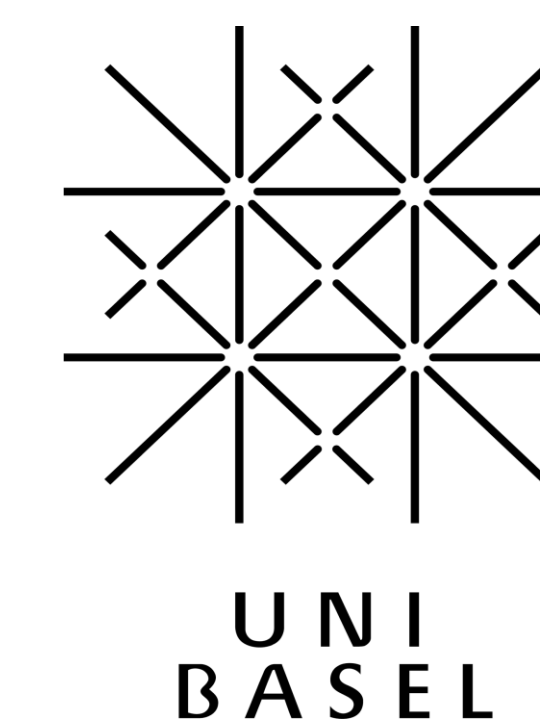


# Numeric Cognition and Experience-Based Economic Valuation

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## Introduction

The perception and integration of information from a sequence of symbolic numbers is a complex task. It is a prerequisite for experience-based economic behavior, and yet it is usually not part of economic decision theory.

