Exploring clusters of parent interaction styles during math conversations with their preschool-aged children

Shirley Duong

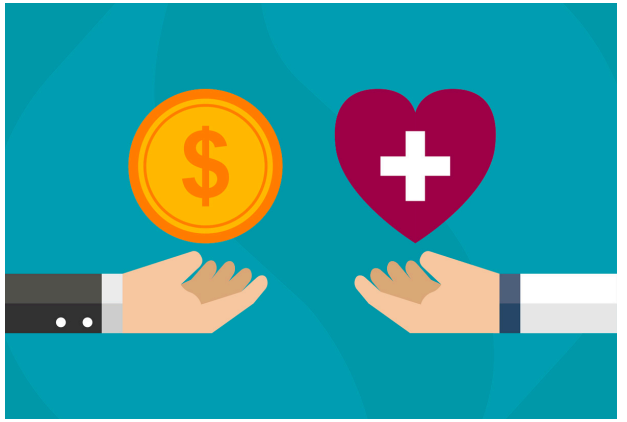
Cognitive Talk Series

University of Pittsburgh

11/10/21

Parents Promoting Early Learning

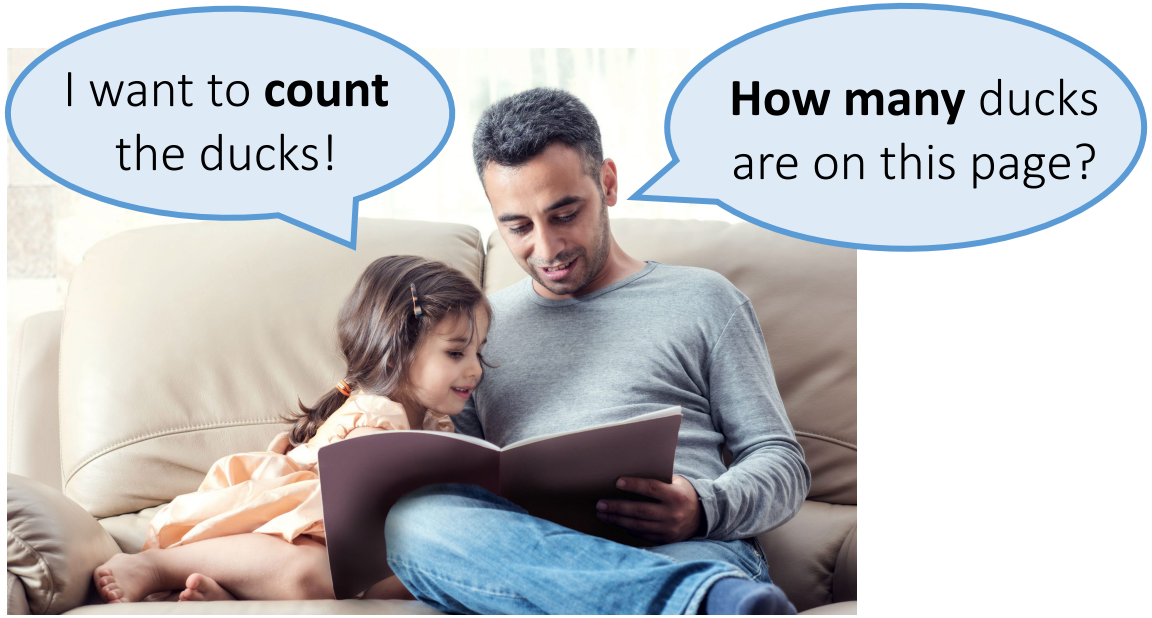
Math skills are important!



Hanushek & Woessman (2015); **Watts et al. (2018),**

Home numeracy environment (HNE)

Parents play an essential role in the development of children's math abilities.



Bachman et al. (2020); Casey et al. (2018); Elliott et al. (2017); Gibson et al. (2020); Vandermaas-Peeler et al., (2012)

Parent number talk

- Conversations about number between parents and children occur in a variety of contexts, e.g., during play, book reading, or routine activities
- Researchers often capture the frequency or proportion of parental number words or utterances.
- However, number talk is not a unitary construct!
  - Number **questions** (versus statements)
  - **Large** number talk – discussions of numbers greater than 4
  - Number **concepts** – "advanced" concepts include cardinality and arithmetic

Casey et al. (2018); Gibson et al. (2020); Uscianowski et al. (2018)

Parent number talk

- Parents provide opportunities for children discuss numbers and math concepts in many ways and in different frequencies.
- Some research suggests that a greater *quantity* or *proportion* of number talk benefits children's math development.
- However, parents may not be consistent in the frequency and types of number input that they provide.

Research question (RQ) 1: Do parents differ systematically across various measures of number talk?

Parent number talk

- Parents provide opportunities for children discuss numbers and math concepts in many ways and in different frequencies.
- Some research suggests that a greater ***quantity*** or ***proportion*** **of number talk** benefits children's math development.
- However, parents may not be consistent in the frequency and types of number input that they provide.

RQ2: Which measures of number talk describe this systematic variation well?

Parent number talk

- Parents provide opportunities for children discuss numbers and math concepts in many ways and in different frequencies.
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- However, parents may not be consistent in the frequency and types of number input that they provide.

RQ3: Do parents' number-related interaction styles relate to children's math abilities?

Participants

- 123 four-year-old children and their parents (94% mothers) (M_{age} = 4.40 years, *SD* = 3.60 months, Range = 4 – 4.98 years)
- Median yearly household income = $96,000 (*SD* = $70,351.65)
- Most parents (*n* = 90) reported having at least a Bachelors degree

Data sources

- Observations of parent-child interactions
- Child math skills

Parents Promoting Early Learning

Observation of parent-child interactions

- Pretend grocery shopping activity (8 minutes)
- Observations were video recorded and transcribed at the utterance level
- Each utterance was coded for number talk

Number talk coding

Example conversation

Parent (P): What numbers are these [on the cash register]?
Child (C): One and two
P: And three four five six seven eight
P: You want to check me out now?
C: Yeah
P: Okay I got three pizza slices
C: Three pizzas
…
C: I need eighty dollars
P: I only have two tens
P: How many dollars do you think I have if I add these two?
C: Okay give me that then
P: Thank you for the discount

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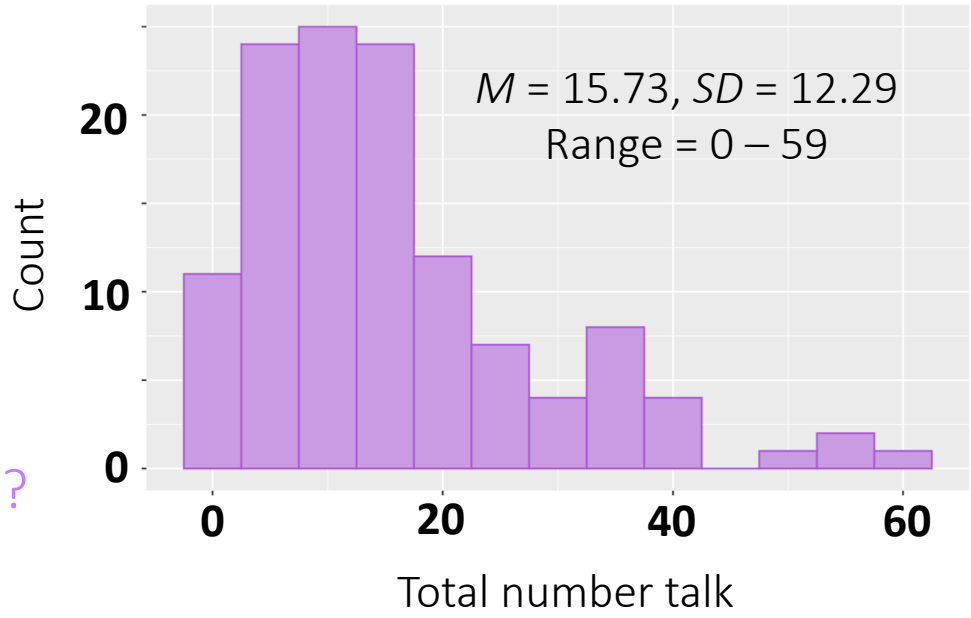
Frequency of parent number utterances



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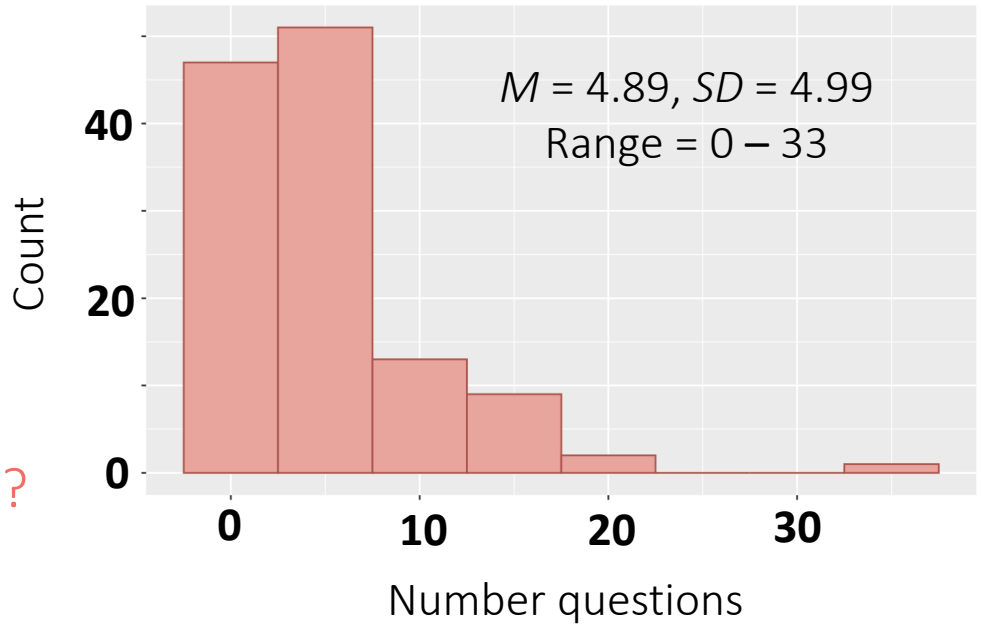
Frequency of parent number ***questions***



