Introduction

Verb Network Strengthening Treatment (VNeST) is a verb-centered treatment designed to promote generalization to noun and verb retrieval in single words, sentences and discourse. The treatment, based on principles of semantic theory surrounding the interrelationship of verbs and their thematic roles (e.g., McRae, Ferretti, & Amyote, 1997), requires participants to generate explicit thematic roles related to trained verbs (the verb network) that represent common (*A chauffeur drives a limousine*.) and personal (*My husband drives a semi*.) event schemas, thereby simultaneously activating world and personal knowledge and word meaning within a basic sentence frame (subject/agent–verb–object/patient).

Previous findings from two single-subject design studies with 6 people (Edmonds & Babb, 2011; Edmonds, Nadeau, & Kiran, 2009) provided preliminary evidence of increased lexical retrieval in sentences with generalization to lexical retrieval in single words naming of nouns and verbs and discourse. Responses (collected from only two communication partners) on the *Communicative Effectiveness Questionnaire* (CETI: Lomas, et al, 1989) indicated significant improvements in functional communication.

The current study aims to replicate and extend previous findings with a larger number of participants. Specifically, we asked whether training a set of verbs generalizes to production of 1) sentences containing trained verbs (*The carpenter measures the lumber*.), 2) sentence containing untrained semantically related verbs (*The farmer weighs the apples*.), 3) sentences unrelated to treatment (*The dog watches the cat*.), and 4) single word naming of nouns and verbs. Changes to Western Aphasia Battery-Revised (WAB-R) scores and responses to the CETI completed by communication partners (e.g., spouses of participants) were also evaluated.

Method

Participants. Nine native English speakers with chronic aphasia (> 1 year post-stroke) participated. All had one left hemisphere ischemic CVA. None exhibited any exclusionary measures, including history of neurological disorders/learning disabilities, drug/alcohol abuse, unmanaged depression, moderate or greater apraxia of speech (Apraxia Battery for Adults-2). See Table 1 for results from the WAB-R, *An Object and Action Naming Battery* (to evaluate noun and verb naming), the Northwestern Assessment of Verbs and Sentences test and the CETI. (Discourse samples were also collected, and are currently being analyzed.)

Seven participants had communication partners (Mean age=51.2) (3 spouses, 3 adult children, 1 sibling) who completed the CETI at pre- and post-treatment. All scored within normal limits on the Montreal Cognitive Assessment. The CETI evaluates communication abilities across 16 common situations (e.g., getting involved in group conversations about self) with a visual analog scale of 100mm that ranges from "Not at all able" to "As able as before stroke." See Table 1 for results.

Design. A single-subject experimental design with a multiple baselines across participants was used (but only group data is provided here). The baseline phase included 5 sessions where the sentence probes and control task were administered. The sentence probes consisted of pictures depicting scenarios containing trained verbs (N=10) (*The carpenter is*

measuring the lumber) and semantically related untrained verbs (N=10) (*The farmer is* weighing *the apples*.). Many pictures were used in previous studies, but some were replaced with pictures containing more specific terms (e.g., "mother" was replaced with "nun," "baby" (used as a patient) was replaced with "apples."). A control task required participants to generate an adjective synonym in a sentence completion task (*Someone who is sick is also said to be* ill.). After a stable (i.e., non-ascending) baseline was established, treatment was conducted 2 times/week, 2 hours each, for 10 weeks. Probes were re-administered every 2 weeks (data not reported here) during the treatment phase. One to three post-treatment probes were administered the week immediately after treatment, and maintenance probes were conducted 3 months post-treatment.

Treatment stimuli. Ten concrete verbs were trained. Stimuli consisted of cards containing 1) the names of the trained verbs (*measure*) and 2) related agent and patient nouns (*chef/sugar*) representing a range of scenarios. Sentences used for semantic judgment were also developed.

Treatment procedure. For the treatment protocol, participants: 1) generated 3 agent-patient pairs (*chef/sugar*) related to the target verb (*measure*), 2) answered three *wh-* questions related to one pair (*Where/When/Why does a chef measure sugar*?), 3) decided whether 12 orally presented sentences containing the verb (*The chef measures the book.*) were semantically correct, 4) generated the verb independently one time, 5) repeated step 1.

<div align="center">Results</div>

Wilcoxon signed rank tests were conducted to evaluate pre- to post-treatment changes on all dependent variables across the group (See Table 2). The results showed post-treatment improvement on sentences containing trained ($p = .004$) and semantically related untrained verbs ($p = .008$) with no change in the control task ($p=.066$), indicating maintenance of internal validity. Effect sizes for the mean changes for the trained and untrained sentences and the control task were 3.6, 2.1 and .48, respectively. All but one participant exhibited Cohen's effect sizes >1 for trained and untrained conditions; among those the range was 1.09 to 7.9 for trained and 1.2 to 5.6 for untrained. No changes between post-treatment and maintenance probes were observed for trained ($p=.984$) and untrained ($p=.750$) probes among the 7 participants for whom we currently have maintenance data, indicating maintenance of improvement.

Confrontation naming of objects and actions from *An Object and Action Naming Battery* also improved significantly ($p = .027$ and $p=.023$, respectively). No changes in NAVS sentence production ($p = .106$) were observed despite an increase in average number of correct sentences (M(SD)=8.6(8.5) to 13.9(9.4)). (See Discussion for possible explanation).

