

Semantic transparency
of math language
in Mandarin-speaking dyads

NSF Advancing Informal STEM Learning (AISL)

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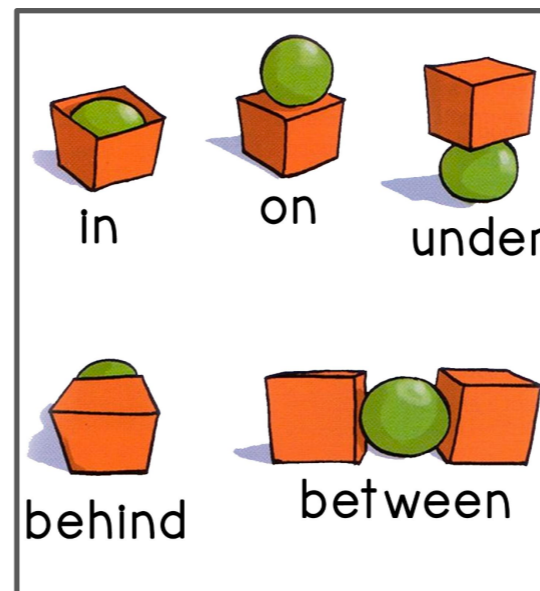
- Examine how everyday home interactions and environments support toddlers' early math language across cultures & languages
 - 200 families (100 Mandarin, 100 English)
 - Two home visits per family (400 visits)
 - Natural observations + structured interactions
 - 400 hours video data
- Preliminary results from 15 Mandarin infants

