RELATIONAL STIMULUS GENERALIZATION AND TRANSPOSITION IN THE YOUNG CHICKEN´S PSYCHOPHYSICS: WITHIN OR BETWEEN DESIGNING?

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**Abstract**
*In our former experiments on the young chicken´s psychophysical performance we investigated the role of a context-dependent test-series manipulation mostly on the basis of a between-designing methodology (e.g., Sarris, 1998, 2006; Hauf et al., 2008). In the present study of successive instead of simultaneous stimulus presentation during training and testing, a* within- *versus* between-*design procedure was used to investigate different groups of infant chickens for two different perceptual dimensions, size and colour. Naturally the successive/within-design task for each chicken is much harder to accomplish than that of the common simultaneous/between-group procedure (2AFC task, in both cases). The findings of this comparative method-oriented investigation will be presented and discussed in the light of our previous developmental paradigm of relational psychophysics.*

"If epistemology is to become scientific it will have to learn from neurophysiology and *bio*psychology but also from developmental (genetic) psychology and from whatever evolutionary biology has to say about cognition."
Mario Bunge 1983, p. 8 (emphasis added here)

Almost twenty years ago the comparative psychologist David R. Thomas, University of Colorado, USA, made the observation that as new technologies are developed in psychophysics, which are sensitive to relational ("contextual") effects also in non-humans, there should be such findings in birds and other animals as well. He rightly added the following: "Although it is much easier to demonstrate relative stimulus encoding in humans than in animals, it is now clear that this (´contextual´ encoding) is not an exclusively human phenomenon." (Thomas et al., 1991). Our own work, which may be seen in the spirit of Thomas´ assertion, is part of the relational psychophysics paradigm that has been developed and tested in the first author's animal laboratory (cf. Sarris, 1998, 2004, 2006; see also Sarris et al., 2001; Hauf et al., 2008). The reader may like and consult the published examples, which illustrate the background of the present investigation on contextual ("relational") stimulus generalization and transposition (*TP*) with young chickens. Here the main findings of a method-oriented *TP* investigation are reported with a special emphasis of a within- versus between-group methodology in animal-developmental psychophysics, with an eye on the perceptual-cognitive functioning of the infant chicken's relational choice behaviour.

## Main Purpose of the Study

In this follow-up study a successive, instead of simultaneous, training and generalization-testing procedure was used with different animal groups of infant chickens, namely several between-design subgroups and two within-design groups (two alternative-forced choice method, *2AFC*; see below). Specifically, we wanted to compare with another the results stemming from animal psychophysical experimentation based on:

(1) The use of *within* versus *between designing* and
(2) The choice of *size* stimuli versus *colour* objects (yellow-red dimension).

It should be mentioned that our earlier investigations of successive versus simultaneous size and colour stimuli had led to somewhat irregular ("*noisy*") context-dependent data trends for the chicken groups studied, presumably because of the too small sample-sizes used (Sarris, 2006, Fig. 4.12).

## Method: Apparatus, Designing, and Procedure

The apparatus, designing, and general procedure as employed in this study were basically the same as those reported in our previous work (e.g., Sarris, 1998, 2006; Hauf et al., 2008).

*Apparatus*

A computer-controlled two-way shuttle discrimination box was used, with two identical chambers for the training and test objects. A sliding door between these compartments was allowing the electronically controlled access to the chambers. Behind each stimulus-object position was a loudspeaker providing the "maternal" calls (reinforcement 1), and above each feeder (reinforcement 2) there was a fan with a stream of warm air (reinforcement 3). This computer-controlled apparatus with its multiple reinforcement-provision had been constructed for the training and testing of infant chickens many years ago (cf. Sarris, 1998).

*Designing*

In part A of the study (between design), six groups, i.e. two times three different subgroups of infant chickens were individually trained and tested, namely one subgroup each for the three contextual conditions (C0, C1, or C2) for the size as well for the colour dimensions used. In part B (within design) there were only two main animal groups, which were trained and tested under the same three context conditions (C0, C1, or C2), namely one group for the size and another one for the colour conditions. The numbers of the subjects are listed in Figures 1 (*size*) and 2 respectively (*colour*; see below); they refer only to those animals, which had passed, first, the training and, secondly, the testing criteria as strictly used in this kind of animal experimentation.

*Procedure*
On their first day of life (day 1), all infant chickens were given three training sessions lasting for about 10 to 15 minutes each; afterwards, on all the other days (days 2, 3, etc) four sessions were provided. During the sessions each trial began with the placing of each animal randomly

in one of the chambers while the lights were off; then the alternate chamber for the first trial was lit, the trial started with the door opening, and the "maternal" calls (loudspeaker calls: see above) were played from both object positions (pre-training phase) thus encouraging the bird to orient toward the training stimuli (for further details of the training and test procedures cf. Sarris, 1998; Sarris et al., 2001; Hauf et al., 2008).

