)/pujisu/(Praying) picture card was presented. Out of these subject should identify /akalisu/(Yawning). After successful retrieval of verb, subjects are asked to retrieve agent and patient corresponding to the verb. In this example it was /Magu/(Baby) /hasigejalli/(Bed); if subject fail to retrieve agent and patient similar cueing strategies was used as above mentioned.
2	Reading aloud agent patient and verb pair	Subjects were asked to read /Magu/(Baby)/hasigejalli/(Bed)/akalisu /(yawning). If subject fails to read, researcher will read for the subject.
3	Generating who, where, why and when question for the generated pairs	/yaru hasigejalli akalisu/('who' yawned in the bed).If a subject fails to answer, subject should select out of these choices /magu/(Baby)/raitha/(farmer).Likewise similar strategies were used for the questions related to /jalli/(where) /javaga/(When) and /jake/(Why) questions.
4	Semantic judgment of the generated pairs	/huli/(Tiger) /hasigejalli/(Bed)/ akalisu /(Yawning) (inappropriate agent) here subject should respond by saying 'YES' or 'NO'. Likewise, similar strategies for following questions were employed.
5	Retrieval of verb with promoting	In step 5, subject should retrieve the verbs /akalisu/(Yawning). If subjects fails then semantic cue/navuu nidde bandaga yenu madutivi/(what we do when we get sleep) were given.
6	Retrieval of verb and corresponding agent and patient	Here Subject were asked to retrieve verb / akalisu/(Yawning) of his own, also the relevant agent and patient (/Magu/(Baby) /hasigejalli/(Bed)) corresponding to the verb retrieved.

**APPENDIX C**

<b>Target Verb:</b>															
<b>Step 1a:</b>	S1	S2	S3			S4	Pictorial	Orthographic	Maximal Cue						
<b>Step 1b:</b>	Agent						Patient								
	S1	S2	S3	S4	Pictorial	Orthographic	Max Cue	S1	S2	S3	S4	Pictorial	Orthographic	Max Cue	
1															
2															
3															
4															
<b>Step 2:</b>	Read Aloud		Independent Reading							Choral Reading					
<b>Step 3:</b>	Questioning		1 <sup>st</sup> Pair				2 <sup>nd</sup> Pairs				3 <sup>rd</sup> Pair				
			WC		WCC		WC		WCC		WC		WCC		
	Q 1														
	Q 2														
	Q 3														
	Q 4														
<b>Step 4:</b>	Semantic Judgment		1 <sup>st</sup> Pair				2 <sup>nd</sup> Pair			3 <sup>rd</sup> Pair			Remarks		
	St 1														
	St 2														
	St 3														
	St 4														
<b>Step 5:</b>	Verb Retrieval														
<b>Step 6:</b>	Repetition Without cueing														