Implicit Sequence Learning in Preschool-Aged Children: A Comparison of Fixed- and Self-Paced Paradigms

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-- Introduction --

Few studies have addressed implicit learning in preschool-aged children. Two studies from our laboratory have suggested reduced learning in 4-year-olds compared to older children and adults. However, the tasks used in these studies have had significant methodological differences. Traditionally, serial-reaction time (SRT) tasks have used response-contingent pacing in which the participant's own reaction time determines the duration of each trial. In contrast, recent paradigms have used fixed trial pacing. This method can control for total stimulus exposure and task duration across participants, but is accompanied by changes in response demands and feedback motivation. In the current study, we directly compared learning on fixed-pace and self-paced versions of a spatial sequence learning paradigm in 4-year-olds and adults. We hypothesized that 4-year-old children would show reduced learning relative to adult participants, regardless of the paradigm used. In addition, we hypothesized that preschoolers would show greater learning when stimulus presentation was self-paced.

-- Question --

Do preschool-aged children show increased learning on tasks with self-paced trials compared to fixed-paced trials?

-- Participants --

All participants were initially screened for serious medical issues, learning disabilities, and personal or family history of neurological and/or psychological disorders.

Included Participants

Group	Task	N	Mean Age (sd) in years	Age Range	Gender Ratio
Preschoolers	*Fixed-Paced*	28	4.79 (.27)	4.07 - 4.98	14F, 14M
	Self-Paced	30	4.86 (.17)	4.12 - 4.99	15F, 15M
Adults	*Fixed-Paced*	30	23.95 (4.41)	18.51 - 34.27	15F, 15M
	Self-Paced	30	22.32 (3.21)	18.28 - 31.10	15F, 15M

Excluded Participants

Group	Task	N	Mean Age (sd) in years	Age Range	Gender Ratio
Preschoolers	*Fixed-Paced*	41	4.80 (.22)	4.08 - 4.99	18F, 23M
	Self-Paced	17	4.76 (.30)	4.01 - 4.98	6F, 11M
***Fixed-Paced child exclusions**: low accuracy (30), failure to complete task (7), explicit awareness of sequence (1), experimenter errors (3)* ***Self-Paced child exclusions**: low accuracy (8), failure to complete task (5), explicit awareness of sequence (1), experimenter errors (3)*					
Adults	*Fixed-Paced*	7	24.03 (5.64)	18.12 - 33.04	2F, 5M
	Self-Paced	5	21.83 (3.48)	19.00 - 27.40	3F, 2M
***Fixed-Paced adult exclusions**: high clinical questionnaire data (7)* ***Self-Paced adult exclusions**: high clinical questionnaire data (3), explicit awareness of sequence (2)*					

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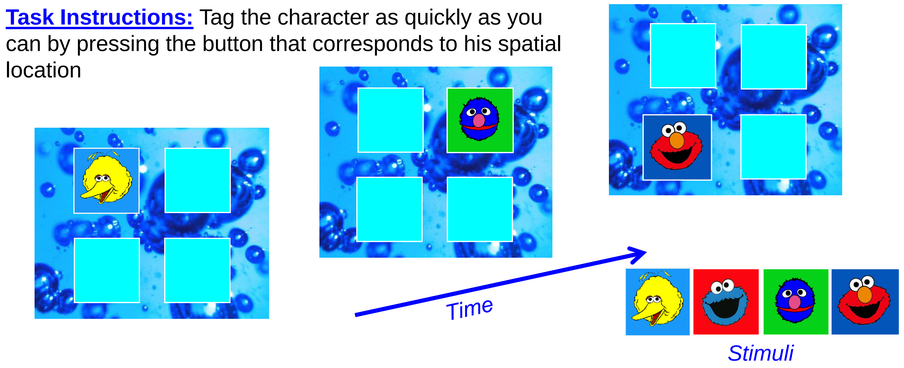
-- Methods --

Task Instructions: Tag the character as quickly as you can by pressing the button that corresponds to his spatial location



