Observational and Rule-Based Artificial Grammar Learning (AGL) in Individuals with Aphasia

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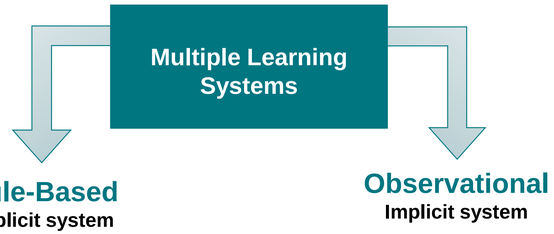


Both systems engaged in developmental language learning[1]

- How is learning impacted in individuals with neurological impairment?
- **Aphasia** is an acquired language disorder as a result of a brain injury or stroke, impacting comprehension and production of speech.
- Many behavioral language interventions in aphasia can be categorized into **explicit** and **implicit** learning approaches[2-4].
  - Effects of learning approach on therapeutic outcomes are not well understood[5-6].

AIM 1: Determine whether **stimulus modality** affects learning comparing *visual* vs. *auditory* AGL conditions.
- *H1:* Learning outcomes will be greater for visual vs. auditory in PWA.

AIM 2: Determine whether **instruction method** affects learning, comparing *observational* vs. *rule-based* AGL conditions.
- *H2a*: At the group level, learning outcomes will be greater for controls than PWA.
- *H2b:* At the individual level, learning outcomes under the rule-based and observational condition will vary across PWA.

Participants:

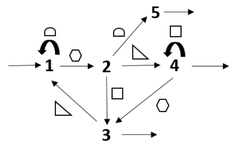
10 People with Aphasia (PWA)
- Ages 41-70 (*M* = 57, *SD* = 9.07)
- Post stroke or brain injury
- Chronic stage of recovery

8 Controls:
- Ages 49-77 (*M* = 61.13, *SD* = 9.51)
- No history of neurological or developmental disorder

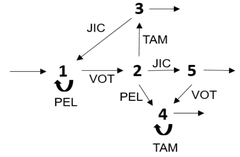
ID	Aphasia severity (WAB AQ score)	Aphasia Type
PWA1	Mild (96.8)	Anomic
PWA4	Moderate (74.2)	Conduction
PWA5	Moderate (74.2)	Anomic
PWA9	Moderate (59.1)	Broca's
PWA22	Mild (94.4)	Anomic
PWA36	Mild (98.6)	Anomic
PWA44	Moderate (74.2)	Conduction
PWA3	Moderate (67.1)	Broca's
PWA32	Mild (92.4)	Anomic
PWA37	Moderate (52.4)	Broca's

AIM 1: MODALITY EFFECT Observational Auditory vs. Visual stimuli

Visual Condition
Grammar B[9]

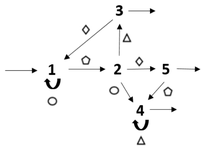


Auditory Condition
Grammar A[9]



AIM 2: INSTRUCTION METHOD Rule-Based vs. Observational Visual

Rule-Based Condition
Grammar A



Observational Condition
Grammar B

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Artificial grammars have been used to study implicit (observational) learning [7-10]. This study developed a novel rule-based protocol

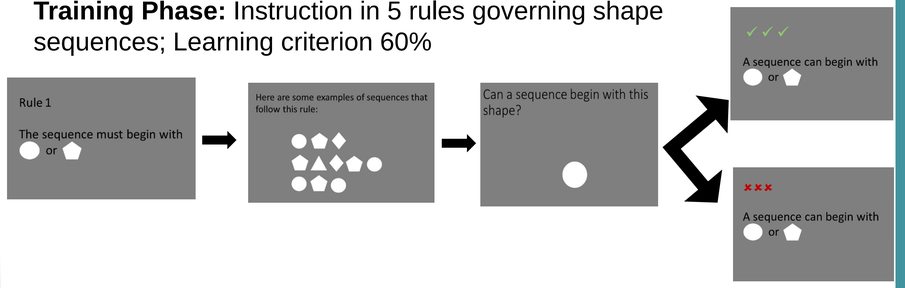
Observational Task Protocol

Training Phase: Match-Mismatch task (no feedback)
- 23 unique grammatical strings (x8), total exposures = 92

Testing Task: 32 novel sequences are presented for grammatical (16) vs. non-grammatical (16) judgement
- Verbal Instructions: "All the sequences you have seen or heard followed a pattern. You will now see new sequences some follow the pattern and some do not."

