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LEARNING TO COUNT IN A MULTILINGUAL ENVIRONMENT

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Background

Mastering the counting list is a critical stage in children's numerical concept learning.
At some point in their development, children must arrive at a **productive rule to master the counting principles** (i.e., how the next number in a sequence is generated).

Given that the number system is inherently linguistic, a **productive rule enables the child to overcome (linguistic) exceptions and arrive at a principle in this context.**

Do children use productive rules to learn the counting list and how does this relate to the understanding of counting list direction (n-1 and n+1).

If yes, what does this look like **in L2 speaking (multilingual**) children?

Methods

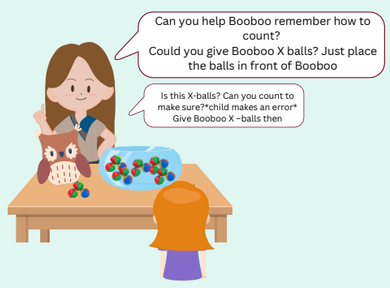
169
51%
5.4: 6.8 YM
Mage = 66.08 months (SD = 7.16)

40%
X2 (1,169) = 0.62, p = 0.43
F (1,165) = 0.02, p = 0.88
X2 (3,163) = 5.34, p = 0.15
60%

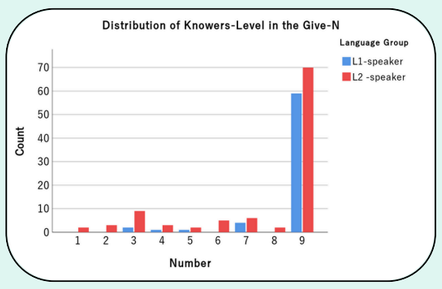
Counting Task:
Mastery of the counting list & productive rules.

Initial Highest Count (IHC): the number counted to without an error.
Final Highest Count (FHC): the number counted to with prompts**.**
Resilience: counting 2 decades past an error.

Give-a-Number:
Understanding the cardinality (i.e., the last item is a set denotes the number of the whole set).

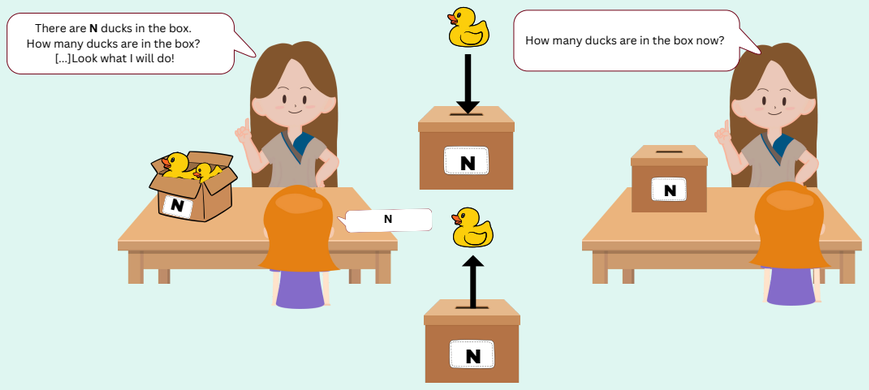


= 1, 3, 2, 6, 4, 5, 7, 9, 8



X2 (8,169) = 12.41, p = 0.13

Direction Task:
Understanding of succession and predecession.



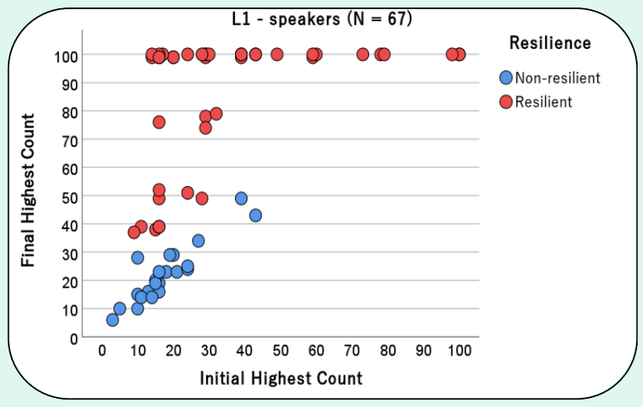
N = 2, 8, 13, 17

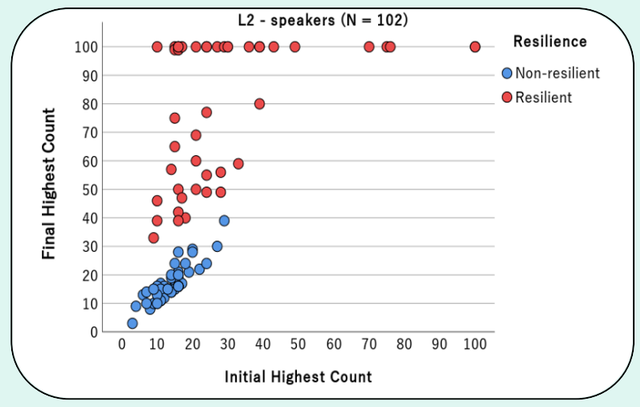
Let's connect here!

