Octuplicate this interval!

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Stevens’ direct psychophysical scaling methods\(^1\) rest on the assumption that subjects are capable of processing ratios of sensation magnitudes. This assumption became empirically testable when Narens\(^2\) stated necessary conditions of commutativity and multiplicativity to be satisfied by the data. Their validity can be tested by magnitude or ratio production experiments\(^3\), in which the participant is instructed to adjust the magnitude of a comparison stimulus in a ratio \(p\) or \(q\) to the magnitude of the standard stimulus. The monotonicity axiom, which is even more fundamental, can be tested by determining whether presenting different numerals \(p\) produces corresponding ordered adjustments, i.e., whether representation of magnitudes occurs on a sensory continuum. If different successive ratio productions are commutative (i.e., exchanging their order does not affect the outcome), it can be assumed that the participant represents sensation magnitudes on a ratio scale. In addition, the multiplicativity axiom can be tested to show that successive ratio productions result in the same outcome as the single adjustments of their mathematical products. If the latter property holds, the participants use the numerals like scientific numbers.

To test whether these axioms hold for duration perception, \(N = 10\) participants were asked to adjust the duration of a comparison tone to specific ratios of two different standard durations. In each trial, the standard interval (indicated by tones, presented via headphones) was followed by a comparison interval of random duration. The comparison interval had to be adjusted to a \(p\) multiple of the standard (\(p \in \{1, 2, 3, 4, 6, 8\}\)). In addition, there were five types of successive adjustments (per standard), required for the commutativity and multiplicativity tests, in which participants had to extend a previously adjusted comparison interval (e.g., \(p\) times as long as the standard) by another ratio production factor \(q\). Each participant produced twelve adjustments of each type, resulting in a total 264 of adjustments.

In line with previous findings obtained for other sensory continua such as area\(^4\), pitch\(^5\), or loudness\(^6\), monotonicity held for the duration adjustments of all participants. Significant violations of commutativity were found in 12.5% of all pertinent tests, whereas multiplicativity was violated in 32% of the tests. These results demonstrate that participants are quite capable of processing duration on a ratio scale level, but that the numbers used to describe perceived duration cannot be taken at face value. Thus, the fundamental assumption of Stevens’ direct scaling methods is of restricted validity for the perception of duration: even if a ratio scale of duration may be assumed, the overt responses cannot be interpreted as directly reflecting that internal scale.

References


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