

Low- and high- math anxiety individuals' representations of math:

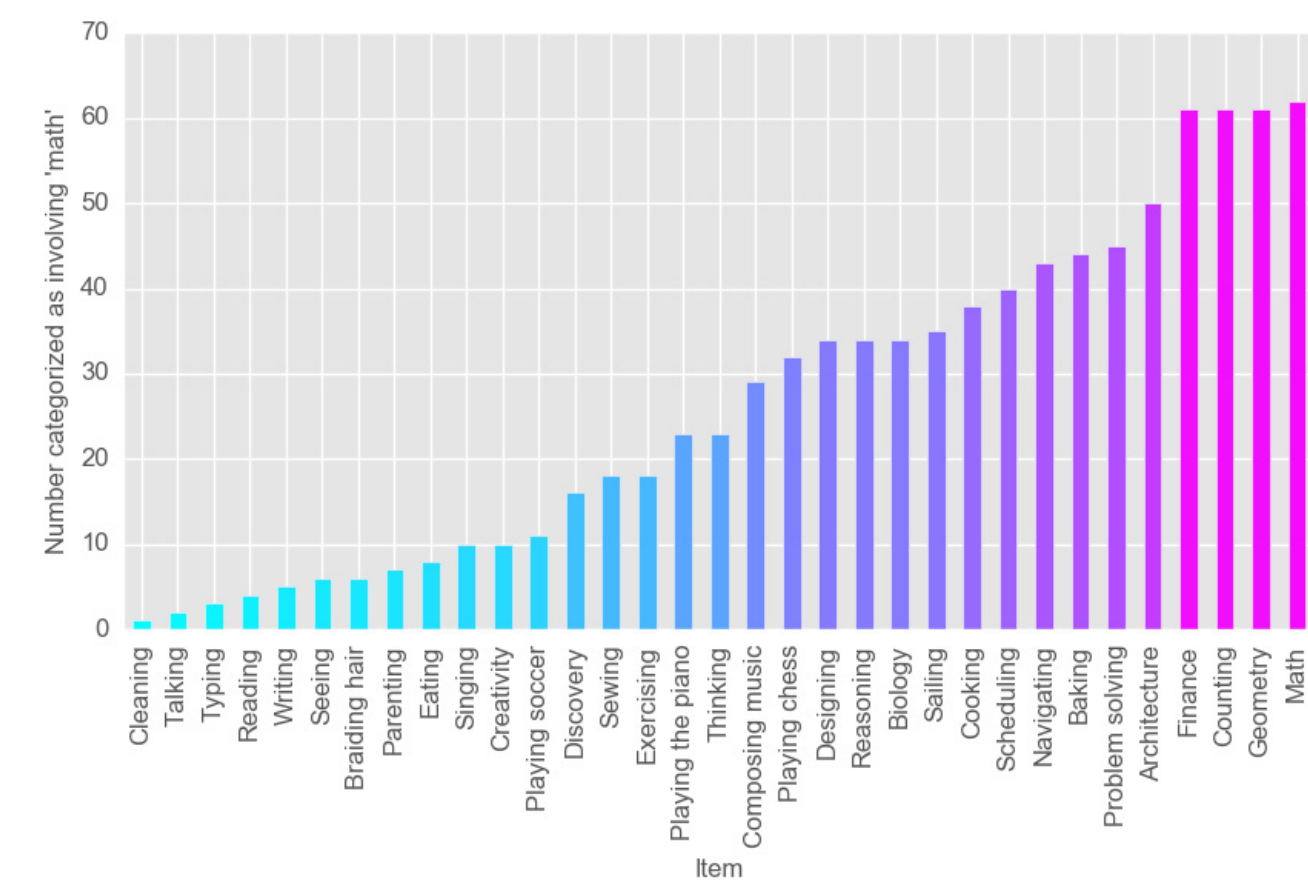
A multidimensional scaling analysis

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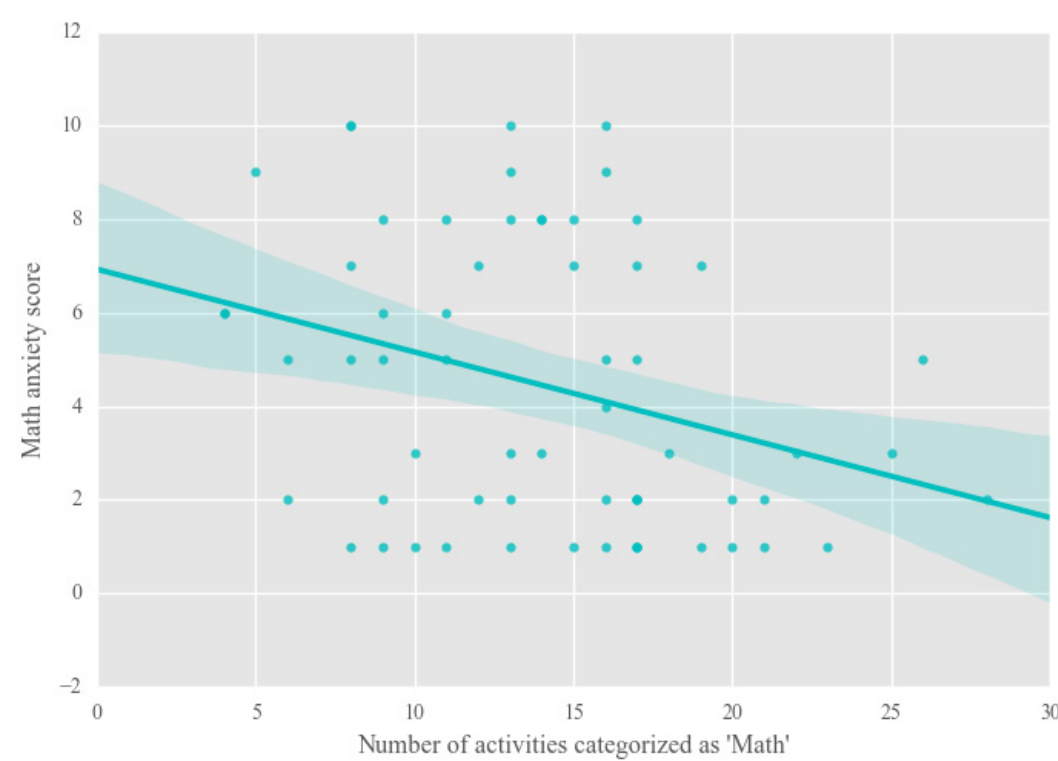
Background

- Individuals can hold math conceptions that range from **narrow** (*I am only doing math when I do arithmetic*) to **broad** (*Swimming is mathematical because the angle of your arm affects your speed*).

- In a previous study¹, adults indicated whether they believed a set of activities did or did not involve math. Participants had varied ideas of what kinds of things involved math.



- The breadth of an individual's math conception (the number of activities they categorized as "math") was related to their level of math anxiety¹: Individuals with higher math anxiety categorized fewer items as "math" (see figure).



Understanding how math exists in individuals' conceptual spaces is vital for informing future interventions on math anxiety, and to encourage conceptions of math that are broad and multifaceted — which may be protective against math anxiety — as opposed to narrow and restricted.

Research Questions

- How are activities related to math organized in individuals' mental representations?
- Does the structure of individuals' math conceptions vary depending on their math anxiety?

We predict that math anxious individuals will have a smaller and more tightly clustered set of activities or topics they count as math, which may center on those that are explicitly numerical and include fewer that are more creative or abstract.

- We conducted an exploratory study using classic cognitive science tools to begin to understand how activities related to math are perceived and represented by individuals, and along what dimensions those representations might vary.

Methods

Participants: 24 undergraduate students at the University of California, Berkeley (5 male, mean age = 20.2 years) participated in a preliminary study to explore how low- and high-math anxiety individuals might develop differing definitions of what math is, or *math conceptions*.

- In the first of three blocks, participants rated the similarity on a scale from 0 to 10 between all possible pairs of a diverse list of 17 items (e.g. 'How similar are typing and architecture?'):

- Architecture
- Finance
- Cooking
- Navigating
- Problem solving
- Exercising
- Scheduling
- Playing chess
- Typing
- Sewing
- Writing
- Playing sports
- Biology
- Designing
- Reasoning
- Composing music
- Playing an instrument

- In addition to rating the similarity of each possible pair of items, participants answered whether each activity "could involve math" (yes/no/not sure). Participants also completed the 24-item Math Anxiety Rating Scale². The order of these two tasks was counterbalanced across participants.

