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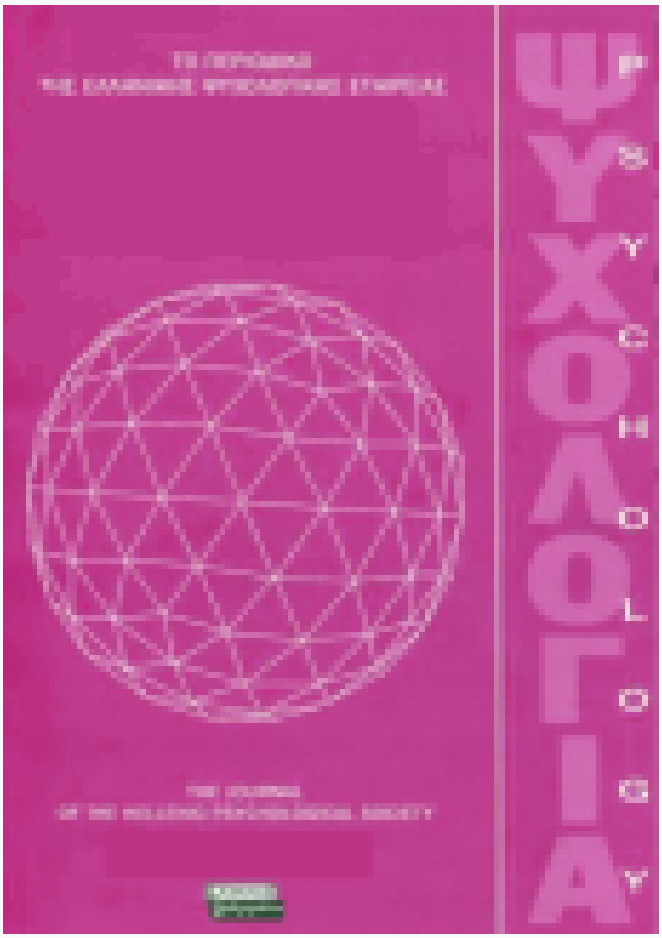

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Frame-of-Reference Effects in Psychophysics: New Experimental Findings with Baby Chicks

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ABSTRACT Newborn chicks were trained in a simultaneous-discrimination task to peck selectively either at a red versus green or at a small versus large box. Pecking at the correct box was reinforced by a combination of a hen's maternal call and/or the delivery of a stream of warm air or selectively by the former or the latter as a single reinforcer, always together with food, and furthermore with food only. Training started on the first day of life; after reaching the criterion of training performance, subsequent generalization testing followed. It was expected, and subsequently supported by the empirical data, that the combination of these reinforcers would be more effective than the use of the single reinforcement components. Lawful generalization-test data were obtained, especially with colour. These findings were extended by some data of a context-effect study showing that perceptual relativity in size perception is likely to occur not only with older animals but also in baby chicks.

Key words: Generalization, psychophysics, reinforcement.

Introduction

Psychophysical *relativism* is a basic characteristic of human and animal behavior, a notion which is supported by many earlier findings demonstrating contextually induced *shifts* of the Point of Subjective Indifference (PSI) in postdiscrimination-generalization tests (e.g., Sarris,1990, 1994; Sarris, Sander, & Elfering, 1995; Sarris, Elfering, & Sander, 1995). More specifically the frame-of-reference model as suggested by Sarris and Zoeke (1985) predicts a shift of the PSI level as a function of the training- and test-stimulus values as well as the amount of practice with the test stimuli. Also, the latter authors postulated and confirmed an *age-related* influence on PSI shifts in humans to the effect that context manipulations lead to more dynamic behavioral changes in younger children than in older ones or in adults.

The present study, with a simultaneous-discrimination task and the use of multiple reinforcers, was aimed at the demonstration of perceptual relativism not only with hen but also with baby chicks. The different reinforcers to be tested were a hen's maternal call, the delivery of a stream of warm air, and/or the provision of food. A systematic analysis of this reinforcer combination should provide a better knowledge of the contribution of each single reinforcer to the behavioral effects in the baby chick's stimulus discrimination. Whereas the methodological investigation of the reinforcement efficiency was one of the main aims of this study, the relevance of context effects in developmental visual psychophysics should be also demonstrated here.

