Training Metaphor Interpretation in RHD Patients: Preliminary Results

Introduction

This paper describes and evaluates a tool for remediating a metaphor deficit often associated with right hemisphere brain damage (RHD) due to stroke (Kempler, 2005; Myers, 1999; Tompkins, 1995). The intervention is based on two theoretical components: first, the ability to process "coarse grained" semantic information such as connotative associations between words (Beeman, 1998); second, working memory used to select alternatives from a set (e.g., Tompkins et al.,1994). The training format, inspired by Thinking Maps® (Hyerle, Innovative Learning Group, 1995), provides graphic displays of the associations that underlie metaphors.

Metaphor interpretation involves associations to concepts from different semantic domains (e.g., job: profession, fulfilling, frustrating, confining, etc., and prison: confining, bad, for criminals, etc.). A listener identifies which associations shared by the two words could provide a basis for metaphor: "Some jobs are prisons" could mean that some jobs are confining.

We used a single subject experimental design consisting of baseline (extended in length for 2 patients), training, and post-training phases for metaphor interpretation and also for an untrained line orientation task (Benton test short form, Qualls et al., 2000). We also obtained ancillary measures including, among others, working memory span (Tompkins et al., 1994), appreciation of connotation (Brownell et al., 1984), and non literal language comprehension (Kempler & Van Lancker's1996 Familiar and Non Literal Language Comprehension test, FANL-C).

Our prediction is that initiation of training will be associated with change in metaphor interpretation but not with any change in Benton performance.

Method

Patients. Five RHD stroke patients have completed the protocol. (See Table 1.) Eligibility for entry into the training program was based on poor performance on the FANL-C.

Baseline Assessments: 10 or 20 sessions.
Rationale: To assess simultaneously the patient's pre training performance level on the target of training and on an untrained task that is not expected to change.
Metaphor Task: The patient provides oral interpretations of 10 novel metaphors such as "Father is an ATM." Items were constructed using word association norms.
Scoring: 0 (no response) to 6 (complete and appropriate).
Line Orientation Task: a short form of the Benton Test.

Task I: Judgments of Single Word Connotative Meaning
Rationale: To illustrate and practice thinking about connotative meaning.

Task: The patient is familiarized with the computer display and answers yes/no questions about 10 words. For example, "Think of the word 'father'. Is this word typically considered 'beautiful' …. 'strong' …. 'active' …. 'passive'?"
Scoring: An item is "correct" if the patient responds in less than 5 seconds.
Criterion: Completion of 5 sets of 10 words each.

Task II: Judgments of Word Associations
Rationale: To illustrate and practice judging typical associations.
Task: The patient sees a target word and 5 possible associations and responds whether the association is appropriate or not. For example: "Is 'muffin' typically associated with 'moon'?" See Figure 1.
Scoring:1 point for prompt (<5 sec) and accurate responses and .5 points for correct, delayed responses.
Criterion for this and later tasks: 90% correct x 3 sets of 10 words each.

Task III: Generation of Word Associations
Rationale: Practice generating 5 words associated with a target.
Task: Patient must generate 5 associations to fill empty bubbles linked to a target word contained within the center bubble.

If the patient is unable to generate associations or if he or she generates personalized associations, the examiner will try to provide cues and to redirect as needed by returning to the set of 10 questions listed under Task I.

Scoring procedure: A patient achieves 1 point for each correct typical association. (excluding personalized responses) and .5 point for delayed responses.

Task IV: Judgment of Patient-Generated Associations to Link 2 Words
Rationale: To provide practice generating associations and evaluating appropriateness of associations between 2 words.
Task: A) The patient generates 5 accurate associations to Word 1. B) The patient is shown Word 2 and C) is asked whether the associations for Word 1 can also be associated to Word 2. Ideally, some will and others will not. See Figure 2.
Scoring: 1 point generating 2 common associations and .5 point for generating 1 common association.

Task V: Selection of Appropriate Metaphor Ground from Candidate Dual Associations
Rationale: To provide practice selecting the basis for a metaphor from a set of candidates.
Task: The patient views a metaphor within a double bubble map and selects the appropriate interpretation from 3 choices (correct, literal, close substitution using another metaphor). For the item "The child is a weed", the alternatives are
A) The child plays outside in the backyard.

B) The child is a pesky plant that grows
in a garden.

C) The child grows very quickly.

Scoring: 1 point for each correct response (.5 point if delayed).

Results and Discussion.

