

BRK-017 · Making sensation measurable: psychophysics and mental chronometry

BRK · Conceptual Breaks

Juan Segurolo · All Rights Reserved

The fact that a sensation is privately experienced does not prevent public experiments on the conditions under which people distinguish stimuli or make responses. Nineteenth-century psychophysics and mental chronometry exploited this possibility. They did not put a ruler directly inside experience. They connected controlled physical differences, observable judgments and response times through models whose assumptions could be examined.

The break was methodological as well as conceptual. Questions about sensation and mental operations acquired quantitative forms. But the numerical result did not automatically reveal the structure of a mind: a threshold, an inferred scale and a difference of response times represented distinct claims.

1. A difference has a context

Adding a small weight may be noticeable when the starting weight is small and difficult to notice when it is large. The relevant experimental relation is between a physical increment and the level from which the increment begins. Fechner's account of Weber's law made proportional stimulus differences central to a quantitative treatment. [1]

In an idealized range, write the just-noticeable increment as $\Delta I = kI$, where I is stimulus intensity and k a proportionality

constant. This is not a universal law of every sense at every intensity. Threshold behavior, adaptation, task and the manner of presenting the alternatives can affect its applicability.

For an illustrative k of 0.05, a starting intensity of 100 arbitrary units gives an increment of 5, while a starting intensity of 200 gives an increment of 10. The physical increment doubles even though the proportional difference stays the same. These invented values illustrate a relation, not historical measurements or recommended limits for human detection.

The measured judgment is also not automatically a private unit of experience. Reporting that two stimuli differ is an action in a task. To turn a pattern of such actions into a scale of subjective magnitude requires an additional argument.

2. From discriminable steps to a sensation scale

Fechner proposed treating equal just-noticeable differences as equal increments of sensation. Combined with a proportional stimulus-increment rule, this leads to a logarithmic relation between a constructed sensation magnitude and physical intensity. His *Elements of Psychophysics* explicitly connects the empirical relation and the proposed measurement principle. [1]

The reasoning can be shown without concealing the assumption. If each proportional increase I to $I(1 + k)$ counts as one equal subjective step, n steps take the stimulus from an initial level I_0 to $I_0(1 + k)^n$. Solving gives $n = \ln(I/I_0)/\ln(1 + k)$. Thus equal ratios correspond to equal numbers of these constructed steps.

The logarithm follows from the premises; it does not independently verify them. A person might discriminate successive changes reliably without experiencing each as an equal increment

of magnitude. The inferential leap is therefore not in the algebra but in identifying a discrimination unit with a sensation unit.

This distinction makes the project scientifically interesting rather than futile. It reveals an assumption that can be criticized, compared with alternative scaling methods or tested under different tasks. A quantitative account gains precision when its bridge from observation to interpretation becomes explicit.

3. Measuring time between stimulus and response

Donders' work on the duration of mental processes approached a different observable. The interval between a stimulus and a response contains several events, including sensory processing and response production. Comparing tasks could, under assumptions, isolate the time associated with an additional discrimination or choice. His nineteenth-century paper is available in a 1969 English translation. [2]

One task might require the same response whenever a signal appears. Another might require a choice between responses according to the signal. Their mean reaction times can differ. The difference is an observation; assigning it to a particular intervening mental operation is an interpretation based on a model of task structure.

This was a substantial change in what could be investigated. A mental operation did not need to be directly visible if its addition to an otherwise comparable task had a measurable temporal consequence. The method made an internal-process hypothesis answerable to public timings.

4. Subtraction works only when the terms mean what we claim

Suppose, illustratively, that a simple task takes an average of 250 milliseconds and a choice task 340 milliseconds. The difference is 90 milliseconds. It represents the duration of an added operation only if the other relevant components remain unchanged and the arrangement of processing permits subtraction.

If adding a choice also slows stimulus encoding, changes preparation or alters motor execution, the 90 milliseconds combines several effects. If stages overlap in time, the difference need not equal the duration of any single stage. Accurate arithmetic cannot repair an incorrect model of what is being subtracted.

Sternberg's 1969 analysis explicitly examined processing stages and extensions of Donders' method. Its importance here is the shift from treating a difference score as self-interpreting to examining which experimental manipulations and stage assumptions support an inference. [3]

Repeated observations can reduce uncertainty about the mean difference while leaving the structural interpretation uncertain. These are different uncertainties. An experiment may establish a very stable effect without uniquely identifying the mental operation responsible for it.

5. Measurement without a metaphysical verdict

Neither a psychophysical threshold nor a reaction-time difference settles every question about the relation between mind and body. The experiments establish relations among physical conditions, reports and actions. A philosophical claim about what experience ultimately is requires arguments beyond the successful timing or scaling procedure.

Conversely, uncertainty about ultimate ontology does not make the experimental relations useless. One can compare conditions, examine regularities and discriminate between process models without first resolving every metaphysical disagreement. The possibility of this intermediate achievement was part of the conceptual change.

It would also be misleading to compress Weber, Fechner and Donders into one unified “cognitive revolution.” Their questions, methods and theoretical commitments differed. The connection is a family of ways to make aspects of mental life quantitatively investigable, not a single doctrine adopted at one moment.

6. A new form of explanatory responsibility

The lasting contribution was a disciplined division of labor. Instruments specified stimuli and times. Participants supplied judgments or responses. Models connected those observations to claims about sensation or processing. Each connection could succeed, fail or require modification independently of the others.

What became unnecessary was the demand that a process be directly visible before it could be studied quantitatively. What became necessary was a defensible account of how the visible measurement constrained the invisible process. That requirement remains demanding precisely because a number can be accurate while the interpretation attached to it is too strong.

Related reading

BRK Article 016, “Formal proof encounters internal limits,” distinguishes a formally valid operation from stronger claims that require additional assumptions.

References

- [1] Fechner, G. T. *Elements of Psychophysics* (1860), selected passages in the 1912 English translation, reproduced in *Classics in the History of Psychology*. <https://www.yorku.ca/pclassic/Fechner/>
- [2] Donders, F. C. "On the speed of mental processes." *Acta Psychologica* 30, 412–431 (1969), translation of the 1868–1869 paper. [https://doi.org/10.1016/0001-6918\(69\)90065-1](https://doi.org/10.1016/0001-6918(69)90065-1)
- [3] Sternberg, S. "The discovery of processing stages: Extensions of Donders' method." *Acta Psychologica* 30, 276–315 (1969). [https://doi.org/10.1016/0001-6918\(69\)90055-9](https://doi.org/10.1016/0001-6918(69)90055-9)