Development of implicit location probability learning

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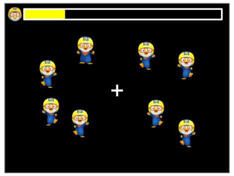
Background

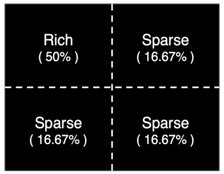
- **Location probability learning (LPL)**
  - Habitual attention bias toward a rich region where a target frequently appeared in a visual search task
  - Acquired without intention or explicit awareness
  - Spared in cognitive and neurological deficits (e.g., visual neglect, autistic spectrum disorder, Parkinson's disease)
  - LPL has been observed in older adults, but the developmental trajectory of LPL has not been examined empirically

- **Questions**
  - When do children show LPL? Is children's LPL comparable to adults'?
  - How does children's LPL relate to development-dependent learning factors (i.e., executive functions)?

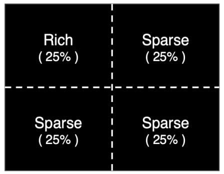
Method



Target Distractors



Training block

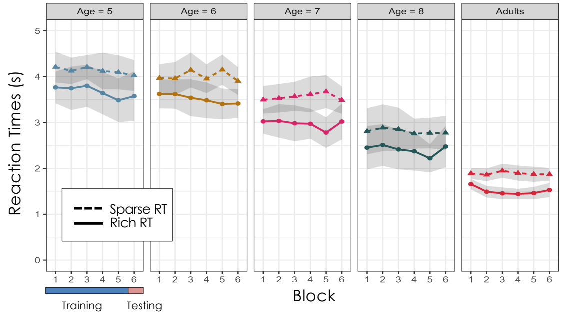


Testing block

- Participants: 63 children (ages 4-9) and 13 adults
- Visual search task: find and touch a hands-down penguin as quickly as possible
  - Training blocks (5 blocks)
    - Targets appeared in the rich quadrant in 50% of trials and in each sparse quadrant in 16.67% of trials
    - The location of the rich quadrant was counterbalanced across participants
  - Testing block (1 block)
    - A target appeared equally often in the rich and sparse quadrants
    - Testing block removed the possible influence of short-term inter-trial priming in the training blocks
- Executive function was measured with the NIH toolbox

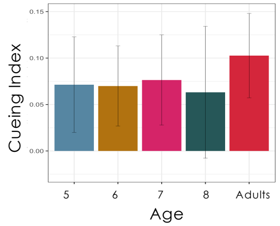
Results

Children showed LPL



- Developmental change in the overall RT
- Developmental stability in the LPL (Sparse RT > Rich RT)

Children's LPL was comparable to adults'



$$\text{Cueing index} = \frac{\text{Sparse RT} - \text{Rich RT}}{\text{Sparse RT} + \text{Rich RT}}$$

- No age difference in the cueing index during testing blocks

Executive function predicts overall RT

Multiple regression analysis for variables predicting the children's search performance in the testing block

Predictors	Raw B	*t*	R^2	*df*	*F*	*p*
Overall RT model			**.641**	**(5, 24)**	**8.562**	**<.001**
Age	-307.689	-4.453				<.001
PSM	.619	.167				.869
LSWM	17.341	2.762				.011
DCCS	-11.247	-2.739				.011
flanker	-12.742	-2.140				.043

Executive function *does not* predict LPL

Predictors	Raw B	*t*	R^2	*df*	*F*	*p*
Cueing Index model			**.229**	**(5, 24)**	**1.425**	**.251**
Age	-.007	-.560				.581
PSM	<.001	.653				.520
LSWM	-.003	-2.333				.028
DCCS	<.001	.066				.948
flanker	.001	1.396				.176

- Picture Sequence Memory (PSM): episodic memory
- List Sorting Working Memory (LSWM): working memory
- Dimensional Card Sorting Test (DCCS): cognitive flexibility
- Flanker: inhibitory control

Conclusions

- LPL occurs early in development and remains stable until early adulthood
- Habitual attention learning follows a distinct developmental pattern from explicit goal-driven spatial attention learning