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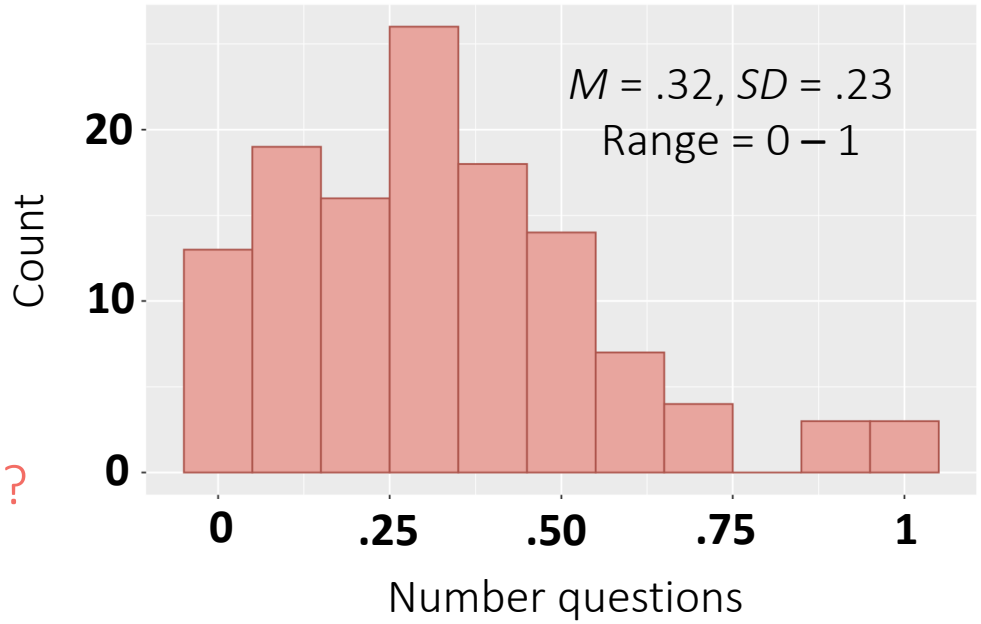
Proportion of parent number ***questions***



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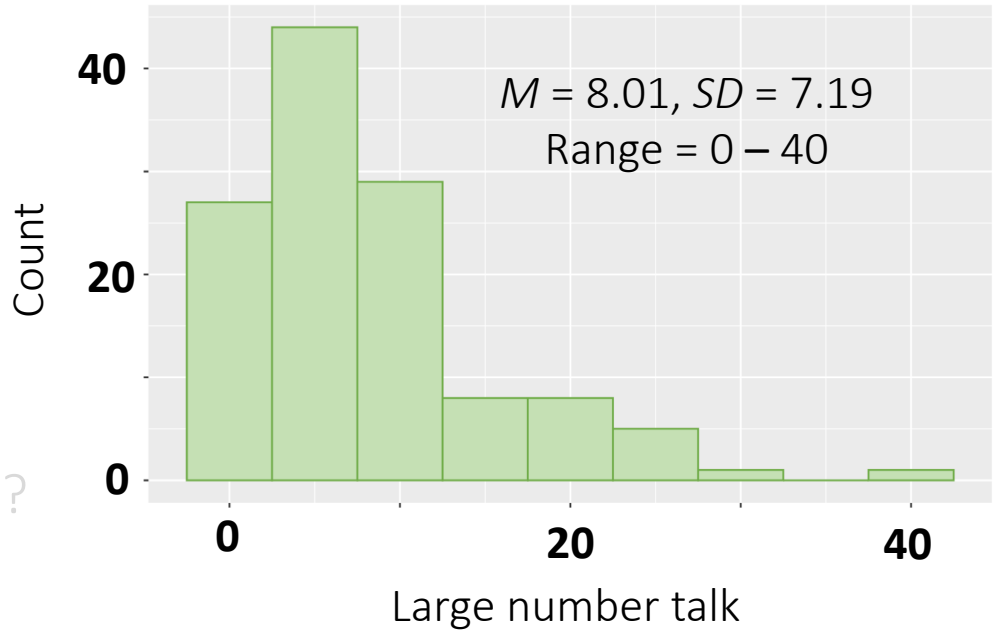
Frequency of ***large*** number talk = utterances with # > 4



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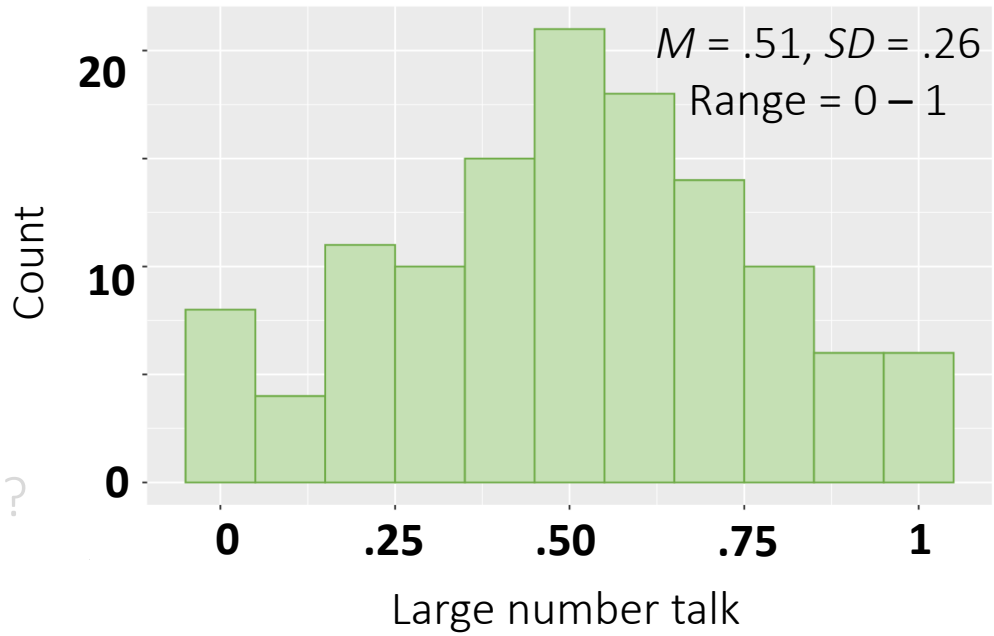

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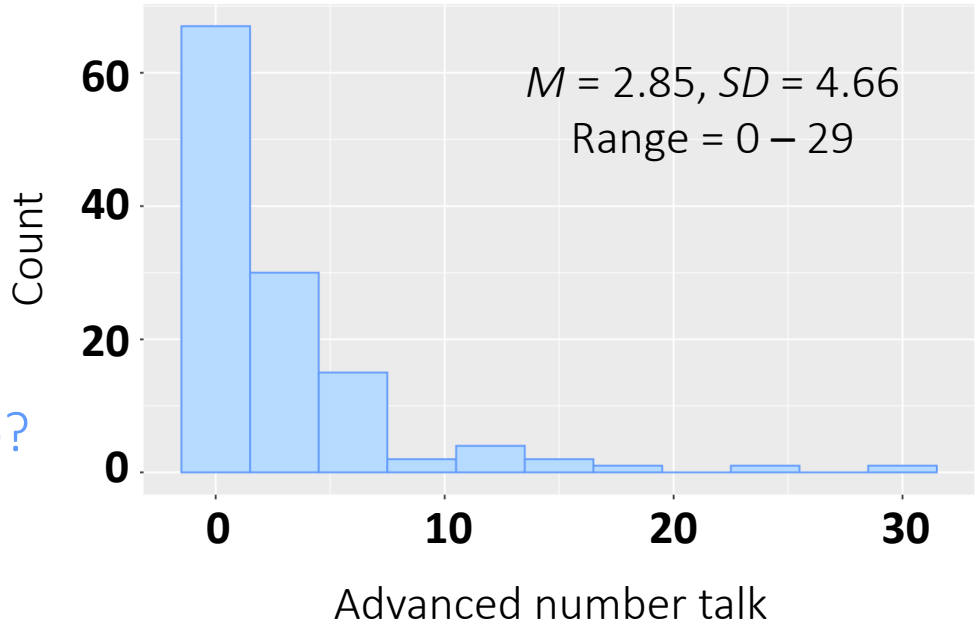
Frequency of parent ***advanced concept*** number utterances = Talk about labeling sets or arithmetic



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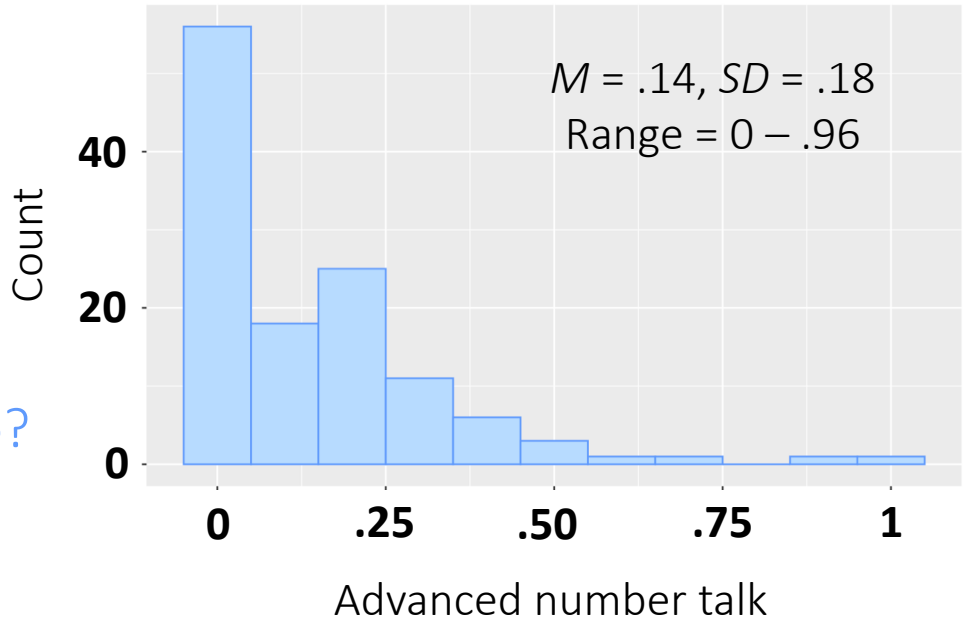
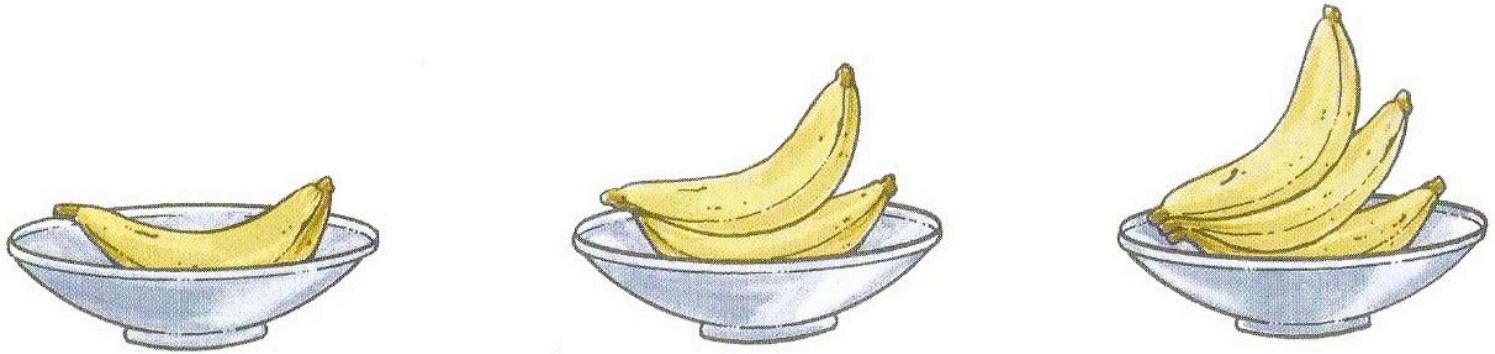


Child math skills

- Woodcock-Johnson Applied Problems subtest
- Measures ability to analyze and solve math problems

Point to the bowl with two bananas.



