

Supplemental Material S2. Compilation of generalization principles identified in three resources

Generalization Approaches	Definition	Example	Stokes & Baer (1977)	Thompson (1989)	Coppens & Patterson (2018)
1. Train and hope	Generalization of acquired treatment outcomes to specific, untreated stimuli or settings is measured but not directly targeted in treatment.	Palmer et al. (2019) provided word-finding exercises over a period of six months to 83 adults with chronic aphasia, via a self-managed computerized word-finding program that focused on personally relevant words (e.g., family names) in the context of repetitive practice and feedback. Primary outcome measures included (1) improvement on confrontation naming of trained words (acquisition), and (2) improved conversation (generalization). They found that participants improved on trained words, but this did not generalize to conversation.	X	X	X
2. Sequential modification	Intervention is directly and systematically applied across responses and/or settings to which generalization is desired (often following absent or deficient generalization in "train-and-hope").	Wambaugh and Thompson (1989) initially found nominal generalization of their <i>wh</i> -interrogative training for four individuals with Broca's aphasia. However, generalization across stimulus conditions was then facilitated by sequential modification of training (e.g., incorporating novel social dyads).	X	X	
3. Introduce natural contingencies	Capitalize on stable, natural contingencies within the client's daily environment, by teaching behaviors that will be naturally	Carragher et al.'s (2015) "Interactive Storytelling Therapy" explicitly supports a communicative task (constructing and relaying stories,	X		

	reinforced (e.g., in a social context).	given multimodal support) that involves naturalistic information exchange within the context of an everyday activity. Following treatment, their participants with aphasia demonstrated increased communication of salient ideas within a novel narrative task.			
4. Train sufficient exemplars	Train enough exemplars (e.g., multiple settings, conversation partners, or stimuli) to elicit induction to additional (untrained) responses and/or stimuli. Note that the number of exemplars required will vary across clients according to multiple factors (e.g., baseline proficiency in treatment target).	Thompson and Warner (1987) trained a client to use specific phrases to request food items but did not find generalization to a real restaurant setting until training was extended to a simulated restaurant.	X	X	X
5. Train loosely	Decrease control of stimuli presented and increase flexibility of cues presented and responses allowed, to approximate conditions occurring in natural environments.	Response Elaboration Training (RET; Kearns, 1985), is a loose training procedure in which the client is asked to comment on pictorial stimuli, then repeat longer sentences based on responses to follow-up questions.	X	X	X
6. Use indiscriminable contingencies	"Indiscriminable contingencies" are situations in which a learner is unable to predict whether their next response will lead to reinforcement (Freeland & Noell, 2002). This unpredictable reinforcement schedule (e.g., intermittent or delayed	Goodkin (1969) reported that incorporating "verbal conditioning techniques," including delayed feedback, resulted in an increased frequency of relevant utterances for one individual with aphasia. This effect was more apparent for the	X		

	feedback) prevents ready discrimination of contingencies and creates behaviors that are more durable (i.e., generalization across time).	delayed versus immediate ("token reinforcement") feedback condition.			
7. Train "to generalize"	Reinforcement is programmed only for moving along a pre-specified generalization gradient, such that the criteria for "correct" responses change as the client progresses in treatment.	Melodic Intonation Therapy (MIT; Sparks et al., 1974), involves a structured, intensive therapy protocol, based on using rhythm and melody to facilitate spoken output, for individuals with aphasia. The program is divided into progressively more complex levels, where speech is first intoned in unison, then via repetition, and finally internally during propositional speech.	X		
8. Expect generalization for structurally or topographically related stimuli	Generalization should be planned for responses that are similar in surface form, but not necessarily those that are unrelated.	Cannito and Vogel (1987) demonstrated generalization of their treatment target (regular plural morpheme) to untrained exemplars and conversational contexts for an individual with Broca's aphasia. However, generalization to irregular plural forms did not occur.		X	X
9. Train verbal mediation	Use language in the form of self-instruction and self-report to bridge between training and generalization settings.	Olsen et al. (2012) showed that teaching individuals with aphasia to use the strategy of self-cueing (associating personalized cues with trained lexical items) led to stimulus (across level) generalization of those items to discourse contexts.	X	X	