## Research Question

To what extent can economic behavior be explained by regularities in the perception and integration of numeric information?

## Hypothesis

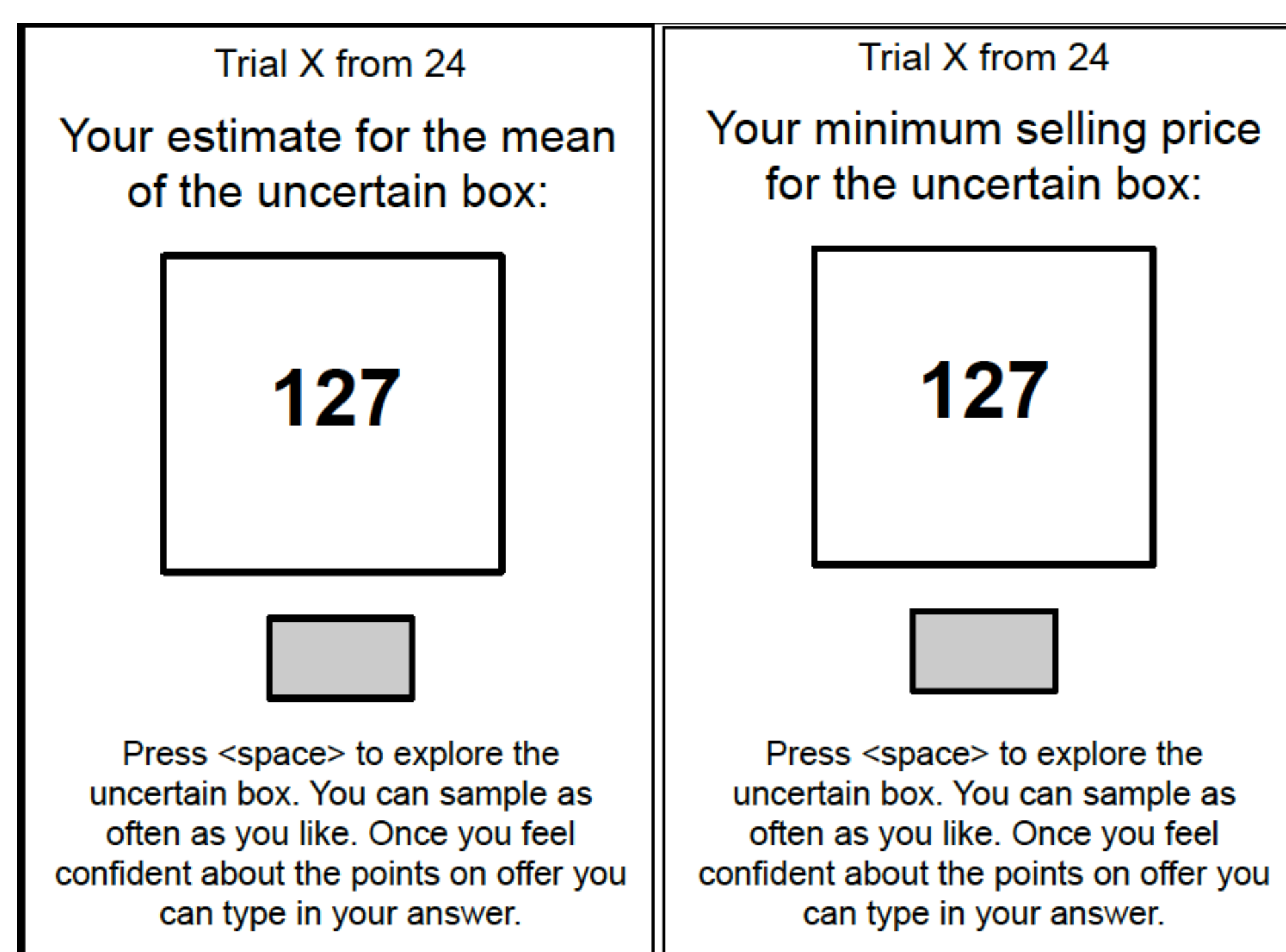
According to the compressed mental number line hypothesis, estimates of the mean of a number sequence should be