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If I picked 3 of these flowers, how many flowers would you have left?

Correlations between parent number talk (NT) and child math skills: **Frequencies**

	1	**2**	**3**	**4**
1. NT frequency	--			
2. Number Qs	.28**	--		
3. Large NT	.26**	.79***	--	
4. Advanced NT	.27**	.65***	.61***	--
5. Child math	.11	.04	.02	.06

*$p < .05$, **$p < .01$, ***$p < .001$

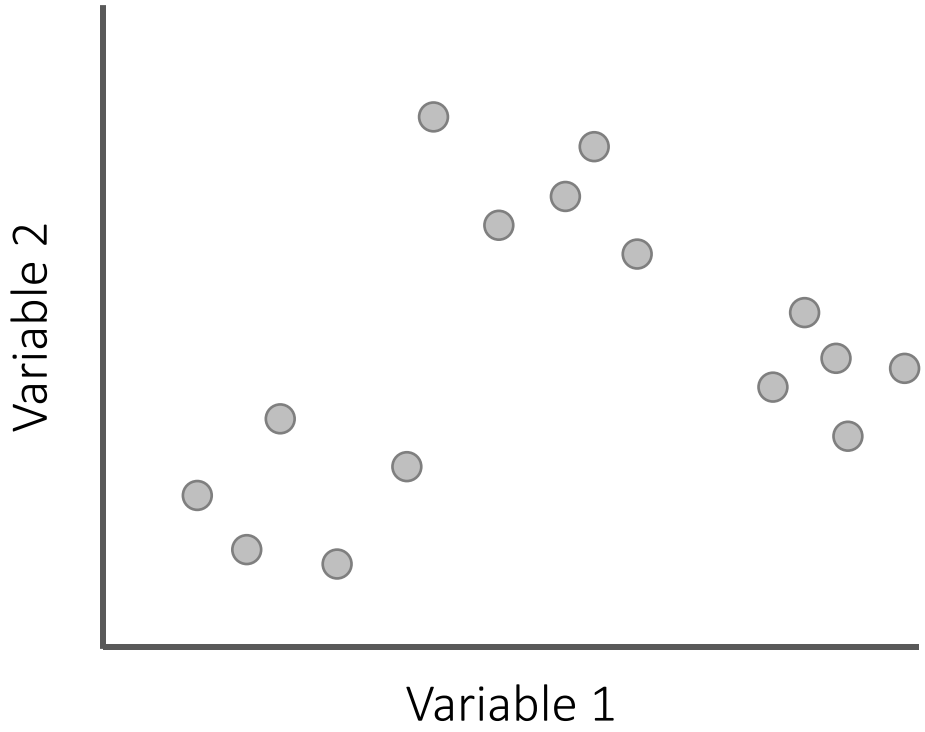
Correlations between parent number talk (NT) and child math skills: **Proportions**

	1	**2**	**3**
1. Number Qs	--		
2. Large NT	.16	--	
3. Advanced NT	.05	.13	--
4. Child math	-.12	-.02	.09

*$p < .05$, **$p < .01$, ***$p < .001$

k-means cluster analysis

- Objective is to group data points based on similarities across variables



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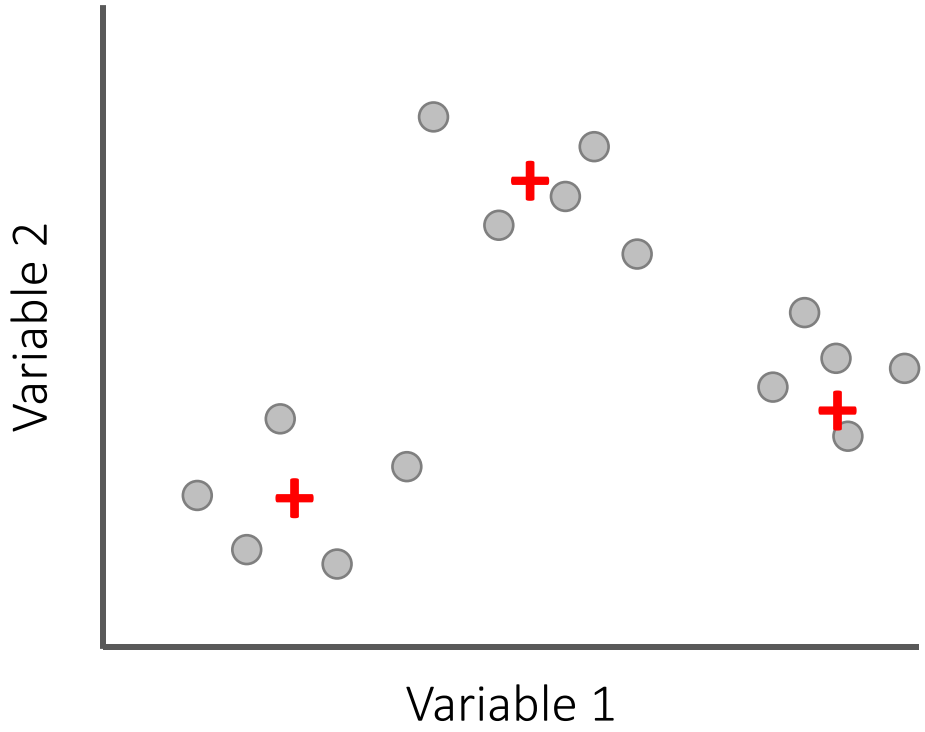

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- Objective is to group data points based on similarities across variables
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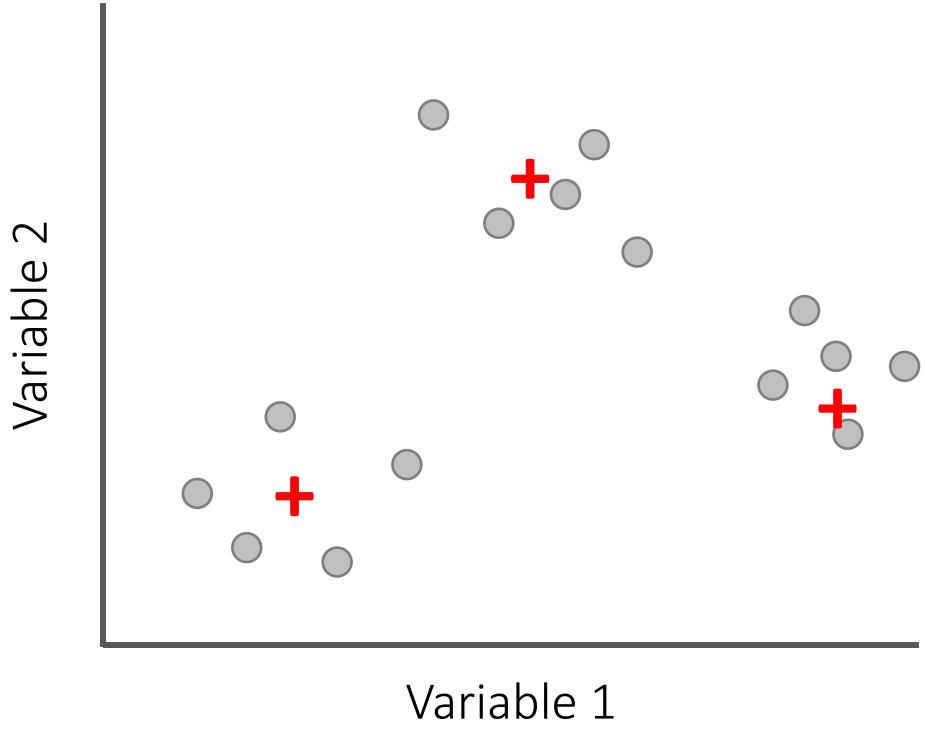
  Average silhouette method
  - Estimates the average distance between clusters
  - Large average silhouettes are ideal
  - Compute the average silhouette for a range of *k*'s



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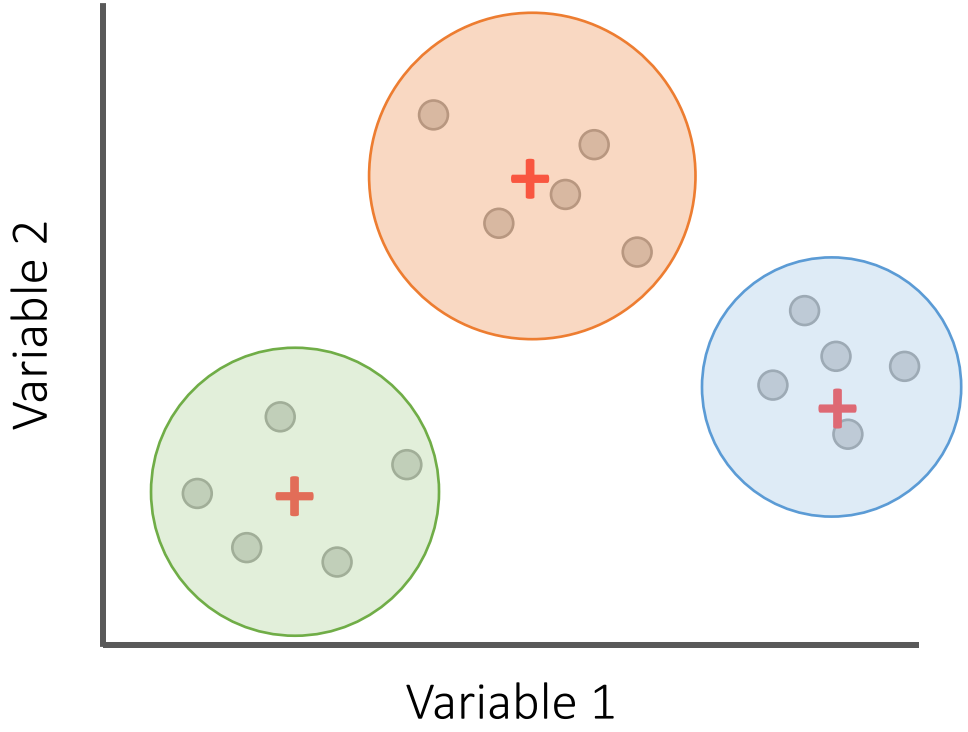