## Results and Discussion

*Results: Within- versus Between-Group Data*

The main findings, stemming from the test phase with the respective psychophysical C0 (control, i.e. context-free), C1 and C2 conditions, are summarized in Figure 1 (*size* stimuli) and Figure 2 (*colour* objects). Both figures contain the mean trends and their respective standard errors for the successive size and colour conditions in the between- (*top*) and the within- (*bottom*) design. Note that the graphs for both design types reflect remarkably clear-cut context effects in the sense of the transposition phenomenon (*TP*). Note also that these psychophysical stimulus-response curves are well in line with the theoretical trends as predicted from a mathematical frame-of-reference ("transposition") model as described in length elsewhere (e.g., Sarris, 2004, 2006; cf. also Anstis & Sarris, 2006).

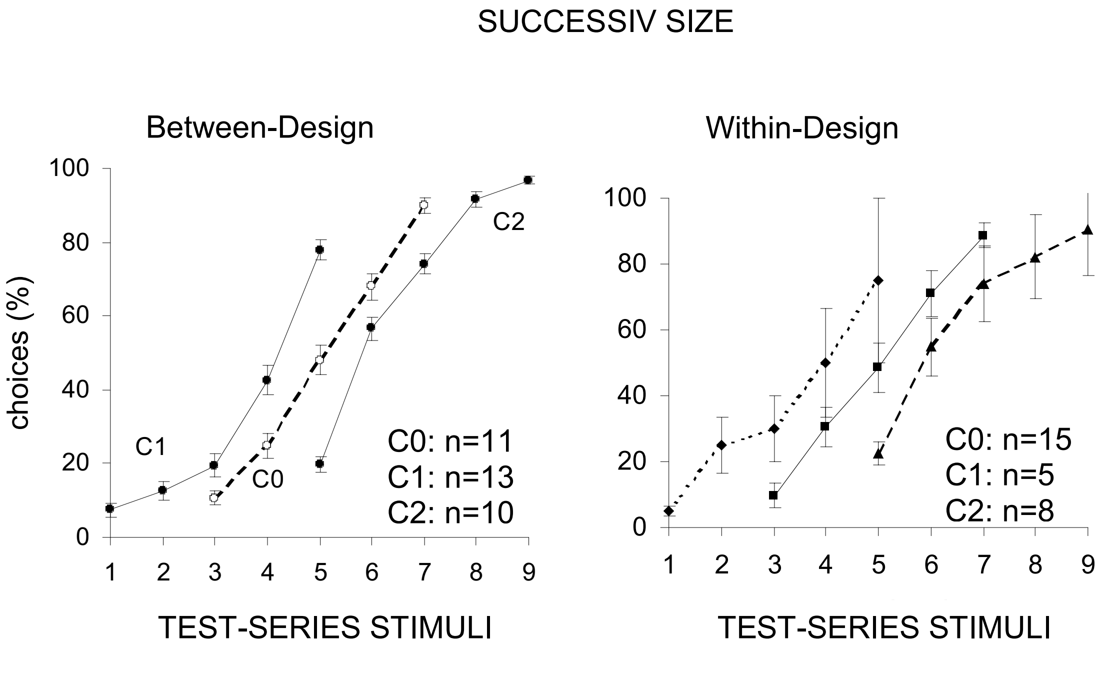


*Fig. 1. Size* data: the infant chickens' mean test-phase choices; between- (*left*) versus within- (*right)* design graphs. C0 = context-free, C1 & C2 = context-effect trends (transposition, *TP*).

