The numerical size effect in symbolic numbers and everyday number frequency

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The study
The present study examines whether the size effect in Indo-Arabic numbers can be modified within a comparison task by changing the frequency with which the numbers are presented.

The size effect means that when two numbers are compared, performance deceases with larger numbers (Moyer & Landauer, 1967).

The current explanation for the size effect is the larger overlap of the representations of large numbers in the Analogue Number System (ANS) – an innate, continuous, noisy numerical representation (e.g., Dehaene, 2007).

The size effect can also be explained by a mental lexicon-like system termed the Discrete Semantic System (DSS) in which it depends on the frequency of the numbers (Dehaene & Mehler, 1992; Krajcsi et al., 2016; Verguts et al., 2005).

An earlier study showed that modifying the frequency of numbers induces a size effect in new, artificial symbols (Krajcsi et al., 2016). Other effects in numerical cognition have been shown to change within a session of the comparison task (e.g., distance effect – Krajcsi & Kojouharova, submitted; Kojouharova & Krajcsi, in preparation).

The study shows that the size effect can be modified by reducing the overlap in the ANS representations of large numbers in the ANS.

Methods
- Indo-Arabic numbers from 1 to 9 presented in pairs, excluding ties
- Number comparison task, in which participants chose the larger number of a number pair by pressing a key
- Three conditions with different frequency of presentation for each number (everyday, uniform, reverse)
- 2382 trials in the everyday and reverse frequency conditions (794 trials per block) and 2376 trials in the uniform frequency condition (792 trials per block)

Results
- Stimulus frequency has a clear effect on the size effect.
- On the other hand, everyday statistics is also visible in the size effects (e.g., reversed stimulus frequency decreased the size effect, but did not reverse it entirely)
- Frequency of the stimuli are learned very quickly (in the first third of the session), and no further change is visible

Comparison in the slope of the size effect between the three conditions

\[ \chi^2(2, N = 47) = 8.05, p = 0.018 \]

\[ \chi^2(2, N = 47) = 15.2, p < 0.001 \]

\[ \chi^2(2, N = 47) = 20.4, p < 0.001 \]

Conclusions
- It is possible that there are two sources of the size effect observed in a comparison task
- One of the sources is the frequency of the numbers in the session and is consistent with the DSS
- The other source can be the statistics experienced in everyday life, resulting in a more stable component of the effect, which could be consistent with both DSS and ANS models

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