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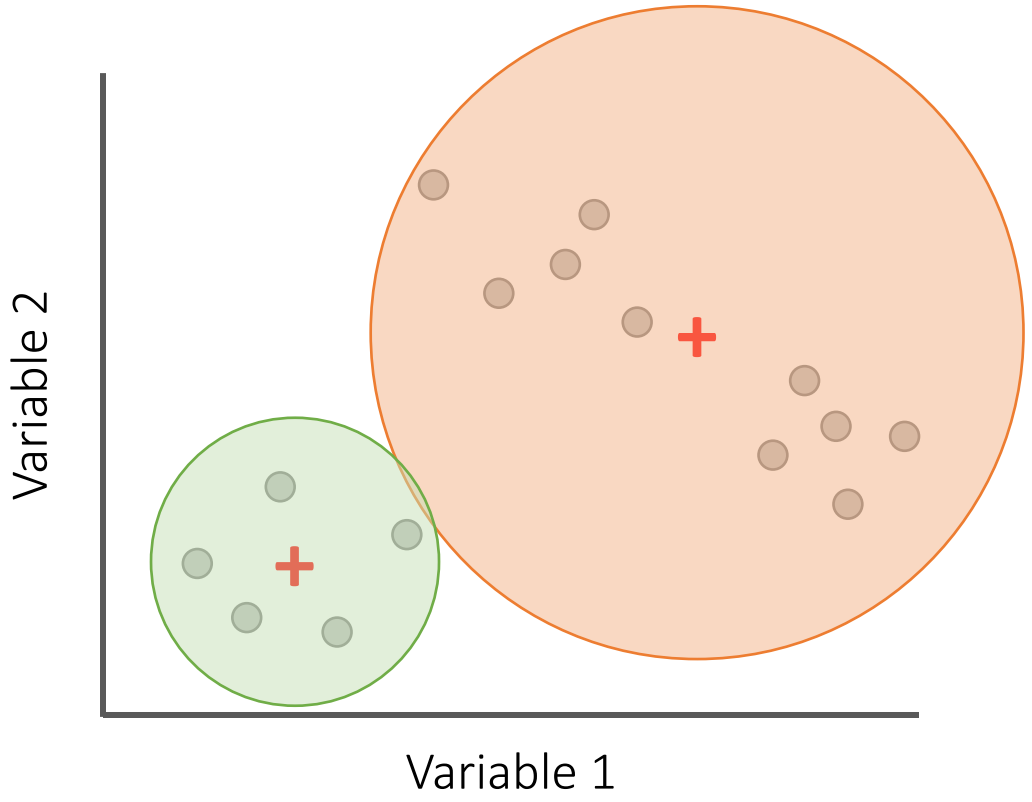

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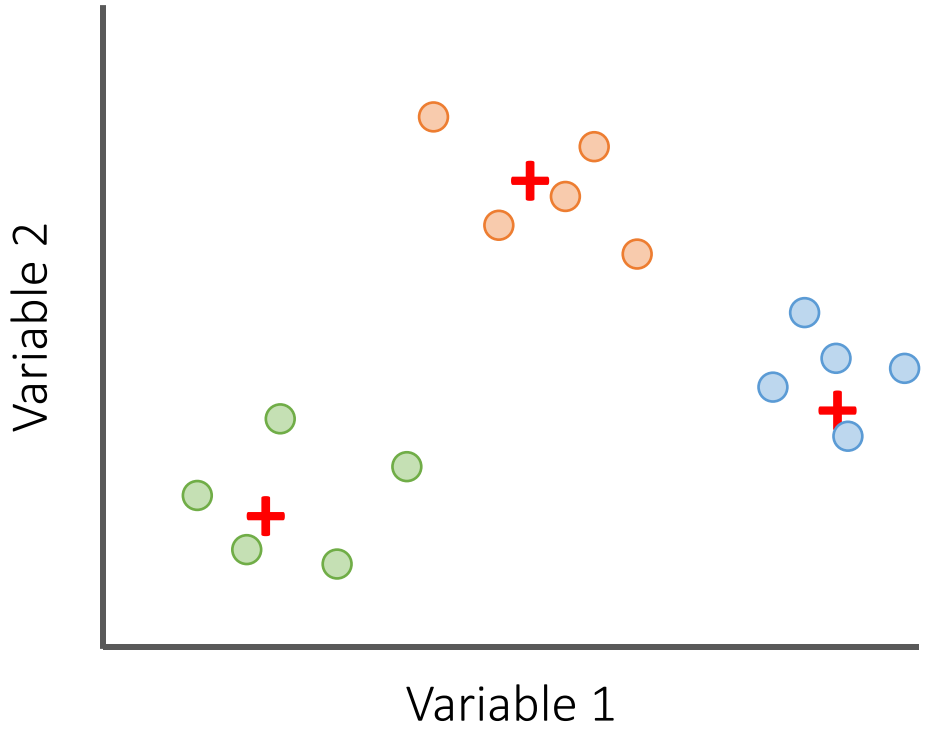
- Objective is to group data points based on similarities across variables
- Determine the optimal *k*, the number of cluster centroids
- Allocate data points to clusters to minimize the within(-cluster) variation



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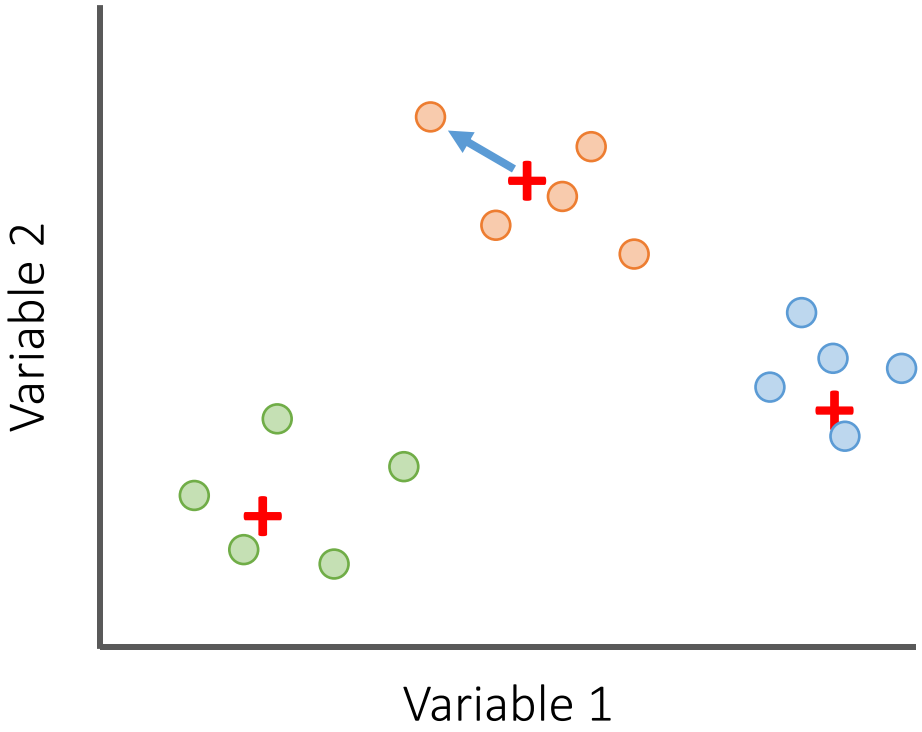

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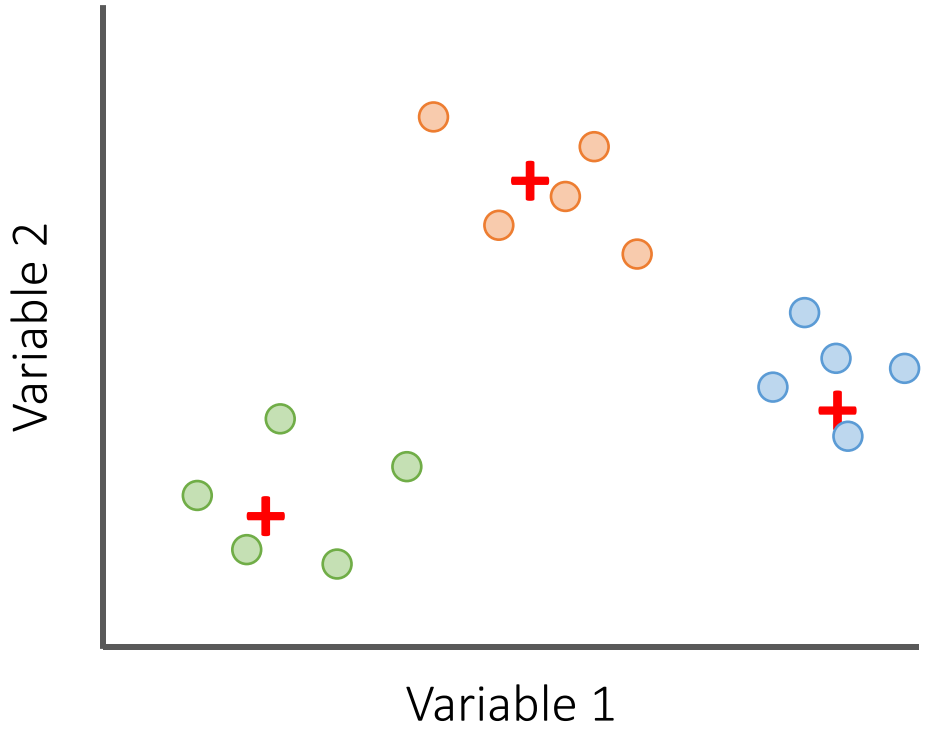

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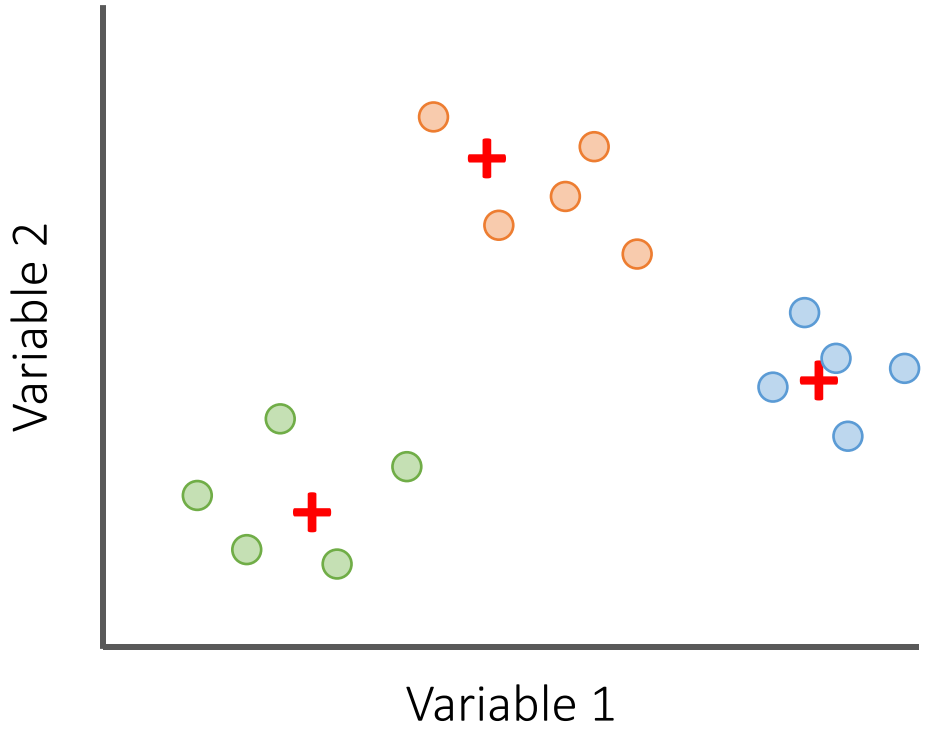

