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A Review of Verb Network Strengthening Treatment

Theory, Methods, Results, and Clinical Implications

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This article examines Verb Network Strengthening Treatment (VNeST), a relatively new treatment approach for anomia in people with aphasia. The VNeST protocol aims to promote generalization to increased lexical retrieval of untrained words across a hierarchy of linguistic tasks, including single-word naming of nouns and verbs, sentence production, and discourse. The concept of the verb network relates to the centrality of the verb to the semantics and syntax of a sentence. The VNeST protocol elicits diverse agents (e.g., *musician*) and patients (e.g., *tambourine*) around trained verbs (e.g., *shake*) to activate a range of semantic concepts and personal responses to potentially facilitate generalization to a multitude of lexical items. The pre- and posttreatment generalization results for the 19 participants reported in English are analyzed. Participants represent a range of aphasia severities and types, including Broca's, transcortical motor, anomic, Wernicke's, and conduction aphasia. A previous study that evaluated 3 monolingual Korean speakers on a modified version of VNeST that accommodated Korean's verb final word order is also summarized. The findings across the 5 English studies and the Korean study revealed increased noun and verb naming and lexical retrieval in sentences and discourse on untrained items and tasks for more than half of the participants, suggesting preliminary efficacy for VNeST. Potential predictors and mechanisms of improvement are explored, and clinical implications, including consideration of goals, outcome measures, dosage, inclusion and evaluation of writing, and verb selection, are discussed.
Key words: *anomia*, *aphasia*, *generalization*, *Verb Network Strengthening Treatment*, *verbs*

WORD-FINDING difficulties (anomia) are widely prevalent in aphasia. They impact single-word-, sentence-, and discourse-level communication and all grammatical words forms (e.g., nouns, verbs, adjectives; Laine & Martin, 2006). Anomia also can impact a person's communication significantly by compromising his or her ability to convey intended thoughts and ideas, which can impact interpersonal relationships and participation in a variety of daily activities. Given the prevalence and impact of anomia, most treatment approaches for aphasia have addressed the need to improve word retrieval.

The aim of this review article is to familiarize the reader with one approach, Verb Network Strengthening Treatment (VNeST), which is a relatively new treatment of aphasia that aims to improve lexical retrieval across a hierarchy of linguistic contexts, including sentences and discourse. First, VNeST's aims, theoretical underpinnings, methods, results, and potential predictors and mechanisms are summarized. Then clinical implications based on current knowledge are discussed.

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AIMS OF VNeST

The aim of VNeST is to promote increased lexical retrieval abilities beyond what is explicitly trained so that, after treatment, participants may be able to communicate through sentences and discourse and more accurately convey the ideas they want to express. Broadly speaking, this can occur through increased lexical retrieval in persons with sparse output or through increased specificity in word retrieval (with a corresponding reduction in empty or general output) in persons with more fluent speech. The VNeST protocol was designed to be a practical extension of its theoretical underpinnings, which would be engaging, challenging, and personalized for participants. Finally, it was designed with the long-term intention that it might applied to languages other than English.

THEORETICAL UNDERPINNINGS OF VNeST

The theoretical foundation of VNeST is built on the centrality of verbs to the semantics and syntax of sentence production. The semantic aspect of VNeST, which is critical to potential generalization of lexical retrieval abilities, relates to the semantic interrelationship of verbs and their thematic roles, and forms the basis for the "verb network." See Figure 1. The concept of this network is predicated on priming/facilitation effects between a verb and its thematic roles such that presentation of a verb (e.g., *scrubbing*) primes/facilitates a response to a related agent (e.g., *janitor*) as compared with an unrelated verb prime (e.g., *cheering*) (Ferretti, McRae, & Hatherell, 2001). This effect is bidirectional in that agents and patients are also prime-related verbs (McRae, Hare, Elman, & Ferretti, 2005). In addition, the relationship has been observed for verb–instrument pairs (*ate–fork*; Ferretti et al., 2001; McRae et al., 2005) and verb–location pairs (e.g., *slept–bedroom*), showing priming effects from locations to verbs, but not vice versa.

