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Editorial: Applications of Functional Measurement in Psychology

Joeri Hofmans*

University of Leuven, Belgium

This special issue contains a selection of papers presented at the second Functional Measurement Meeting in Brussels on June 30th and July 1st 2009[i]. Their common feature is that they all rely on the Functional Measurement framework. In this editorial, we will first elaborate on this framework and then discuss how it responds to important problems in traditional psychological research. Finally, an overview of the papers of the special issue will be given.

FUNCTIONAL MEASUREMENT

According to the Functional Measurement framework, each judgment is multiple determined, and the process through which a judgment arises is described by a chain of three functions (see Figure 1). In particular, a Valuation Function converts observable stimuli S_1, S_2 and S_3 into concurrent psychological representations (s_1, s_2 and s_3). Through Psychological Integration s_1, s_2 and s_3 are combined into a single implicit response r, and subsequently an observable response R is generated by means of a Response Function. Further, it is important to note that two axioms are central to Functional Measurement. The first, what Anderson (2008) calls "The Axiom of Purposiveness", states that any perception,

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thought or action is goal-oriented. From this axiom follows that psychological theories that do not consider purposiveness as a central concept are bound to miss the essence of the phenomena they aim to describe and explain. In Functional Measurement, purposiveness is inherent to the Valuation Function, the Integration Function and the Response Function, which all depend on the goal that the individual pursues at the time of the operation. A second axiom that is central to Functional Measurement is "The Axiom of Integration", which states that perception, thought, and action depend on the integrated action of multiple informers. From this axiom follows that psychological theories that do not consider integration as a central concept or that do not have adequate tools for identifying integration processes are bound not to understand thought and action. Functional Measurement gives this axiom a central place and by studying the Integration Function, with as one of the major findings that this function can be described by simple algebraic rules such as addition, averaging and multiplication (for an overview, see Anderson, 1981, 1982, 1996, 2008).

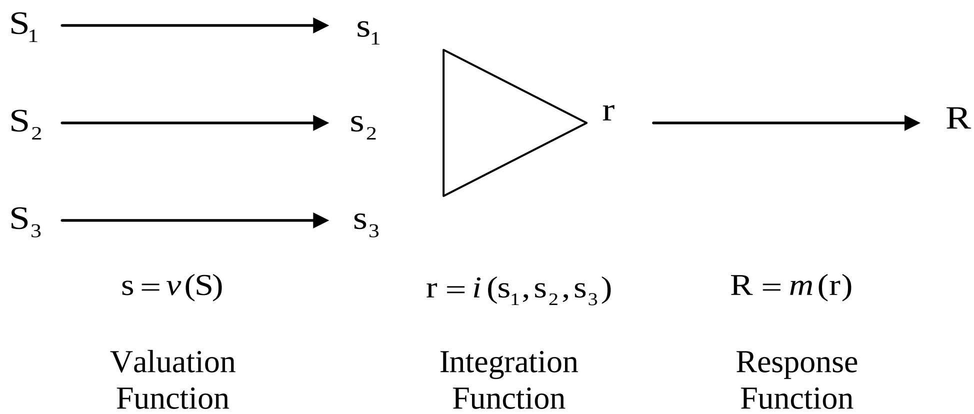

Figure 1: Functional Measurement diagram with S_n: observable (physical) stimuli, s_n: the subjective stimuli, *r* the subjective response and *R* the observable response, *v*: valuation function, *i*: integration function, *m*: response function.

DISTINCTIVE FEATURES OF FUNCTIONAL MEASUREMENT

In this section we will argue that Functional Measurement is markedly different from other frameworks that are frequently used in psychological research. In particular, three important differences will be discussed: the fact that Functional Measurement pursuits unification, that it allows for true psychological measurement, and that it combines research at the idiosyncratic and at the nomothetic level.

Most psychological theories have, until now, not fully recognized the centrality of the axioms of purposiveness and integration. The well-known result is that psychological phenomena are mostly studied in a rather disjointed fashion (i.e., by evaluating the impact of a single variable a time). As a result, present day psychological science appears as a very fragmented field that populated is by mini theories, each one explaining a very narrow segment of psychological reality. Unification appears largely elusive, and as a consequence, progress is (at best) slow: mini theories reign for a time in their respective fields until they are replaced by more fashionable others. This special issue neatly illustrates how Functional Measurement is able to unify psychological science by establishing the three integration laws (i.e., addition, averaging and multiplication) on strong empirical ground in many areas, such as: moral algebra (Hommers & Lee), ethical decision making (Muñoz Sastre, González, Lhermitte, Sorum, & Mullet), marketing (Brengman, Wauters, & Mairesse; Shanteau & Hilgenkamp), pain research (Moore & Peterson), sleep research (Mairesse et al.), developmental psychology (Bayless & Schlottmann), quality of life research (Theuns et al.), and intuitive physics (Cocco & Masin; De Sá Teixeira, Oliveira, & Amorim).