Math language

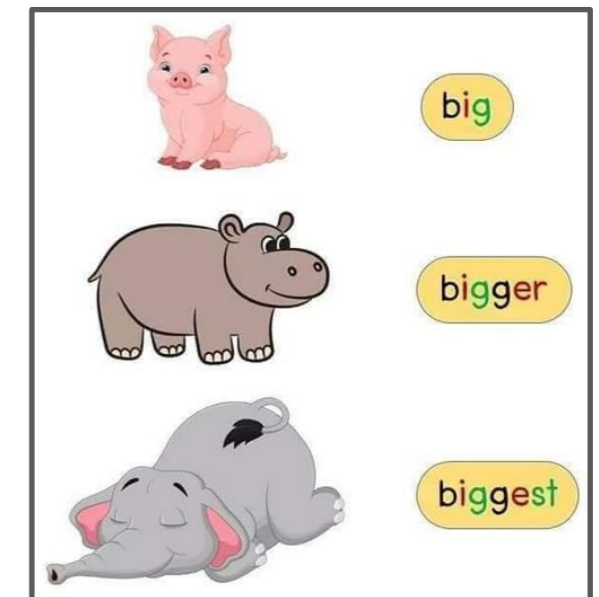
numbers



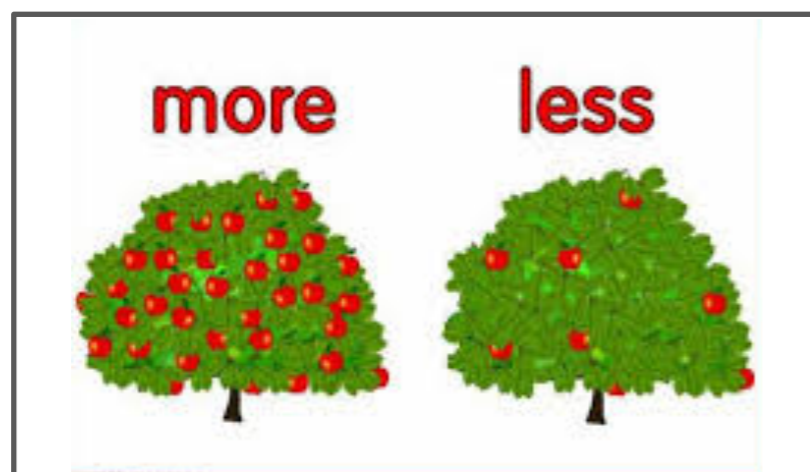
spatial relations



magnitudes



quantifiers



shapes

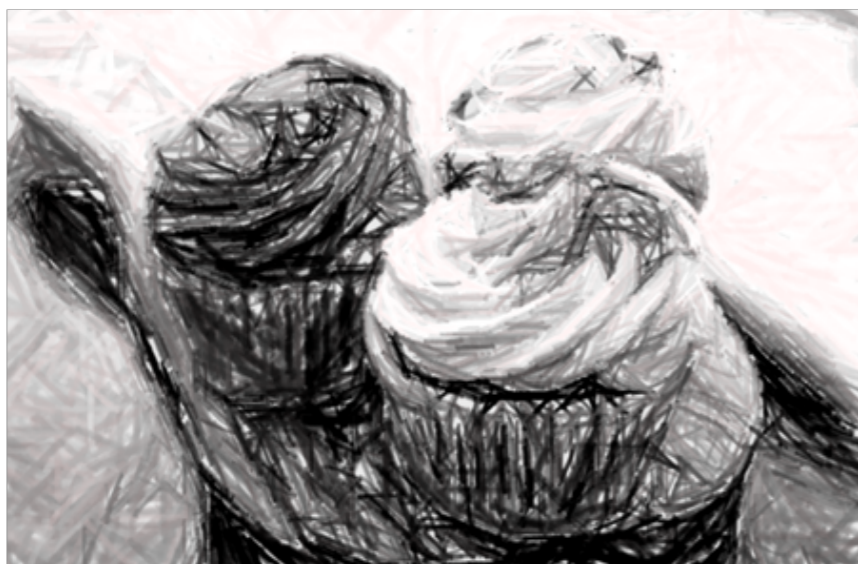


Toddlers' early math vocabulary predicts later math ability, academic success, and STEM outcomes

Levine et al., 2012; Masek et al., 2024; Slusser et al., 2019

Math words are abstract and hard for toddlers to learn

Number: 3



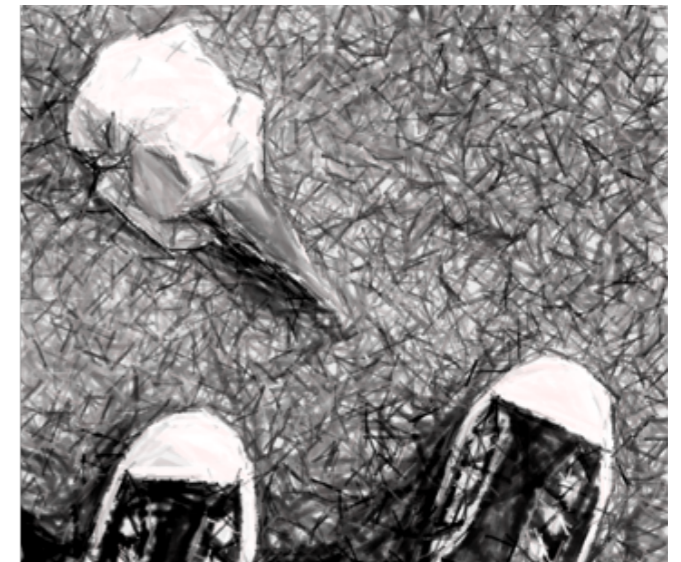
“Down” can refer to perceptually distinct things...



