Non-linguistic learning in aphasia: Effects of training method and stimulus characteristics

Sofia Vallila[1,2] & Swathi Kiran[2]

[1]Harvard-MIT Division of Health Sciences and Technology, Boston, MA [2]Aphasia Research Laboratory, Boston University, Boston, MA

Introduction

Why do some patients benefit from therapy while others don't?

In a previous study, Vallila & Kiran (2012, under revision) found that 9/19 patients with aphasia were not able to learn non-linguistic categories following feedback or paired associate instruction. Based on results, patients were divided into two groups: *learners* and *non-learners*. Building upon these findings, in the current study we ask:

- **RQ1:** Does stimulus typicality/feature overlap impact learning ability of *learners*?
- **RQ2:** Does stimulus typicality/feature overlap impact learning ability of *non-learners*?
- **RQ3:** Are there any differences between feedback-based & paired associate instruction?

Background

We hypothesize that learning represents a critical, underexplored factor in aphasia rehabilitation and suggest that predicting whether a patient will improve following therapy instruction may depend more upon that individual's ability to learn new information in *general* than upon a specific ability to relearn and master *language*. The rational for the current study is based on the following:

- Studies have demonstrated that features of learning such as **training method, feedback, stimulus characteristics** and **response selection** differentially affect learning in clinical populations (Ashby et al., 2003; Knowlton et al., 1994; Maddox et al., 2008)
- The **complexity account of treatment efficacy (CATE)** hypothesis (Thompson et al., 2003) draws attention to the potential **impact of stimulus complexity on treatment outcomes in aphasia**.
  - Kiran & Thompson (2003): Training atypical exemplars resulted in improved naming of both typical and atypical exemplars. Training typical items only improved naming for trained items.
  - Attempts to replicate these findings have led to variable results (Stanczak et al., 2006; Kiran, 2008).

We suggest that individuals may differentially be able to generalize from atypical to typical items during therapy. **In the current study we explore the impact of stimulus typicality when learning a nonlinguistic category task. Our long term goal is to identify a diagnostic metric that will help clinicians tailor therapy, selecting appropriate targets on a patient-by-patient basis.**

Methods

Stimuli: Cartoon animals with 10 binary dimensions from Zeithamova et al. (2008)

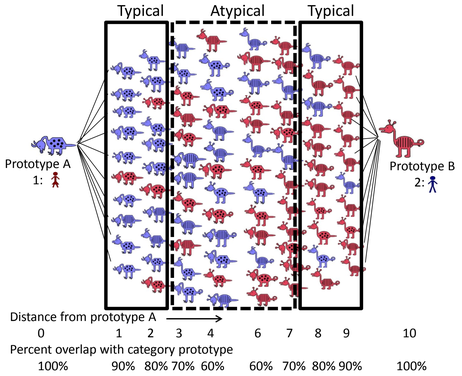
Testing conditions[a]:

- Training on **Typical (Typ), high overlap** animals only: PA and FB
- Training on **Atypical (Atyp), low overlap** animals only: PA and FB

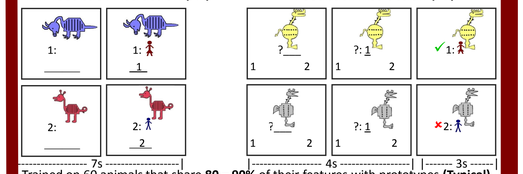
[a] In previous Vallila & Kiran study (Baseline Task), training included animals from all distances 1-9. Based on results, patients were identified as *learners* or *non-learners*.

Criterion for learning:

- Linearly increasing %BResponse as distance increases (slope =10)
- Significant positive correlation of %BResponse with distance

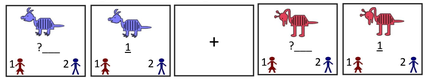


Non-feedback instruction (PA) **Feedback instruction (FB)**



Trained on 60 animals that share **80 – 90%** of their features with prototypes **(Typical)** or on animals that share **60 – 70%** of their features with prototypes **(Atypical)**

Testing phase following both PA and FB instruction



Tested on 16 animals seen in training, 45 novel members of categories and both prototypes

Participants & Sample Baseline Data (previous study with training on animas at distances 1-9)

19 patients with aphasia participated (12 control participants also participated in baseline study)

Patient ID		Age	Aphasia Type	AQ	Baseline
BUBA12	F	33.7	Conduction	24.8	Learner
BUMA57	F	52.7	Wernicke's	41.4	Learner
BUMA23	F	65.7	Broca's	28.4	Learner
BUMA79	F	49.7	Anomic	93.9	Learner
BUMA03	F	77.2	Anomic	98	Learner
BUMA32	M	52.7	Conduction	48	Learner
BUMA74	M	86.8	Anomic	88.1	Learner
BUMA71	M	61	Anomic	91	Learner
BUMA59	M	69.5	Wernicke's	33.8	Learner
BUMA55	M	51.9	Anomic	61.3	Non
BUMA15	M	59.5	Anomic	82.8	Non
BUMA44	M	61	Conduction	67.9	Non
BUMA42	M	47.7			Non
BUMA66	M	68	Anomic	74.3	Non
BUMA81	M	79.9	Conduction	76.6	Non
BUMA08	F	63	Anomic	69.1	Non
BUMA72	F	63.7	Anomic	67.7	Non
BUMA49	F	67.5	Transcortical Motor	82.2	Non
BUMA62	M	49.3	Broca's	58.2	Non

Note: AQ = Aphasia Quotient

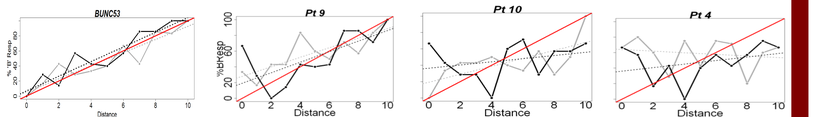
Summary of results from baseline study:

- **10/12** controls learned following both methods of instruction
- **9/19** patients showed learning of category structure
  - Of these, 3/9 patients showed control-like learning
  - 6/9 patients learned following one method of instruction
- **10/19** did not learn category structure

Based on results from our preliminary study, patients were divided into two groups: *Learners* and *Non-learners*. In the current study, we further explore learning ability in these two groups.