Method

Animals. Altogether, N = 24 White Leghorn chicks *(Gallus gallus domesticus)*, one-day old at

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the start of the experiments, were kept as a flock in a scratching pen with a natural light/dark cycle, except for the four chicks of the so-called *priming* condition which were reared in darkness for the first 24 hours. The chicks were mildly deprived of food; however, water was available ad lib. Sixteen baby chicks participated in the reinforcer-efficiency and colour-generalization experiment; in addition, eight chicks served as subjects in the context-effect study of size discrimination.

General procedure

Variation of reinforcer conditions: Training. The simultaneous-discrimination training started on the first day of life. First, the baby chick was waiting in the dark (resting) part of the rectangular test apparatus, i.e., either in *chamber* 1 or in *chamber* 2; then, the partition wall was lifted thus giving access to the second, i.e., lightened compartment containing the two *training stimuli* (TS). The apparatus is shown in *Figure 1.*

In order to enhance rapid approaches to the TS short sequences of maternal calls were emitted by loudspeakers mounted under the respective two stimulus objects, which were light-coloured cardboard cubes standing on feeders (Fig. 2A). The cubes were pushed away when pecked by a chick thus allowing free access to the *food* for about 5 seconds or/and to the delivery of *warmth* and *maternal call* as reinforcers. The use of either colour or size of the *TS* objects was counterbalanced across chicks.

Whereas a correct choice led always to a reinforcement, an incorrect choice was immediately followed by darkness. Throughout, the subsequent trial was switched from one chamber (e.g., *front*) to the other one (e.g., *background*) of the experimental apparatus. Each training session lasted about 15 min. On the first day two daily sessions were provided; beginning with day 2, three sessions were employed.

Generalization tests. After reaching the criterion of 70% correct responses in two successive sessions, generalization testing started. *Figure 2A* shows the training and test stimuli of the generalization experiment. Each stimulus of the test-stimulus set was presented three times whereas each trial consisted of one of the test stimuli including the unrewarded *TS.* During testing every choice was reinforced. The test-series sessions started always with 10 retraining trials followed by 12 test trials; thereafter, 5 retraining trials were provided.

Context-effect tests. A discrimination training of differently-sized cubes, with constant colour, was followed by one of three *context* conditions. Each test series consisted of five cubes in ascending volume by equal geometric steps, namely: Condition C_0, the no-context control condition, was *symmetrically* constructed whereas the contextual conditions C_1 and C_2 were *asymmetrically* arranged around the respective *TS* (see *Figure 2B*).

Results

Training performance

The training colour-data as shown in *Figure 3* are group data (N1 = 16 baby chicks). The data of

The reinforcement conditions provided for the correct peckings were either

(1) food
(2) food and warmth
(3) food and maternal call, or
(4) food, warmth, and maternal call*.

* Furthermore, in conjunction with condition (4), a so-called priming-procedure was introduced as an additional condition 4a (i.e., a 30 min-preexposure to the bright-lightened experimental apparatus was provided: cf. Honey, Bateson, & Horn, 1994).