**“let’s sit
down”**

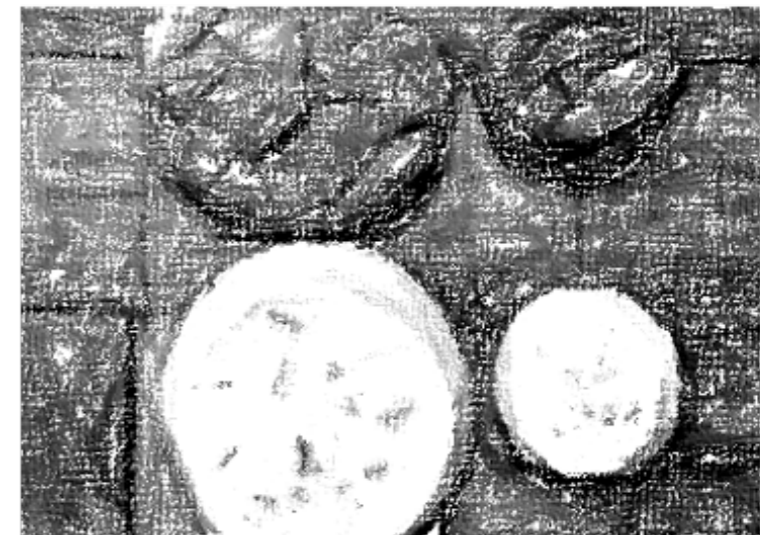
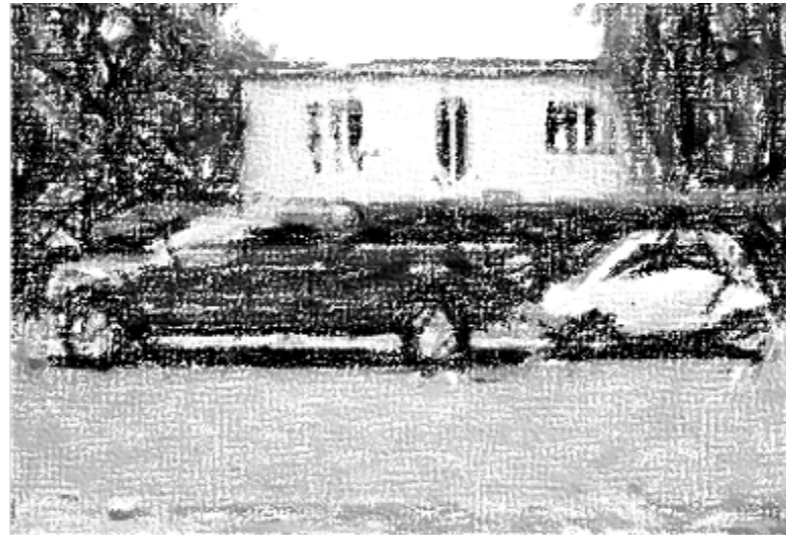
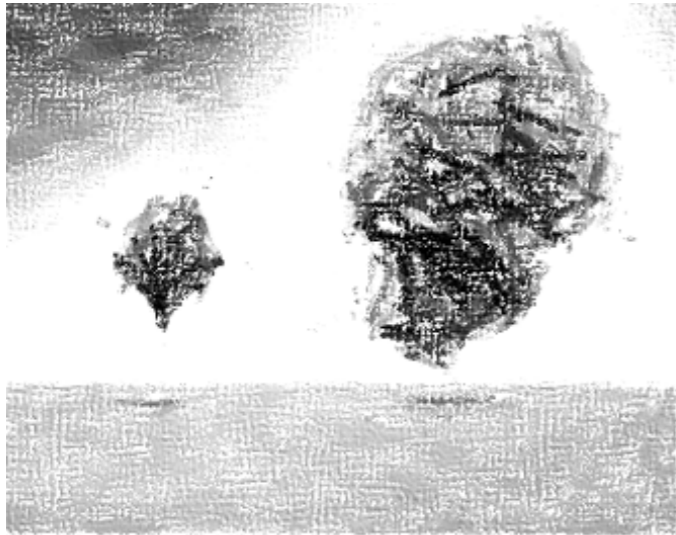


**“down the
drain”**



**“it’s down
there”**

“Big” & “small” can refer to perceptually distinct things...



Math language is hard, but toddlers still acquire math words.

How?

How do infants acquire math words?

- Lots of varied exposure
- Toddlers have rich sensorimotor experiences surrounding exposure
- Linguistically: semantic transparency may also support math language learning

Semantic transparency may facilitate learning

- Semantic transparency is the degree to which the meaning of a word can be inferred from its components

Languages vary in the level of semantic transparency

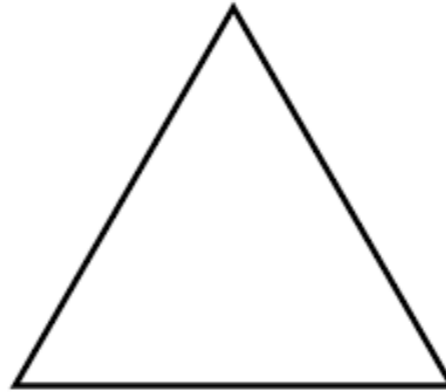
English Translation	Literal Translation	Chinese Word	Pinyin
Eleven	ten-one	十一	shí yī
Twelve	ten-two	十二	shí èr
Thirteen	ten-three	十三	shí sān
Fourteen	ten-four	十四	shí sì
Fifteen	ten-five	十五	shí wǔ
Sixteen	ten-six	十六	shí liù
Seventeen	ten-seven	十七	shí qī
Eighteen	ten-eight	十八	shí bā
Nineteen	ten-nine	十九	shí jiǔ
Twenty	two-ten	二十	èr shí

Transparent number-naming systems can facilitate early numerical development.