The VNeST protocol requires activation of specific thematic role concepts (i.e., not pronouns or general terms such as *woman*, *boy*) related to a given verb (e.g., *pilot* [agent] and

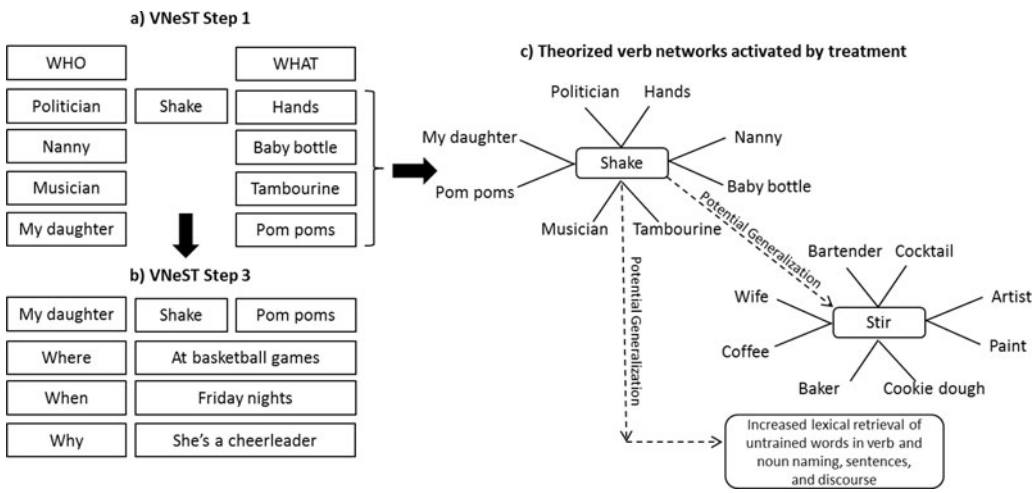

Figure 1. (A) VNeST example of possible responses to "shake" on Step 1. (B) Selection of one scenario to expand in Step 3 (Step 2 involves reading all the scenarios aloud.). (C) Theorized networks most immediately activated by treatment. Activation of these networks and ones activated through generation of a diverse array of event schemas (not pictured) predicts improved lexical retrieval of untrained nouns and verbs, sentences, and discourse (e.g., Edmonds, Nadeau, & Kiran, 2009). From "Effect of Verb Network Strengthening Treatment in Moderate-to-Severe Aphasia," by L. A. Edmonds and M. Babb, 2011, *American Journal of Speech-Language Pathology, 20*, pp. 131–145. Copyright 2011 by American Speech-Language-Hearing Association. Adapted with permission.

helicopter [patient] for *fly* [verb]). The hypothesis is that systematic activation of agent and patient thematic roles around target verbs will promote increased activation of the concepts that comprise verb networks (i.e., content words), resulting in an increased likelihood for accurate lexical retrieval of the target words in sentence production (e.g., Bock & Levelt, 1994; Schwartz, 1987). In addition to increased activation of target concepts, VNeST may also promote semantic distinctions among potential competitors, which could also promote more successful lexical retrieval (e.g., Noonan, Jefferies, Corbett, & Lambon Ralph, 2010). Thematic role assignment is also inherently trained in VNeST, as participants must determine the agent (doer) and patient (receiver of, or person or thing affected by the action) of their created scenario around the given verb. This may potentially aid in mapping thematic role information onto syntactic argument structure, an ability that can be impaired in persons with aphasia (e.g., Barbieri, Basso, Frustaci, & Luzzatti, 2010; Edmonds, Obermeyer, & Kernan, 2014).

Because verbs can have a multitude of meanings and relate differently to various thematic role combinations, three to four agent–verb–patient scenarios are elicited with the expansion of one scenario through responses to *where*, *when*, and *why* it occurs (e.g., pilot-fly-helicopter-to the hospital-everyday-because of medical emergency). The VNeST protocol uses structured elicitation of these scenarios not only to strengthen lexical-semantic relationships but also to activate episodic and autobiographic memories from participants, which generally are intact in persons with aphasia. The idea is to promote effortful, personal, and salient semantic processing while recruiting large neural networks involving lexical semantics and long-term memory, thereby providing more opportunities for neural reorganization and/or strengthening, which could facilitate generalization to a multitude of lexical items (e.g., Raymer et al., 2008).

Finally, as discussed previously, a verb is integral to syntax of a sentence so much so that a verb's argument structure is thought to be an integral part of the verb's semantic representation (e.g., Conroy, Sage, & Lambon Ralph, 2006; Druks, 2002; Mitchum & Berndt, 2001; Webster & Whitworth, 2012) and consequently specifies its predicate argument structure (PAS) in sentence production. Thus, the VNeST protocol of repeated and diverse production of thematic roles around a target verb in canonical order (subject–verb–object) may not only strengthen the semantic representation of the verb and its relationship to various thematic roles but may also potentially strengthen specification of PAS and basic sentence syntax. Because the VNeST protocol integrates semantics, syntax, and thematic role assignment, it offers multiple potential mechanisms for improvement in sentence production (Edmonds, Obermeyer, et al., 2014), making it suitable for persons with different sources of sentence/discourse production impairments.