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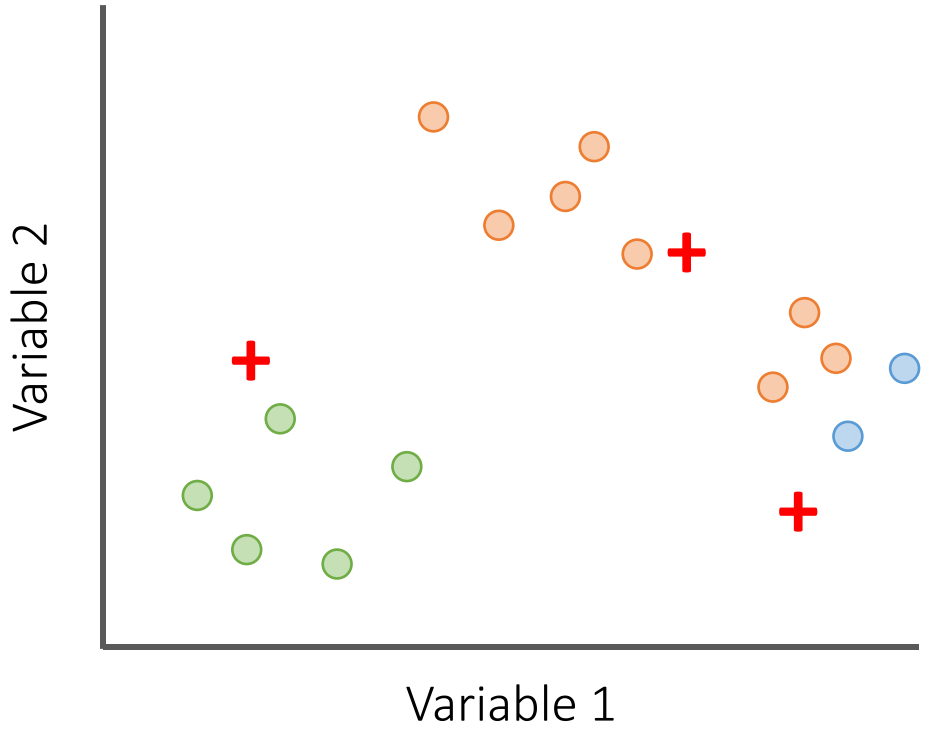

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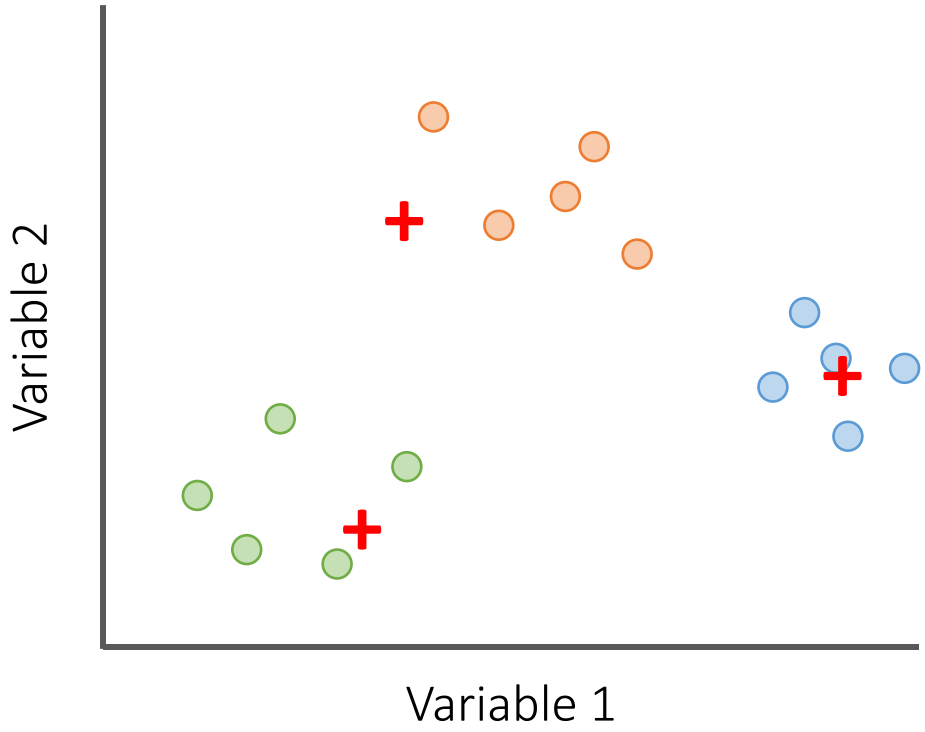

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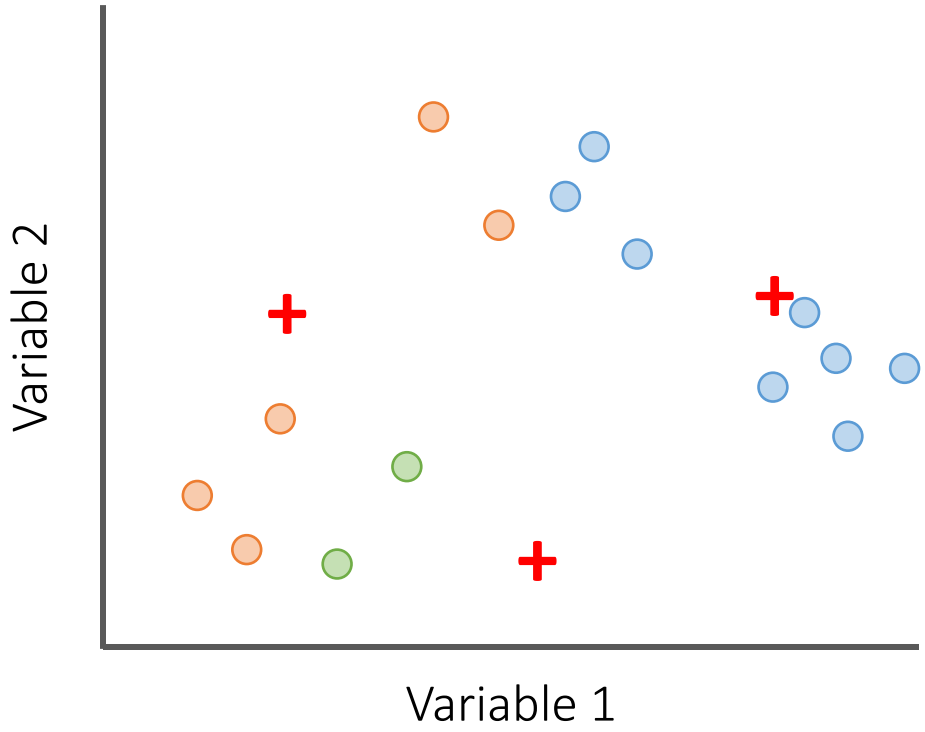

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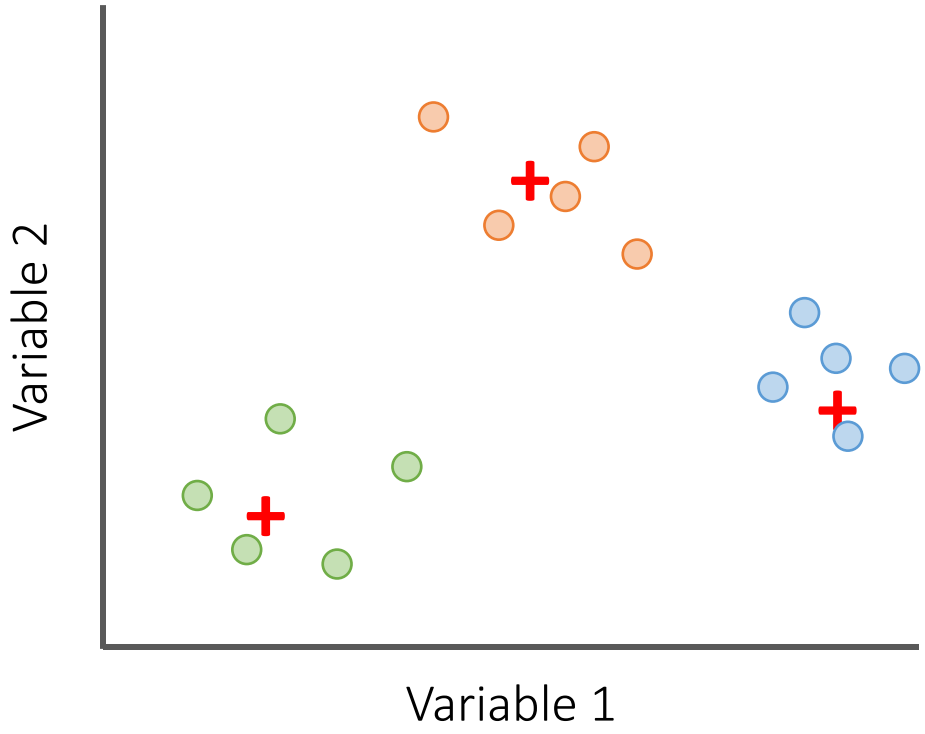

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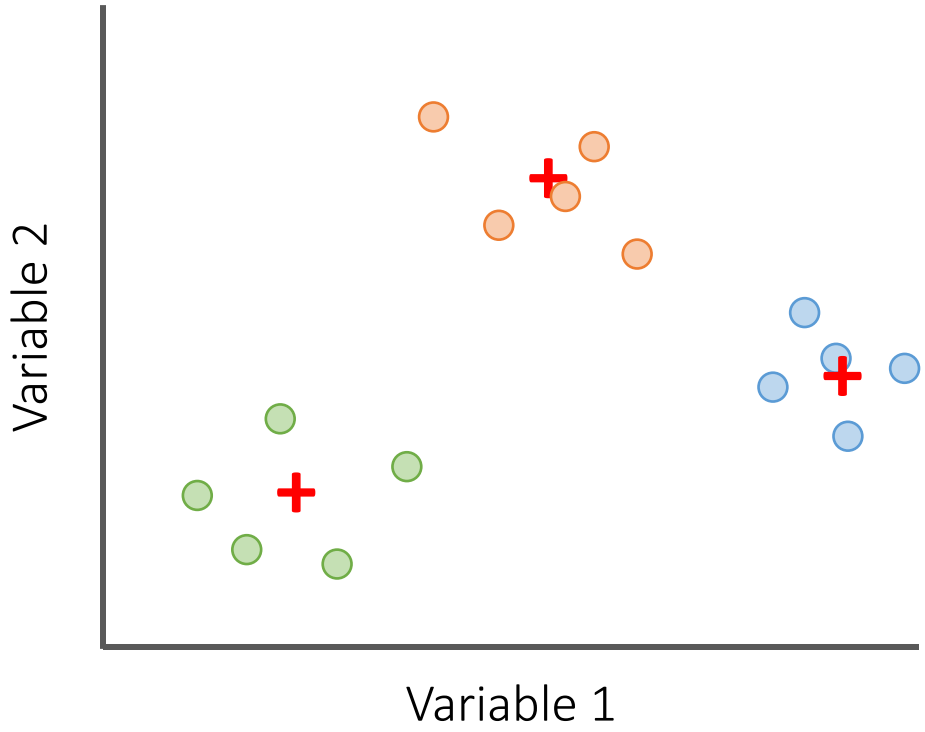