Miller et al., 1995; Lê & Noël, 2020; Rasmussen et al., 2006

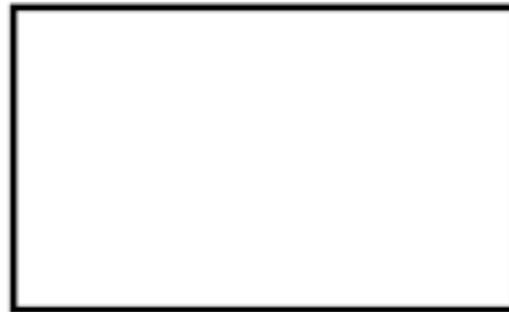
Other transparent math words

three-angle shape



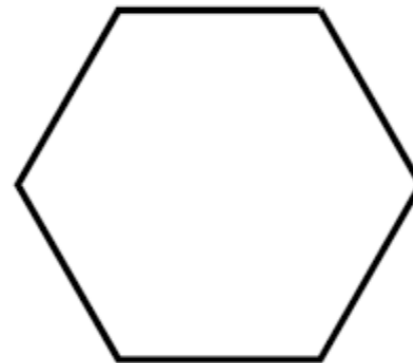
triangle

long-square shape



rectangle

six-side shape



hexagon

Even non-math words contain transparent math concepts

thigh



big leg

calf



small leg

donut



sweet-sweet circle

How much exposure to math talk
do toddlers experience?

What non-math words contain
math concepts?

Everyday home activities

- 1-hour video-recorded natural home activity
- 15 English–Mandarin bilingual toddler–mother dyads from NYC
- Toddlers: 18–30 months old (M = 23.9 mo)
- Mothers: aged 30–43 years (M = 35.5 yr)