Significant changes on WAB scores were reported (mean of 75 to 81, $p =.027$). Responses from the communication partners on the CETI reveal a significant improvement ($p = .016$) in reported functional communication with average ratings increasing from 32.5 to 61.1.

Discussion

The current study aimed to evaluate the effects of VNeST in a group of diverse participants with aphasia. The findings indicate an overall positive group response to VNeST. Improvement to sentence production for the probe pictures containing trained and untrained stimuli support the theoretical underpinnings of VNeST that propose generalization between trained verbs and related thematic roles to semantically related verb networks.

Generalization to lexical retrieval in single words was observed with increased verb and noun naming, suggesting improved access to concrete actions and objects beyond trained items. The increase in verb naming is notable, since treatment primarily involves noun retrieval (the trained verb is provided, but the participant generates 6 nouns per verb). The lack of group improvement to the NAVS stimuli seems due to variability of performance, as five of the nine participants showed improvement, with increases ranging from 93% to 600%, with the other four showing negligible or decreasing changes. We are currently evaluating NAVS errors to better understand participant differences.

The improvement in WAB-R scores suggests clinical changes in aphasia severity (Katz & Wertz, 1997) in the majority of participants. These changes, in addition to the other impairment-based results, are enhanced by encouraging reports from communication partners who reported large increases in functional communication. Thus, the findings from the current study replicate previous results and add growing support for VNeST as a potentially useful treatment to aid lexical retrieval in sentences and single words with corresponding changes in aphasia severity and functional communication by report. Error and discourse analyses (to be completed by conference time) will further enhance our understanding of the overall response of these participants to VNeST.

Table 1. Results for all participants (pts) for tests given pre- and post-treatment

Pt	M/F	Age	Education	Aphasia type	WAB-R AQ (max=100) Pre	WAB-R AQ Post	O&A-objects (N=162) Pre	O&A-objects Post	O&A actions[+] (N=100) Pre	O&A actions Post	*NAVS Sentences (N=35) Pre	*NAVS Sentences Post	CETI-partner (Max=100) Pre	CETI-partner Post
1	M	49	14	Anomic	81.6	93.6	145 (89%)	157 (97%)	81	94	26 (74%)	25 (71%)	n/a	n/a
2	M	69	12	Anomic	88.1	86.1	141 (87%)	151 (93%)	80	81	7 (20%)	4 (11%)	41.3	72.4
3	M	69	13	Anomic	81.9	81.1	87 (54%)	103 (64%)	50	50	1 (3%)	7 (20%)	n/a	n/a
4	F	70	15	Anomic	78.5	84.9	144 (89%)	158 (98%)	61	80	6 (17%)	18 (51%)	25.2	60.0
5	F	70	16	Conduction	72	82	109 (65%)	102 (63%)	63	67	15 (43%)	29 (83%)	45.6	63.5
6	M	81	18	Conduction	66.6	75	123 (76%)	120 (74%)	68	67	2 (6%)	13 (37%)	10.4	38.9
7	F	68	14	Wernicke	52.9	63.8	125 (77%)	137 (85%)	15	41	0	1 (3%)	30.0	77.6
8	F	58	15	TCM	81.4	82.8	143 (88%)	147 (91%)	76	82	15 (43%)	10 (29%)	42.8	48.2
9	M	71	22	TCM	72.1	79.4	117 (72%)	137 (85%)	65	79	5 (14%)	18 (51%)	31.9	67.3

*Northwestern Assessment of Verbs and Sentences: Please note that the pictures were used without provision of the verb, and each verb was only shown once in its most complex form (e.g., optional 2-place verbs were only shown one time with both thematic roles). These changes are different from the test's standard protocol. [+]Percent accuracy is not provided for *An Object and Action Naming Battery* actions, since the total possible is 100.

Table 2. Results of group analyses of dependent variables from pre- to post-treatment

Variable	Pre-tx		Post-tx		Post-tx vs. Pre-tx		[+]p value
	Mean	SD	Mean	SD	Mean	SD	
Sentence probes							
Trained Sentences (N=10)	1.6	1.0	5.3	3.2	3.7	2.6	**0.004**
Untrained Sentences (N=10}	1.7	0.8	3.4	1.9	1.7	1.3	**0.008**
Pre-post tests							
WAB-R Aphasia Quotient (100=max)	75.0	10.6	81.0	8.2	6.0	5.2	**0.027**
O&A Nouns (N=162)	126.0	19.7	135	21.7	8.7	8.9	**0.027**
O&A Verbs (N=100)	62.1	20.3	71.2	16.8	9.1	9.4	**0.023**
*NAVS sentences (N=35)	8.6	8.5	13.9	9.4	5.3	7.5	0.106
CETI communication partner (100=max)	32.5	12.3	61.1	13.5	28.7	13.5	**0.016**

[+]p-value based on Wilcoxon Signed Rank Test. *Northwestern Assessment of Verbs and Sentences: Please note that the pictures were used without provision of the verb, and each verb was only shown once in its most complex form (e.g., optional 2-place verbs were only shown one time with both thematic roles). These changes are different from the test's standard protocol.

References

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