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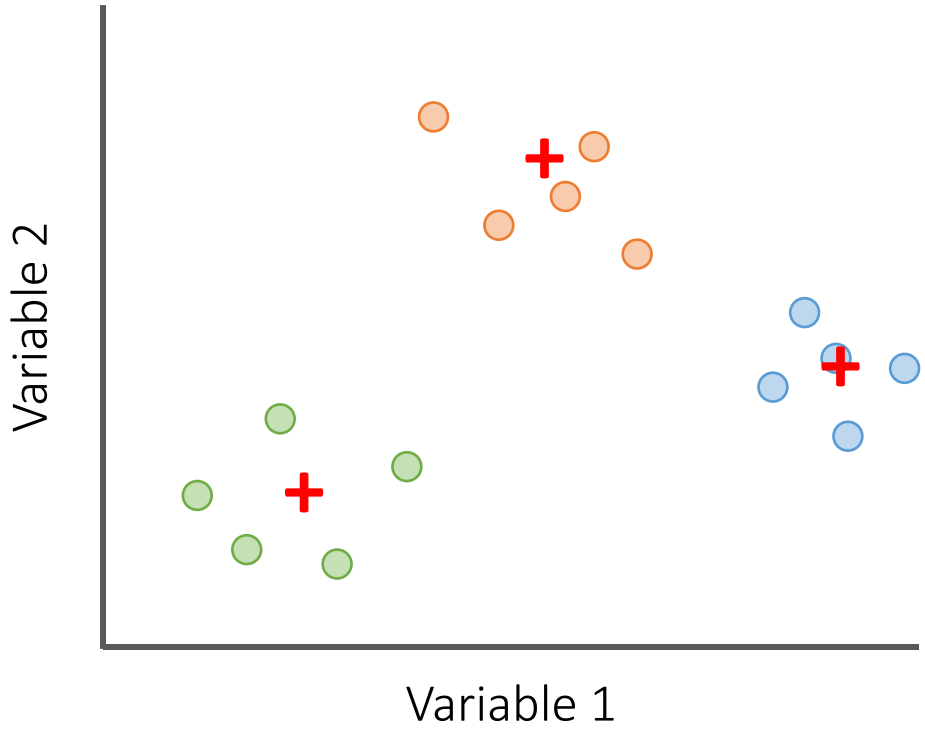

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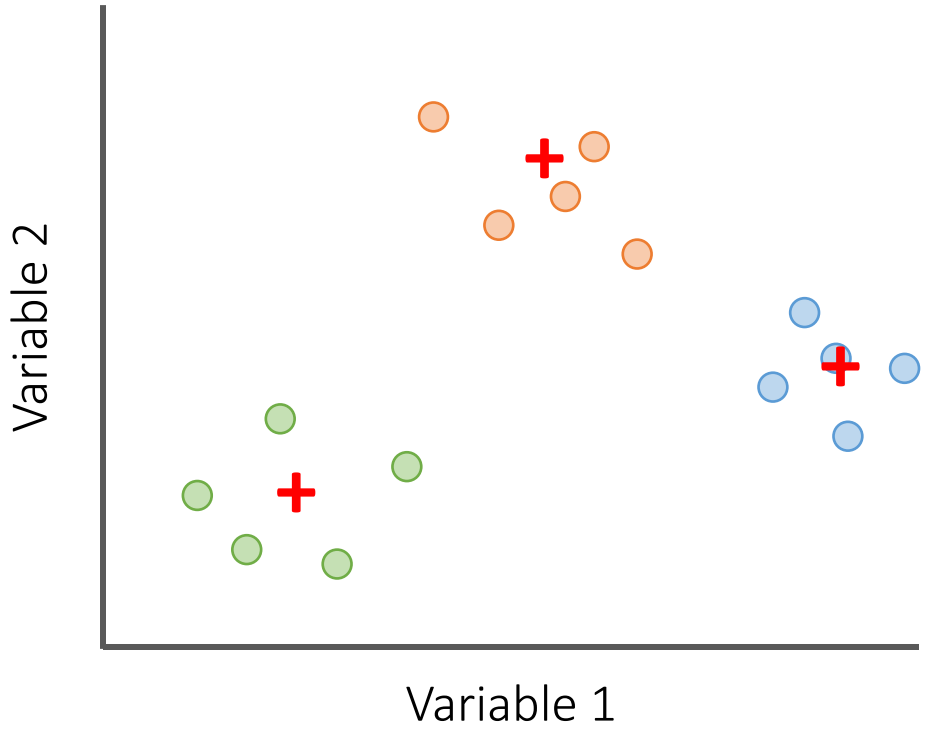
- Optimize clusters by iteratively "stabilizing" the location of the centroids
- Validate clusters



Cluster analysis

- Determine the optimal *k* for clustering on two sets of variables
  - **Frequencies** of number questions, large number talk, and advanced number talk
  - **Proportions** of number questions, large number talk, and advanced number talk
- Run *k*-means cluster analysis on each set
- Compare the derived clusters using validation measures
  - The degree of connectedness between clusters (connectivity)

Clusters of parents based on ***frequencies*** of number talk

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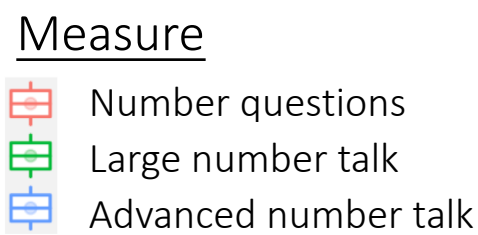

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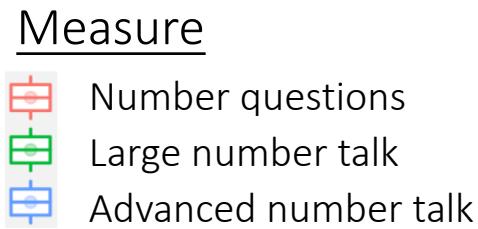
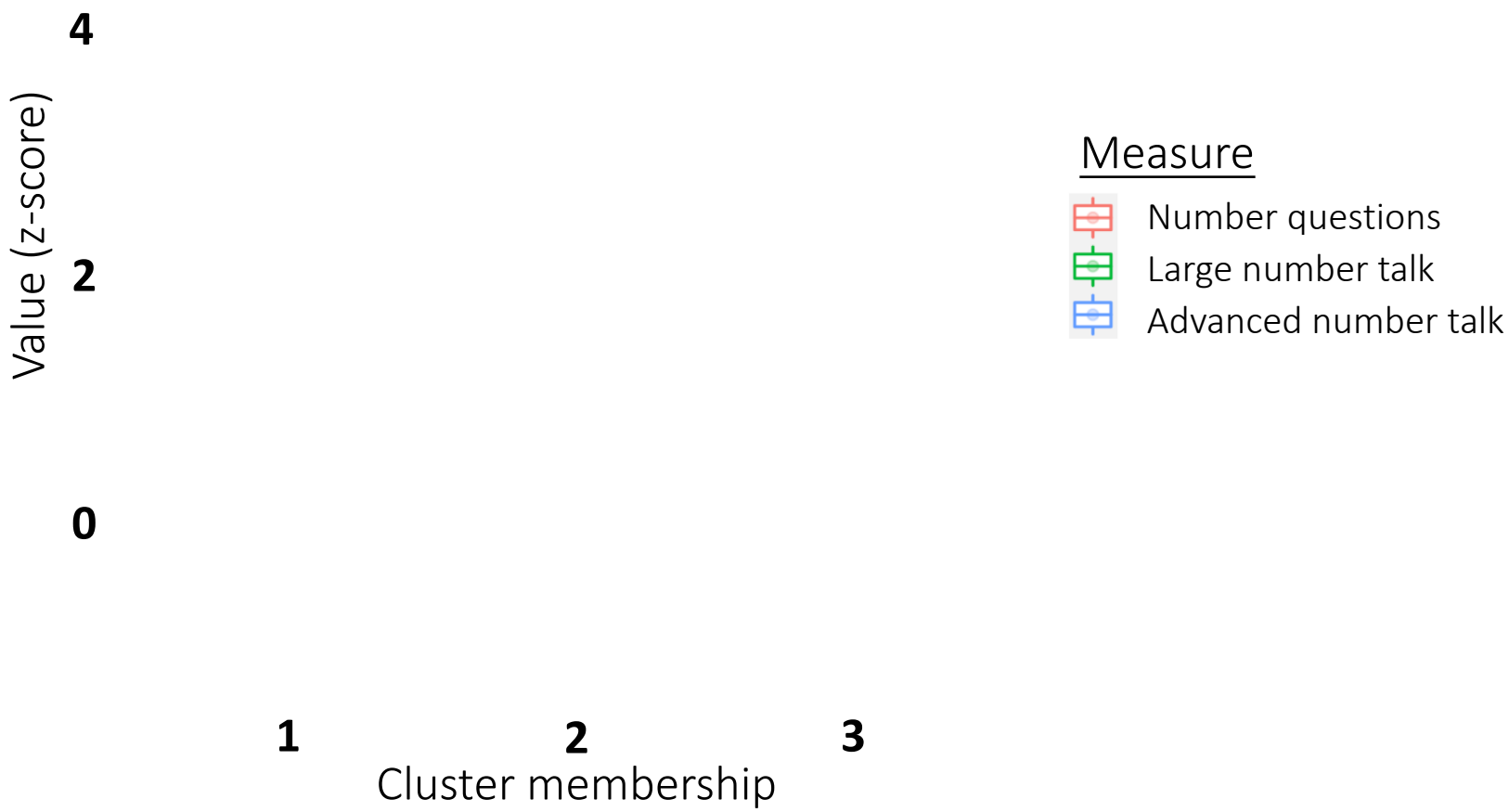