Results

Counting Performance in L1 and L2 speakers

	Overall	L1 (SE)	L2 (SE)	ANCOVA:
IHC	24 (20)	30 (2.76)	21 (1.71)	p = .002, η_p^2 = .05
FHC	54 (38)	65 (4.41)	47 (3.64)	p <.001, η_p^2 = .06
Total prompts	6 (4)	7 (0.53)	6 (0.44)	p = .17, η_p^2 = .01
Resilience	55%	67%	47%	X ^{2} = 6.61, p = .01
Age				p <.001, η_p^2 > .14

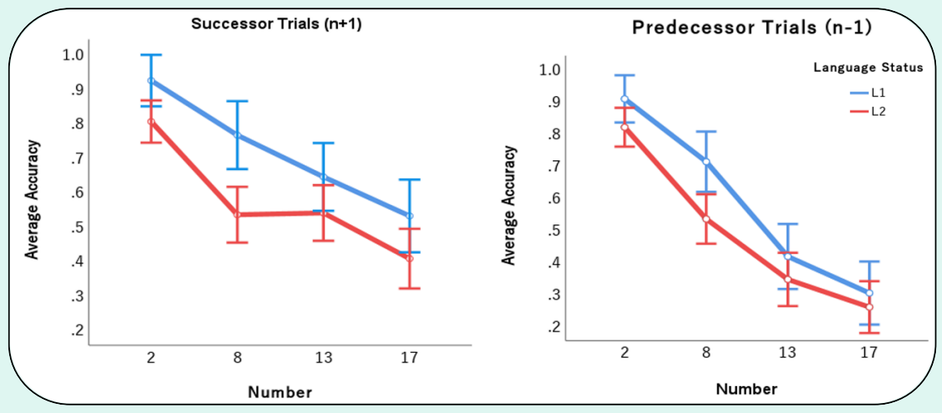




Overall, L1 speakers demonstrated higher counting mastery and resilience than L2 speakers.

Direction Task Performance

Model	BF_{10}	BF_{incl}
Age + Number + Direction + Language Status + Number*Direction	>100	
Age		>100
Number (2,8,13,17)		>100
Direction (n+1 vs n-1)		>100
Language Group		3.121
Number*Direction		>100



Language status did not influence substantially the understanding of successor and predecessor. Both L1 and L2 found larger number trials harder then small number trials.

Predictors of Direction Task Performance

Small Successor Trials			Small Predecessor Trials		
Model	BF_{10}	BF_{incl}	Model	BF_{10}	BF_{incl}
Age + IHC + FHC + Resilience + CP + Language	>100		Age + FHC + CP	>100	
Age		17			>100
IHC		<1			<1
FHC		2.87			>100
Resilience(1)		10.16			<1
Knower level (CP)		80.91			6.35
Language (L2)		6.09			<1

Large Successor Trials			Large Predecessor Trials		
Model	BF_{10}	BF_{incl}	Model	BF_{10}	BF_{incl}
Age + IHC + FHC + Resilience + CP + Language	>100		Age + IHC + FHC + Resilience + CP + Language	>100	
Age	>100				6.80
IHC	4.46				>100
FHC	52.72				>100
Resilience(1)	2.07				<1
Knower level (CP)	>100				39.01
Language (L2)	<1				8.51

FHC was predictive in both cases.
CP knowledge was more predictive for successor trials.
Language was a factor only the successor but not the predecessor.

FHC and IHC predicted the performance.
CP knowledge was more predictive for the successor trials.
Language was a factor for the predecessor, but not for successor.

Take-home

Building a conceptual understanding of how counting represents numbers requires mastering CP, Succession, and Predecession, which may be acquired sequentially.

One of the mechanisms children (to some extent) rely on to acquire these skills is the productive rules of language.

L1 and L2 speakers profit similarly from prompts to improve their IHC, but language status (L1 vs L2) should be considered when testing such populations.