

FRAME-OF-REFERENCE CONCEPTIONS AND CONTEXT EFFECTS IN PSYCHOPHYSICS

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Abstract

A basic rationale which all frame-of-reference models in psychophysics have in common is the concept of stimulus relations ("relational psychophysics"). Why is it that it took so long, in the short history of scientific psychology, to bring together the fruitful ideas stemming from perceptual-synthesis psychology and psychophysical measurement methodology? Some examples taken from different fields of perception and judgment may help to clarify the basic conceptual and experimental problems involved in "context" dependent psychophysics. Here I ask which will become the future of the urgent research issues in respect to the contextual effects, and what will be the course of development of the more domain-oriented paradigms in this field. Guidelines in the view of past and present experimental work in psychophysics are provided.

The classical concepts of "frame of reference", "stimulus ratio" and "shifting-level", originally stemming from Gestalt psychology, are related to the fact that a growing body of modern psychophysical work is based on the assumption of *stimulus relations* as its fundamental origin. These three concepts have to do with the fact that there exist ubiquitous "contextual" effects in many, if not all, stimulus-response measurements (Sarris, 1975, 2001). However, what did the early Gestaltists mean by these concepts and, apart from its historical impact, what would be the best way to define them?

In my talk I shall first describe the quite heterogeneous meanings and implications of these Gestalt concepts before the most prominent stages and types of *contextual* effects in psychophysics will be described (Fig.1). – In light of the contributions to the present *Theme*

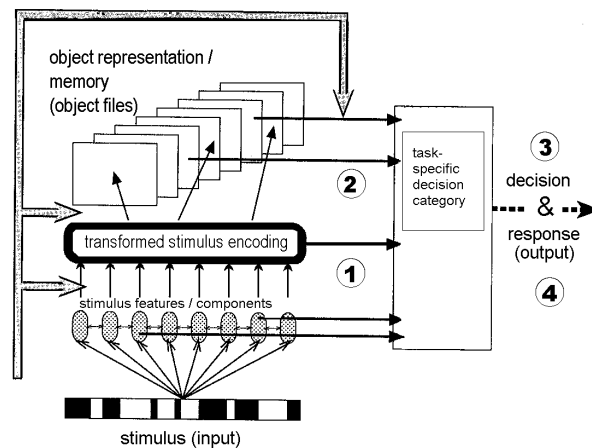


Fig. 1 A general *four-stage model* of the intertwined mechanisms held to be responsible for the (1) sensory information-gathering, (2) perceptual information-integration, (3) decision-making, and (4) response-evoking processes in perception and psychophysics. This *four-stage model* is the basis for the various *frame-of-reference* and *context* effects as reported in the research literature (see below, text). – (Modified from Ahissar & Hochstein, 1998.)

Session, the following considerations may provide a background against which the papers by the other speakers may be understood (see Allen Parducci, Gerd Haubensak, Gregory R. Lockhead, Peter Petzold, and Norman H. Anderson, this volume).

Frame of Reference, Stimulus Ratio, and Shifting Level

So far these Gestalt concepts have been used mostly in vague terms; they are briefly treated in the following sub-paragraphs.

Frame-of-reference concept. – The original meaning of this classical concept may be best understood in terms of the critique of the then-prevailing elementaristic (“atomistic”) approach. For example, hundred years ago many researchers still sought to explain the perception of the orientation of a line in terms of an assumed sum of the “elementary” sensations of the directions of its separate points (Rock, 1990; cf. Rock, 1997). Contrast this view and its consequences against the notion later proposed by Max Wertheimer: Through a reduction tube a contour in the scene might appear to be either “oblique” or “vertical” depending on the target stimulus-surround. This is a major example of a *spatial* frame-of-reference (*FR*) effect. By the use of modern psychophysical techniques, it becomes a

straightforward task to measure such a FR effect precisely, leading to the following statement: One and the same stimulus is perceived and judged differently as a quantitative function of the *FR*.

Stimulus-ratio concept. – A further case of the *relational* approach in psychophysics is illustrated by the ratio principle. For instance, a given response is said to be “relational” in correspondence to the respective stimulus *ratio* used in the sense that a perceived (a-) chromatic quality is not locally determined but depends, in principle, on every other part of the visual field. According to Hans Wallach, a former student of Wolfgang Köhler’s, there is the fundamental assumption that, for instance, the perception of surface lightness is based on the relative ratio between the light reflected from the figure to that reflected from its immediate surround.

Shifting-level concept. – Still another Gestaltist, Kurt Koffka, has introduced the concept of a “*shifting level*” in order to deal with the systematic perceptual-judgment “shifts”. For example, an observer is repeatedly tested with either an ascending or descending stimulus series whereby the physical values are gradually enlarged or degraded; as a consequence, some characteristic response changes are obtained (e.g., such “*shifts*” occur in the post-discrimination generalization phase during which the test-stimulus context induces a systematic change of the respective responses; cf. Sarris, 2001, for an overview).

The vagueness of the FR term has hampered past research for at least fifty years in both human and animal psychophysics. Typically, different investigators in the field are still dealing with heterogeneous experimental paradigms thus aiming at different stages of the sensory-perceptual-cognitive information processing (Fig. 1).