1 **2** **3**

Cluster membership

Clusters of parents based on ***frequencies*** of number talk



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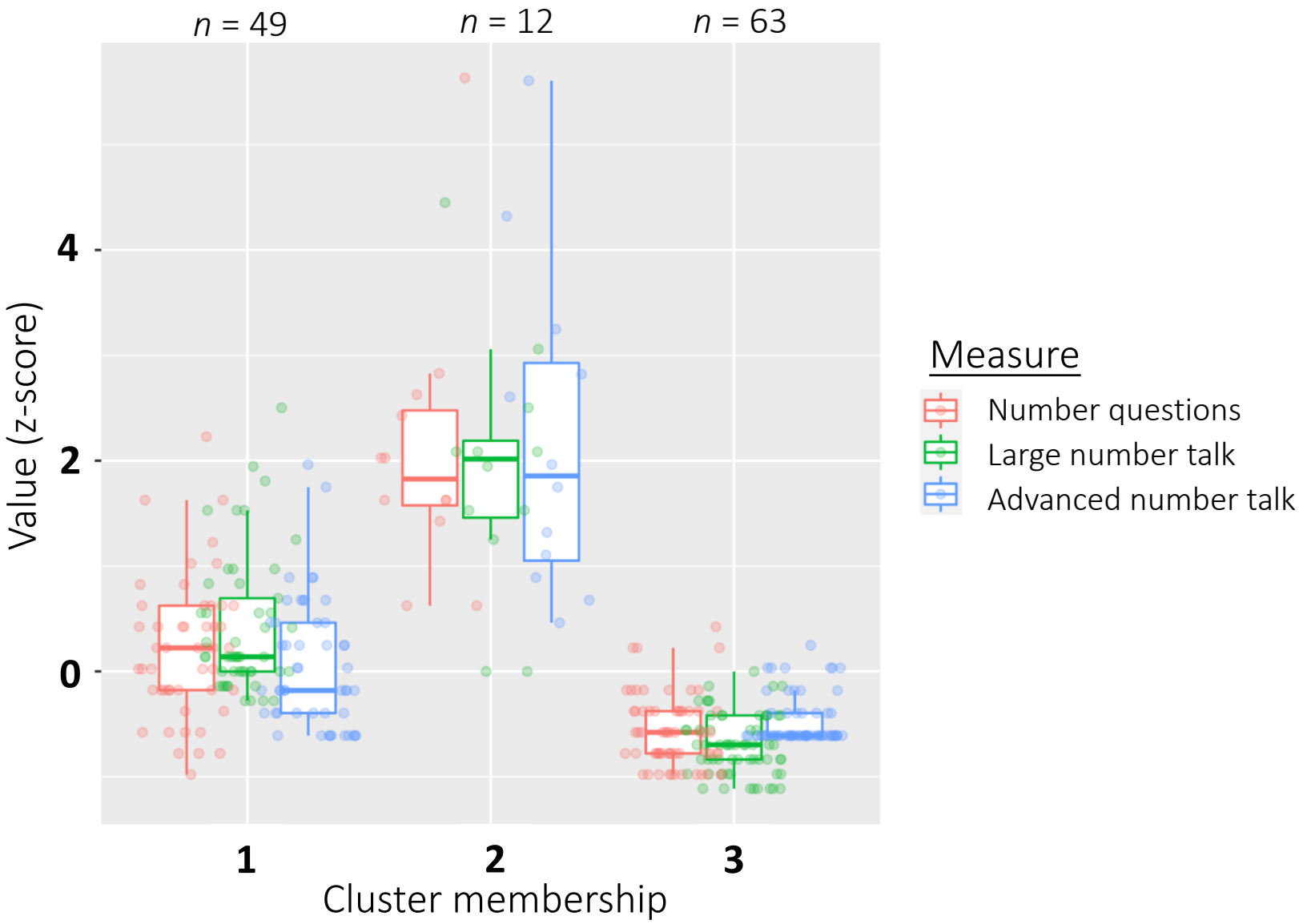

Connectivity of clusters = 7.47

Clusters of parents based on ***proportions*** of number talk

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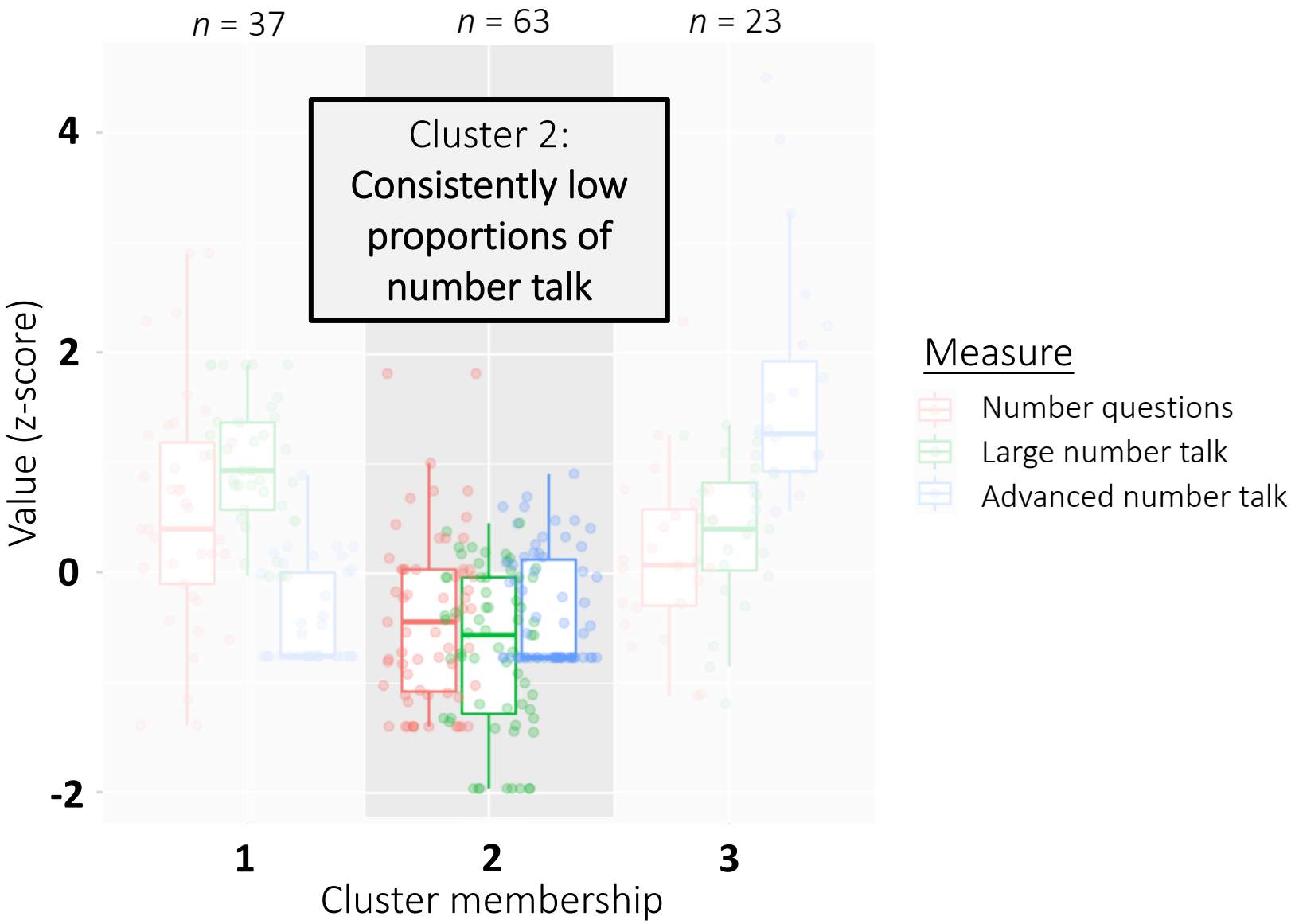

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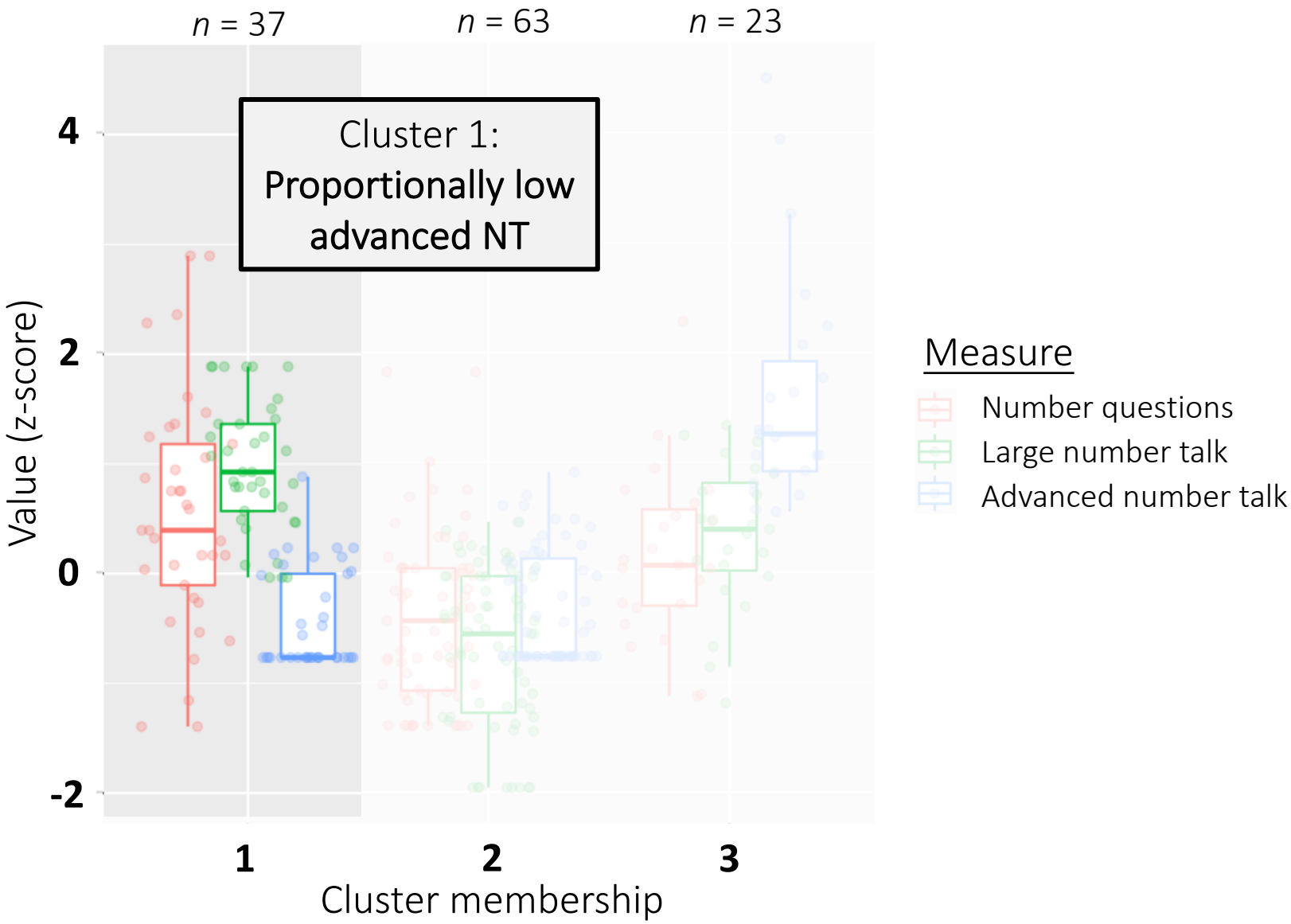