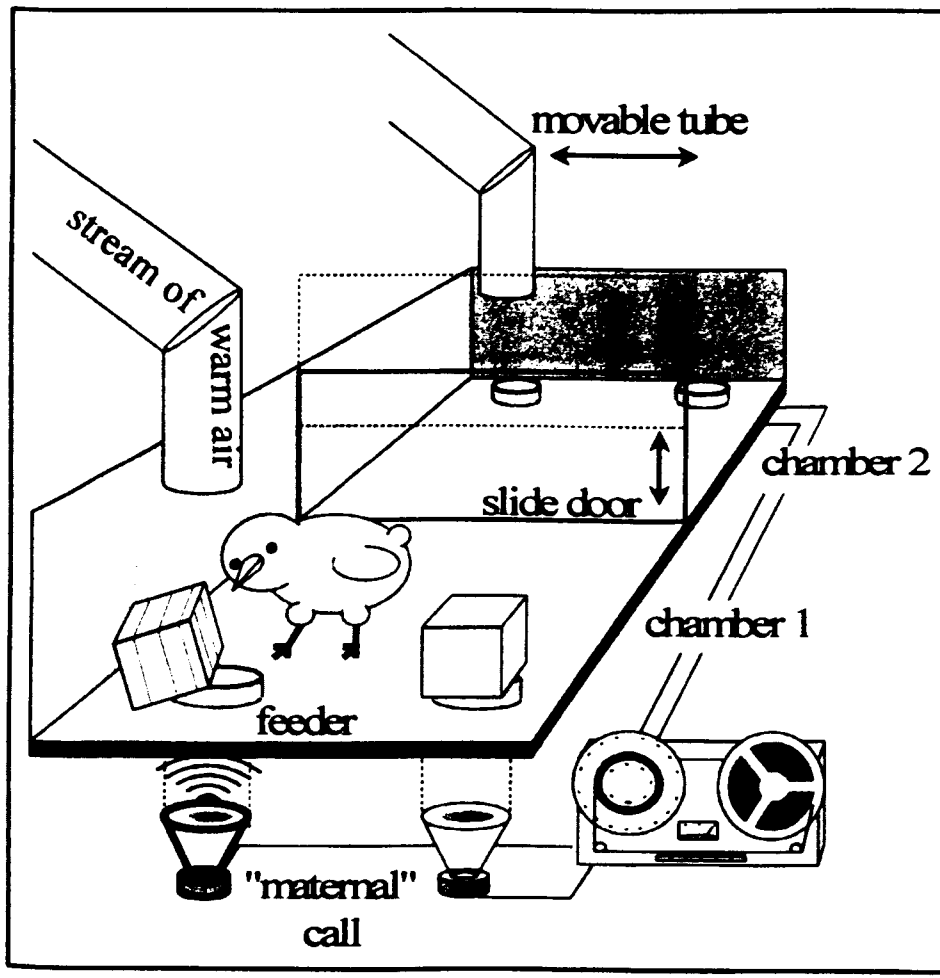

Figure 1: Two-choice apparatus, with chambers 1 (front) and 2(back) used to train and test baby chicks with colour and/or size stimuli (red; green). The air-path tube ("stream of warm air") is movable from the right to the left side of each chamber and vice versa; the two loudspeakers ("maternal call") were also used as automatic reinforcer devices. (A simpler version of this apparatus is described in detail elsewhere; cf. Vogel, 1996.)

only those animals are presented which obtained a substantial training progress over the *first four days*. The graphs illustrate that the differences in training results during the first days *(left side)* appear to depend on the different reinforcement conditions; however, these initial differences became rather diminished beginning with the second week of the experiment *(right side)*. Furthermore, the best training performance was obtained by a combination of all the single reinforcement cues, namely: *food, maternal call* plus *warmth*. Presumably because of the very short preexposure an additional learning enhancement could not be demonstrated during

