# Real-World Estimation Taps Into Basic Numeric Abilities

Barbara K. Kreis[1], Julia Groß[1] , Thorsten Pachur[2,3]

[1] University of Mannheim, [2] Max Planck Institute for Human Development, Berlin, [3] Technical University of Munich

## INTRODUCTION

Accurately **estimating quantities** is an important everyday task (e.g., time to get to a location or assessing environmental issues such as annual $CO_2$ emissions).[1]

Which **psychological factors** enable us to make accurate estimates?

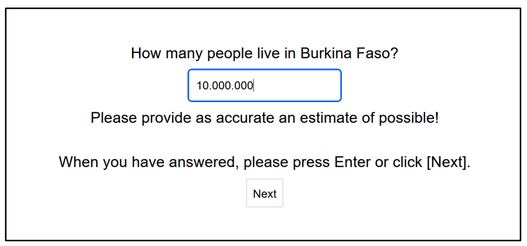
Most research on real-world estimation has focused on how **domain knowledge** (e.g., specific exemplars, range of the values of the domain) helps produce accurate estimates.[2] But is knowledge all that matters?

Here we consider whether also basic numeric abilities – such as **symbolic-number mapping**, the ability to accurately represent quantities relative to each other on a mental number line – contribute to real-world estimation. Symbolic-number mapping has been shown to subserve various other numeric decision-making tasks (e.g., risky choice) [3] but has not yet been investigated in the context of real-world estimation.

In two experiments, we tested whether **real-world estimation is associated with symbolic-number mapping.**

## METHODS

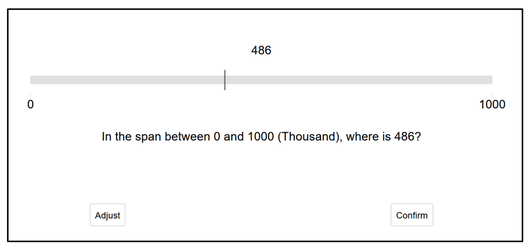
The experiments were conducted online (Prolific). Participants performed two tasks.




To measure **real-world estimation accuracy**:
Country Populations Estimation Task

Estimation Error =

$$\left|\log_{10}\left(\frac{estimated\ value}{actual\ value}\right)\right|$$




To measure **symbolic-number mapping accuracy**:
Number-Line Task

Mapping Error =

$$\left|\left(\frac{estimated\ value - actual\ value}{actual\ value}\right)\right|$$

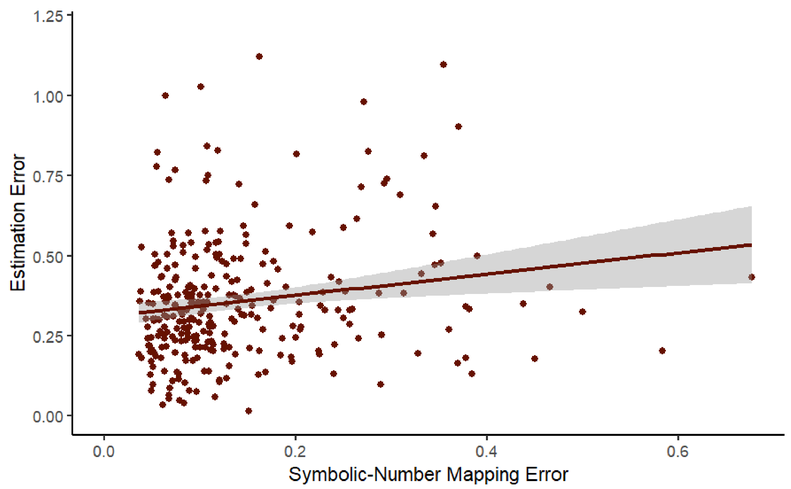
## RESEARCH QUESTIONS

1) Is accuracy in real-world estimation **associated** with accuracy in symbolic-number mapping? (EXPERIMENT 1)

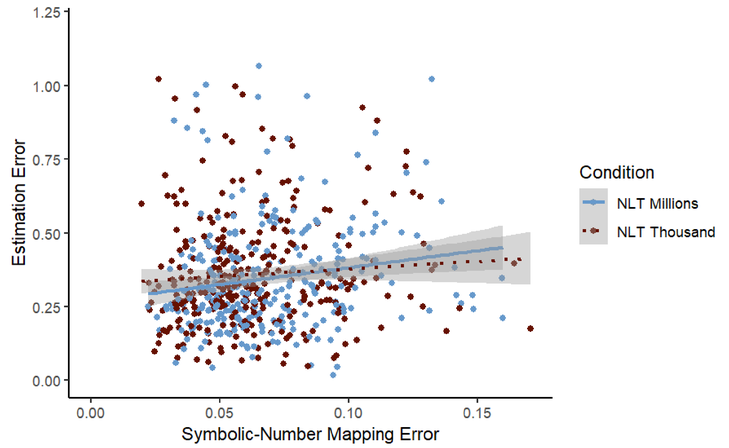
2) Does the association also hold when **controlling for domain knowledge**? (EXPERIMENT 2)
→ Self-report measure of domain knowledge

3) Is the **association stronger when the range of the number-line task** used to measure symbolic number mapping (traditionally up to 1,000) **matches the range of the estimation task** to measure real-world estimation? (EXPERIMENT 2)
→ In one condition participants performed a number-line task ranging from 0 to 1,000 (*NLT Thousand*), in another condition ranging from 0 to 100,000,000 (*NLT Millions*).

## EXPERIMENT 1 (*N* = 286)




## EXPERIMENT 2 (*N* = 592)




## RESULTS

**1) Estimation accuracy is associated with symbolic-number mapping accuracy (BF = 52).**

**2) Estimation accuracy is independently associated with symbolic-number mapping (BF = 37) and domain knowledge (BF > 1,000).**

**3) The association is independent of the number-line range (Thousand or Millions) (BF = 0.8).**

## CONCLUSIONS

Symbolic-number mapping contributes to real-world estimation accuracy, and it does so independently of domain knowledge. This association is independent of whether symbolic-number mapping is measured with a small-number or a large-number range.

Our research suggests that interventions to improve real-world estimation can benefit from not only focusing on imparting knowledge about specific domains but could also include a more generalized route by training symbolic-number mapping.

References

1 Boyce-Jacino, C., Peters, E., Galvani, A. P., & Chapman, G. B. (2022). Large numbers cause magnitude neglect: The case of government expenditures. *Proceedings of the National Academy of Sciences*, *119*(28), e2203037119.

2 Brown, N. R. (2002). Real-world estimation: Estimation modes and seeding effects. In *Psychology of Learning and Motivation* (Bd. 41, S. 321–359). Academic Press.

3 Peters, E., & Bjalkebring, P. (2015). Multiple numeric competencies: When a number is not just a number. *Journal of Personality and Social Psychology*, *108*, 802–822.

If you have any questions, comments, or simply want to connect, please don't hesitate to contact me:
E-Mail: barbara.kreis@uni-mannheim.de
Twitter: bk_kreis