Different Types of Contextual Effects in Psychophysics

In their recent handbook article, Lawrence E. Marks and Daniel Algom rightly emphasize the fact that there exist different *stage* theories (or models) of psychophysical processing, and they “acknowledge the possibility ... that context can affect processes occurring at every stage: in early sensory transduction, in later perceptual encoding, possible cognitive recoding, and in decision response ... “ (Marks & Algom, 1988; p 148). Whereas these authors do not suggest any specific model in order to specify the potential information-integration mechanisms involved, I here propose the general *four-stage model* as depicted in *Figure 1* (see above).

Process stages and contextual effects. – It is assumed that there are four main-process stages; namely: (1) *sensory information-gathering*, (2) *perceptual information-integration*, (3) *cognitive decision-making*, and (4) *response-evoking processing*. Based on these stages there

are several main types of contextual effects, which have been studied during the last hundred years; namely:

- *Stage 1*: sensory contrast effects
- *Stage 2*: frame-of-reference illusions
- *Stage 3*: cognitive information-integration effects
- *Stage 4*: response-scale distortions.

In addition, I assume that many if not all of the main “contextual” findings represent a combination of different stage-processing effects; for example: context effects which are based on the processes related to stages 1 plus 2, or stages 2 plus 3, or stages 3 plus 4 (or on even more complex processes, i.e. on stages 1, 2 plus 3, or stages 2, 3 plus 4). As a consequence, more than just four (stage-) types of context effects may result. In other words, experimentally one may find four, seven (or even more) types of contextual effects. – In my talk I shall illustrate this idea by providing some basic examples.

Psychophysical scaling and contextual effects. – In this case the emphasis is on those process stages 2, 3 and 4 which are basically related to the psychophysical scaling methodology and the so-called psychophysical laws (cf. Lockhead, 1992; Baird, 1997; Marks & Algorn, 1998). Clearly, a lot of the work published during the last fifty years has been concentrated on these special “contextual” problems involved in psychophysical measurement.

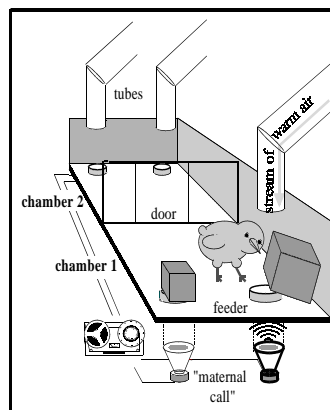


Fig. 2 Experimental apparatus used for the study of “contextual” size-discrimination effects in the *baby chick*, when the test-stimulus context during the postdiscrimination-generalization phase is systematically varied (see text; cf. Sarris, 2000, 2001).

Comparative psychophysics and contextual effects. – As a point of principle relevance consider the research issues implied by comparative psychophysics, i.e. animal versus human perception (including developmental psychophysics, from an evolutionary perspective). In contrast to main-stream psychophysics, the behavioral methods are of major interest (e.g., for human infants, subhuman animals, clinically impaired patients). My own research conducted during the last twenty-five years has addressed the problems involved in the comparative (verbal) study of very young children and subhuman animals (like chickens), by the use of *behavioral* choice-methods. Briefly stated, remarkable “contextual” effects have been demonstrated, during the postdiscrimination – test phase under systematic one- and two-dimensional test-context variations (cf. Sarris, 1994, 2000, 2001; see also the *posters* by Hauf & Sarris and Sarris, Hauf & Arlt, this volume). The experimental study of the *baby-chicks’* psychophysical response as systematically shifted by the asymmetry-variation of the test stimulus-context provides a rare and profound example of comparative psychophysics (Fig. 2).

Discussion and Conclusions

In contrast to past research, today’s study of contextual issues in psychophysics has led to a variety of fruitful research agenda (cf. the investigations concerning the role of “*top-down*” processes in perception as well as in psychophysical measurement, or the consideration of multiprocess models in order to explain the diversity of psychophysical findings). – Thus, the discussion should be focussed on several major problems, each of them presented here in form of a *question*:

- *Relevance of FR theorizing*: Despite the loose definition of its term, which theoretical role might or should the “*FR*” concept play in ongoing context-dependent psychophysics, along with the other classical Gestalt concepts (“*stimulus ratio*”, “*shifting level*”)?
- *Typology of psychophysical context effects*: Given the ubiquitous influences of special stimulus (and other) context conditions, is there a need for the establishment of an experimentally impressive *typology*; and if so, in which way may the proposed *multiprocess model*, with its stages 1 through 4, become an acceptable foundation for further research?
- *Convergent-operation methodology*: From a strict empirical perspective, is the systematic application of some *convergent-operation methodology* – for example, in the study of task-dependent context effects – needed as a *conditio sine qua non*, including the application of the *behavioral* psychophysics paradigms?
- *Unified-theory approach*: At the present time of inquiry how fruitful are, or will become, *broader* psychophysical theories or models (e.g., Baird, 1997)?

Conclusions. – In conclusion, I propose the following general guidelines for the future study of context-dependent issues in psychophysics:

- (1) Psychophysical investigations directed towards the further analysis of contextual effects should be planned and conducted more fully in line with *domain-research* oriented paradigms (e.g., *FR & perceptual constancy*; *FR & perceptual learning*).
- (2) Future research should also be guided by the extension of context-dependent psychophysics to other major areas of interest like, for example, to developmental psychology (“developmental psychophysics”, “infant psychophysics”) or to comparative psychophysics (“e.g., monkey/cat/chick psychophysics”).
- (3) A *process-oriented* research strategy as illustrated above (Fig. 1) should be used most systematically; thereby, future study programs might be guided by quantitative *small-scale* or *large-scale* models or theories in perception and psychophysics.

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