APPLICATIONS OF FUNCTIONAL MEASUREMENT IN PSYCHOLOGY

Research Meeting

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Department of General Psychology
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Abstracts of Talks and Posters

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TALKS

ALGOM, D. (Tel-Aviv). *Functional measurement and perceptual independence.*—The integration of information and the disintegration of information both are indispensable for adaptation. The former is explicated by Functional Measurement, the latter by models of selective attention and perceptual independence. To examine their relationship, a variety of selection and independence concepts is described including perceptual independence and perceptual separability within General Recognition Theory, and Stroop and Garner effects. Each of these related concepts is then connected to concepts and theorems of Functional Measurement. It is shown that the respective tools and interpretations constrain each other in significant ways. Independence informs and constraints Functional Measurement. Conversely, Functional Measurement provides a conceptual framework to understand the locus and action of independence as well as another, practical tool to assess it.

ANDERSON, N. H. (San Diego). *Unified science based on psychological laws.*—Unified science of psychology is possible with the psychological laws of information integration. These laws solve the long-sought goal of true measurement of psychological values. These laws apply to single individuals – nomothetic laws for idiographic understanding. These laws have made worthwhile progress in nearly every area of human psychology: judgment-decision, learning/memory, psychophysics/perception, developmental, and social-personality. These laws constitute a unified foundation for psychological science, with unique analytical power.

DE SÁ TEIXEIRA, N., & **OLIVEIRA, A.** (Coimbra). *Multidimensional quantitative semantics of pain: A nomothetic-idiographic approach through functional measurement.*—Multidimensional pain assessment is based on the notion of separability of pain into sensory and affective components but lacks an understanding of the process of integration of these components into the overall experience of pain. This poses limits on the development of adequate composite indices of pain and on the generality of a quantitative approach to the language of pain. The present paper reports the results of an empirical study which was made to determine how individuals integrate the sensory and affective components of pain expressed by pain descriptors taken from three measurement instruments. The results support a weighted average integration rule with weights being equal or differential depending on the measurement instrument. This paper

shows how functional measurement provides a way to unfold successive layers of nomothetic generality of both substantive and practical value, leaving room for the idiographic valuation of pain descriptors.

FALMAGNE, J. C. (Irvine). *On meaningful scientific laws on bounded domains, with an application to the Size-Weight Illusion data of Norman Anderson.*—The size-weight illusion refers to the tendency of judging a small object to be heavier than a large object of the same weight. Except for the fact that human subjects are involved, this phenomenon has the features of a physical experiment. (It was in fact studied in the late nineteenth century by the physicist Augustine Charpentier.) In the experiment analyzed here, the input variable are the physical quantities measuring the size and weight of the object. The output variable is number between 1 and 20 assigned by the subject as an evaluation of the perceived weight. This output is also regarded here as measured on a ratio scale. Thus, three ratio scales are involved in the notation of the data, which put constraints on the feasible mathematical descriptions of this phenomenon. This is true in any event if one accept the standard requirement that the form of the law be unaffected by a change of units in the variables involved. In such a case, the principles of dimensional analysis, suitably generalized, apply and considerably restrict the possible forms of a law describing the phenomenon. These forms are further confined if one interpret the underestimation of the weight as resulting from a contraction effect of the size on the perceived weight. These ideas are developed in this paper and lead to particular mathematical forms for the law, which are shown to fit Norman Anderson's classical data.

GEISSLER, H.-G. (Leipzig). *Real-time integration in perceptual updating: The apparent vertical as case of study.*—Delayed changes in the position of the apparent vertical after step-like changes of stimulus conditions are used to explore processes of perceptual updating. It is shown that the involved processes of temporal integration can be conceived as real-time analogues of serial integration in judgment. Invariance of the overall rate $1 / T$ of updating provides a basis to argue (1) that perceptual change is accelerated or slowed down as a function of relative weighting of adjacent situations and (2) that metric characteristics of temporal change are unique to the integrative outcome rather than specific to modal contributions of postural versus visual information. Empirical results favor a memory-based central account of temporal integration upon explanations in terms of passive sensory information transmission.