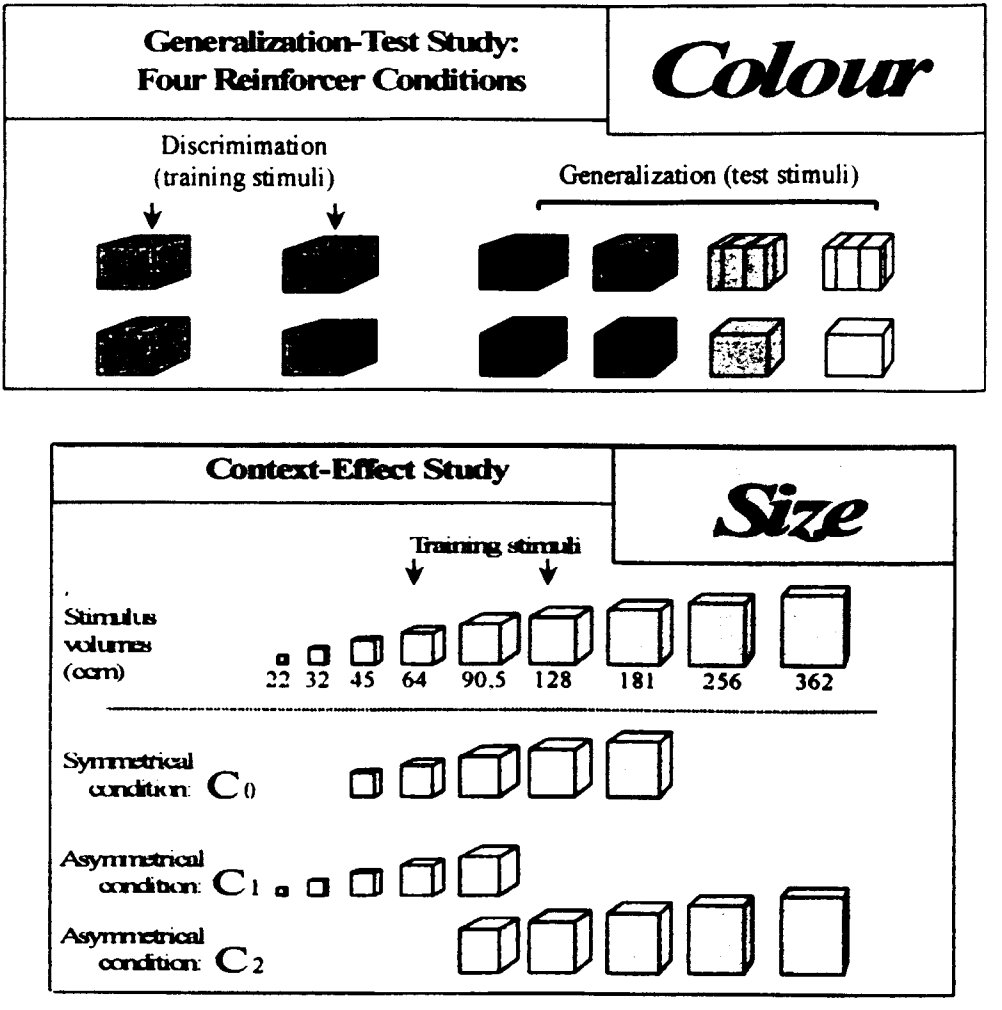

Figure 2: Schematic overview: Training and test stimuli. - A. Training and test stimuli of the colour-generalization experiment (the striped objects represent the red cubes, the non-striped objects the green ones); B. training and test stimuli of the context-effect study of size, with constant colour.

the socalled priming session (condition 4a, cf. *Method*): The data of this condition are very similar to those of condition 4; they are not included in *Figure 3*.

The generality of all these findings will have to be proven in future research by using a larger number of subjects for the different reinforcement conditions as used here.

Generalization and context-effect tests

Generalization tests. *Figure 4* shows the generalization-test data as obtained for the four experimental conditions (*colour* data). Apparently, each generalization curve declines, more or less, in the direction of the lighter stimuli as expected. As predicted none of the four curves