Sample baseline plots by participant and learner type

Control Learner **Patient Learners** **Patient Non-learner**



PA slope = *8.70
FB slope = *9.74

PA slope = *6.06
FB slope = *6.71

PA slope = * 4.87
FB slope = 1.98

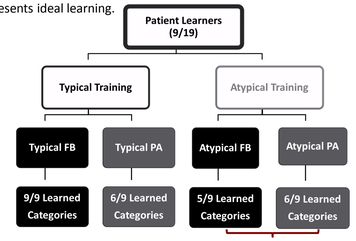
PA slope = -1.04
FB slope =2.27

RQ 1: Does stimulus typicality/feature overlap impact learning ability of baseline task *learners?*

Slopes of regression lines were fit to each individual's results. Slope of 10 represents ideal learning.

	FB		PA	
	Typ Slope	Atyp Slope	Typ Slope	Atyp Slope
BUBA12	*10.409	*10.84	*10.1	-8.29
BUMA57	*9.886	*10.114	*9.719	*9.589
BUMA23	*10	*8.977	*-10.108	*9.004
BUMA79	*8.75	*6.727	*9.61	-1.039
BUMA03	*10.523	*9.091	*11.212	*8.009
BUMA32	*8.485	-5.962	*10.736	*-6.602
BUMA74	*5.144	2.076	*4.74	*8.268
BUMA71	*9.351	-1.5	0.065	*9.351
BUMA59	*10.205	1.068	-4.026	*4.264

* Indicates significant correlation between %BResponse and distance at p<.05. Lightly shaded boxes indicate learning



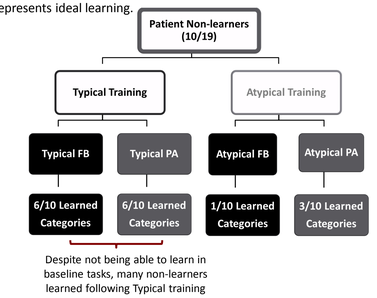
Many patients showed generalization of learning from Atypicals to Typicals

Conclusion: Many patient learners (5-6) were able to show learning in the more complex condition: Atypical training. We hypothesize that for these patients, the most efficient therapy might be therapy that targets complex stimuli (i.e. most likely patients to show generalization to typical items when trained on atypical items in therapy).

RQ 2: Does stimulus typicality/feature overlap impact learning ability of baseline task *non-learners*?

Slopes of regression lines were fit to each individual's results. Slope of 10 represents ideal learning.

	FB		PA	
	Typ Slope	Atyp Slope	Typ Slope	Atyp Slope
BUMA55	*11.386	*6.098	*6.883	-4.61
BUMA15	*9.72	2.482	*8.788	-1.991
BUMA44	*10.227	-5.758	*3.918	1.688
BUMA42	*10.614	-6.212	*9.61	-7.511
BUMA66	*7.576	-2.932	-1.775	2.771
BUMA81	*10.614	-6.212	3.333	*8.29
BUMA08	-0.962	0.758	*11.472	1.861
BUMA72	0.879	-5.962	*8.009	*8.485
BUMA49	-2.364	-4.083	-7.424	
BUMA62			0.281	-8.658

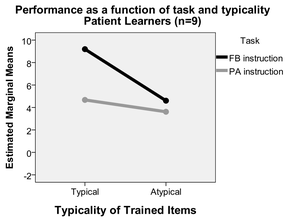


Despite not being able to learn in baseline tasks, many non-learners learned following Typical training

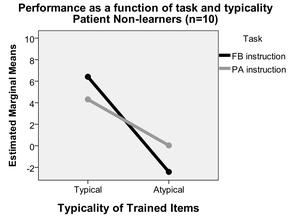
Conclusion: Results suggest that many patients (6/10) who have difficulty learning novel category information benefit from training on a limited set of stimuli that saliently emphasize category features. Training on typical items appears to facilitate learning for these patients.

RQ 3: Are there any differences between feedback-based & paired associate instruction?

To explore the difference between instruction method and category learning, we conducted a 2 (task: FB & PA) x 2 (condition: Typ & Atyp) ANOVA using slope of learning as the dependent measure.



No significant main effect of Typicality $F(1,26) = 1.94$, $p = .17$
No significant main effect of Task $F(1,26) = 1.84$, $p = .18$
No significant interaction Typ x Task effect $F(1,26) = .76$, $p = .39$



Significant main effect of Typicality $F(1,27) = 13.39$, $p = <.01$*
No significant main effect of Task $F(1,27) = .01$, $p = .92$
No significant interaction Typ x Task effect $F(1,27) = 1.62$, $p = .21$

Conclusion: There is no main effect of task for either group (learners or non-learners) demonstrating that there are no major behavioral differences between PA and FB learning for this particular task. Results for the non-learner group show a significant main effect of typicality, suggesting that training restricted to Typical exemplars only (under either FB or PA conditions) is the most effective means of instruction for patients with demonstrated difficulty learning baseline tasks.

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