A second important feature is that Functional Measurement allows for true psychological measurement. This is of the utmost importance as the issue of linear response measures has been long-standing in psychology. Functional Measurement solves this problem and it is again the Integration Function that constitutes the base and frame for the solution (Anderson, 2008). In particular, the key lies in the patterns predicted by the different integration rules. This can easily be demonstrated by the parallelism pattern predicted by an additive integration rule. Assume for example that the attractiveness of a person is an additive function of his/her perceived physical attractiveness, and his/her perceived intelligence. If we then present people with all possible combinations of (a) pictures of faces, and (b) indications of the intelligence of the person, the patterns in Figure 2 would be predicted. It is clearly apparent in Figure 2 that the high intelligence curve lies at a constant distance above the other two curves, as if high intelligence adds a constant amount of attractiveness, regardless which face it is paired with. This is exactly what the additive integration rule predicts and therefore observed parallelism supports additive integration. However, the story is a little more complicated as parallelism will only appear when the Response Function is linear. Indeed, this pattern is only retained under a linear transformation of the subjective responses and, as a consequence, nonlinearity in the response measure would cause deviations from parallelism (see Anderson 1981, 1982, 1996, 2008). In summary, observed parallelism supports both the additive integration rule and linearity of the Response Function. Note that we used the example of an additive integration rule, but that a similar reasoning can be made for the other integration rules as well (see Anderson, 1981, 1982, 1996, 2008). As such, by using the integration rules as base and frame, Functional Measurement results in true psychological measurement. Linearity of the Response Function has further been supported by Hofmans, Mairesse, and Theuns (2007), Hofmans and Theuns (2008), and Hofmans, Theuns and Mairesse (2007). In this issue, the papers of Mairesse et al., and Massin and Busetto explicitly address the issue of scale linearity. In the same vein, but going beyond linearity, Weiss substantiates that information integration can be studied with nominal data as well.

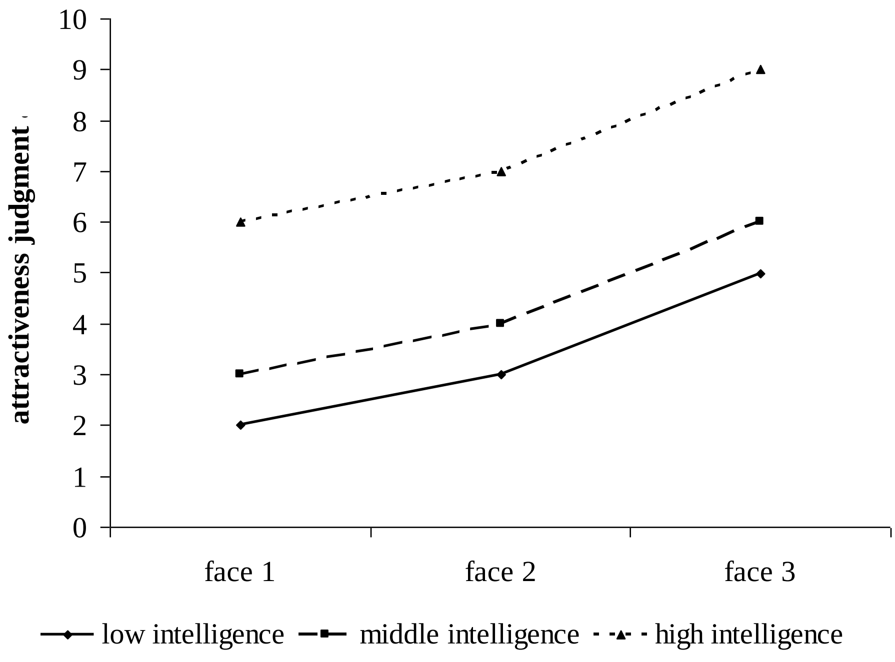

Figure 2: the judged attractiveness of persons described by (a) a pictures of their face, and (b) an indication of their intelligence by a hypothetical participant according to an additive integration rule.