VNeST PROTOCOL

A detailed VNeST tutorial is available in Edmonds' (2014) study. The key features are summarized here, with special attention to linking the theoretical principles to each step. The protocol follows closely to the intent of activating verb networks through systematic and diverse production of event schemas (verbs and their thematic roles). In Step 1, the words "who" and "what" are presented on either side of the transitive verb in canonical order (e.g., *who chop what*). Participants are asked to think of someone who might chop something (or something that might be chopped). Once one thematic role is generated, the other is elicited. Three to four of these scenarios are generated, with increasing cues from the clinician as needed (see Edmonds, 2014). Important to this step: Diverse scenarios are encouraged to promote a broad network of semantic activation, and personal responses are always elicited. For example, for the verb drive, if a participant produced three pairs around family (*my wife/drive/pick-up truck*, *I/drive/van, Susan*

[daughter]/*drive/Ford*), then it would be pointed out that these are all good responses, but they are related to family. The participant would be cued to think of someone who drives for his or her job or as part of a hobby/sport and so on. Then more diverse responses such as *chauffeur/limousine*, *Danica Patrick/race car*, *soldier/tank* might be produced, providing an opportunity for diverse modifications of the neural networks underlying semantic representations of potential agents and patients. See Figure 1 for an example.

Pictures are not used because they can constrain the concept's meaning to what is imaged, and thus potentially limit responses, including personal accounts. This is particularly problematic for verbs, whose potential meanings and relationships are quite diverse and "loose," especially relative to nouns (Black & Chiat, 2003). For example, if a picture of a chef chopping onions was shown, then responses such as *musician/chop/banjo* may not be elicited. This technique in banjo playing is a highly specific and personal response from a professional musician who had not used this term since her stroke. Although there is no way to know, this response may not have been elicited by using a more prototypical picture of someone chopping food. See Edmonds, Mammino, and Ojeda (2014) for a quantitative evaluation of the diversity of responses provided from VNeST 1 study.

Step 2 requires the participant to read each scenario aloud (e.g., "chef chop onions") with assistance, as needed. The inclusion of functor words and/or verb inflection is not prompted (although they are not discouraged if produced). This step strengthens semantic-phonological connections and provides practice at producing the subject, verb, and object as a cohesive utterance. Participants read through these up to three times. Step 3 provides the opportunity for more in-depth elaboration of one scenario produced in Step 1 by adding *where*, *when*, and *why* the activity occurs/occurred. For example, the musician who mentioned chopping the banjo might add that she chopped the banjo in Nashville 2 years ago because they played at a bluegrass festival. See Figure 1. After all treatment materials are removed, Step 4 requires the participant to judge semantic plausibility/correctness of 12 syntactically balanced subject–verb–object sentences (that are read aloud by the clinician) across four categories: (1) Correct: *The pitcher throws the baseball*. (2) Incorrect agent: *The receptionist throws the javelin*. (3) Incorrect patient: *The quarterback throws the candle*. (4) Reversed: *The frisbee throws the children*. Step 5 asks the participant to say what verb they have been working on (to elicit independent retrieval of the verb). Step 6 repeats the prompts of Step 1 without cues to help consolidate the information about each verb. Ten verbs have been trained within our research team's studies. After all verbs are treated once, they are repeatedly cycled throughout the treatment period, with the overall goal of reducing clinician cues and promoting diversity of responses.

VNeST STUDIES AND RESULTS

The effects of VNeST have been evaluated by Edmonds and colleagues with 19 English-speaking participants across five studies (Edmonds & Babb, 2011; Edmonds, Mammino, et al., 2014 [group data for 11 participants]; Edmonds, Nadeau, & Kiran, 2009; Edmonds, Obermeyer, et al., 2014 [individual analyses for participants from in Edmonds, Mammino, et al.'s, 2014, study]; Furnas & Edmonds, 2014) and by Kwag, Sun, Kim, and Cheon (2014) with three Korean-speaking participants. The participants and pre- to posttreatment generalization results from these studies are discussed and are summarized in Table 1. An additional study (Hoover, Caplan, Waters, & Budson, 2015) that evaluated VNeST in addition to a group treatment approach is also discussed.

