

Development of operation-specific lexical consistency effect in arithmetic word problem solving



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Introduction

- Word problems: arithmetic questions demonstrated in narratives.
- Adults showed operation-specific lexical consistency effect in response fluency of word problem solving, suggesting that the processing of linguistic and numerical factors interact during word problem solution (Ng et al., 2021).
- We investigated age-related changes in word problem solving for school-age children and adolescents.

Experiment Design

- We used the same experimental paradigm as in the previous study.
- Independent variables
 - Arithmetic Operation × Lexical Consistency
 - ▶ Consistent: addition-more; subtraction-less
 - ▶ Inconsistent: addition-less; subtraction-more

addition

consistent Sam has 8 books, and Kiki have 2 books **more** than Sam. How many books does Kiki have?

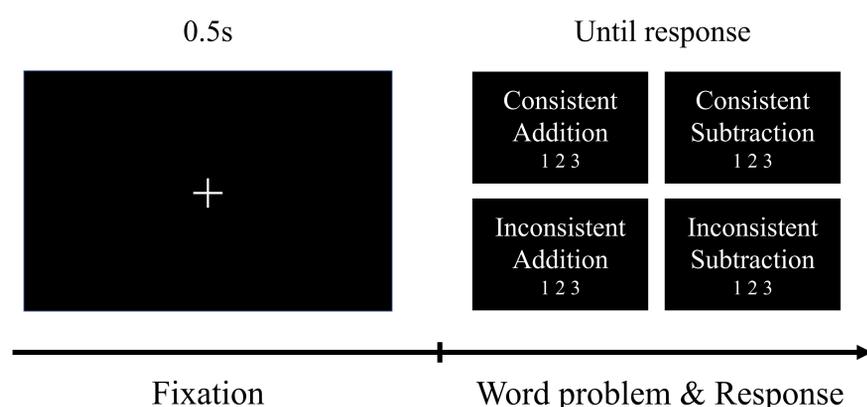
inconsistent Sam has 8 books, and Sam has 1 book **less** than Kiki. How many books does Kiki have?

subtraction

consistent Sam has 8 books, and Kiki have 3 books **less** than Sam. How many books does Kiki have?

inconsistent Sam has 8 books, and Sam has 2 book **more** than Kiki. How many books does Kiki have?

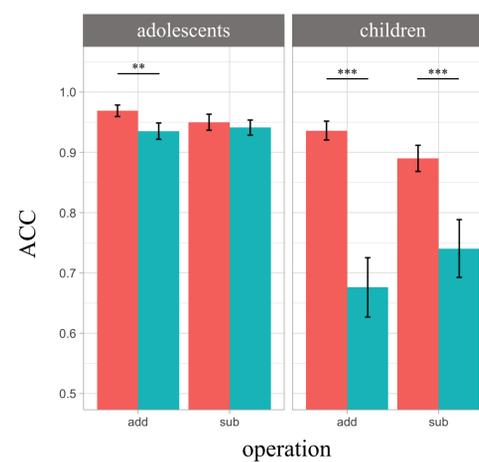
- Dependent variables
 - Task accuracy & Response time



Participants

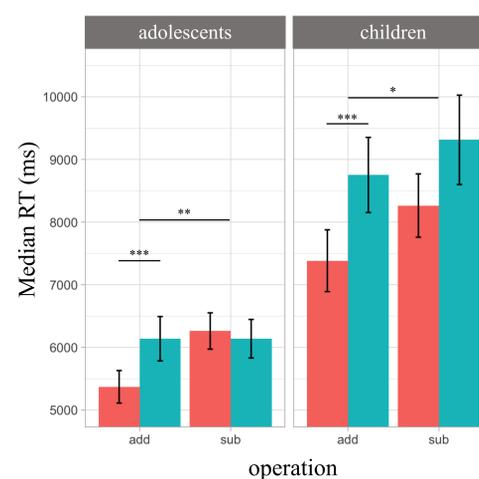
- 30 children (F15, M15)
 - Range: 8-12; Mean: 9.76; Standard deviation: 1.22
- 37 adolescents (F19, M18)
 - Range: 12-18; Mean: 14.64; Standard deviation: 1.97

Results



- A stronger consistency effect was detected for addition problems
- * $p < .05$, ** $p < .01$, *** $p < .001$

	<i>df</i>	<i>F</i>	<i>p</i>
adolescents			
Consistency Effect	36	10.5	.003 **
Operation Effect	36	0.93	.341
Consistency × Operation	36	3.17	.083
children			
Consistency Effect	29	32.4	<.001 ***
Operation Effect	29	0.15	.697
Consistency × Operation	29	13.3	.001 **



- Consistency effect was detected only for addition problems, but no subtraction problems

	<i>df</i>	<i>F</i>	<i>p</i>
adolescents			
Consistency Effect	36	5.19	.029 *
Operation Effect	36	9.01	.005 **
Consistency × Operation	36	7.58	.009 **
children			
Consistency Effect	29	17.6	<.001 ***
Operation Effect	29	6.36	.017 *
Consistency × Operation	29	0.62	.437

Discussion

- Children and adolescents displayed distinct operation and lexical consistency effect during word problem solution
 - a developmental shift from childhood to adolescence in word problem solution
- Lexical consistency may affect numerical processing regarding response precision in the younger age
- With maturation of word problem skills, adolescents demonstrated adult-like interaction effect between linguistic and numerical factors in response fluency

Reference

- Ng, C. T., Lung, T. C., & Chang, T. T. (2021). Operation-Specific Lexical Consistency Effect in Fronto-Insular-Parietal Network During Word Problem Solving. *Frontiers in Human Neuroscience*, 15, 631438.