Finally, Functional measurement '*unifies the ideographic approach, which emphasizes the uniqueness of the individual, with the nomothetic approach, which seeks general laws that hold across individuals*' (Anderson, 2008; p.1). This unification is a major accomplishment as psychological science has long been concerned with the study of general psychological phenomena (i.e., the nomothetic approach), while neglecting important individual differences therein. The key towards unification of the nomothetic and ideographic approach lies in the use of single subject design and individual analyses, which has been the default in Functional Measurement studies for a long time already. In single subject experiments, each participant goes through the entire experiment a number of times, allowing one to define a personal error term, which in turn allows for analyses at the individual level. Such an approach urges the researcher to look for individual differences, while at the same time allowing him/her to search for general, nomothetic integration rules that hold across all individuals. In this issue, the papers of Bayless and Schlottmann; Brengman et al.; Cocco and Masin; Hommers and Lee; Mairesse et al.; Muñoz Sastre, et al.; and Van Acker and Theuns are good examples of the unification of the nomothetic and idiosyncratic approach as they combine analyses at the group level with analyses at the individual level.

As reflected in the preceding paragraphs, Functional Measurement is able to respond to some of the most long-standing problems in psychological research. Almost for five decades now cumulative progress has been made with the three laws of information integration, putting them on solid empirical grounds in almost every area of psychology (for an overview, see Anderson, 1981, 1982, 1996, 2008). Moreover, in the last years several computer programs have been developed that will ease the implementation and analysis of Functional Measurement studies. In particular, Mairesse Hofmans, and Theuns (2008) have developed a java-based Functional Measurement experiment builder; Van Acker created OsuCre, a computer program that allows for the creation of online Functional Measurement experiments; Weiss (2006) designed the Functional Measurement program, which tests amongst others multiplicative models; and Vidotto, Massidda, and Noventa (this issue) developed R-average which allows for the precise estimation of the parameters of different types of averaging models[1]. In summary, the

[1] Another collection of papers was published in the 12th issue of Teorie & Modelli (http://www.pitagoragroup.it/pited/teoriemodelli.html) as a result of the first Functional Measurement Meeting held in Padova (10^{th} and 11^{th} May 2007). These papers, together with amongst others a book review of "Unified Social Cognition" (Anderson, 2008), and several computer programs for the construction and analysis of Functional Measurement

usefulness of the Functional Measurement framework is beyond doubt and this is clearly reflected in the papers of this special issue.

APPLICATIONS OF FUNCTIONAL MEASUREMENT

In general, the papers can be subdivided into two major categories. In the first category, the main focus is on topics related to the Functional Measurement methodology, while in the second category, this methodology is applied for studying substantive phenomena.

Methodological papers

Functional Measurement with nominal data. (a) David J. Weiss argues that even with nominal data, which is the type of data we are confronted with when studying behavior, statements about the effect and interplay of experimentally manipulated factors can be made. He presents the Nanova (Nominal analysis of "variance") method and illustrates that this method is able to extract cognitive strategies from behavioral actions.

The averaging model. (b) Giulio Vidotto, Davide Massidda, and Stefano Noventa present and evaluate R-average, that is, an R-package able to estimate the parameters of different types of averaging models. In addition, the package provides multiple information criteria for the purpose of model selection. In another study on the averaging model, (c) Stefano Noventa, Davide Massidda, and Giulio Vidotto reconceptualize s_0 and w_0, the initial state parameters of the averaging model, in a number of ways. Furthermore, they review the problems associated with their uniqueness and identifyability and propose a method to deal with these problems.

Data-collection. (d) Frederik Van Acker and Peter Theuns compare different data-collection methods (i.e., face-to-face, computer based, and web-based data collection) on a series of criteria. It appears that participants in the computer based Functional Measurement experiments are less sensitive to the experimental manipulations, and that similar integration rules are found in both the face-to-face and the web-based setting. The authors conclude that web-based Functional Measurement experiments yield data of sufficient quality, and that their ability to test a large number of respondents makes them an attractive alternative to the traditional face-to-face studies.

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experiments are available on the Functional Measurement website (http://functionalmeasurement.vub.ac.be/).