Studies by Edmonds and colleagues

The 19 monolingual English participants from the Edmonds and colleagues studies were diagnosed with chronic aphasia, (>9 months after the onset of cerebrovascular

Table 1. Participant results on an abbreviated list of results from published VNeST studies

VNeST Study	Participant Aphasia Types	Noun Naming	Verb Naming	Discourse				>5 Points on WAB[b]	CETI
				Sentences[a]	#Words	%CIU	%CU		
Study 1	2 with moderate TCMA, 2 with moderate CA	4 of 4	3 of 4	4 of 4	DNT	DNT	3 of 4	4 of 4	DNT
Study 2	2 with severe Broca's aphasia and mild AOS	2 of 2 spoken, 1 of 1 written	1 of 2 spoken, 1 of 1 written	1 of 2	2 of 2	2 of 2	DNT	2 of 2	2 of 2
Study 3	1 with Broca's and mild-moderate AOS, 1 with anomic and moderate-severe AOS	2 of 2 spoken, 1 of 2 typed	0 of 2 spoken, 2 of 2 typed	DNT	2 of 2 spoken, 1 of 2 typed	1 of 2 spoken, 2 of 2 typed	2 of 2 spoken, 0 of 2 typed	1 of 2 on WAB AQ, 2 of 2 on Writing section	DNT
Study 4/5	5 with mild anomic, 1 with moderate CA, 1 with mild CA, 1 with moderate jargon aphasia, 1 with moderate-severe Wernicke's, 1 with mild TCMA, 1 with moderate TCMA	8 of 11	7 of 11	6 of 11	3 of 11	3 of 11	5 of 11	7 of 11	9 of 9
Study 6	2 with moderate Broca's, 1 with mild anomic; Korean monolinguals with VNeST in Korean in South Korea	3 of 3	DNT	3 or 3 w/sentences containing trained and untrained semantically related verbs	DNT	DNT	DNT	2 of 3	DNT
Summary across studies	22 participants	19 of 22 spoken 2 of 3 written/typed	11 of 19 spoken 3 of 3 typed	14 of 20 spoken DNT	7 of 15 spoken 1 of 2 typed	6 of 15 spoken 2 of 2	10 of 17 spoken 0 of 2	16 of 22 spoken n/a	11 of 11 n/a

Note. The reported outcomes were administered pre- and posttreatment with the exception of Study 6, where sentence probes were administered at baseline, during treatment, and at posttreatment. Study 1, Edmonds et al. (2009); Study 2, Edmonds and Babb (2011); Study 3, Furnas and Edmonds (2014); Study 4/5, Edmonds, Obermeyer, et al., (2014)/Edmonds, Mammino, et al. (2014); Study 6, Kwag et al. (2014). AOS = apraxia of speech; AQ = Aphasia Quotient; CA = conduction aphasia; CETI = Communication Effectiveness Index (Lomas et al., 1989); %CIU = Correct Information Unit; %CU = complete utterances (contains informative subject-verb-(object); DNT = did not test; n/a = not available; TCMA = transcortical motor aphasia; VNeST = Verb Network Strengthening Treatment; WAB = Western Aphasia Battery; WAB AQ = Western Aphasia Battery Aphasia Quotient (Kertesz, 1982, 2006).

[a]Sentences were evaluated with stimuli from the Northwestern Assessment of Verbs and Sentences picture stimuli without any prompts (Thompson, 2011).

[b]>5-point increase on AQ indicative of clinically significant improvement (Katz & Wertz, 1997).

accident [CVA]). All but one participant had a single left-hemisphere CVA (hemorrhagic and ischemic) (i.e., Participant 2 [P2] in Edmonds & Babb's, 2011, study experienced bilateral strokes). Participants represent a range of aphasia severities, types, and patterns of impairment, but none exhibited more than moderate impairment on the composite score of the Cognitive Linguistic Quick Test (Helm-Estabrooks, 2001), and all exhibited sufficient comprehension to engage in testing and treatment tasks. Participants received treatment on 10 verbs for 4–15 weeks, with most receiving 10 weeks of treatment. All participants received two treatment sessions per week, totaling 3–3.5 hr per week (except the two participants in Furnas & Edmonds', 2014, study who received treatment three times per week, 2 hr per session for 6 weeks).