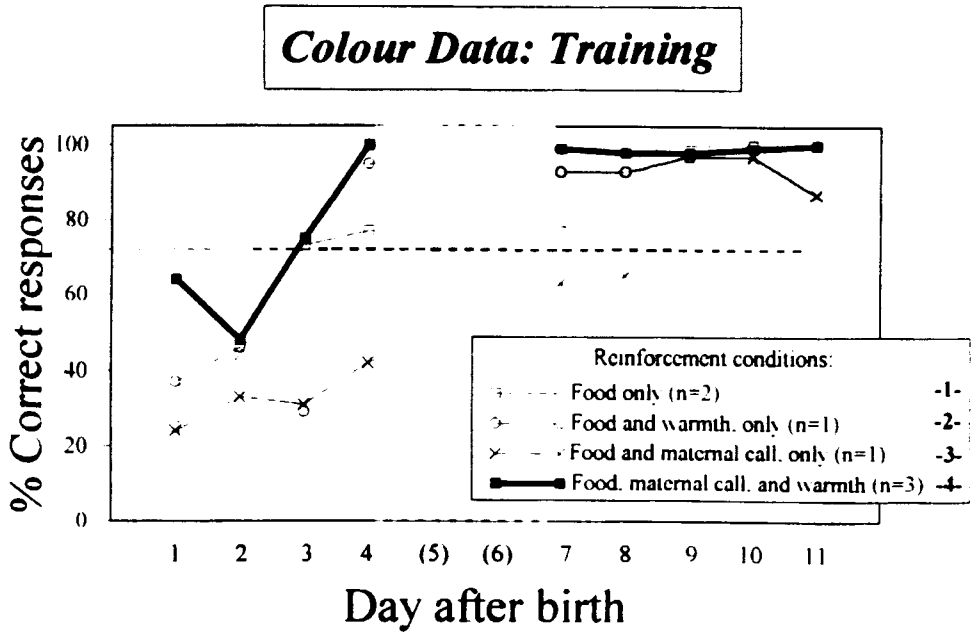

Figure 3: Percent correct responses in training for the main experimental reinforcement groups of baby chicks (cf. main text).

exhibits a central tendency effect which one should have observed by the use of an asymmetrical test series. Furthermore, no differences between red and green lightness-generalization data were obtained.

Context-effect tests. As an example, the data of one out of the eight chicks are shown in *Figure 5*. The training condition in respect to the reinforcers used was condition 4, i.e., *food, maternal call,* and *warmth* (cf. Hauf, Schellhorn, & Sarris, 1997). Baby chick #2 was only five days old at the beginning of the context-effect tests. Testing with the symmetrical (C_0) and asymmetrical (C_1, C_2) test series provided different response patterns as expected. *Thus, one and the same stimulus is reacted to ("perceived") differentially depending on its position in the respective asymmetrical context series* (i.e., *perceptual relativity*). - A fuller report of the context-effect data may be found in Schellhorn (1997).

Discussion and Conclusions

During the first days of life, at the earliest stage of their ontological development, chicks show already basic signs of perceptual *relativity,* namely strong contextual effects in psychophysics as illustrated here in the realm of the postdiscrimination-learning paradigm. Such effects illustrate the *plastic* nature of the psychophysical behavior in animal perception and they seem to point to some higher-order processing of perception. In earlier studies with hen at an adult age, i.e., with about ten up to twenty weeks old chicks, much more systematic *shifts* were found resulting from the use of many different contextual test-series as illustrated in *Figure 6;* these shifts were found systematically in a kind of testing-the-limits approach (Sarris, 1990, 1994). Naturally, it would be interesting to try and investigate the respective parametric trends analogously also in the very young chick, perhaps by the use of the so-called *DEM*

