# Cognitive and psychometric modelling of responses and response times

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*Editorial*

# Cognitive and psychometric modelling of responses and response times

The programme of the International Meeting of the Psychometric Society 2015 in Beijing has shown that there is a growing interest in modelling response times. Therefore, we decided that a special issue on the current state of affairs in psychometric response time modelling is in order and the *British Journal of Mathematical and Statistical Psychology* indicated that it would gladly host such a special issue under the title 'Cognitive and Psychometric Modelling of Responses and Response Times'.

## Response times in psychology

The use of response times in psychology can be traced back to Sir Francis Galton who in the 1880s used the time needed to respond to a suddenly illuminating light bulb as a measure of general intelligence. Interestingly, although these experiments initiated the field of psychometrics, it is not yet common practice to involve the response times in psychological inferences. Until a decade ago, this could be attributed to the challenges associated with administering response times without the availability of computerized test procedures. However, as the use of computerized tests has increased rapidly, nowadays it seems that the limited use of response times in psychometric modelling might be due to: (1) (applied) researchers' limited awareness of the possibilities that arise if the response times are added to the standard analysis of the responses; and (2) the limited availability of modelling tools to apply state-of-the-art response time models. In this editorial, we address how the present issue of the *British Journal of Mathematical and Statistical Psychology* aims to improve and contribute to both of these themes.

## Different perspectives on response time modelling: Statistical and mathematical psychology

The first aim of this special issue is to increase our understanding about what response times can contribute to psychological research. To this end, this issue contains methodological papers that draw in various degrees from two perspectives on response time modelling.

The first, measurement, perspective on response time modelling is grounded in statistical psychology. In this perspective, a psychometric view is adopted in which the responses are considered the main source of information about *inter-individual* differences in the underlying psychological construct. Within this view, the response times are added to the measurement model as additional information about the construct. This typically facilitates measurement procedures. For instance, measurement precision can be increased in computerized testing or suspicious response patterns can be identified in large-scale educational testing.

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The second, cognitive, perspective on response time modelling is grounded in mathematical psychology. From this perspective, response times are seen as the main source of information about *intra-individual* differences in the underlying cognitive processes that operate in a given person. This information is typically used to deepen psychological theory. For instance, it is investigated how cognitive processes work and how they are affected in experimental conditions.

Interestingly, both perspectives have in common that they intend to quantify psychological properties, while they differ in their incentives, methods, and interpretations. That is, in the measurement perspective, no theoretical interpretation is given to the data. That is, the data are seen as simply representing differences between individuals and items. In the cognitive perspective, however, the data are interpreted in terms of an underlying theoretical cognitive process. To enable these substantive inferences, strength is drawn from strong modelling assumptions (e.g., the assumption that a decision process is driven by noisy accumulation of information which stops if evidence for one of the response alternatives exceeds a threshold). In the statistical perspective, assumptions are less strong (e.g., the matrix of responses can be separated into a normally distributed column effect and a normally distributed row effect) which makes a substantive interpretation of the effects challenging as they reflect purely statistical effects.

The second aim of this issue is to improve the applicability of state-of-the-art response time models. To this end, for all papers in this issue, the necessary computer code (and, where possible, the data) is available as online appendix. The code either uses existing R packages (including lme4, diffIRT, and glba), newly developed R routines, or the Mplus software package, and will thus hopefully be straightforward to apply to new data sets.

## This issue

This issue covers the following topics. *Kang* proposes an estimation procedure that helps the incorporation of response times into the measurement model for the responses using the proportional hazards model. *Ranger, Kuhn, and Szardenings* propose model fit statistics for models that combine measurement modelling with cognitive process modelling. *De Boeck, Chen, and Davison* and *Goldhammer, Steinwascher, Kroehne, and Naumann* use an experimental paradigm to study the interplay between responses and response times in a measurement model. *Bolsinova, Tijmstra, and Molenaar* study a response and response time measurement model that allows for both inter- and intra-individual differences in the responses. *Visser and Poessé* present a fit routine to facilitate application of the linear ballistic accumulator model from mathematical psychology. *Molenaar and Bolsinova* present statistical and substantively motivated extensions of a measurement model that incorporates responses and response times. *Van Rijn and Ali* compare the signed residual time model – which shows similarities to the diffusion model from mathematical psychology – to more conventional response and response time measurement models.

To conclude, this special issue contributes to the use of response times in the quantification of psychological properties by drawing strength from both measurement and cognitive perspectives and by providing the necessary numerical procedures to do so. We hope that this improves the use of response times in both research and applied practices in psychology in general and in psychometrics in particular.

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