The synopsis of findings from these studies includes a hierarchy of language measures most related to their hypotheses and predictions for generalization: single-word naming of nouns and verbs and lexical retrieval in constrained sentence production and discourse. In addition, reported are aphasia severity as determined by the Western Aphasia Battery (WAB; Kertesz, 1982) or WAB–Revised (WAB-R; Kertesz, 2006) and functional communication by proxy (for 11 participants) on the Communication Effectiveness Index (CETI; Lomas et al., 1989). Evaluation of performance on all these items does not suppose that every participant would improve on every measure. However, investigating a range of linguistic tasks involving lexical retrieval was intended to allow us to "catch" improvement where it might occur and to detect potential patterns of improvement that might provide insight into potential mechanisms and predictors of improvement (e.g., Edmonds, Obermeyer, et al., 2014; Webster & Whitworth, 2012).

All participants were tested on the objects and actions from an Object and Action Naming Battery (OANB: Druks & Masterson, 2000) except for the four participants in Edmonds et al.'s (2009) study, who were administered the Boston Naming Test (BNT; Goodglass, Kaplan, & Weintraub, 1983) and the verb naming subtest from the (then unpublished) Northwestern Assessment of Verbs and Sentences (NAVS; Thompson, 2011). As seen in Table 1, the vast majority of the participants (86%) improved in noun naming and the majority of participants also improved in verb naming (58%). These generalized improvements in single-word lexical retrieval suggest that VNeST engaged semantic networks.

For all studies, pictures from the NAVS were used to elicit sentences that contained one-, two-, and three-place verbs. (The verb was not provided as in the NAVS protocol.) The results showed that nearly 75% of the participants improved in sentence production, suggesting that VNeST has the potential to promote improved untrained sentence production in constrained tasks. To evaluate sentence production in discourse, the measure of *complete utterances* (CUs) was developed to capture the intent of VNeST, which is increased lexical retrieval within basic sentences. The concept of a CU is analogous to that of a Correct Information Unit (CIU; Nicholas & Brookshire, 1993) but is an utterance-level measure that contains both a complete sentence frame and content words informative to the topic and each other (Edmonds et al., 2009). A complete sentence frame is defined as an utterance containing a subject, verb, and (object) [+SV]. Grammatical, morphological, and phonemic errors are acceptable because these are not targeted in treatment and are not penalized according to Nicholas and Brookshire (1993). Relevance [+REL] of utterances is determined by evaluating whether the entire S-V-(O) segment is relevant to the topic. The following examples from the WAB picnic picture (Kertesz, 2006) illustrate how CUs are coded and scored: (1) The house is up [+SV][−REL][−CU]; (2) A man with some book [−SV][+REL][−CU] (missing main verb); (3) To see it over in that way [−SV][−REL][−CU]; (4) The woman is pouring a drink [+SV][+REL][+CU]. Results across studies show that a majority of participants (59%) improved on this conservative

measure. Although this measure has not been standardized, it has been shown to have high interrater reliability and is conceptually similar to existing discourse measures. Utterances first are broken up as T-units (main clause + subordinate clause(s); e.g., Hunt, 1966). Then there is determination of whether a subject, verb, and object (if required) are present within the main clause. Then each subject, verb, or object word is evaluated using CIU principles to determine if all the words are relevant to the topic (and to each other within the utterance). If all words are present and relevant, then it is deemed a complete utterance.

Finally, 11 of 11 communication partners of the treatment participants (e.g., spouses, sibling, and adult children) reported improvements on the CETI, suggesting that the improvements observed on the more impairment-based measures may have transferred to functional communication. Anecdotes from family members regarding increased functional communication have also been reported (Edmonds et al., 2009; Edmonds, Mammino, et al., 2014). Although these findings are encouraging, further research is needed to evaluate functional communication more directly.

Because VNeST fundamentally is a semantic treatment, there is potential for improved lexical retrieval within spoken and written modalities (e.g., Kay, Lesser, & Coltheart, 1992). In some of the studies discussed, writing and typing were incorporated into the VNeST protocol and generalization to writing/typing was evaluated (in addition to spoken output). Edmonds and Babb (2011) added writing for P2, who had a WAB (Kertesz, 1982) Aphasia Quotient of 36.4 and neologistic speech. Given her severe impairment in spoken output, the protocol was modified to allow her to write her responses during treatment, but *only when the clinician was not able to discern her spoken response.* Her results showed improved noun and verb naming in the written (and spoken) modalities (no other writing was evaluated).