Results

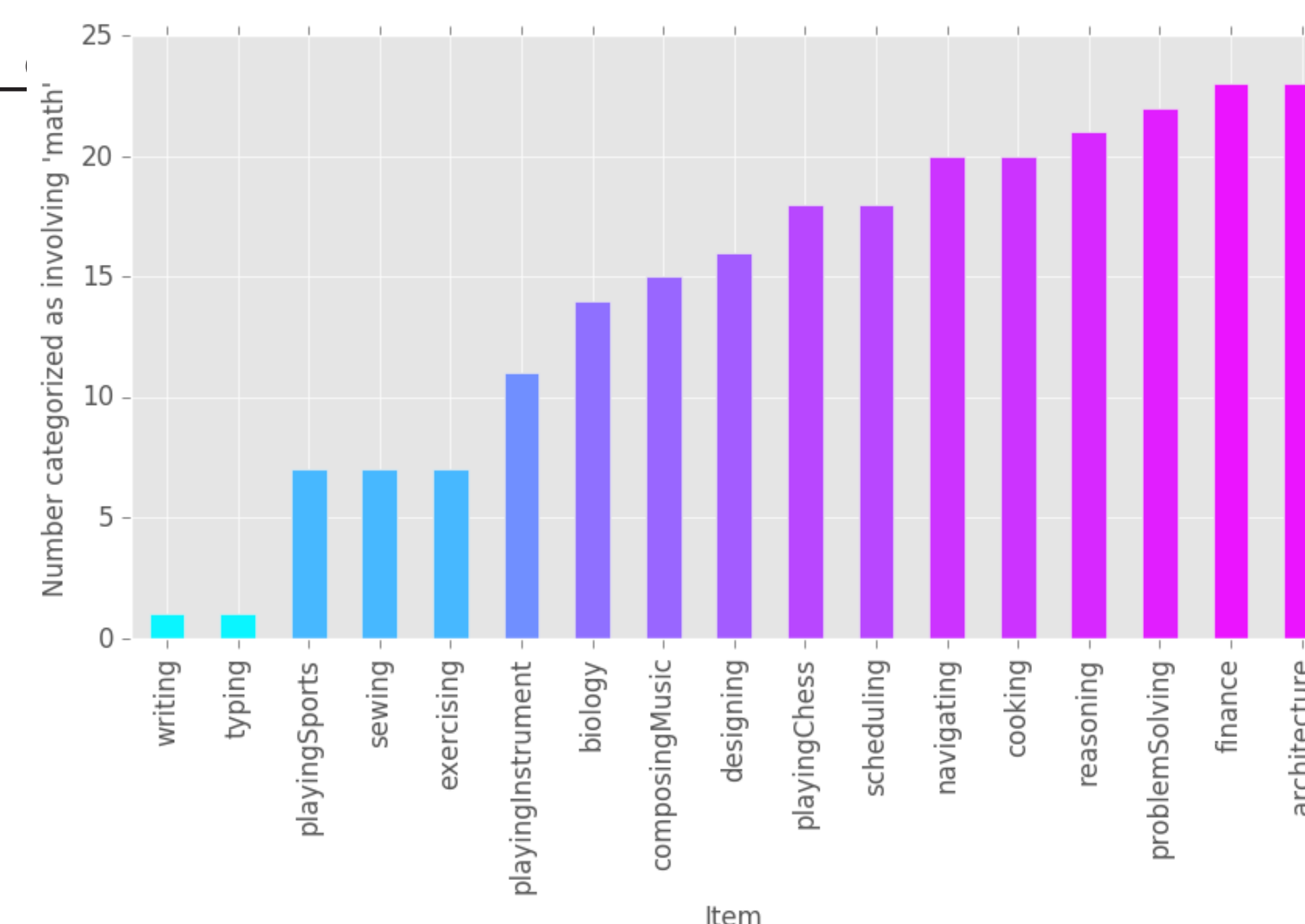
Math Anxiety

Math anxiety varied among participants ($M = 2.76$, $SD = 0.50$).

Breadth of conception

As seen in previous studies, breadth of conception varied across participants.

Did not replicate previous correlation between math conception and MA, but there were several procedural differences.