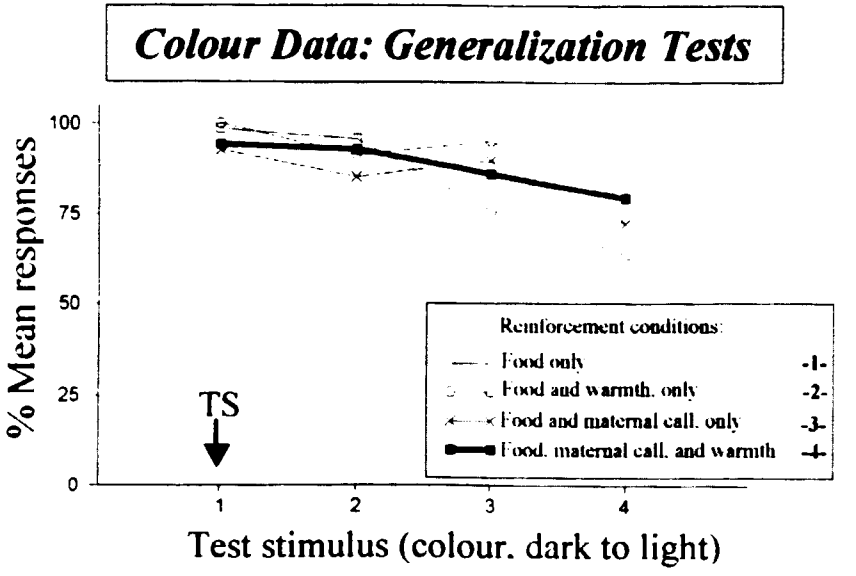

Figure 4: Mean generalization-test data of the four experimental conditions as used for the colour study (the arrow points to the rewarded training stimulus, TS).

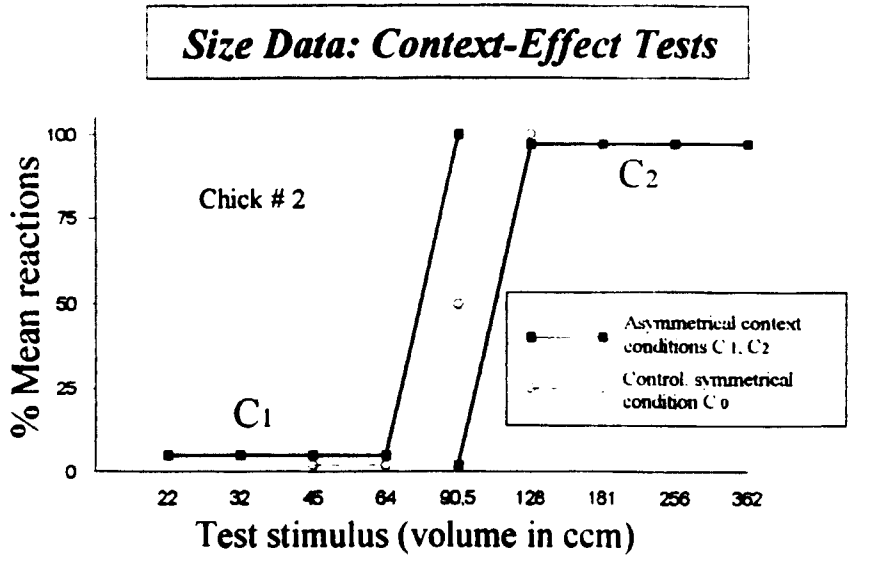

Figure 5: Context-effect data of n=1 baby chick for the size study, with test-series C_0, C_1 and C_2; see main text. - (Redrawn from the data provided by Schellhorn, 1997).