SUCCESSIV COLOUR

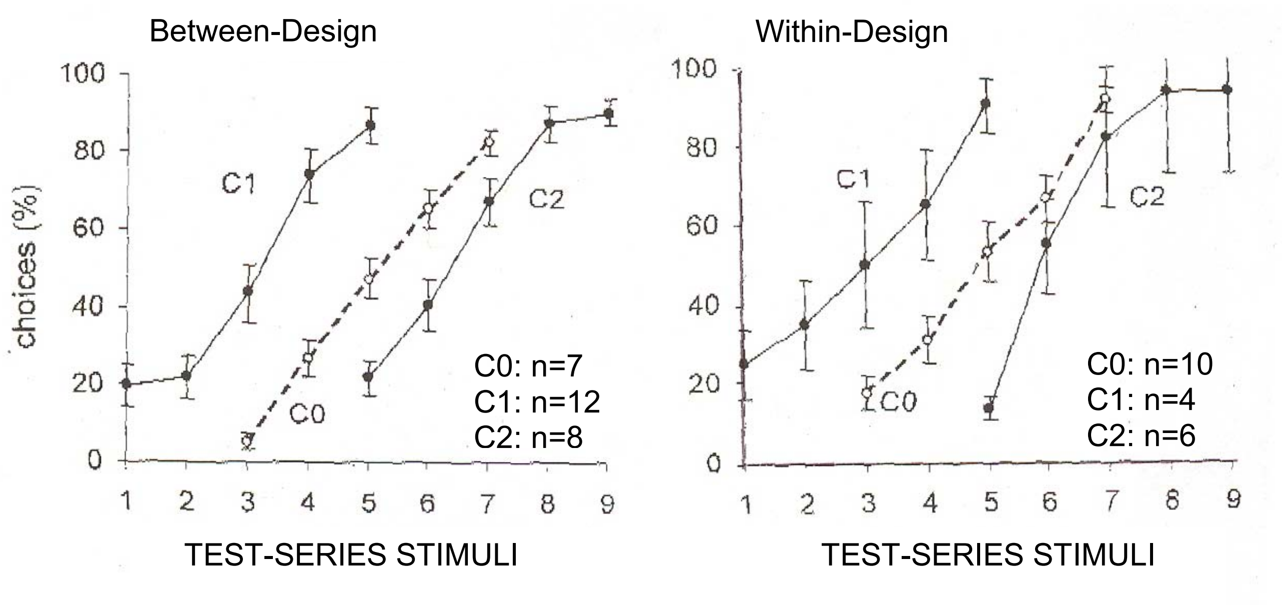


*Fig. 2. Colour* data: the infant chickens' mean test-phase choices; between- (*left*) versus within- (*right*) design graphs. C0 = context-free, C1 & C2 = context-effect trends (transposition, *TP*).

However, as the outstanding result of these experiments it should be stressed that the *standard errors* are very much larger for the *within*-design graphs as contrasted with those stemming from the between-group design (Fig. 1, Fig. 2). Clearly, the application of the within-design methodology seems to be responsible for the chickens' high inter- and intra-individual test choice variability. This important finding holds for both size and colour and it is probably due to the much more demanding memory-informational "load" involved in the within-group performance, in stark contrast to the perceptual-cognitive efforts needed for the infant bird's working memory in the case of the between-design.

*Discussion: Where Do We Go From Here?*

The findings of this study have confirmed and extended the previous results with infant chickens as found in the first author's lab over the years (for a summary of these earlier experiments see Sarris, 2006). In addition, for the first time some truly lawful design-dependent *standard errors* have been obtained here. Probably, these enlarged standard errors reflect the *bio*-psychologically highly relevant information-processing load as being involved during the infant chicken's test performance. Indeed, this *testing-the-limits* result for the within-design conditions, as opposed to those under the between-design methodology, seems to mirror the infant bird's utmost perceptual-cognitive test-achievement flexibility; but beyond a certain testing-the-limits stage with even more extreme context-test stimuli, a gradual transposition-performance breakdown is to be expected under the within-condition demands. Accordingly, we propose that future studies should be based also on a longitudinal design as schematically illustrated elsewhere (Sarris, 2006; Sarris et al., 2010). Due to space limitation, the corroborating results taken from a "*relational*" versus "*absolute*" training-test study, with still other infant-chicken groups, are not discussed here (cf. Hauf et al., 2008).

There is a strong need to continue and extend the present experimental knowledge in this special field of comparative-cognitive psychophysics as entertained in the work at Frankfurt's laboratory (for an alternative theoretical account of our data see, for instance, Thomas, 1993; Ghirlanda & Enquist, 2007; furthermore, from an epistemological and methodological point of view cf. Craver & Bechtel, 2007; Sarris, 2010). Indeed, the major findings of this study should be treated from a broader theoretical and empirical perspective than the discussion has indicated here. For instance, one such important issue is connected with the "relational" versus "absolute" nature of all comparative perception and psychophysics thus pointing to the still-open question of the "perceptual-cognitive" processing as contrasted to the more sensory character of the classical associative information-processing perspective (neural-network modelling) as discussed controversially in the literature.

Finally, since the experimental context effects as reported above are highly variable, i.e. very labile, for the infant chicken's relational choice behaviour (pronounced inter- and intra-individual *variability*), the use of a *multiple noise-filter* methodology has become demandatory for the data analysis (cf. Sarris, 2006). As a matter of experimental and statistical fact, the respective *"signal"* versus *"signal and noise"* data fluctuation appears to be a unique example of the general nature of all developmental processing in animal and human infancy thus leading to the unresolved question: What is the neurobiological basis (brain functioning) of this inter- and intra-individual response variability as observed in the case of the chicken's transposition? For a principle notion concerning this general query the reader is referred to the opening motto provided by Mario A. Bunge (Bunge, 1983).


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