HOFMANS, J., MAIRESSE, O., & **THEUNS, P.** (Brussel). *An alternative for prescribed integration rules in testing the linearity of a response measure.*—One method to test whether graphical ratings are linear response measures is to prescribe an integration rule and test whether the resulting pattern of factorial curves is that predicted by this rule. This method does not guarantee that respondents do not use an integration rule different from the prescribed rule. To resolve this problem, we had participants graphically rate either the weight of a beam varying in density and volume or the velocity of balls of different masses rolling down slants of various lengths. After the experiment, we asked participants whether they knew the formulas to calculate beam mass and ball velocity. The participants who knew the correct formulas produced patterns of factorial curves in agreement with the formulas. These results confirm that graphical ratings are linear response measures.

HOMMERS, W. (Würzburg). *Everyday judgmental schemes for punishment and recompense.*—Harmdoers may be punished or required to give recompense for the harm. These modes of treatment may be used concurrently in the legal system and in everyday morality. In contrast, most psychological research on morality has studied these modes of treatment separately. Therefore, levels of three moral informers (buyer's as well as seller's fault and his apology) about a car damage after a used car sale were to be rated from the buyer's perspective with regard to how much money the seller should give to the buyer as recompense and how much to donate to a charity organization as punishment. The results were that nearly half the subjects used only recompense while the others used both recompense and punishment, that some subjects required overcompensation, and that the meaningful patterns of information integration differed for punishment and for recompense.

MAIRESSE, O., HOFMANS, J., DE VALCK, E., CLUYDTS, R., & **THEUNS, P.** (Brussel). *On the linearity of subjective sleepiness measures.*—The present study was conducted to investigate the linearity of subjective sleepiness scales and to contribute to the debate about the nature of the interaction between circadian (C) and homeostatic (S) processes in models of alertness-sleepiness regulation. In this study, a partial sleep deprivation experiment was conducted and replicated using symbolic stimuli. Our findings provide support for the linearity of subjective sleepiness scales. Consistent with the basic assumptions of Borbély's model an additive integration of Processes S and C was noted in a majority of partici-

pants, which suggests the independence of these processes during the biological day.

MARKS, L. E. (New Haven), **ELGART, B. Z.** (Pittsburgh), **BURGER, K.** (New Haven), & **CHAKWIN, E. M.** (Princeton). *Human flavor perception: Application of information-integration theory.*—The perception of flavor arises from the combination of inputs from several sensory modalities, especially gustation (taste proper) and olfaction (the primary source of flavor qualities). Both the perception of intensity of suprathreshold flavorants and, notably, the detection of weak flavorants are consistent with a rule of additivity. Thus, the detectability, d', of mixtures of the gustatory flavorant sucrose and the olfactory flavorant vanillin approximates the additive sum of detectabilities of the two components, within a model that assumes pooled noise in the flavor system that derives from both modalities. When gustatory and olfactory flavorants are presented in isolation, however, under conditions that encourage or permit selective attention to one modality or the other, it may be possible to filter out the noise associated with the unattended modality, and leading thereby to a rule of vector summation.

PETZOLD, P. (Jena). *Assimilation and contrast – Two effects of information integration.*—Assimilation and contrast in judgmental tasks are considered as effects of information integration. While assimilation appears when context attributes are integrated into the judgment equivalent to the representation of the focal stimulus, contrast occurs when context attributes are integrated into internal standards. Both processes may jointly operate in judgment processes. If so, the observed effect is determined by the predominant process. If categorical information acts as context, the kind of context effect is connected with a typical variation of the stimulus differentiation within and between categories. Assimilation is combined with an increase of differentiation between categories and a decrease of differentiation within categories, whereas contrast is linked to the opposite tendencies. Whether the assimilation-producing process or the contrast-producing process is predominant is partially determined by the goal of the task.