Furnas and Edmonds (2014) adapted VNeST for computer use and delivered the treatment via teletherapy. In this study, the protocol incorporated typing by first requiring participants to provide a spoken response and then to type their response into a textbox on the computer. The two participants had apraxia of speech (AOS) as well as Broca's aphasia. The results showed improved typed noun naming in one participant and improved typed verb naming for both, although verb naming in the spoken modality did not also improve, potentially due to AOS limitations. Both participants were quite impaired in typed discourse in pretreatment. At posttreatment, number of words and %CIUs doubled for P1. P2 also showed increased %CIUs in the typed modality. Neither exhibited an increase in %CUs in typed discourse, but they did in spoken discourse. In addition, both participants improved on the writing subtest of the WAB. The results of these studies indicate that VNeST can promote cross-modal generalization and may offer more clinical options for participants with limited spoken output and/or AOS. See Edmonds (2014) for information on providing feedback on writing responses.

VNeST in monolingual Korean speakers

Kwag et al. (2014) evaluated VNeST with three monolingual Korean speakers. Two participants were diagnosed with moderate Broca's aphasia and one with mild anomic aphasia (according to the Korean version of the WAB [K-WAB; Kim & Na, 1997b]), and all were more than 12 months after a singular left-hemisphere CVA. The treatment was modified from Edmonds' published protocol in the following ways: (1) 12 verbs were trained (as compared with 10); (2) the order of the agent, verb, and patient was changed to reflect Korean's verb-final syntax (agent, object, verb); (3) pictures were used to illustrate the basic action; (4) only max cues were provided when a participant could not retrieve and agent or patient (they were presented with one plausible response and one foil), whereas the original protocol elicits some type of semantic cue before max cueing (Edmonds, 2014); (5) *wh*-questions were asked for all

agent–verb–patient scenarios (as compared with one); and (6) dosage was 45–50 min per session, two times per week (as compared with ~3–3.5 hr per week).

Generalization was examined on sentences containing trained and untrained verbs, noun naming with the Korean version of the BNT (K-BNT; Kim & Na, 1997a), and on the K-WAB (Kim & Na, 1997b). Kwag et al.'s (2014) results were generally similar to Edmonds' studies in English. All participants improved on sentences containing trained and untrained verbs and on noun naming (K-BNT), and the 2 participants with moderate Broca's aphasia improved more than 5 points on the K-WAB. Discourse was not assessed. The implementation of VNeST in Korean is in keeping with its original development, as it was intended to be primarily a semantic-based treatment without explicit language-specific syntax or manipulations. The Korean results support the possibility that VNeST's emphasis on semantics may allow for its implementation in other languages with appropriate word-order adaptations, although its potential effect on discourse is still unknown.

VNeST compared with group treatment and VNeST + group treatment

Hoover et al. (2015) addressed three research questions regarding verb treatment. In one, the results of verb training were compared across three groups of six participants with Broca's aphasia of more than 6 months after the onset of a single, language-hemisphere-dominant CVA. The treatments included modified VNeST alone, socially oriented group treatment alone, and modified VNeST + group treatment. Each group was trained on a different set of frequency- and length-matched transitive verbs. Each set contained 27 verbs associated with one of nine functional conversation topics (e.g., dining, travel, occupation). Twice-weekly sessions of impairment-based individual and/or socially oriented group treatment were provided. Each participant received 2.25 hr of individual and/or 2.25 hr of group therapies across 2 treatment days for 6 weeks, depending on group assignment.

The VNeST protocol was modified in the following ways: (1) 27 verbs were trained (as compared with 10); (2) only maximum cueing was provided, whereas the original protocol elicits some type of semantic cue before max cueing (Edmonds, 2014), (3) *when*, *where*, and *why* questions were asked for all three agent–patient pairs (as compared with only one pair); (4) sentences with semantic anomalies were not provided for semantic judgment—rather grammatical judgments on the generated sentences were conducted if participants made grammatical errors. The socially oriented group treatment was conducted in a conversational format (Elman, 2007; Simmons-Mackie, Elman, Holland, & Damico, 2007) with 27 different verbs. Discourse was generated using the topic headings, which encompassed the trained verbs. Participants also engaged in language games, functional scripts, and discussion using the verbs on the list surrounding each conversational topic. The combined group received both treatments.

As the treatment group comparison was part of a larger study, only trained verbs were compared posttreatment. All groups showed improvement on trained verbs, with no differences observed across groups. The authors mentioned that the conversational nature of the group treatment provided an "unforeseen opportunity" for the participants to use all of the verbs in the group environment (Hoover et al., 2015, p. 793), resulting in a potential confound. Because this study measured only performance on trained items, these data are not included on Table 1, which summarizes generalization measures.