10. Consider client's associated symptoms and characteristics	Variables reported in the aphasia literature to predict generalization include extra-linguistic cognitive ability and aphasia severity. Motivation and level of comprehension likely also play a role but neither have been investigated systematically with respect to generalization.	Cognitive ability (e.g., scores on Ravens Progressive Matrices) has been shown to be correlated with both acquisition (Fillingham et al., 2006) and generalization (Kendall et al., 2014).	X	X
11. Internalize the strategy	Teach clients to use a self-generated strategy. The strategy must be automatized for it to be useful (Coppens & Patterson, 2018).	Royall & Horner (1983) utilized Cued Speech (visual self-cueing strategy) to facilitate discrimination across phonemes in the context of severely impaired auditory comprehension for an individual with aphasia.		X
12. Include semantic processing	Semantic-based therapy tends to facilitate generalization effects, although this effect cannot be isolated from phonological stimulation (and vice versa; Howard, 2000). Semantic approaches typically include manipulating the semantic features associated with target treatment items.	Semantic Feature Analysis (SFA) relies on re-establishing connections among semantic features to facilitate word finding (Boyle, 2004).		X
13. Treat more complex items	The CATE (Complexity Account of Treatment Efficacy) hypothesis has been successfully applied to direct treatment effects and response generalization in both syntactic and semantic applications.	Training atypical (i.e., more complex) category exemplars in the context of anomia treatment tends to facilitate generalization to more typical exemplars, but not vice versa (Kiran & Thompson, 2003).		X

14. Train verbs	It is thought that the greater complexity of verbs compared to nouns, in terms of intrinsic morphological and syntactic characteristics and greater diversity of semantic links, translates to better sentence production and generalization to related exemplars, respectively.	Verb Network Strengthening Treatment (VNeST; Edmonds et al., 2009; Edmonds, 2016) aims to activate thematic role concepts associated with target verbs, thus promoting lexical retrieval at the sentence or discourse level.	X
15. Train items in a sentence context	Linguistic context (e.g., embedding target lexical items within a sentence structure) may provide additional cues that appear to facilitate word finding and positively influence generalization.	Papathanasiou et al. (2007) found that combining SFA with a sentence production task led to generalization of treatment gains to untrained words across two individuals with aphasia.	X
16. Train the underlying mechanism	This strategy involves focusing on what is thought to underlie specific aphasia symptoms.	Treatment of Underlying Forms (TUF; Thompson & Shapiro, 2005) involves training clients to produce sentences by focusing on syntactic mechanisms that create non-canonical surface sentence structures from underlying canonical forms (e.g., <i>wh</i> -movement), with well-established generalization to untrained sentences with the same type of movement.	X
17. Combine communication modalities	Alternate modalities can be taught as a compensatory strategy or to deblock representations; in either case, the goal would be generalization across modalities	Raymer et al. (2006) reported that a naming + gesture therapy protocol for anomia led to generalization to untrained exemplars for gestures, but not oral naming, across nine individuals with aphasia.	X

	and/or to untrained exemplars in the trained modality.				
18. Program "common," functional, and salient stimuli	Assume that generalization will occur if there are sufficient stimulus components (e.g., peers, physical stimuli, language phrases) that are present naturally across both training and generalization settings.	Karidas (2013) compared the effects of personally relevant and non-relevant treatment stimuli on discourse performance in the context of a semantic, complexity-based treatment for three individuals with fluent aphasia. Although all participants achieved improved discourse (as measured by CIUs), this effect was not specific to personally relevant nor irrelevant stimuli.	X	X	X
19. Add discourse, conversational training	Similar to <i>sequential modification</i> , the idea is to intervene directly at the level at which generalization of treatment gains is desired.	Researchers have shown that change at the discourse level may require discourse to be targeted directly in therapy (Milman, 2016; Whitworth et al., 2015). For example, Milman's (2016) <i>Integrated Discourse Treatment for Aphasia</i> (IDTA) focused on promoting generalization of impairment-based treatment to discourse by training linguistic structures both in isolation and in functional discourse tasks.			X
20. Add home practice	Similar to <i>natural maintaining contingencies</i> , a home program must contain well-designed, functional applications to facilitate stimulus generalization.	Constraint-Induced Aphasia Therapy (CIAT; Pulvermuller et al., 2001), a form of Intensive Language-Action Therapy (ILAT; Defrancesco et al., 2012) is an intensive treatment paradigm based on the premises of learned non-use, massed practice,			X

and treatment intensity. Johnson et al. (2014) found that adding a "transfer package" (including a home practice component) to CIAT led to gains for individuals with aphasia on measures of functional communication as well as standardized testing.

References

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