SCHLOTTMANN, A. (London), & **ANDERSON, N. H.** (San Diego). *Belief learning and revision studied with information integration theory.*—The belief learning model of information integration theory describes how beliefs develop and change with serial information. The model allows measurement of how stimulus informers presented on successive trials affect successive belief states. A complete serial curve of belief development

can be obtained, even when only the final belief is known. This novel capability for measuring belief learning curves gives a high-resolution, trial-by-trial view of the evolving belief, in contrast to the less detailed measures of traditional approaches to the order effect problem in belief learning. The information integration theory model has done well in demanding tests in judgment-decision and social cognition, even with young children. This article describes the basic model, how it may be tested, how it may be used to measure order effects from the data, and how it relates to other approaches.

SHANTEAU, J. (Manhattan), **PRINGLE, R.** (Baltimore), & **ANDREWS, J.** (Eugene). *Why functional measurement is (still) better than conjoint measurement: Judgment of numerosity by children and adolescents.*—Supporters of Conjoint Measurement (CM) continue to cite an argument from Krantz, Luce, Suppes, and Tversky (1971) from a reanalysis of the city-occupation study by Sidowski and Anderson (1967). Anderson (1982) refuted this argument and demonstrated the superiority of Functional Measurement (FM); one of the arguments made by Anderson is that CM lacks power to reveal substantive interactions. Still, Coxon (2006, p. 9) recently concluded, "the interaction (in Sidowski & Anderson) is an artifact of the assumption that the rating scale is interval level…(because) an order preserving [monotone] additive representation is possible" (p. 7). In the present study, first grade children, fourth grade children, and adolescents assessed judgments of numerosity based on size (area) and density. FM analyses revealed that adolescents followed the normative multiplicative rule, while children were generally additive. CM analyses, in contrast, were insensitive to the different integration rules followed by children and adolescents, i.e., an additive representation existed for all ages. Thus, an important developmental trend that is apparent both graphically and statistically in FM analyses disappeared in CM analyses. This not only supports Anderson's arguments about the superiority of FM techniques, it provides a relevant counter-example to the CM arguments based on the Sidowski and Anderson study.

VIDOTTO, G., & **VICENTINI, M.** (Padova). *A general parameter estimation procedure for averaging models.*—Anderson and Zalinski proposed a procedure of parameter estimation for equal and complete differential averaging weight models. This procedure can analyze the data from one subject and one session at a time, and is designed to allow for proper tests of statistical significance. In the present study we describe an alternative general procedure for parameter estimation and for model selection. It allows

selecting an optimal number of parameters, providing reliable parameter estimation for averaging models. To test the goodness of the estimation, the procedure considers the AIC and the BIC validation criteria, which are reliable goodness-of-fit indices and can also be used for concurrent model comparison. We have compared the two procedures by a Monte Carlo simulation. Results show that these procedures offer similar performances in parameter estimation. However, analysis of residuals shows that the new procedure produces always unbiased estimates of the expected values for all the examined response conditions. This improvement could depend on the minimization routine.

WEISS, D. J. (Los Angeles). *Extracting individual contributions to a team's performance.*—The success of a team depends on the individual capabilities of its members and on how they combine their efforts. Because team members have different responsibilities, individual performance statistics may not accurately convey how much a person contributes to the team's overall effectiveness. When it is feasible to substitute contenders for the various positions on a team, an objective comparison of individuals against their counterparts is available. A graphical decomposition of team scores allows for objective assessment of individual performances in context. At the same time, the pattern seen in the graph clarifies the structure of team functioning. The analysis is illustrated with data from two professional basketball teams, both of which functioned in an approximately additive manner. Systematic substitution designs can be used in controlled settings; these allow statistical evaluation to complement the graphical analysis.

WILKENING, F. (Zürich). *Demystifying three orthodox views of cognitive development via functional measurement.*—In traditional accounts of cognitive development, children's cognition is characterized as being (1) initially deficient, confined to unidimensional thinking, (2) holistic, nonanalytic by nature, and (3) governed by strict developmental sequences of conceptual structures, if not across-the-board, then at least within domains. Developmental applications of functional measurement and information integration theory have shown that all three assertions are wrong. Children's thinking is multidimensional, analytic, and highly adaptive from the early ages on, with simultaneous knowledge representations at several levels. Children's intuitive physics is a field in which all these capabilities come to light most impressively.