VNeST outcomes summary

Overall, the results of these collective studies on VNeST provide preliminary evidence of efficacy (Robey, 2004) of the approach to facilitate improved lexical retrieval abilities across single words, sentences, and discourse in persons with a range of types and severities of aphasia. Further evidence

of efficacy comes from preliminary reports of improved functional communication. It is difficult to compare VNeST's results to other treatment approaches, given differences in participants, methodologies, and outcome measures. However, on the basis of reviews of single-word-naming treatments and verb-focused treatments, VNeST appears to exhibit relatively robust generalization to noun and verb naming, sentence production, and lexical retrieval within sentences in discourse, although more research is needed. See Conroy et al. (2006) and Webster and Whitworth (2012) for verb treatment reviews, Boyle (2010) for a review of semantic feature analysis, and Druks (2002), Kiran and Bassetto (2008), and Nickels (2002) for reviews of single-word approaches to treatment.

POTENTIAL PREDICTORS AND MECHANISMS OF IMPROVEMENT WITH VNeST

The generalization results for the 22 participants from the six studies summarized in Table 1 show that the majority of participants improved on all tasks. However, given the variety of aphasia types and severities represented, different patterns of improvement have been reported. Edmonds, Obermeyer, et al. (2014) endeavored to identify specific predictors of improvement and/or potential mechanisms of improvement in a post hoc analysis of the 11 participants from Edmonds, Mammino, et al.'s (2014) study. A thorough review of the in-depth analyses is beyond the scope of this article; however, some findings are summarized to contextualize the results reported in Table 1 and to inform the later section on clinical implications.

Examination of overall patterns of improvement revealed no relationship between the degree of generalization and severity of aphasia impairments (e.g., more impaired participants did not improve more or less than less impaired participants). With respect to specific outcomes, improvement across participants was not hierarchical; that is, improvement on sentences did not correspond to improvements in naming, and discourse improvements did not correspond to sentence-level improvements, a finding consistent with the literature (e.g., Webster & Whitworth, 2012). Task effects also were observed such that some participants improved more on constrained sentences, others benefited from the flexibility in discourse, and some improved on both, a phenomenon also reported in previous studies (e.g., Mayer & Murray, 2003; William & Canter, 1982).

Although there were different patterns of generalization, one common improvement across participants was an increase in lexical retrieval, although how those improvements interacted with sentence construction/PAS differed across participants. For example, some participants at pretreatment were better able to create basic sentence frames and as such the improved lexical retrieval resulted in improved sentence production. Others improved in lexical retrieval with corresponding improvements in sentence construction. In some cases, it was unclear whether the improvement to sentence construction was related to repeated exposure of a basic subject–verb–object frame in VNeST or whether the improved lexical retrieval allowed for more complete sentence frames. However, one notable observation among the six participants who improved on NAVS sentence production was illuminating. Five of the six improved not only on sentences containing one- and two-place verbs but also on three-place verbs (e.g., The woman is throwing the ball for the dog.). This was an unexpected finding because VNeST focuses primarily on two-place use of the verbs (subject and object). The only relationship between the participants who improved on three-place verbs across all participant and language measures was that their pretreatment sentences within discourse contained better subject–verb–object constructions than their production of relevant words (i.e., they had syntactically complete sentences with empty, incorrect, or nonspecific words). Although improvement to three-place sentences could be explained by Step 3 of treatment (extending one agent–verb–patient

scenario with optional arguments [e.g., My wife-measure-windows-in the living room-last weekend-because we need new curtains]), the correspondence to relatively intact sentence structure suggests that increased lexical retrieval due to VNeST facilitated the production of more accurate words within already good sentence frames. This finding reveals a potential predictor of improvement that must be investigated empirically. Some noted barriers for greater generalization were persistent difficulties with sentence frame construction and reduced self-monitoring.

CLINICAL IMPLICATIONS

More investigations into the effects of VNeST are needed. Nevertheless, the findings across studies provide some preliminary implications for clinical practice, which are discussed in the following text.

Treatment candidates

The overall findings from VNeST studies suggest that the approach may be appropriate for patients with mild to moderate-to-severe fluent or nonfluent aphasia. These are apparent in the types of aphasia listed in Table 1, assuming adequate comprehension for the VNeST protocol (with cueing, see Edmonds, 2014). The findings also suggest that those with more severe forms of aphasia, concomitant AOS, and jargonistic and characteristic Wernicke's output can improve with VNeST (see Edmonds & Babb, 2011; Furnas & Edmonds, 2014; Edmonds, Mammino, et al., 2014; Edmonds, Obermeyer, et al., 2014 [P7 and P9]). The addition of writing in Step 1 (and potentially Step 3) provides an additional modality for participants with spoken output limitations. Kwag et al.'s (2014) adaptation of VNeST for Korean with promising results also suggests that VNeST may be implemented in other languages with consideration of language-specific word order.