- below the true mean,
- lower when variance is higher and
- lower for left- compared to right-skewed sequences.

## Method

### Overview

- Participants sample from continuous number sequences that vary in the mean, the variance, and the skewness.
- There are two blocks with 18-24 trials per block.
- The task differs between blocks:
  - Participants estimate the mean (accuracy incentivized).
  - Participants give their certainty equivalent (BDM auction).

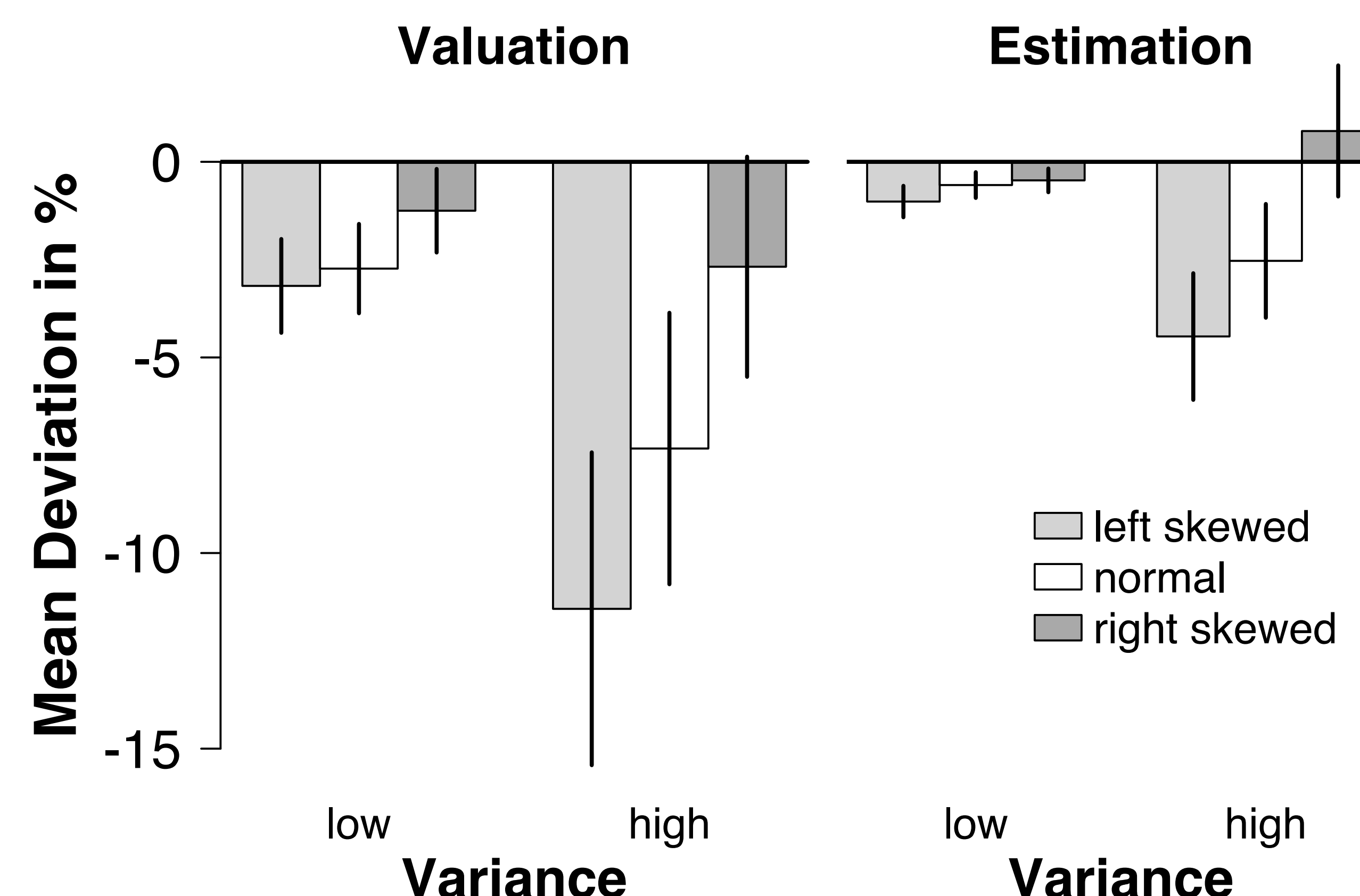


Main dependent variable:  $p_{dev} = \frac{answer - m_{seq}}{m_{seq}}$

## Results

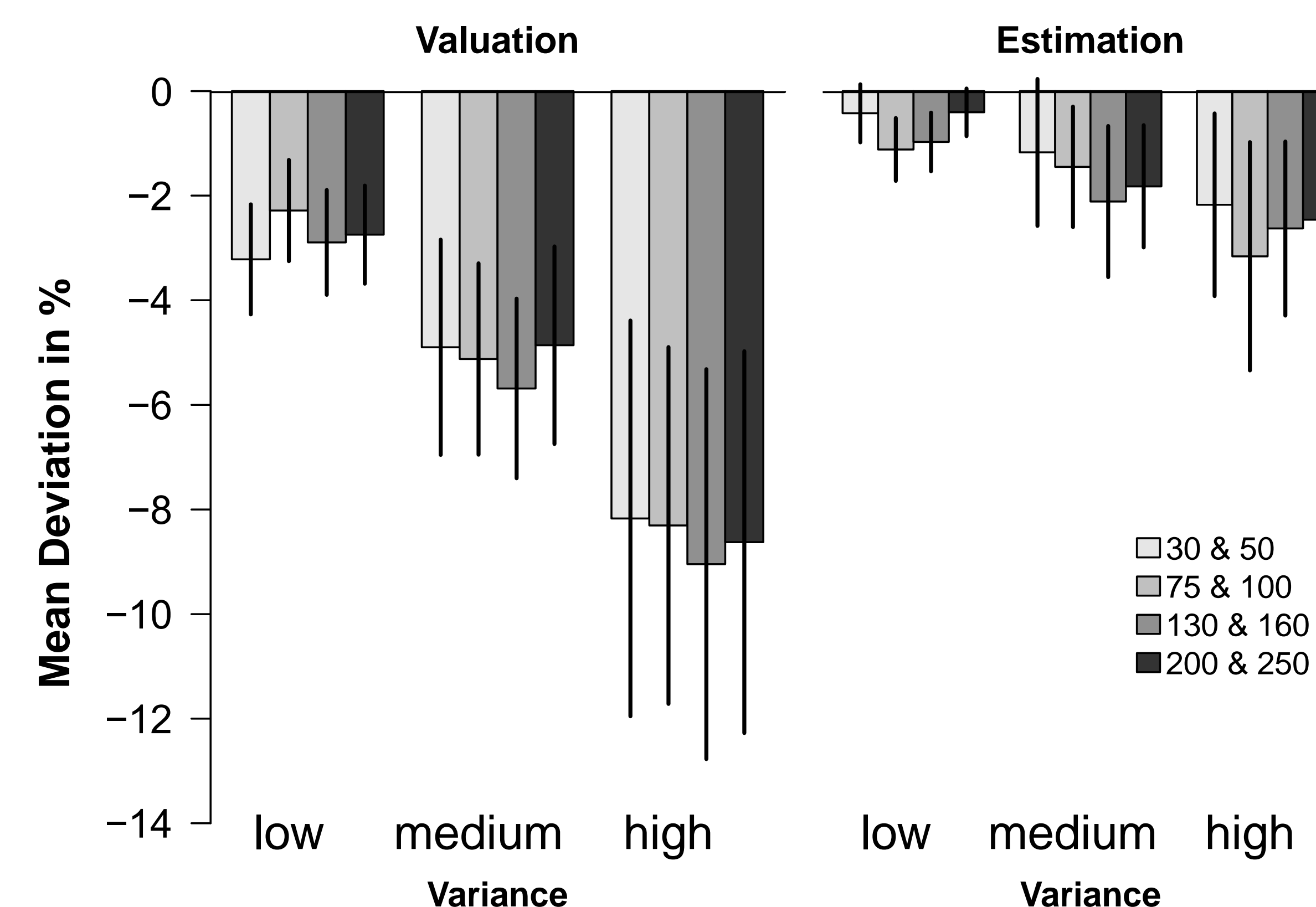
### Experiment 1 & 2:

These two experiments (n=109) show that people underestimate and undervalue number sequences compared to the true mean. High variance and left-skewed sequences lead to stronger underestimation and -valuation.



### Experiment 3:

In previous studies there was a positive effect of the mean on deviations. This might be due to the fact that variability (variance/mean) was lower for higher means. This study (n=120) held variability constant and showed that the variability, but not the mean had an influence on valuations.



### Experiment 4:

In two blocks, participants (n = 110) gave certainty equivalents, but in one block they knew the mean and in another block they had to estimate the mean first before they gave their certainty equivalent.