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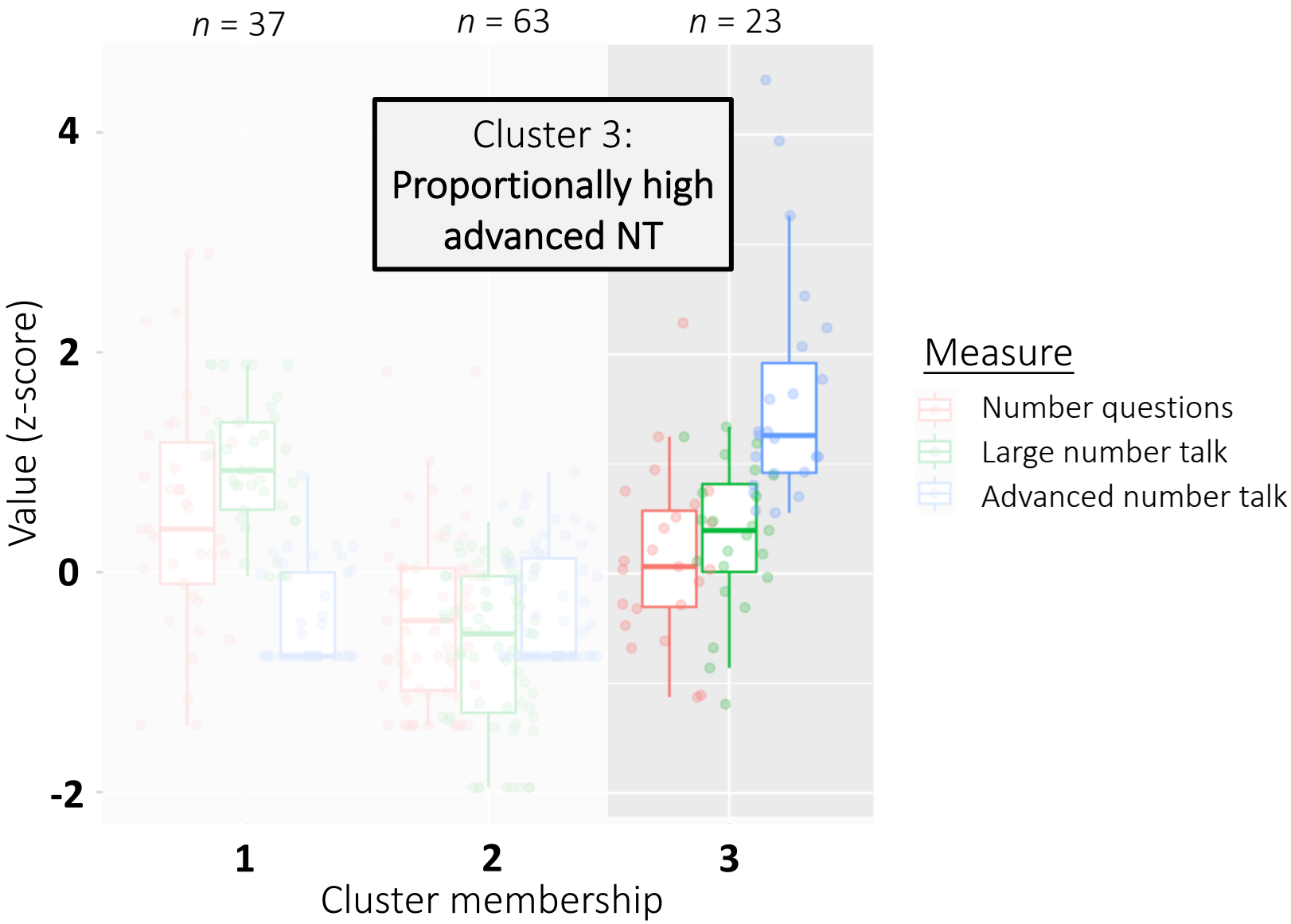

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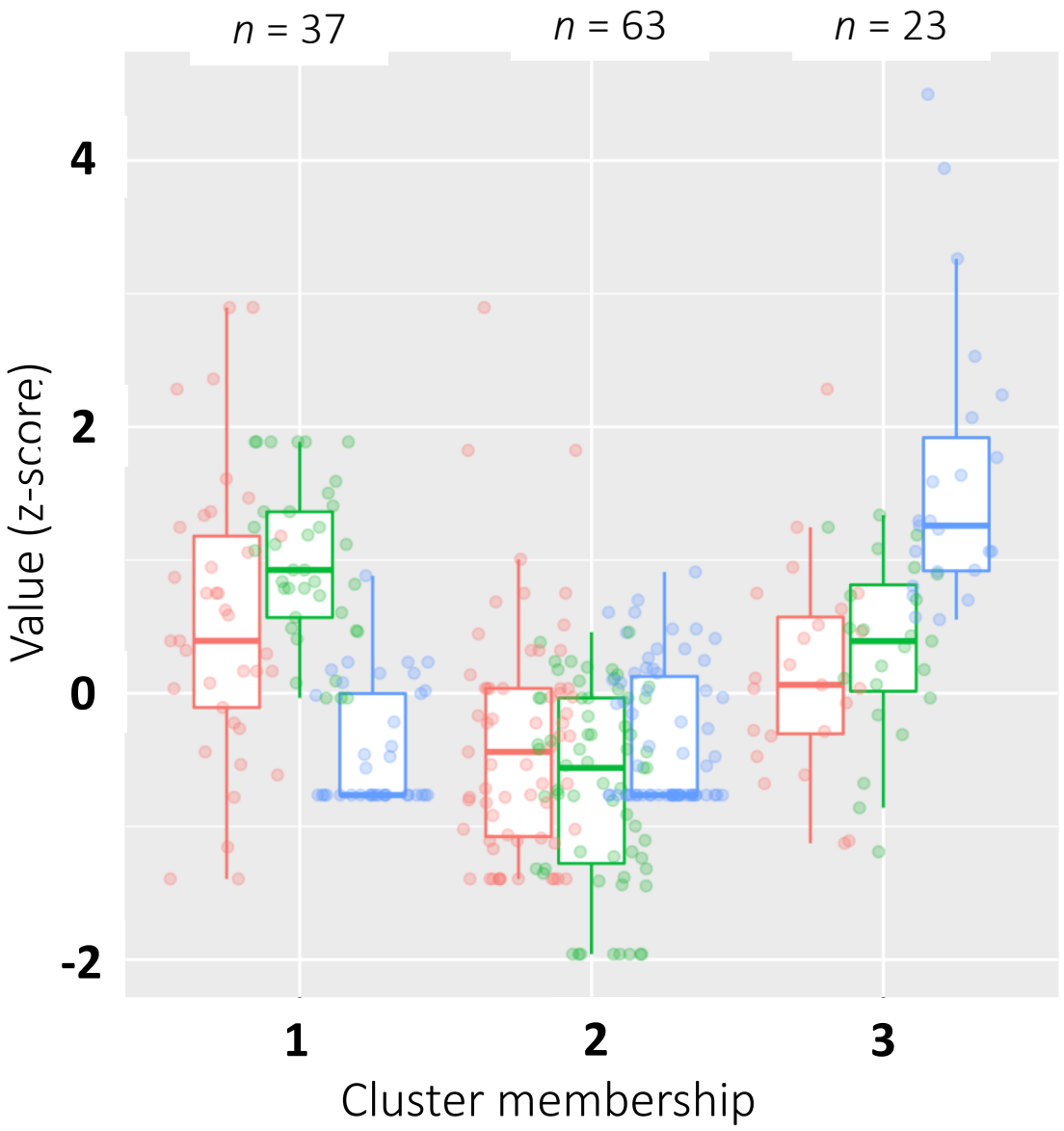

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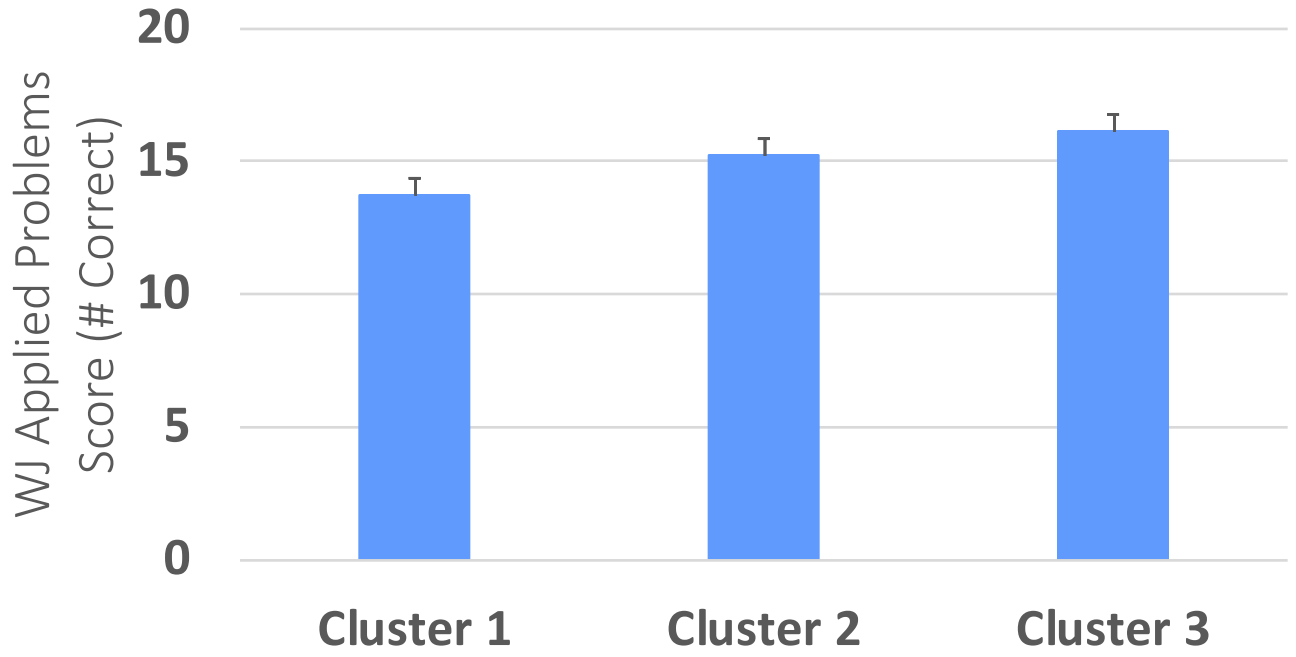
s = 4.44

Comparing clusters on child math skills

RQ3: Is there an association between parent number-related interaction style and child math skills?

It appears so!

Parent clusters differ on children's math skills, *Welch's F*(2, 60.01) = 3.97, *p* = .024



Cluster 3:
Proportionally high advanced NT

Summary

- Single measures of parental number talk do not significantly relate to children's math skills.
- Parents vary systematically across different measures of the *proportion* of number talk provided during dyadic interactions.
- A majority of parents in this sample provide consistently low proportions of number questions, large number talk, and advanced number talk.
- Parents' number-related interaction styles relate to children's math skills.

Limitations and future directions

- Limitations of *k*-means:
  - All clusters are (hyper-)spherical
  - Each data point "equally" belongs in its cluster
  - Sensitive to outliers
- Selection of variables
- Do parents' number-related interaction styles relate to children's *later* math skills and are these associations domain-specific?

Thank you for listening ☺ Any questions?

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Special thanks to the Parents Promoting Early Learning research team (especially the number talk coders) and the participating families!

Parents Promoting Early Learning

Pitt KiT Lab Kids' Thinking

UNIVERSITY OF PITTSBURGH

LRDC Learning Research & Development Center

NIH National Institutes of Health