Whole-number magnitudes interfere with decimal processing in children across strategies, and high performers additionally process rational magnitudes

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Introduction

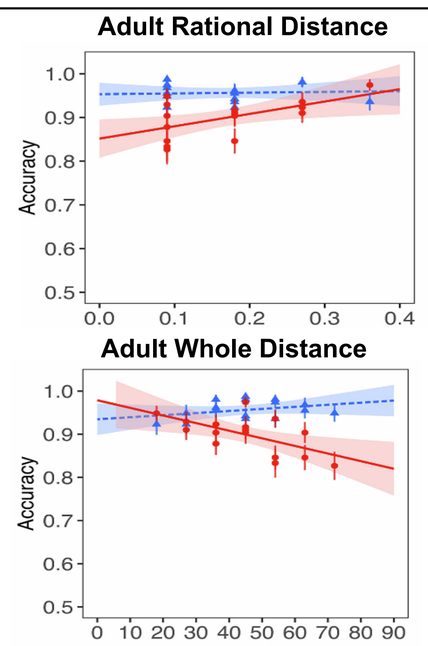
Research Question 1: What strategies do children use during decimal comparison?

- Children frequently perform worse on *Inconsistent* than *Consistent* fraction and decimal comparisons, demonstrating "whole-number bias."[1]
- Studies of fraction comparison reveal multiple flawed strategies in children[2] and adults[3], but decimal comparison strategies have not been studied.

Consistent	Inconsistent
0.2 vs. 0.87	0.27 vs. 0.8

Research Question 2: Do children show rational and whole-number distance effects?

- Numerical distance effects during whole-number comparisons are well-known[4]
- Rosenberg-Lee et al. (2023) showed positive rational distance effects in adults during decimal comparison[5].
- Adults also show negative whole-number distance effects during decimal comparison[5].
- Even proficient adults process whole number referent magnitudes during decimal comparison which interferes with performance



Participants

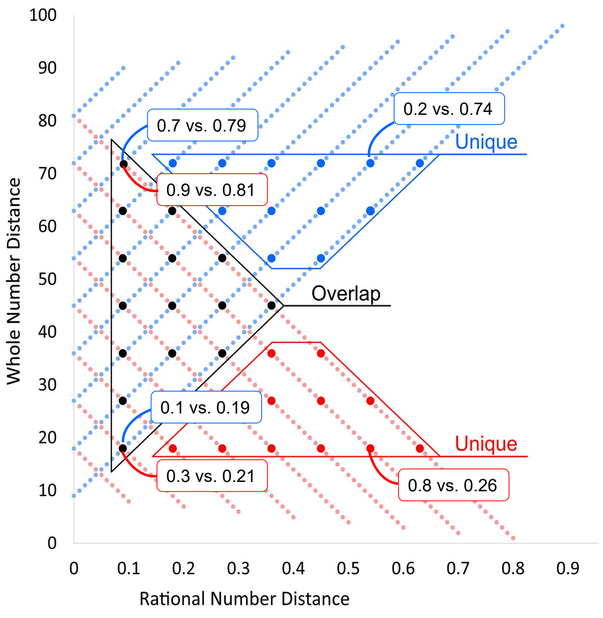
178 6th-8th graders

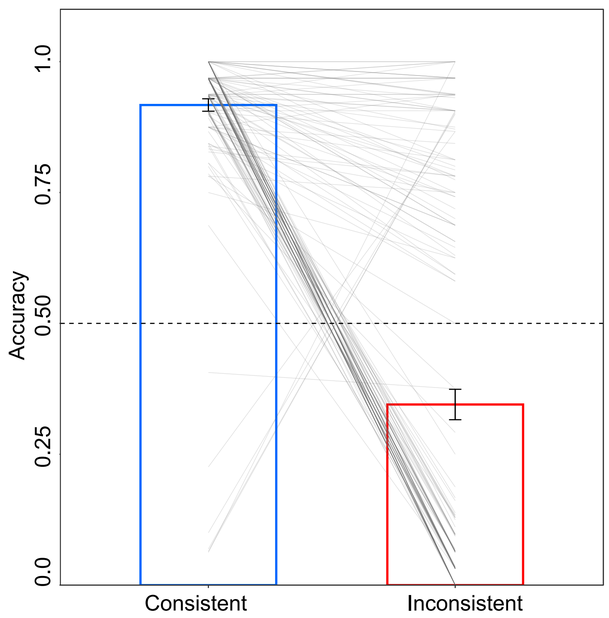
Mean age: 12.54 ± .90			Age range: 11-15	
Girls: 82	Boys: 67			Other: 6
Latino(a)/Hispanic: 103	Black/African American: 9	White/European descent: 16	Multiracial: 6	Other: 21