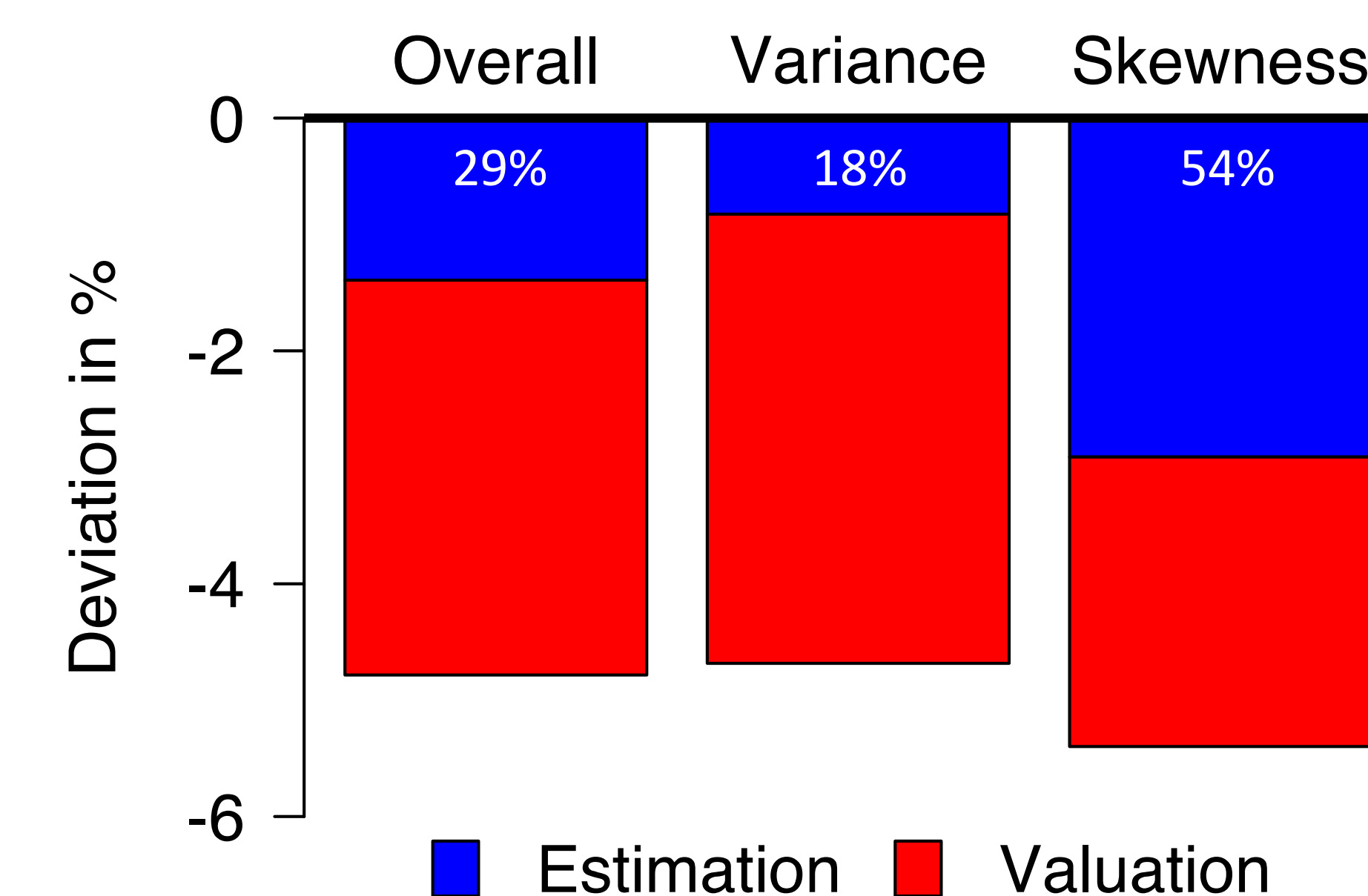
In line with the idea that estimation biases influence economic valuation, certainty equivalents were lower when the mean was unknown (deviation from true mean: -10.33%) compared to when the mean was known (-9.98%) – significantly negative intercept in mixed-effect regression (p < .001).

Pre-registered replication of all effects reported in Experiment 1 & 2 in a fixed sampling (20x) design.

### Quantitative effect of estimation biases on economic valuations:

Assumption:

Economic Valuation = Estimation + Economic Preference



**Variance:** Ratio of deviation in high variance – low variance in estimation over valuation

**Skewness:** Ratio of deviations in left-skewed – right-skewed in estimation over valuation

## Discussion

- The results are not in line with overweighting of high numbers in the gain domain nor with underweighting of rare events.
- Overall support for the compressed mental number line hypothesis.
- When sampling was free, sample size increased with the sequence's variance (adaptive sampling) and did not differ systematically between tasks.
- Experiment 2 & 4 were pre-registered at: <https://osf.io/ehkuz/>

## Take-Home

- Part of what is conceived as preferences in experience-based economic behavior stems from regularities in numeric cognition.