Rating model. (e) Sergio C. Masin and Martina Busetto test the rating models of Anderson, Haubensak, Helson, and Parducci. They show that an extension of Anderson's model is needed to account for the Dai Prà effect and they support the contention of each model that ratings are linear measures of mental magnitude.

Framing effects. (f) Finally, the paper by María Teresa Muñoz Sastre, Charlène González, Astrid Lhermitte, Paul C. Sorum, and Etienne Mullet is in between the methodological and the substantive category. In particular, they show that framing ethical questions about life-ending procedures in terms of unacceptability instead of acceptability has little or no impact on the results. Hence, they conclude that Functional Measurement is resistant to goal-framing effects.

Substantive papers

Sleep research. (g) Olivier Mairesse, Joeri Hofmans, Daniel Neu, Armando Luís Dinis Mónica de Oliveira, Raymond Cluydts, and Peter Theuns test whether the Two-Process Model of Sleep Regulation, in which circadian and homeostatic processes are assumed to combine additively, corresponds to the empirical reality. They show that, when linear metrics are used to measure subjective sleepiness, both processes combine according to a differential weighting averaging model, which implies that the Two-Process Model of Sleep Regulation is rejected in favor of a more complex one.

Marketing. (h) James Shanteau and Heather Hilgenkamp evaluate in which manner the brand name of a consumer product impacts on purchase intention. They study three different product categories, and for each category the brand name and actual product of three brands are crossed according to a factorial design. Their results show that perceptions of quality are independent of actual quality, and that the strength of the brand equity effect depends on the product type. (i) Malaika Brengman, Birgit Wauters, Cathy Macharis, and Olivier Mairesse examine how 'threat' and 'efficacy', two concepts that often appear in models on health promotion, are valuated when determining exercise intention. They find that four clusters, or consumer groups, can be distinguished, each with their own valuation pattern.

Pain research. (j) Philip J. Moore, Jeffrey S. Chrabaszcz, and Rolf A. Peterson assess how anxiety sensitivity, a dispositional factor, and event expectancy, a situational factor, subjectively combine to determine pain anxiety. Their results suggest that the integration can be described by an additive model, which had important implications for the treatment of anxiety-related disorders.

Quality of life. (k) Peter Theuns, Nico Verresen, Olivier Mairesse, Rianne Goossens, Lien Michiels, Els Peeters, and Maarten Wastiau study how feelings of happiness are jointly determined by relations with partner, friends, and parents. They conclude that this joint effect can be approximated by an averaging model with equal weights, which implies that the effect of one kind can be compensated by the effect of another kind of relationship.

Intuitive physics. (l) Alberto Cocco and Sergio C. Masin had participants estimate the elongation of a spring while imagining that a load stretches it. This imagined elongation is a multiplicative function of spring length and load weight, which is consistent with Hooke's law. Furthermore, they show that load weight is combined with imagined elasticity rather than with spring length. (m) Nuno Alexandre De Sá Teixeira, Armando Luís Dinis Mónica de Oliveira, and Michel-Ange Amorim study the representational momentum, which is the phenomenon that the vanishing point of a moving target is perceived as displaced in the direction of the movement. By means of a series of Functional Measurement experiments, they are able to show that it is a simplification of the physical principles that underlies representational momentum.

Child development. (n) Sarah Bayless and Anne Schlottmann had 5- and 7-year-olds play a marble rolling game in which task difficulty and expected value (i.e., the reward) varied. Children then judged how happy they would be to play games of variable difficulty for different prizes. These judgements followed the multiplicative structure predicted by the normative expected value model, which suggests that children can use task difficulties as estimates of personal success probability in skill-related tasks. (o) Wilfried Hommers and Wha-Yong Lee study moral development in German and Korean 8-, 10-, and 12-year-old children by employing a task which combines elements of Kohlberg´s stage theory and Functional Measurement. Additive integration, cultural and developmental differences, as well as an outstanding moral impact of recompense in size and distinctiveness are observed.

Psychophysics. (p) Osvaldo Da Pos, Linda Baratella, and Gabriele Sperandio study how information on the luminance of an object and its environment are integrated in order to determine the grayness of the object. Their results indicate that the gray color of the object derives from an additive integration of the information about luminance of the object and the environment, with the weights of this information varying with the mean luminances.

Concluding, we are most grateful to the authors of this special issue for their excellent contributions. We believe that the multitude of interesting topics nicely illustrates the potential of Functional Measurement, not in the least to unify psychological science.

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