Time perception

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When randomization hurts

I have always been fascinated by people's ability to estimate how long things take. Most tasks that people face, from driving to playing tennis, require precise estimates of duration. However, these estimates are subject to various biases. For instance, people tend to overestimate short durations and underestimate long durations. This effect, known as Vierordt's law, has been extensively documented since its discovery by Karl von Vierordt in 1868. However, I struggled to find a mechanistic explanation for this effect.

In 2021, Stefan Glasauer and Zhuanghua Shi meticulously demonstrated that Vierordt's law might be an artefact of a widely used experimental method: randomization. Through the reanalysis of previous empirical data, simulations from an iterative Bayesian updating model and new empirical data, the authors showed that Vierordt's effect almost completely vanishes when durations that participants are asked to estimate are not randomized.

The explanation for this finding has to do with the ecological validity of randomization. In daily life, most phenomena are relatively stable (that is, they exhibit only small fluctuations). Thus, for example, it is sensible to base a prediction about tomorrow's temperature on today's temperature. By contrast, in psychophysical experiments, randomization of experimental stimuli or conditions creates abrupt changes from trial to trial. According to the authors, these large trial-to-trial changes create an 'unnatural' situation that renders the usual strategy inefficient: participants cannot rely on the previous time periods (trials) to predict the next one. Indeed, under randomization conditions, when participants rely on this strategy, this translates into Vierordt's law: they underestimate durations that are unusually long compared to previous durations and overestimate durations that are unusually short compared to previous durations.

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These results are relevant well beyond the topic of time perception. For instance, a common finding in the motor imagery literature is that it takes more time to imagine short actions than to execute them, and less time to imagine long actions than to execute them. In other words, the durations of short actions are overestimated whereas those of longer actions are underestimated. These effects in motor imagery studies are assumed to reflect genuine cognitive processes related to motor imagery. However, they might be strengthened by randomization.

The paper by Glasauer and Shi resonated with me because it questions one of the gold-standard methods of modern experimental psychology and forced me to think about when randomization is appropriate and when it is not. Whereas randomization prevents habituation or expectation biases that might arise when the same stimulus is repeated multiple times or when stimuli are presented in an ascending or descending order, it has consequences of its own. Indeed, the simulations and empirical data reported by Glasauer and Shi show that sometimes randomization can generate effects that are not related to the cognitive processes of interest. This is an important message for researchers from all disciplines.

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Competing interests

The author declares no competing interests.

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Related articles: Vierordt, K. *Der Zeitsinn nach Versuchen* (H. Laupp'sche Buchhandlung, 1868); Glasauer, S. & Shi, Z. Individual beliefs about temporary continuity explain variation of perceptual biases. *Sci. Rep.* **12**, 10746 (2022); Guillot, A. et al. Understanding the timing of motor imagery: recent findings and future directions. *Intl Rev. Sport Exerc. Psychol.* **5**, 3–22 (2012)