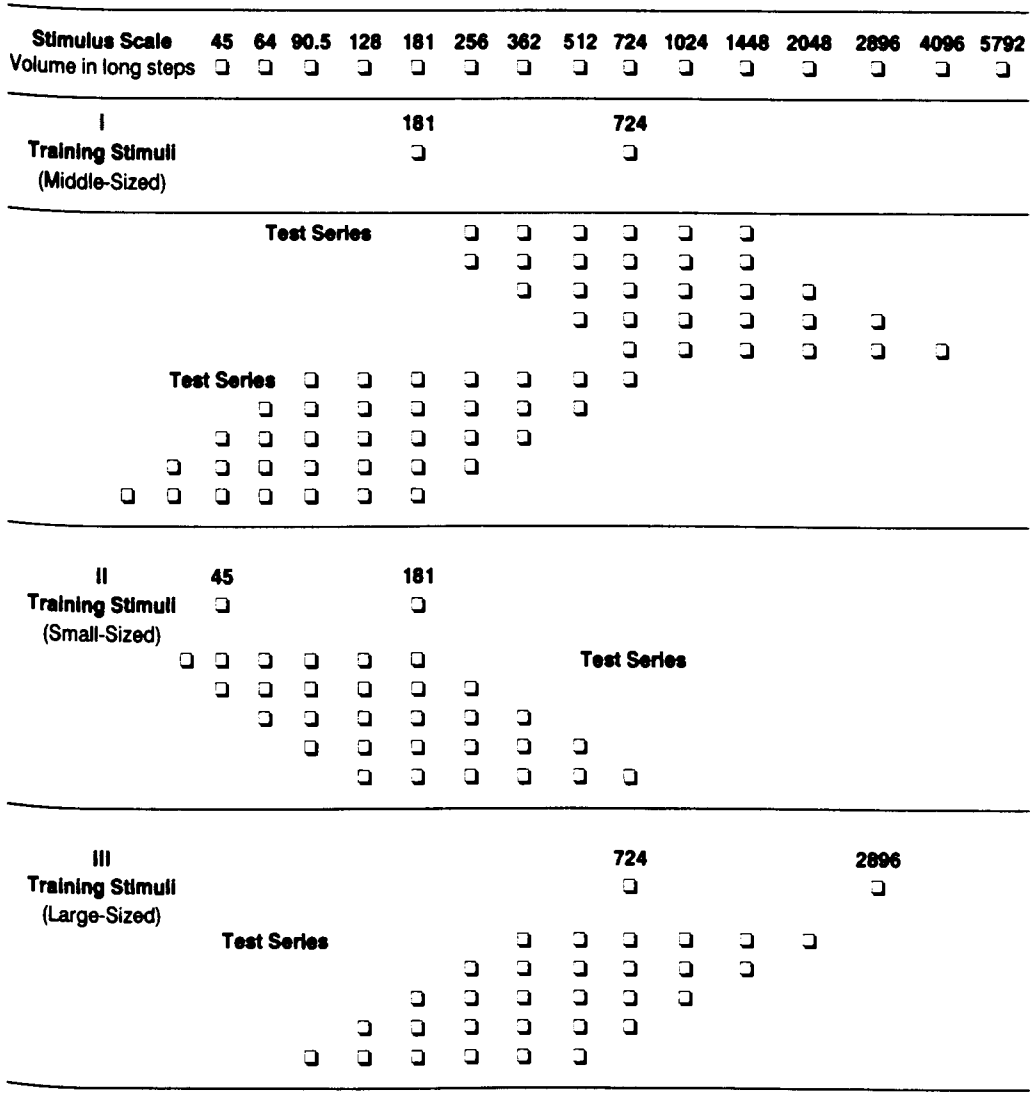

Figure 6: Physical size values used in earlier experimentation on psychophysical context effects in adult chicks: three sets of training and test stimuli for the systematic study of gradual test-series shifts (cf. Sarris, 1990, 1994). See main text.

technique (*D*ifferential *E*xposure *M*ethod) as employed successfully with a computer-driven touch-screen device; thereby the *DEM* technique provides a special guidance which enables dicrimination learning at a much faster rate (Sarris, Elfering, & Sander, 1995).

In the present study, the main findings lead to the following conclusions:

– The *combination* of reinforcement cues provides the best learning results in a simultaneous-discrimination task for baby chicks. The findings are in line with those of auditory and

visual learning enhancement-data obtained in earlier studies (cf. Van Kampen & Bolhuis, 1993).

- The generalization-test *colour* data show lawful transposition as expected from earlier work.

- The context-effect findings point to the principle of *perceptual relativity* also in the baby chick.

- Further research should clarify the question to which extent discrimination training can be improved by the use of a, say, much longer preexposure time during the first days of life ("*priming*").

In sum, the data confirm the general predictions concerning both generalization and context effects in psychophysics not only with adult hens but already with *baby chicks.* In reference to the findings from human developmental psychophysics, future research might be directed more specifically toward the various species-related ontogenetical communalities and differences of perceptual relativity under comparable context conditions thus aiming at the disentanglement of the perceptual-cognitive as well as the memory factors involved in the genesis of behavioral relativity during postdiscrimination testing.

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