Rule-Based Task Protocol

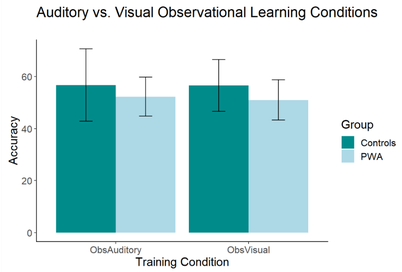
Training Phase: Instruction in 5 rules governing shape sequences; Learning criterion 60%



Testing Task: 32 novel sequences are presented for grammatical (16) vs. non-grammatical (16) judgement
- Verbal Instructions: "You will now see new sequences. If the sequence follows the rules you just learned then click the yes button. If they do not follow the rules click the no button."

Results

AIM 1:



	Control Mean (SD)	PWA Mean (SD)
Obs. Visual	56.63 (11.98)	51.6 (9.79)
Obs. Auditory	56.75 (16.68)	52.29 (8.10)

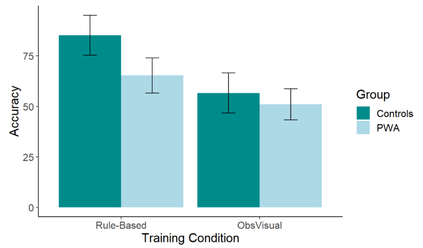
Visual and Auditory Observational ANOVA Table

Predictor	df_{Num}	df_{Den}	SS_{Num}	SS_{Den}	*F*	*p*
Group	1	13	190.01	2536.65	0.97	.342
Condition	1	13	3.71	1228.15	0.04	.846
Group x Condition	1	13	2.51	1228.15	0.03	.873

Note. df_{Num} indicates degrees of freedom numerator. df_{Den} indicates degrees of freedom denominator. SS_{Num} indicates sum of squares numerator. SS_{Den} indicates sum of squares denominator.

- **PWA and controls learned equally in both the visual and auditory modalities.**

AIM 2:



	Control Mean (SD)	PWA Mean (SD)
Rule Based	85.25 (11.78)	61.9 (9.48)
Obs Visual	56.63 (11.98)	51.6 (9.79)

Visual Rule-Based and Observational ANOVA Table

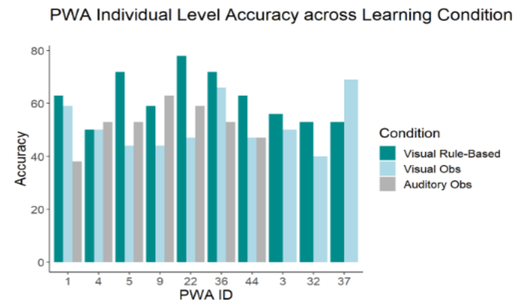
Predictor	df_{Num}	df_{Den}	SS_{Num}	SS_{Den}	*F*	*p*
Group	1	16	1789.20	1775.69	16.12	.001
Condition	1	16	3367.01	1870.99	28.79	.000
Group x Condition	1	16	746.23	1870.99	6.38	.022

Note. df_{Num} indicates degrees of freedom numerator. df_{Den} indicates degrees of freedom denominator. SS_{Num} indicates sum of squares numerator. SS_{Den} indicates sum of squares denominator.

- **Controls and PWA performed better on rule-based task as compared to the observational task. Control participants had higher accuracies than PWA**

Individual results:

- **Learning outcomes varied across PWA under the different instruction methods.**



Implications:

- Contrary to our hypothesis, learning outcomes were similar for the visual and auditory modalities, suggesting that PWA with mild-moderate deficits may learn equally with visual and auditory instruction.
- In the rule-based condition, control participants had higher accuracy than PWA, consistent with research that language mediates learning[11].
  - However, PWA demonstrated learning success with rule-based instruction
- Understanding learning mechanisms has implications for a range of neurological populations with disordered language networks.
- Future work aims to further characterize learning profiles to align learning ability and intervention method

References