# TO AVERAGE OR NOT TO AVERAGE? – THAT IS THE QUESTION

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1938 - Skinner joins the 'non-statistical side'

It is obvious the kind of science proposed here belongs on the non-statistical side. … *in placing itself in that position it gains the advantage of a kind of prediction concerning the individual that is necessarily lacking in a statistical science. … Individual prediction is of tremendous importance so long as the organism is to be treated scientifically.*

Skinner, B.F. (1938). *The behavior of organisms.* New York: Appleton Century [emphasis added; p 443].
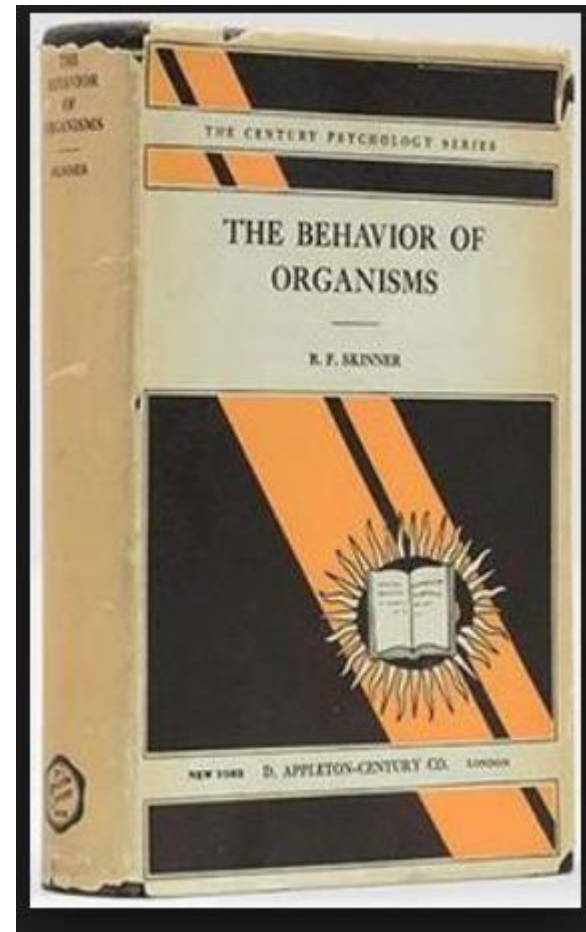
1960 - Sidman endorses Skinner's position

*Reproducible group data describes some kind of order in the universe, and as such may well form the basis of a science. … It is a science of averaged behavior of individuals who are **linked together only by the averaging process itself**. Where it fits in the scheme of natural phenomena is a matter for conjecture. My own feeling is that it belongs to the actuarial statistician and not to the investigator of behavioral processes.* [p274-275]
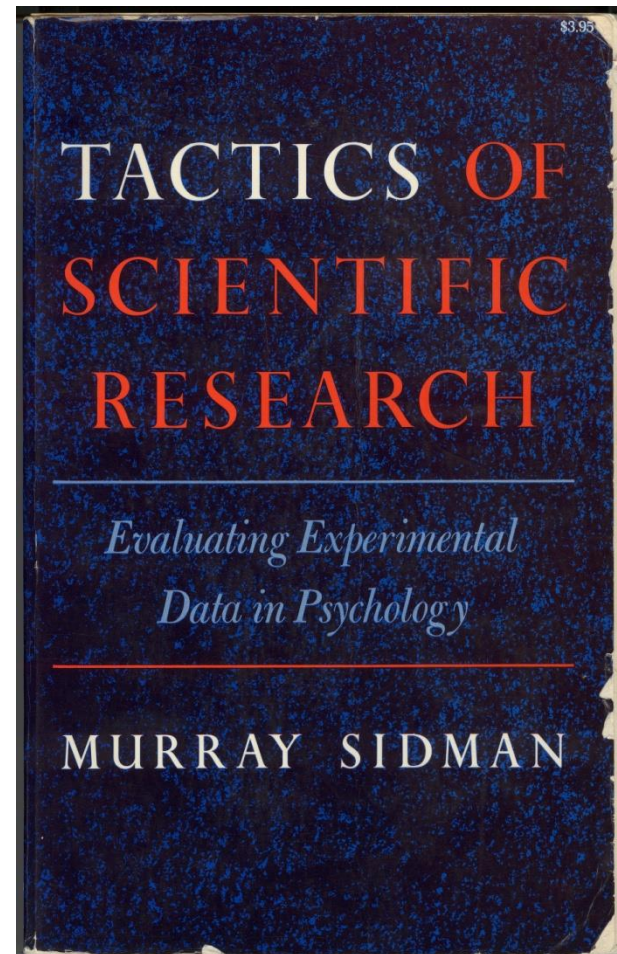
1970's - Applied behaviour analysis follows suit

The individual is of paramount importance in the clinical science of human behaviour change. Until recently, however, this science lacked an adequate methodology for studying behaviour change in individuals. [p1]…

Averaging of results

A … difficulty noted by many applied researchers is the obscuring of individual clinical outcome in group averages. [p15] … It is difficult to say anything about individuals within the group based on the average response since … some are improving and some deteriorating. [Hersen & Barlow (1976) p 56].

