

# Does size matter?

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*Propositions of the thesis*

Does Size Matter? Behavioral and Neural Insights into the Representation of Small and Large Number Symbols

Fabian van den Berg

- I. The acquisition of numbers, connecting numerical meaning to visual symbols, only partially relies on associating a representation (words/numeral) to a real-world quantity. - *This Thesis*
- II. Directly associating non-symbolic quantities and symbolic number representations occurs for symbols 1-4, where an exact numerical meaning can be extracted from non-symbolic quantities without counting. Symbols beyond the subitizing range rely on the inference of symbol-to-symbol relationships rather than being mapped onto a non-symbolic variant. - *This Thesis*
- III. Canonical finger-number representations have gained an ideographic/iconic status in long-term memory, allowing for fast retrieval of their meaning, bypassing subitizing or counting strategies. - *This Thesis*
- IV. Canonical finger-number representations facilitate the processing of number symbols in adulthood, possibly a remnant of their role in learning numbers during childhood. - *This Thesis*
- V. Behavioral measures cannot differentiate between numerical understanding and the use of non-numerical strategies; neural measures, on the other hand, can investigate the processes underlying behavioral results to numerical tasks and determine if the numerical meaning was accessed or not. - *The Discipline*
- VI. The early N1 EEG ERP component indicates a "violation of expectation" effect after a symbol has been associated with a non-symbolic counterpart. The later P2p EEG ERP component reflects the cognitive resources needed to retrieve the numerical meaning of a symbol. - *This Thesis*
- VII. The N1 and P2p ERP components can be used in learning paradigms to investigate whether symbols, finger-numbers, or other representations are truly understood as having numerical meaning. - *This Thesis*
- VIII. To better understand how the brain processes numerical information and learns to connect this to abstract symbols, we must embrace new research methods, new analysis techniques and be prepared to let go of existing frameworks. - *The Discipline*
- IX. Fundamental research investigating the neural basis of number processing in adults and typically developing children forms the foundation for future experimental paradigms and interventions; one cannot improve something without knowing how it works - *The Discipline*
- X. Understanding the processes involved in numerical processing and how numerical representations gain meaning can provide a scaffold for researchers and teachers to improve how children learn to navigate an increasingly number-heavy world. - *Impact of this thesis*
- XI. "An alleged scientific discovery has no merit unless it can be explained to a barmaid." - *Lord Ernest Rutherford of Nelson*