POSTER SESSION 1

BEN-NATHAN, M., & **ALGOM, D.** (Tel-Aviv). *The perceived magnitude of two-digit numbers: A functional measurement analysis.*—Are two-digit numbers perceived through direct route from the whole stimulus or through integration of their components? If the former, then two-digit numbers are merely words whose meaning (magnitude) is acquired in the same way as that of any other word in language. If the latter, then a normative adding-type rule of integration acts on scale values which change in the various combinations according to Weber's law. In two experiments, we subjected the perception of two-digit numbers to Functional Measurement analysis. The former theory predicts approximate parallelism of the factorial plot (of decades and units), the latter a linear fan shape. We found parallelism for both Arabic and verbal notations, supporting the theory that two-digit numbers are subject to a single, one-dimensional valuation.

CORNELI, E., & **VICOVARO, M.** (Padova). *Intuitive cognitive algebra of sliding friction.*—The cognitive algebra of the friction of a flat object sliding on a flat horizontal surface was studied. In agreement with physics, imagined friction depended additively on the coarsenesses of surfaces and depended multiplicatively on object weight and coarseness of the horizontal surface. In disagreement with physics, imagined friction depended on object weight and area of contact surface multiplicatively, and was lower when the contact surface's longer side was parallel to the direction of motion. These results are important for the teaching of the physics of friction.

DA POS, O., & **BASILARI, A.** (Padova). *Factorial constraints of transparency.*—The present paper reports the results of an experiment designed to determine the constraints of the factorial pattern of data that a valid model for the perceived extent of achromatic transparency (rated α) must predict. Consider a transparent achromatic disk in the middle of two adjoining achromatic rectangles with the common border of the rectangles dividing the disk in half. Let a and b be the luminances of the left and right rectangles, respectively, and let p and q be the luminances of the left and right halves of the disk, respectively. By varying p and q factorially for different pairs of a and b and plotting mean rated α as a function of p, we have found that a valid model of transparency must meet the constraints that (i) the rated extent of transparency of the disk varies essentially linearly with p, (ii) that factorial curves converge upward as p increases, and (iii) that the mean slope of factorial curves increases as the difference between

a and *b* decreases. A new model of transparency is proposed which satisfies these constraints.

LAFRATTA, A. (Padova). *On the activation of information integration rules*.—Studies show that training with feedback activates nonspontaneous integration rules capable of superseding previously activated spontaneous rules. The present study explored whether verbal instructions without training are sufficient to activate nonspontaneous information integration rules capable of superseding previously activated spontaneous rules. The results show that graphical instructions can activate a multiplicative rule in some participants and that verbal instructions without training are sufficient to activate an additive rule capable of superseding a previous rule activated spontaneously.

OLIVEIRA, A., DE SÁ TEIXEIRA, N., OLIVEIRA, M., BREDA, S. J. (Coimbra), & **DA FONSECA, I.** (Lisbon). *Algebraic integration models of facial features of expression: A case made for pain.*—The upsurge of measurement systems of the face in the late seventies originated a flurry of studies of facial behaviour. The facial action coding system (FACS) has become the most widely used of these systems. Its comprehensive coding of all minimal visible changes of appearance in the face, the facial action units (AUs), allowed for a strict separation between description and inference. As a result, many AUs were descriptively documented to occur with certain expressions, namely of emotion and pain. However, the gap from description to inference can be seen from the virtual absence of knowledge on how AUs combine into meaningful expressions, and what each contributes to their expressive power. This study conjoins the modelling of AUs in 3-D realistic synthetic faces within the integration information theory framework allowing for truly manipulating AUs as independent variables and affording suitable theory and method to handle multi-determination. This approach is illustrated in the domain of pain expressions by taking three pain relevant AUs as factors in typical integration tasks. Outcomes reveal that an additive (summative and/or subtractive) rule governs most aspects of AUs integration, with a major contribution of up/down actions of the lower face. At a more general level, they support the advantages and prospects of a functional, as opposed to taxonomic approach to the processing of facial expressions.

