Using Eye Tracking to Evaluate Language Learning

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Introduction

- Research suggests an explicit approach (e.g., directly informing children of grammatical rules or patterns) may result in a learning advantage (Finestack & Fey, 2009) relative to typical implicit approaches (e.g., positive grammatical examples) when teaching grammatical forms to children with language impairment.
- Despite this finding, not all children demonstrate an explicit language learning advantage. Little is known why treatments have differential effects across children.
- The use of eye tracking measures may yield insight regarding learning differences.
- Three typical eye behaviors include fixations, where the eye focuses on an area of interest (AOI), saccades, where the eye moves between two AOIs, and pupil dilation, which varies in response to physiological or psychological factors including mental effort and attention (Hoffman & Subramaniam, 1995).
- Eye tracking data has been proven to be a useful measure of language processing and grammatical development in young children (Fernald et al., 2008).

Research Questions

When taught a novel grammatical form with explicit instruction, relative to implicit instruction do adults demonstrate:

1.) Greater accuracy?

2.) Greater pupil dilation?

3.) Longer fixation?

4.) More regressions between images?

5.) Differences due to the novel grammatical form taught?

Participants

- Study participants included 40 adults aged 18-45.
- All participants passed a hearing screening and a Cognitive Linguistic Quick Test (CLQT) assessing attention, memory, executive functions, language, and visual spatial skills.

Characteristic	Full Group Data *n*=40
Age (years)	
Mean	23.1
Min-Max	18-40
White : Other	28 : 12
Male : Female	20 : 20
English Primary Language : Other	37 : 3
Currently in College : Other	32 : 8

Method

- Each participant was randomly assigned a sequence number 1-4 to ensure proper balanced randomization.

Sequence	Game 1	Game 2	Person Instruction	Person Marking	Gender Instruction	Gender Marking
1	Person	Gender	Explicit	-f	Implicit	-sh
2	Person	Gender	Implicit	-sh	Explicit	-f
3	Gender	Person	Explicit	-f	Implicit	-sh
4	Gender	Person	Implicit	-sh	Explicit	-f

- Participants completed two computer based language-learning games where they were asked to learn to talk like a creature from outer space. Explicit instruction was used for one form; implicit instruction for the other form.
- One game introduced a novel grammatical form focused on gender while the other introduced a novel grammatical form focused on first person.

Novel Forms

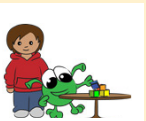
Gender Rule: "When it is a boy, you have to add sh/f to the end. When it is a girl, you don't add anything to the end."


Jake can eat-sh.


Sara can eat.

Person Rule: "When the creature talks about herself or if you talk about yourself, you have to add sh/f to the end. When you or the creature talks about someone else, you don't add anything to the end."

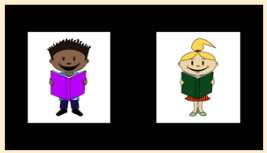

Now you build.

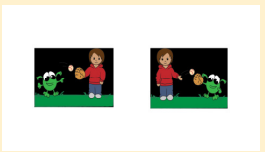

Now I build-f.

Eye Tracking Task

- Eye tracking data was collected during for 20 probes in which participants viewed two side-by-side images along with audio containing a marked or unmarked verb form and selected the picture that matched the audio.

Target Image →

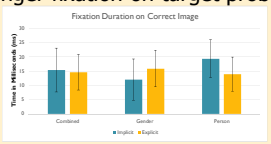

Marked audio: "read-sh"


Marked audio: "catch-f"

← Target Image

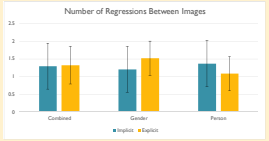
Results

- Question 1: No significant difference was found in percent accuracy between explicit and implicit instruction (p=0.87). A significant difference was found within the explicit condition based on grammatical form (p=0.04) with a higher accuracy for the person form.
- Question 2: No significant difference was found in pupil diameter between explicit and implicit instruction (p=0.90).
- Question 3: No significant difference was found in the fixation duration on target probes between implicit and explicit instruction (p=0.936). A significant difference was found within the implicit condition based on grammatical form (p=0.005) with a longer fixation on target probes of the person form.

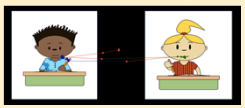


	Combined	Gender	Person
Implicit Fixation Duration on Correct Image (s)	N= 33	N= 15	N= 18
Mean	15.25	12.01	19.31
SD	7.69	6.58	7.20
Min-Max	5.02-37.91	5.02-34.11	9.73-37.91
Explicit Fixation Duration on Correct Image (s)	N= 34	N= 16	N= 18
Mean	14.96	15.83	13.90
SD	6.00	5.96	6.07
Min-Max	5.76-29.62	6.08-28.90	5.76-29.62
Effect Size (Cohen's d-value)	0.04	-0.61	0.81

- Question 4: No significant differences were found in the number of regressions between implicit and explicit instruction (p=0.963). A significant difference was found within the explicit condition based on grammatical form (p=0.015) with a larger number of regressions for the gender form.



	Combined	Gender	Person
Implicit Number of Regressions Between Images	N= 33	N= 15	N= 18
Mean	1.29	1.20	1.37
SD	0.65	0.65	0.65
Min-Max	0.35-3.40	0.50-3.40	0.35-3.30
Explicit Number of Regressions Between Images	N= 34	N= 16	N= 18
Mean	1.32	1.52	1.08
SD	0.53	0.49	0.48
Min-Max	0.20-3.32	0.65-3.32	0.20-3.00
Effect Size (Cohen's d-value)	-0.05	-0.56	0.51


Depiction of Visual Regressions

Conclusions

- Eye tracking measures were not sensitive to detecting learning differences between explicit and implicit instruction.
- Noteworthy trends were found in percent accuracy of probes, fixation duration on target images, and number of regressions.
- These results motivate further investigation into language learning trends that differ based on the type of grammatical form introduced.
- A larger sample size as well as a refined study methodology controlling for baseline cognitive levels of adults is necessary to improve the statistical significance and validity of future results.

Many thanks to the adults who participated in this study. This study was supported by the UMN Undergraduate Research Program and completed in partial fulfillment for the degree of Bachelor of Arts, *summa cum laude* in Physiology.