But, there are regular calls for change

I recommend … that behavior analysts should add statistical inferential procedures to their toolbox, because that tool is useful for scientific, educational, political, and evangelical purposes.

Crosbie, J. (1999), Statistical inference in behavior analysis: Useful friend. *The Behavior Analyst,* 22, 105-108.

An expanded study of … behavior will undoubtedly require more frequent use of group designs and statistical methods. … [these] are the very same methods that behavior analysts eschewed … to create a unique discipline…

Vyse, S. (2013). Changing course. *The Behavior Analyst, 36,* 123 – 135.

This necessitates group averaging

Arguments against averaging #1

An argument from nature

I believe that the fallacy of reified variation – or failure to consider the "full-house" of all cases – plunges us into serious error again and again.
[*The median is not the message,* S. J. Gould, 1997].

Quetelet's proposition

He [Quetelet] suggested that instead of making numerous observations on an individual as he progressed through life, the changes from one age level to another might be studied by making observations on large numbers of people at different ages … This … establishes the precedent for drawing inferences concerning the nature of dynamic individual phenomena on the basis of statistical comparisons made between large groups of individuals.

[Johnson & Pennypacker, 1993, p 91]

Arguments against averaging #2

Quetelet's proposition is a fallacy –

At least two things should be noted about this dreadful literature. First, between-persons data are being used to make an inference of a within-individual effect. Second, a group effect (summed over persons) is being used to infer a causal effect whose nexus is located within the individual. Neither inference is warranted .

[Rorer, L.G., & Widger, T.A. (1983). *Annual Review of Psychology, 34*, 431-463.]

Arguments against averaging #3

Group average = individual trajectory isomorphism requires measurement of an ergodic system

Only when measurement process are ergodic can data on inter-individual variation (IEV) be used to explain intra-individual variation (IAV). But …

… *most psychological processes will have to be considered nonergodic. For nonergodic processes, an analysis of the structure of IEV will yield results that differ from … analysis of IAV. … for … all developmental processes, learning processes, adaptive process … explicit analyses of IAV … are required to obtain valid results.*

[Molenaar (2004), *Measurement: Interdisciplinary Research & Perspectives, 2(4)*, p 202]

Non-ergodic properties of behaviour increasingly recognised

The focus of contemporary developmental science is framed within relational developmental systems models … The emphasis on relational developmental systems results in the view that developmental science is a nonergodic field. *… As a consequence of nonergodicity, developmental scientists stress the importance of person-centered and change-sensitive methodologies …*

[Lerner, et al., (2013). *Review of General Psychology, 17*, 179 – 183; p 179]

Conclusions

Psychology, to the extent that it relies … [on] averages across individuals, becomes an actuarial science, not a science of behavioural processes.

[Branch & Pennypacker (2013). *APA Handbook of Behavior Analysis, Vol 1*, p156].

- Skinner was right!
- There are even more compelling reasons to reject between-subject averaging than there were in 1938, 1960, or 1970's.
- Averaging is permitted (Sidman, Gould) but only with great caution.

Abstract

At its inception in the work of Skinner the nascent field of behaviour analysis eschewed between-subject (group) averaging, Skinner (1938) remarking that [*this] kind of science … belongs on the non-statistical side* (p443), and that *individual prediction is of tremendous importance so long as the organism is to be treated scientifically* (p444). Sidman (1960) strongly endorsed this, while allowing group averaging in specific circumstances. Nevertheless, from time to time, eminent behaviour analysts have called for the field to adopt group statistical methods requiring group averages, often on pragmatic grounds that this will help the field engage more with mainstream research. This paper will first consider why Skinner and Sidman argued as they did, and then consider several more recent arguments that support their position. The first is an argument that extends and generalizes Sidman's from a biological perspective, noting that it is variability that drives natural selection, the most central process in biology, and that natural selection is blind to the average. Stephen J Gould argues that pre-occupation with group averages risks overshadowing proper attention to variability. The second argument considers the dangers of attempting to make inferences about within-subject processes from between-subject data (Quetelet's fallacy), and the third, relatedly, considers the implications of measurement theory that specifies that inter-individual variation can only be used to explain intra-individual variation when the measurement system is *ergodic.* Most measurement in psychology and behaviour analysis, however, is *non-ergodic.* I conclude that the field should continue to eschew group averaging as a matter of principle, except in the instances that fit the conditions specified by Sidman, and with due attention to variablity (Gould).