Repeated math input during daily routine



Mom: **One**

Numbers



Mom: **Two** older sisters

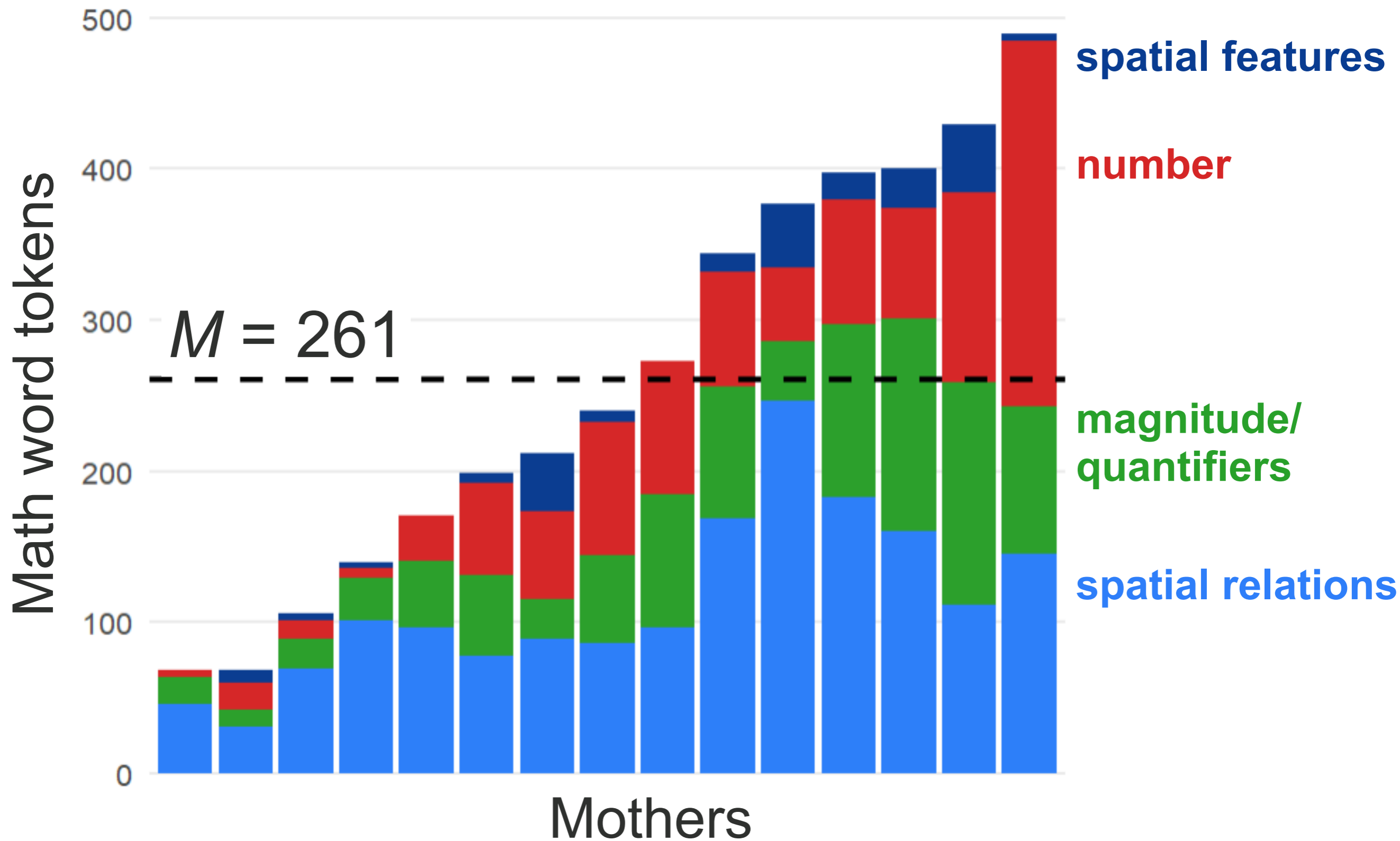
Mom: 两个姐姐

Spatial word: “up”



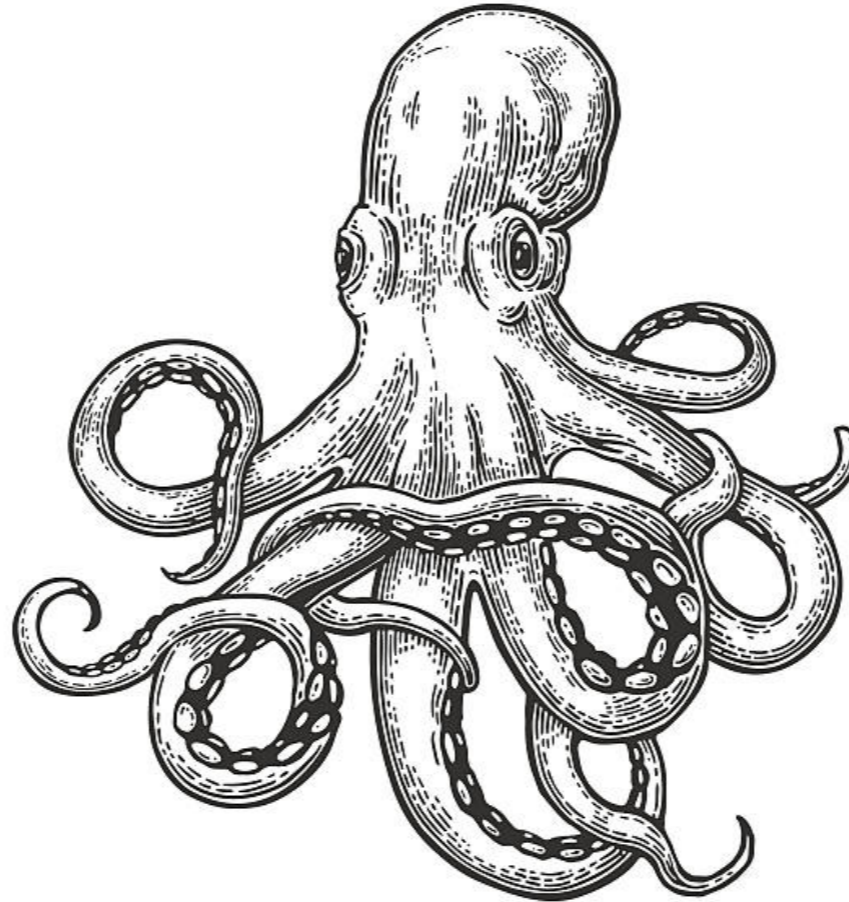
Child: Up

Amount of math exposure



What non-math words contain
math concepts?

