Measurement

SCIENCE

Vol. 103, No. 2684 Friday, June 7, 1946

On the Theory of Scales of Measurement

S. S. Stevens
Director, Psycho-Acoustic Laboratory, Harvard University

A Classification of Scales of Measurement

Paraphrasing N. R. Campbell (Final Report, p. 340), we may say that measurement, in the broadest sense, is defined as the assignment of numerals to objects or events according to rules. The fact that

Chapter 3: Classical test theory (true score theory): X = T + E

- X is a sumscore across items;
- E is a random error score with an expected value of 0 (on average error is 0);
- T is a true score (what the result should be if there were no random error), thus T is the expected value of X
- *In this basic form of CTT no latent variable is explicitly accounted for*

How measurement is actually achieved (is there a quantitative latent variable, if we consider measurement at an interval scale level) remains obscure.

- Qualitative assessment of the content captured by the measurement instrument (content validity)
- Internal behaviour (split-half/internal consistency/test-retest reliability; inter-item correlations, (corrected) item-total correlations; floor and ceiling effects)
- Emphasis on external behaviour of presumed measurements
  - (High) correlation with measurements of similar constructs or other measures of the same construct (convergent validity)
  - (Imperfect) correlation with measurements of constructs to be distinguished from the construct in question (discriminant validity)
  - Differences between groups that are known to be different (known-group validity)
  - Relationship with external criteria that should be strong (concurrent validity)
  - Relationship with external criteria assessed in the future (predictive validity)
  - Functioning in nomological networks (nomological validity)

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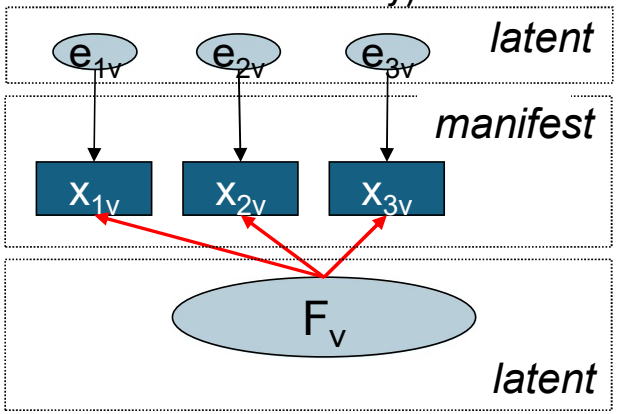
How measurement is actually achieved (is there a quantitative latent variable, if we consider measurement at an interval scale level) remains obscure.

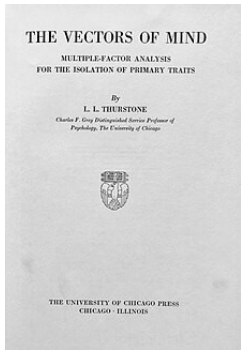
- Introduce a latent variable (→ latent variable theory)

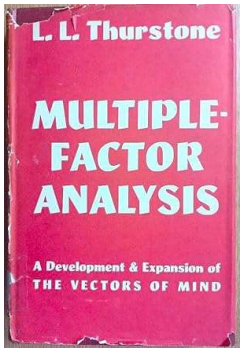
$$x_{iv} = \tau_i + \lambda_i * F_v + e_{iv}$$

$$x_{1v} = \tau_1 + \lambda_1 * F_v + e_{1v}$$
$$x_{2v} = \tau_2 + \lambda_2 * F_v + e_{2v}$$
$$x_{3v} = \tau_3 + \lambda_3 * F_v + e_{3v}$$



- Factor analysis (*fit in CFA*)
- In the end, internal behaviour of item scores.





L.L.Thurstone (1931/35/47)

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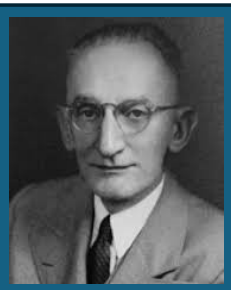
"measurement is the estimation of the magnitude of a quantitative attribute relative to a unit"
Michell, J. (2003). Measurement: a beginner's guide. *Journal of Applied Measurement*, *4*(4), 298-308

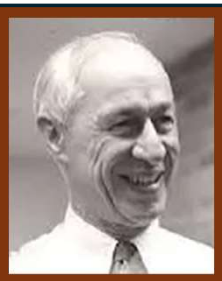
E.g., a measurement of length could be: 2 m
which is 2 times 1 m (=the unit), or
the magnitude of 2 m stands in a ratio of 2:1 to the magnitude of 1 m

Scientific task of measurement:
demonstrating that there is a quantitative latent variable

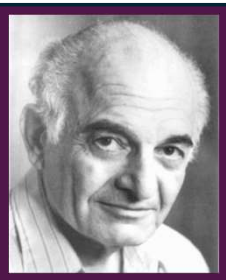
Three scaling methods



Louis Leon Thurstone
(1887-1955):
equal appearing intervals
(two opposing reasons for
disagreement)



Rensis Likert
(1903-1981):
Likert scaling



Louis Guttman
(1916-1987):
Guttman scaling
(cumulative structure,
deterministic model)

PSYCHOLOGY AS A QUANTITATIVE RATIONAL SCIENCE[1]

By Professor L. L. THURSTONE
THE UNIVERSITY OF CHICAGO

Inaugural address as incoming president
of the psychometric society in 1935

Thurstone's paired comparisons
(Law of comparative judgment)

Unfolding models
(D. Andrich, G. Luo, and others)

Frederic Lord (1912-2000):
Item Response Theory

Georg Rasch (1901-1980):
Rasch model

… and something completely different

Index formation

Formative measurement
Formative indicator model
(as opposed to reflective indicator model in factor analysis)

Different philosophical underpinning
(social constructivism, i.e. non realist)

Summary of measurements
Composite variables