Decimals task, stimuli, and overall performance

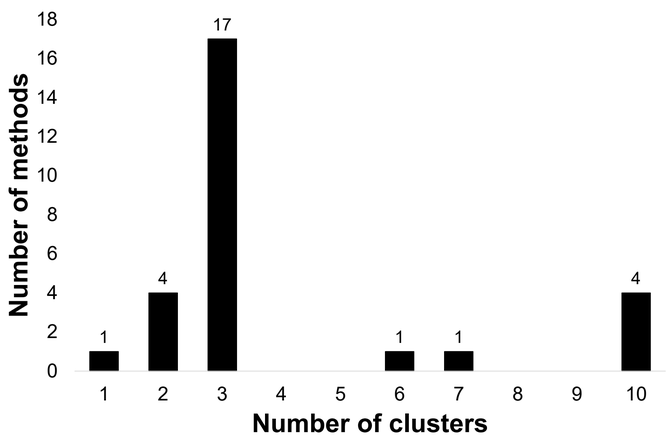
112 trials in 4 Conditions

	Consistent	Inconsistent
Overlap	0.7 vs. 0.79	0.9 vs. 0.81
Unique	0.2 vs. 0.74	0.8 vs. 0.26



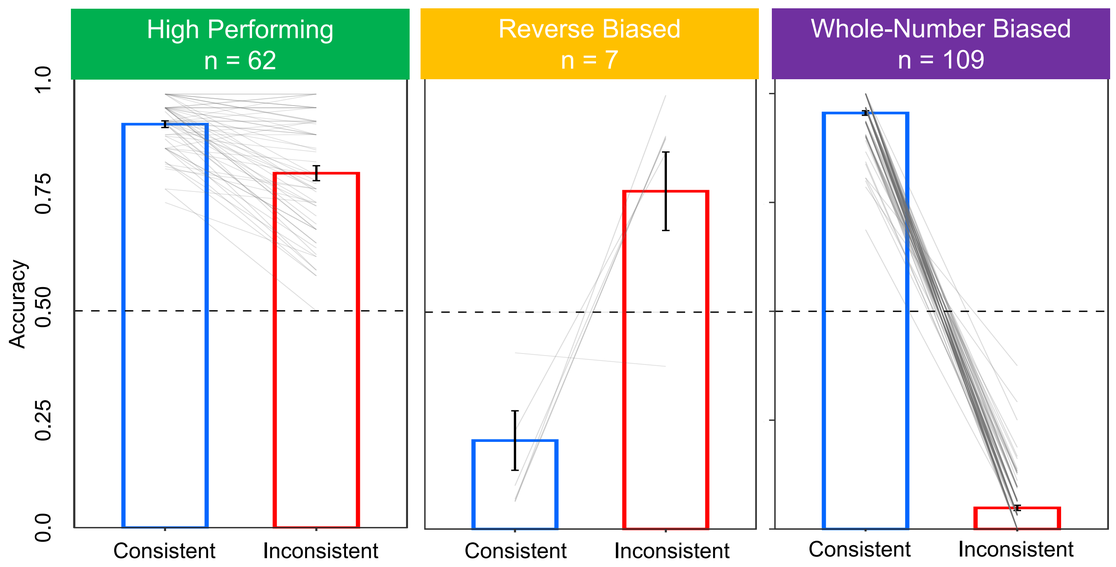


K-means cluster analysis generated 3 strategy groups

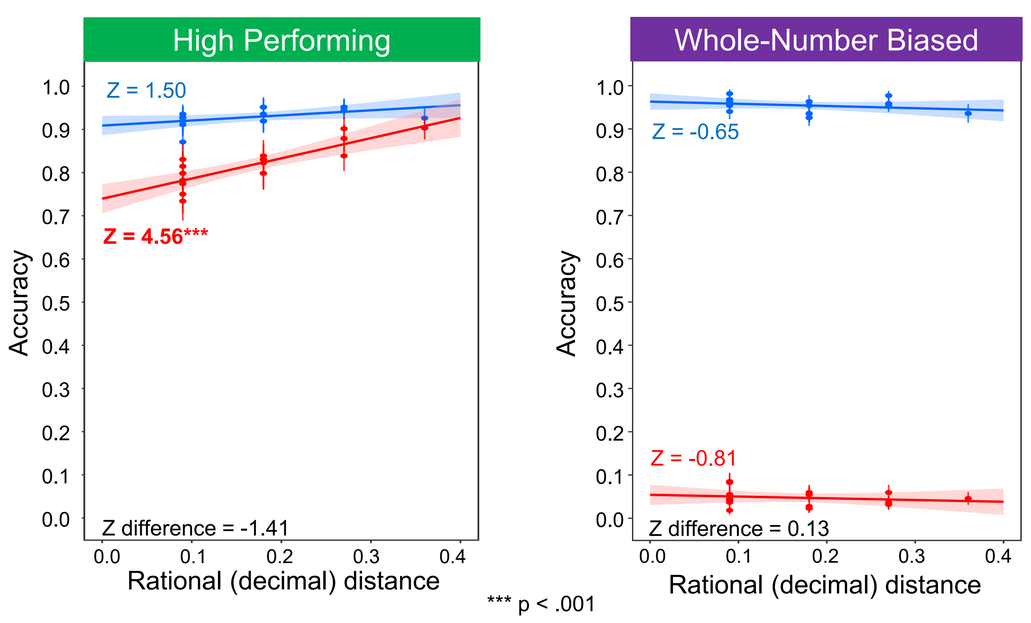


# of clusters	AIC	R^2
1	35.10	0.0000
2	13.96	0.8072
3	16.85	0.8423
4	18.30	0.9249
5	22.26	0.9257
6	24.88	0.9708
7	28.74	0.9754
8	32.61	0.9796
9	36.62	0.9792
10	40.47	0.9841

Decimals performance by cluster

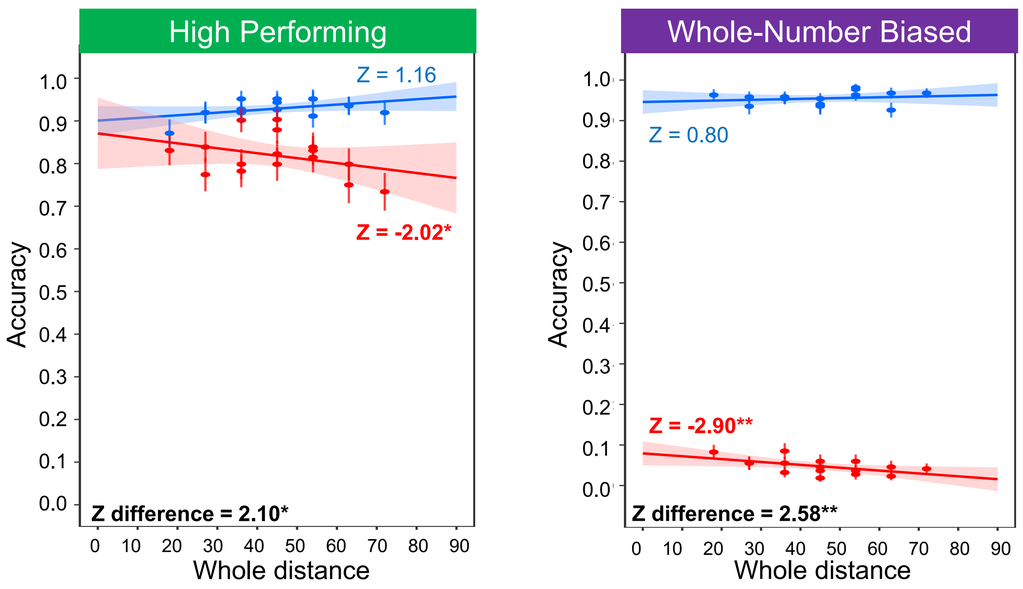


Only High Performing shows positive rational distance effects on Inconsistent trials



*** p < .001

Whole-Number Biased and High Performing show negative whole distance effects on Inconsistent trials



* p < .05; ** p < .01; *** p < .001

Discussion

RQ1: Using cluster analysis, we identified three strategies that middle school children used while comparing decimals:

- Whole-Number Biased (61%), Reverse Biased (4%), High Performing (35%)

RQ2: We leveraged numerical distance effects to distinguish the underlying cognitive processing of Whole-Number Biased and High Performing clusters.

- Whole-Number Biased primarily influenced by number of digits, but also showed negative whole number distances effects.
- High Performing, like adults, overcome interference of digit number, showing positive rational *but* also negative whole distance effects.

References

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