Patients had little trouble with the first two tasks, achieving strong initial performances and quickly reaching and maintaining criterion-level performance. They had much more difficulty on Tasks III and IV that call on skills such as word generation and word comparisons. which are often impaired following brain-damage.

We use two approaches to assess whether initiation of training coincided with change in patients' metaphor and, as a comparison, with their visuospatial performance.

The first approach uses traditional multiple regression. A patient's score (metaphor interpretation, Benton) for each session was the dependent variable. Predictor variables included (X1) session number (two sessions per week) to code gradual improvement over time starting during the baseline phase and continuing through the training phase, and (X2) a dummy-coded variable to distinguish baseline sessions from all later sessions. A significant regression weight for X2 indicates a change linked to training that is distinct from any steady improvement over sessions. The (non) independence of observations for inferential analysis will be assessed and discussed.

We also used a bootstrapping procedure developed by Borckardt et al. (2008) that addresses directly non independence of observations from a single patient. The program computes the autocorrelation (lag 1, i.e., the degree of non independence) for the entire set of observations and, then, under the null hypothesis of no effect, draws (from a normal population) a very large number (e.g., 10,000) of random samples of pre and post-treatment data with the identified level of autocorrelation. The program provides probabilities for different effect sizes under the null hypothesis. One evaluates the obtained training effect to see if it is different from what one could expect under the null.

Results demonstrate that RHD patients years post injury can tolerate and benefit from communication training. (See Table 2.) All but one patient (S4) showed strong effects of training on metaphor interpretation. Bootstrapping analyses, which had greater statistical power, also revealed some training effect for Patient S4 on metaphor, and also effects on line orientation judgments for the two patients (S3, S5) who performed in 20 rather than 10 baseline sessions. Patients showed no striking improvement on the FANL-C test of non literal language, working memory SPAN, or connotation.

The discussion will present individual patient results and speculations on the role of, for example, working memory and sensitivity to connotation, the fading of gains over time,

and the generalization of training effects to other measures of communication and, for two patients, to untreated line judgments.

References

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Table 1: Patient Information and working memory SPAN performance

Patient	Age	Years of Education	Lesion and Etiology	Time post onset (years)	Cognitive and Communication Features +++++ Tompkins et al. SPAN (max = 42) NC mean = 35.6 (6.4x) R CVA mean = 29.6 (12.4x)
S-1	79	11	Right parietal AVM surgically repaired	25	Verbosity, tangential, failure to read social cues SPAN pre test: 32 SPAN post test: 32
S-3	60	12	Right MCA infarct	5	Slight residual neglect, failure to understand nonliteral language SPAN pre test: 24 SPAN post test: 29
S-4	75	12	Right MCA infarct	4	Failure to read social cues, difficulty integrating nonverbal information SPAN pre test: 30 SPAN post test: 31
S-5	68	12	Large right lesion	2	Tangential, verbose. difficulty reading social cues. SPAN pre test: 27 SPAN post test: 31
S-9	68	16	Right frontal lesion	2	Verbose, disinhibited, failure to read social cues SPAN pre test: 31 SPAN post test: 34

Table 2: Regression and Bootstrapping Results

S1

Measure:	Metaphor interpretation	Benton
Number of sessions:	N= 21	N = 21
Baseline mean:	23.7	22.1
Post Initiation of training mean:	36.5	22.5
3 month follow up:	N/A	N/A
Simple r for training:	.802, p = .011 (bootstrapping)	.091, p = .655 (bootstrapping)
Simple r for Session:	.646	.180
Regression:	R^2 = .83, F (2,18) = 44.039, p = .000	R^2 = .117, F (2,18) = 1.192, p = .326
Session*:	β = -1.528, t (18) = -4.463, p = .000	β = +01.163, t (18) = +1.489, p = .154
Training:	β = +2.267, t (18) = +6.621, p = .000	β = -1.025, t (18) = -1.312, p = .206
Increase in R^2 due to training:	.413	.085
Autocorrelation of residuals:	-.110	-.208

S3 (extended βaseline)

Measure:	Metaphor interpretation	Benton
Number of sessions:	N = 31	N = 31
Baseline mean:	31.0	16.4
Post Initiation of training mean:	36.8	18.7
3 month follow up:	30	19
Simple r for training:	.705, p = .002 (bootstrapping)	.339, p = .060 (bootstrapping)
Simple r for Session:	.628	.410
Regression:	R^2 = .499, F (2,28) = 13.947, p = .000	R^2 = .177, F (2,28) = 3.011, p = .065
Session*:	β = - 0.129, t (28) = -0.378, p = .708	β = +.635, t (28) = +1.453, p = .157
Training:	β = +.823, t (28) = 2.415, p = .023	β = -.245, t (28) = -.560, p = .580
Increase in R^2 due to training:	.105	.009
Autocorrelation of residuals:	+.197	-.147