Dosage

The gains reported in the series of VNeST studies reviewed here reflect two sessions per week for 3–3.5 hr per week of treatment using 10 verbs (except for two participants who received treatment for 6 weeks; Furnas & Edmonds, 2014). Eleven participants with controlled dosage of 3–3.5 hr of treatment per week (35 total hours of treatment) exhibited improvement across outcome measures (Edmonds, Mammino, et al., 2014; Edmonds, Obermeyer, et al., 2014), and examination of the slopes of improvement on sentence probes administered throughout treatment revealed that participants did not plateau before 10 weeks (Edmonds, Obermeyer, et al., 2014). Thus, this length of treatment represents what has been most typically provided (although more treatment may be necessary for participants with more severe impairments; see Edmonds & Babb, 2011). Kwag et al.'s (2014) dosage of 45–50 min for two times per week with 12 verbs might be more representative of many clinical environments. Their findings suggest improvements at this dosage, although they did not test generalization to discourse.

Selection of verbs

Treating a variety of verbs to engage large semantic networks is a core feature of VNeST. As such, treating fewer than 10 verbs may result in reduced outcomes. Edmonds (2014) provides some guidelines on verb selection, but central to this process (based on current knowledge) is choosing specific (not general [*go*, *put*, *give*]) transitive verbs that represent different semantic concepts (e.g., drive, bake, throw, measure). Verbs with overlapping meanings, or even themes that result in overlapping scenarios, may promote semantic interference rather than semantic distinction, although this has not been empirically tested.

Goals and complexity

The VNeST protocol is intended as a generalizing treatment to promote lexical retrieval improvements across a hierarchy of linguistic tasks. The robust generalization to single-word noun and verb naming seen in VNeST is consistent with the Complexity Account of Treatment Efficacy (Kiran, 2007; Thompson,

Shapiro, Kiran, & Sobecks, 2003), which proposes that treating at the more complex end of a construct can generalize to a simpler form. Thus, training verbs and nouns together as a cohesive unit in VNeST can promote generalization to single nouns and verbs. Similarly, the observed generalization to one-place verbs on the NAVS (Edmonds, Obermeyer, et al., 2014) suggests generalization to simpler verbs in sentences. In addition to generalization to simpler structures, VNeST has shown generalization to untrained two- and three-place verb sentences and discourse. Thus, VNeST provides the potential for being efficient in that multiple goals may be addressed with one treatment.

To capture the level(s) at which participants improve, a hierarchy of goals and corresponding outcome measures is recommended. Edmonds (2014) details some available measures, including the NAVS for sentence production and verb naming (Thompson, 2011), Nicholas and Brookshire's (1993) stimuli for discourse and the Philadelphia Naming Test (Moss Rehabilitation Research Institute, 2013) for noun naming. A global aphasia measure (e.g., WAB-R) and some measure or questionnaire of functional improvement should also be considered. Evaluating discourse for CUs as well as CIUs (and other measures as time allows) will provide a more complete picture of improvement than CIUs alone. As discussed previously, writing can be incorporated into the protocol and can be evaluated as an outcome measure as well.

Finally, comprehension goals may also be evaluated (within an aphasia battery and/or in addition to one), as some participants with lower pretreatment comprehension have shown notable improvement in comprehension (e.g., Edmonds, Mammino, et al., 2014 [P7 and P9]). Examples of treatment goals include the number of agent and patient pairs produced in Step 1 and/or Step 6; the ability to answer *when*, *where*, and *why* questions with varying degrees of cues; and the ability and degree of cueing needed for reading scenarios in Step 2.

CONCLUSION

The purpose of this article was to summarize the theory, methods, and findings for VNeST and to provide some general clinical implications reflective of our current knowledge. The VNeST protocol requires further investigations to refine the protocol, understand potential predictor variables, and evaluate more functional communication. However, the results of using VNeST with the 22 participants in the six studies reviewed here provide strong preliminary evidence that VNeST may be efficacious for promoting generalization to untrained sentences and discourse in individuals with diverse linguistic presentations. The replication of VNeST results in Korean (Kwag et al., 2014) also opens the possibilities of implementation of VNeST with speakers of languages other than English.

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