Octopus



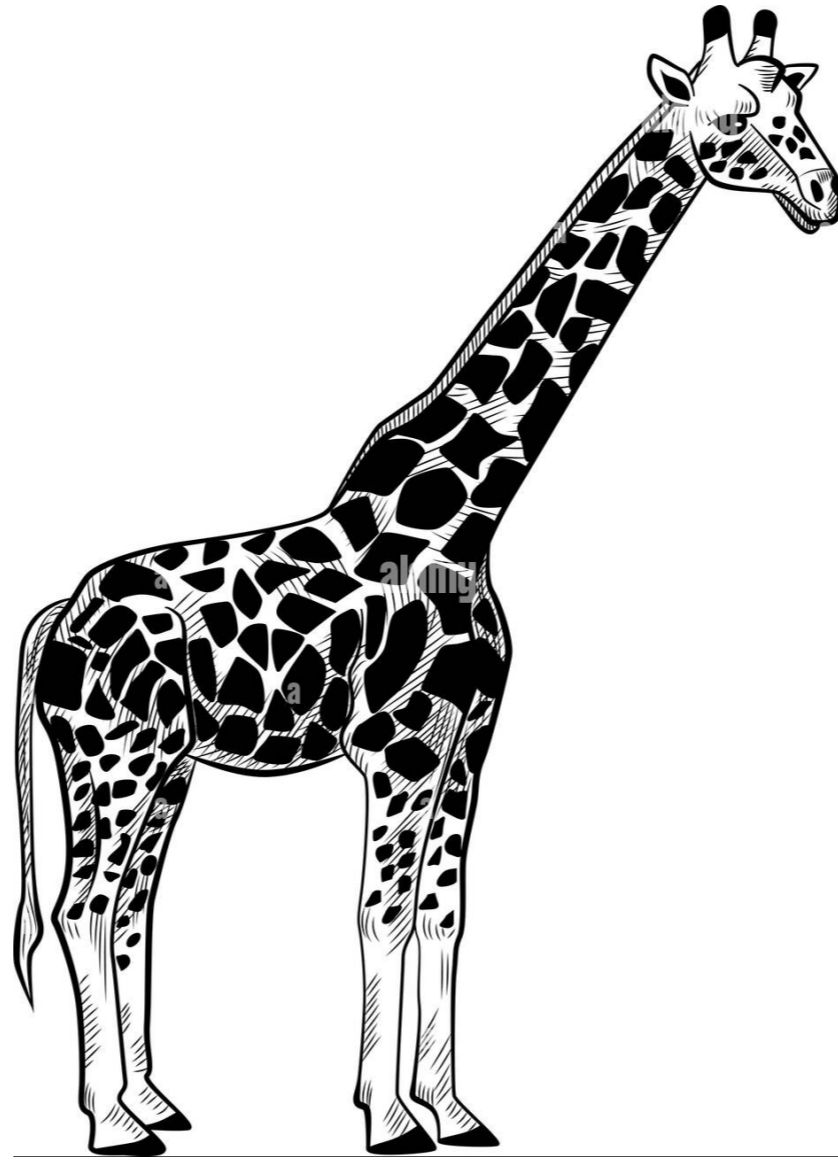
Mandarin: **eight**-hand fish

Polar bear



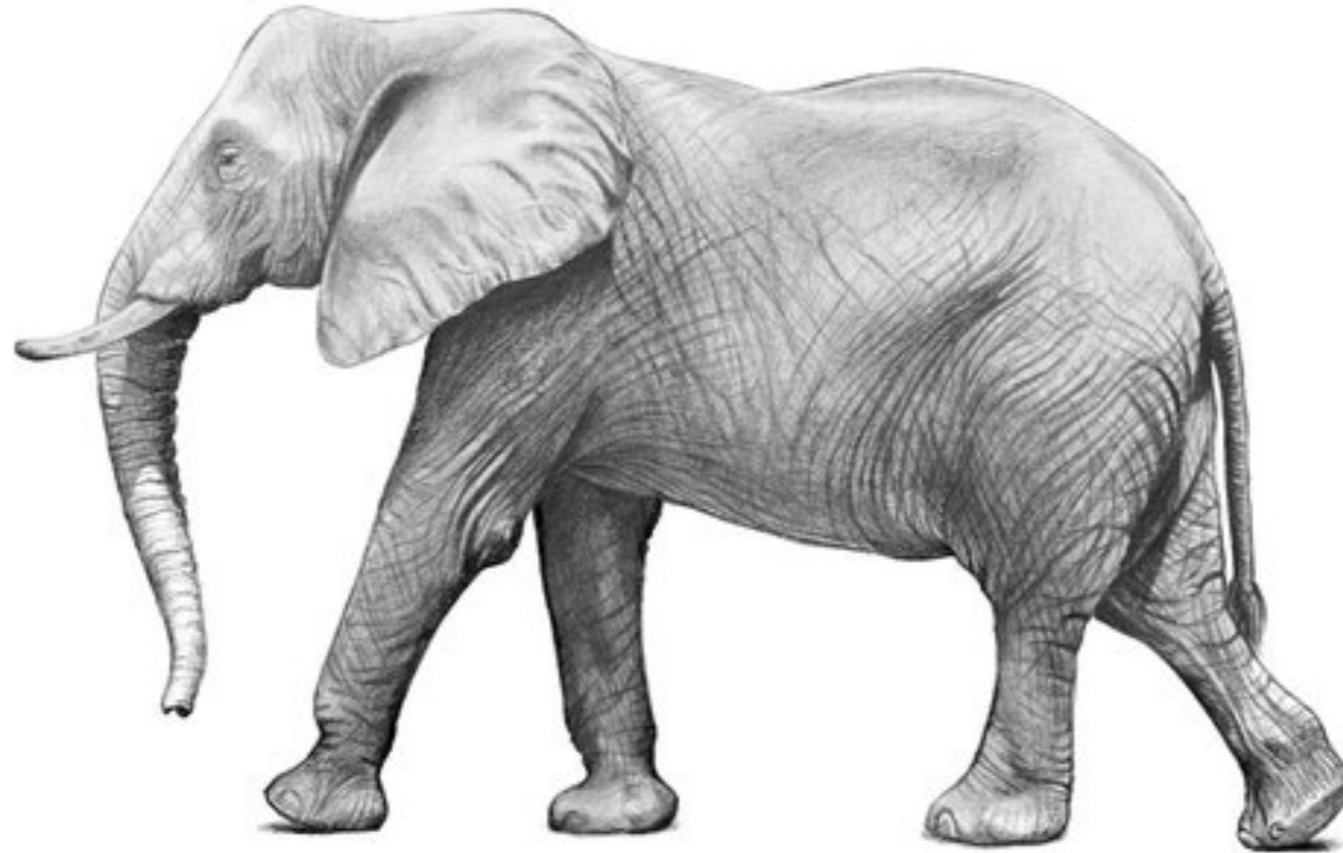
Mandarin: north-pole bear

Giraffe



Mandarin: long-neck deer

Elephant



Mandarin: **big** elephant

Gibbon



Mandarin: **long**-arm monkey

Helicopter



Mandarin: **vertical**-rise machine

French fries



Mandarin: potato **strips**

Breakfast



Mandarin: **morning/early** meal

Conclusion

- Videos of everyday activities capture toddlers' early exposure to math concepts
- Toddlers from US Mandarin-speaking homes are exposed to 200+ math words/hr