S4

Measure:	Metaphor interpretation	Benton
Number of sessions:	N = 26	N = 26
Baseline mean:	26.7	1.6
Post Initiation of training mean:	32.5	1.8
3 month follow up:	31	0
Simple r for training:	.638, p = .010 (bootstrapping)	.066, p = .655 (bootstrapping)
Simple r for Session:	.585	.172
Regression:	R^2 = .414, F (2,23) = 8.133, p = .002	R^2 = .051, F (2,23) = 0.622, p = .546
Session:	β = +.162, t (23) = +.547, p = .590	β = +.403, t (23) = +1.066, p = .297
Training:	β = +.501, t (23) = +1.686, p = .105	β = -.274, t (23) = -.724, p = .476
Increase in R^2 due to training:	.072	.021
Autocorrelation of residuals:	-.136	-.345, p = .063

S5 (Extended Baseline)

Measure:	Metaphor interpretation	Benton
Number of sessions:	N = 36	N = 36
Baseline mean:	34.35	12.85
Post Initiation of training mean:	40.44	13.75
3 month follow up:	40	14
Simple r for training:	.692, p = .000 (bootstrapping)	.431, p = .034 (bootstrapping)
Simple r for Session:	.682	.392
Regression:	R^2 = .537, F (2,32) = 18.545, p = .000	R^2 = .179, F (2,32) = 3.491, p = .043
Session:	β = +.239, t (32) = +1.023, p = .314	β = +.122, t (32) = +.389, p = .700
Training:	β = +.518, t (32) = +2.222, p = .034	β = +.314, t (32) = +1.000, p = .325
Increase in R^2 due to training:	.072	.025
Autocorrelation of residuals:	-.301	.024

S9

Measure:	Metaphor interpretation	Benton
Number of sessions:	N = 19	N = 19
Baseline mean:	34.5	19.8
Post Initiation of training mean:	39.67	20.89
3 month follow up:	43	20
Simple r for training:	.702, p = .030 (bootstrapping)	.214, p = .569 (bootstrapping)
Simple r for Session:	.546	.129
Regression:	R^2 = .507, F (2,16) = 8.234, p = .003	R^2 = .059, F (2,16) = 0.501, p = .615
Session:	β = -.246, t (16) = -.700, p = .494	β = -.227, t (16) = -.469, p = .645
Training:	β = +.914, t (16) = +2.605, p = .019	β = +.411, t (16) = +0.848, p = .409
Increase in R^2 due to training:	.209	.042
Autocorrelation of residuals:	-.304	.326

* For S1 and S3, metaphor interpretation and Benton assessments were not carried out during the treatment sessions. The values for the Session variable in the multiple regression analyses therefore include a break in the sequence that reflects the passage of time (2 sessions per week) during which no assessments were carried out. The results do not change when the session variable does not reflect the break in sequence. The bootstrapping analyses did not include a break.

Figure 1. Sample Display for Task II.

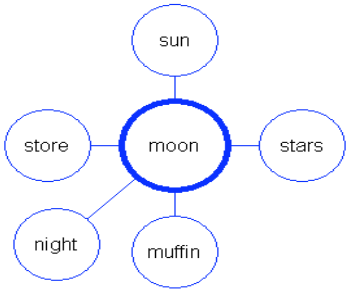
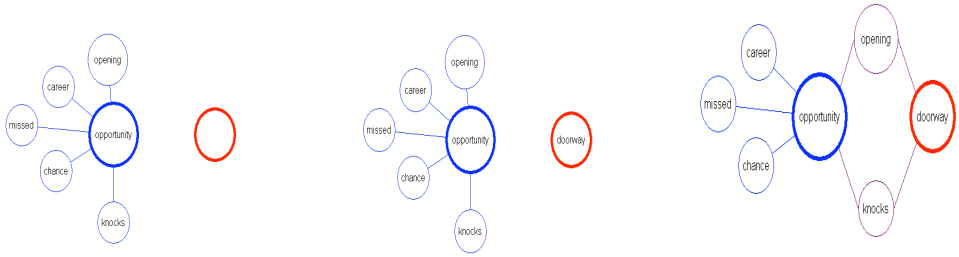


Figure 2. Sample Display for Task IV.



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