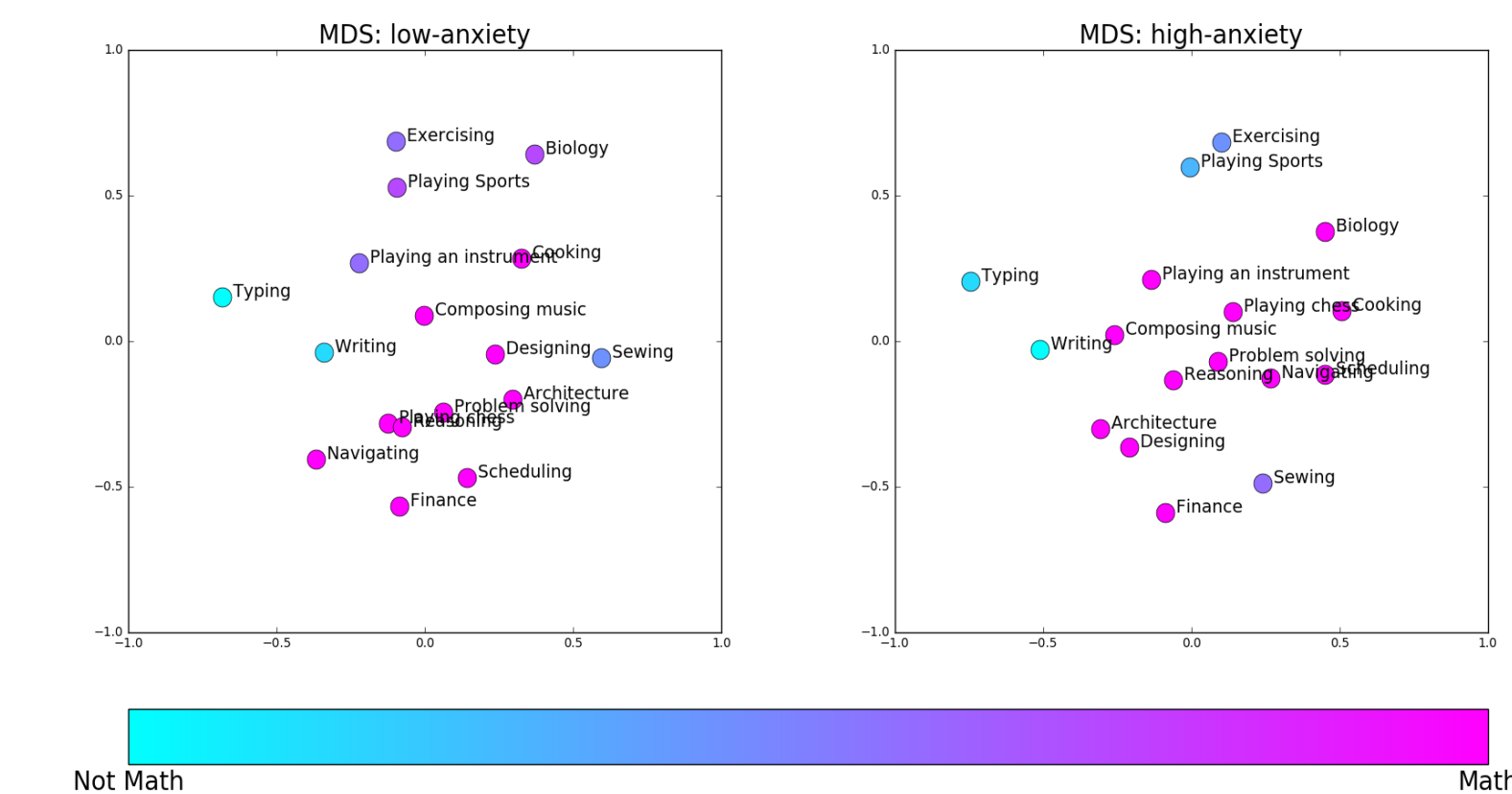


Multidimensional scaling

We divided participants based on a median split of their anxiety score and conducted a multidimensional scaling analysis of each group's mean similarity ratings for each item pair.

Results, cont.

The colors represent the number of people who characterized each activity as involving math.



The conceptual spaces of high- and low-anxiety individuals are essentially identical. Without any prompting, there is structure in the clusters based on the proportion of participants who categorized each activity as involving math.

Conclusions

- As seen in earlier studies, adults have varied conceptions of math.
- 'Mathy' activities tend to be clustered together, with distinct clusters roughly representing creative, intellectual, and physical endeavors.
- These representations were shared, regardless of anxiety.
- Based on the MDS similarity space, it appears that low-anxiety individuals in the previous study categorized activities coming from a greater number of clusters as involving math than did high-anxiety individuals.
- Difference in relation between MC and MA between previous study and this one may be due to decreased item list

Future Directions

- Given that similarity ratings are known to be highly consistent, yet context-dependent³, how will first priming individuals to think about math influence the way they represent math in psychological space?
- Will this differ with level of math anxiety?
- Pile-sorting may enable us to include more items.
- How do conceptions of math *develop* (and how do different curricula influence how math is represented)?

References

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- Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2015). *Psychological Science*, 26(9), 1480–1488.
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