SCUPOLA, N. (Padova). *Additive law for emotional involvement.*—An additive law was found for emotional involvement with events in distant cities (Emotional Involvement = Seriousness of Event + Distance of City)

and for prosocial intervention in such cities (Prosocial Intervention = Seriousness of Event + Distance of City). Functional measurement showed that emotional involvement decreased linearly as the functional distance of cities increased. Since this distance includes all factors that influence the identification with the city, the above additive law should be general and possible to extend to socio-economic or ethnic distance.

POSTER SESSION 2

CHEN, B.-C., & **WANG, M.-S.** (Taiwan). *Measuring interpersonal influence in group decision-making.*—The "individual" is the basic analytical unit in group decision. The group process transforms individual judgments into group decision-making. Unobservable interpersonal influence can be inferred based on observable individual preference and group decision-making. The group process thus resembles that in which individuals integrate multi-cues in information integration theory with cognitive algebra model. The present study discusses budget allocation and uses the experimental design and averaging cognitive algebra model of information integration theory, providing experimental validity for explaining the complex interpersonal influence process via social weight. It has been found that group member judgments are integrated with group decision-making mainly based on a differential-weight rule, and that group influence results primarily from normative social influence rather than from informational social influence.

DAI PRÀ, M. (Padova). *Test of Anderson's model of numerical rating.*— Participants rated numerically the sensory intensity of stimuli for different pairs of anchor stimuli. For each of these pairs there was one graph relating mean rated sensory intensity to stimulus intensity. The pattern of these graphs turned out to be close to that predicted by Anderson's model of numerical rating. A model of wider applicability is proposed which incorporates Anderson's model.

FRUCHART, E. (Marne-la-Vallée), **RULENCE-PÂQUES, P.** (Boulogne), & **MULLET, E.** (Toulouse). *Ecological validity test of laboratory studies of information integration.*—The ecological validity of the judgment schemata observed in the laboratory using the functional measure-

ment methodology was directly tested. The field of human activity that has been chosen is collective sport. It was shown that (a) when necessary precautions are taken to ensure the scale linearity of responses in the judgment conditions and in the ecological condition, (b) when necessary precautions are taken to ensure the total intelligibility of the circumstances of observation (situations governed by clear rules, as in collective sports), and (c) when the laboratory situation and the observation of real-life events are based on the same realities (judgment of the frequency of a given behavior and observation of this frequency), then it is possible to directly assess the compatibility of laboratory data (judgment schemata) and real life data (corresponding patterns of behaviors).

THEUNS, P., HOFMANS, J., & **VERRESEN, N.** (Brussel). *Functional measurement in subjective quality of life estimations.*—Subjective Well-Being (SWB) consists of a subjective evaluation and integration of happiness about specific areas such as standard of living, health, achievement, personal relationships, safety, marriage, and work to the extent that one thinks well of and feels good about these areas. Three functional measurement experiments investigate if the same integration rules apply to various life domains. For most considered life domains an additive model applies. Yet, for some particular combinations of life domains averaging or multiplicative models emerge. It is concluded that further research on the prevailing integration rules for main life domains is necessary if one ever wishes to develop valid life domain based SWB measures.

VAN ACKER, F., THEUNS, P., HOFMANS, J., & **MAIRESSE, O.** (Brussel). *Test of the effect of scale labels on response linearity.*—This paper reports two experiments designed to test whether adding labels to a 7-point rating scale affects the linearity of this scale. We tested whether a pattern of factorial curves found in previous studies for a specific integration rule also occurred when labels were attached to all points of the scale or only to the extremes. The results show that fully labeled rating scales and scales that have labels only for the extreme points reproduce the pattern of factorial curves found in previous studies. We conclude that both of these scales yield linear responses.