- Linguistic features of Mandarin may result in high exposure to the meaning of math words
 - Transparency of math words themselves
 - Math concepts encoded in common nouns

Additional linguistic features

- Mandarin lacks a/an and often uses one instead, leading to a significant number of one in Mandarin.
- Frequently tagging of 'categories' with head noun (e.g., six-side-shape)
- Increased use of cardinal numbers due to the lack of plural marking

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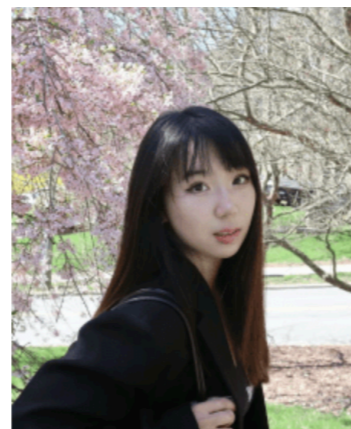
Joshua
Schneider



Kasey Soska



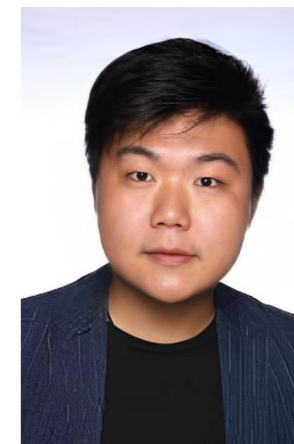
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