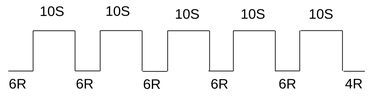
Fixed-Paced Task

- **Fixed trial duration (children = 1500 ms, adults = 1000 ms); ITI = 1500 ms**
- **No accuracy feedback**

Self-Paced Task

- **Variable trial duration; ITI = 500 ms**
- **Pace contingent upon time taken for correct response on previous trial**

Sequence Structure: Identical 10-step partially ambiguous sequence with interleaved random and sequence trials



Awareness: Participants were queried for explicit awareness of the sequence following the task; children were also asked to generate the sequence on a touch screen

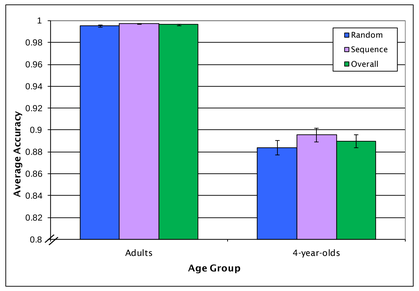
Each participant completed at least 5 blocks of trials (84 trials per block)

Learning Measure

Successful sequence learning is indicated by faster reaction times on sequence trials vs. random trials

1. Reaction times are standardized based on each individual's mean due to group differences in reaction time
2. Learning measure is the mean difference between standardized reaction time on random vs. sequence trials, averaged across blocks

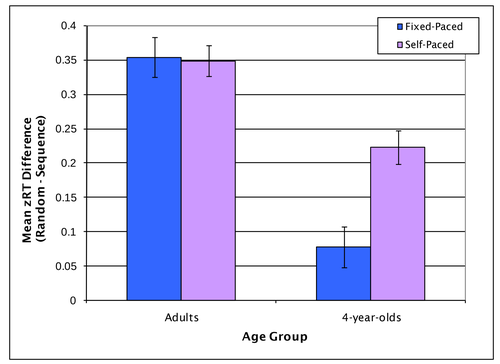
-- Accuracy Results --



- Preschool-aged children were less accurate overall than adults
- No difference in accuracy on random vs. sequence trials in either age group
- No difference in accuracy for fixed- vs. self-paced task in either age group

-- Learning Results --

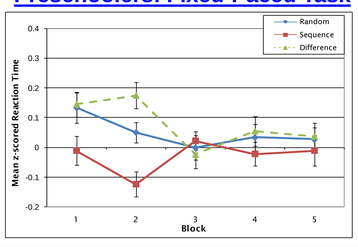
- Adults and preschoolers showed statistically significant learning on all tasks ($p<.01$)
- Magnitude of adult learning did not differ by task
- **Preschoolers learned significantly more in the self-pace condition vs. the fixed-paced condition ($p<.01$)**



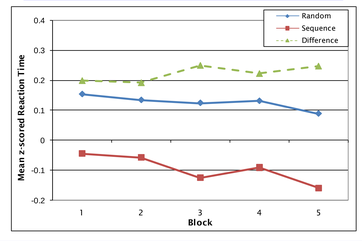
-- Learning Across Block Results --

- Adults showed similar learning across blocks for fixed- and self-paced tasks
- **Preschool-aged children showed differential learning across blocks for fixed- and self-paced tasks**

Preschoolers: Fixed-Paced Task



Preschoolers: Self-Paced Task



-- Conclusion --

Summary: Preschool-aged children learned significantly more on a self-paced version than on a fixed-pace version of the serial reaction time (SRT) task, indicating that tasks demands strongly influence implicit learning in this age group.

Remaining Questions: What are the critical differences between these two tasks that result in greater learning for preschool-aged children?

- pace or timing
- accuracy feedback
- motivation

Future Directions:

- Follow-up study using a self-paced task without accuracy feedback to better assess role of feedback vs. pacing in learning
- Testing older children to determine when performance on fixed- and self-paced tasks becomes equivalent