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Infant Information Processing

Sunin Yi[1]
Department of Educational Psychology, Ewha Womans University

A review of the studies on infant learning, stimulus preferences, and habituation supports the following assertions. Firstly, the finding that a very young infant is capable of control of his basic responses if required implies that his ability for differentiating critical stimulus features is sufficiently adequate to be utilized in response adaptation. Secondly, results from both stimulus preference, and habituation studies indicate that before the infant is able to manage his motoric response, he is extensively engaged in stimulus differentiation and information processing. Thirdly, evidence from current habituation research using more elaborate procedures suggests that attentional processing under habituation is more than a single phenomenon, possibly involving multi-level processing. And lastly, existing data support Jeffrey's hypothesis of serial habituation as a mechanism for perceptual development.

To define perceptual ability is a matter of choosing a criterion. A basic sensitivity to light has been detected from birth by measures of eye blink, pupillary reflex, and heart rate. A sort of spatial localization has been demonstrated by visual pursuit, and a primitive type of pattern vision has been indicated in young infants by optokinetic nystagmus to a moving striped field.

A decade of research on infant learning has shown the early capabilities of infant behavior adaptability. Research in the area of infant conditioning has been mainly concerned with the demonstration that young infants are competent in controlling basic responses as a function of a contingency applied to them. Some investigators have been successful in conditioning reflex activities of the neonate. For instance, classical conditioning of the Babkin response to an auditory CS has been demonstrated by Connelly and Stratton (1969) and classical conditioning of sucking to a tone by Lipsitt and Kaye (1964). With operant conditioning paradigms, Siqueland and Lipsitt (1966) were able to increase the rate of neonate head-turning and Lipsitt, Kaye, and Bosnack (1966) were able to enhance infants tube sucking. Although these studies have been criticized on the ground of methodology (e.g., using a constant inter-trial interval as in the former studies) and for failing to establishing the involvement of the CS in the conditioning (as in the latter studies), leading some researchers (Sameroff, 1971; Fitzgerald and Porges, 1971) to question whether genuine CRs can be established in newborns, the use of increasingly improved techniques seems to demonstrate early infant adaptability of basic responses to the

[1] The author is currently at University of California at Los Angeles, California, U.S.A.

environment.

Results from current infant research using numerous attentional measures, however, have revealed that before the infant is able to demonstrate the motor or verbal control that most learning tasks require, he is actively engaged in stimulus differentiation and information processing. In as much as conditioning is contingent upon the subject's capacity to differentiate a positive or negative stimulus, the young infant's basic response adaptability demonstrated by conditoning techniques only reveals "aftereffects" of more basic processes. Therefore, it is of primary importance to investigate the adequacy of infant's perceptual capability for differentiating stimulus features, before asking whether the infant is able to utilize this ability in making correct choice response.

One of the early attentional measures used in infant perception studies is Fantz's paired-comparison technique. It was used to investigate young infant's pattern perception by Fantz and his coworkers (1962) and was found to have the advantage of obtaining young infant's visual preference based on the natural tendency of infant fixation rather than relying upon a simple reflex response or on a voluntary choice response that is compelled by an externally managed reinforcement. Fantz provided a basic technique with which researchers gained new access to infant psychological processes that have used to be denied, or left intact, because of theoretical as well as methodological reasons, but have emerged so vital to the understanding of human cognitive development.

Compared to its instructive impact upon suggesting the promise of studying infant perception in a more natural way, however, Fantz's studies (1962, and 1964) do not reveal much about what the infants were doing during the first six months when they attended more to the patterned stimulus over the gray, unpatterned stimulus card. It is not certain with Fantz's data whether the differential responsiveness shown by visual preference indicates that the infant has perceived the total stimulus pattern as a form or whether his choice response is simply based upon a minor stimulus difference such as brightness. It will be, then, again, a matter of definition. If whatever differential response that has been demonstrated to a patterned over unpatterned stimulus can be taken as evidence of form perception, one may justifiably say that pattern perception is feasible soon after birth, as Fantz and his associates have interpreted their findings. Without knowing about the fundamental nature of the perceptual differentiation that the infant has made, however, it is of little use to have such data in the understanding of cognitive functioning in the infant. The merit of Fantz's studies is the co-demonstration of habituation to the constant stimulus with a response recovery to the familiar one when paired with a novel stimulus. Fantz's demonstration of habituation excludes challenging accounts of the response decrement in terms of sensory adaptation, fatigue, or extinction of the orienting response.

Along with the paired-stimulus presentations, habituation techniques have been used as eminently responsive measures for an assessment of the infant perceptual discriminability and for an investigation of the process underlying the infant attentional behavior. Results from paired-comparison paradigms and habituation techniques are similar in evidencing the effect of stimulus processing during habituation. Some recent data on the effect of stimulus habituation even indicate infant's delayed recognition of the same object. An example is Fagan's (1973)

demonstration of delayed recognition of the human face masks or photos of faces in infants of 5-to-6-months old. Similar evidence has been shown by typical habituation procedures which involve delayed recognition test of the familiar stimulus features such as colors, forms, and the arrangement of stimulus elements. The implication of these results are paramount in the sense that the infant appears not only to process stimulus information under habituation but also to reprocess what he has previously experienced upon an encounter of the same stimulus at the later time.

According to more elaborate approaches that have been taken by some researchers to discover the fundamental features of habituation, attentional processing in the infant as young as 4 months old appears not to be a simple process but a multilevel process. There are two sets of findings that have relevance to the present discussion. One is Miller's (1972) finding that during a 8 successive 20-second exposures to the total stimulus patterns, 4-month-old infants fixated differentially to the stimulus components. Visual habituation to the component cues occurred in order of cue saliency, with the most salient stimulus showing the greatest amount of habituation. Another is Cohen's (1974) finding that when data were plotted into backward habituation curves, these curves revealed a multifeature of the infant visual response as opposed to what the typical forward habituation curves had shown, namely a gradual change in the response measure over trials. Cohen's results have indicated that while simple checkerboard stimuli produced backward habituation curves similar to those produced by the typical group habituation curves, complex checkerboard patterns, that had more corners and lines to look at, yielded two distinctive habituation phases, first, starting with a very gradual decrease in fixation time and, second, a gradual increase in the response measure, ending up with an abrupt termination of fixation, i.e., habituation.

These data are considered to reveal the behavioral aspect of the information processing program at the lower developmental level. How could these findings be integrated into a meaningful way of accounting for the basic features of early cognitive development? The present review of the infant research findings support Jeffrey's (1968, 1969, and 1976) serial habituation hypothesis which outlines a manner in which perceptual development may occur. According to Jeffrey's hypothesis differences in initial cue saliencies and those resulting from stimulus habituation determine attentional distribution among the given stimulus features. The most salient cue captures the attention first, allowing attentional shifts to other less salient cues only after its initial saliency is reduced; with recovery of the saliency of previously salient cues attentional shifts will occur among stimulus features with increasing frequency; and as individual cues habituated sufficiently to reduce the differences in saliency, a number of cues that could be scanned as a set will be increased. Miller's findings are thought to indicate the habituation of attention that occurs on single stimulus features as Jeffrey's hypothesis postulates that habituation to the component cues occur in order of saliency. Considering the fact that in Millers' experiment only the component cues initially rated as the most salient were habituated sufficiently during the short period of repeated presentation of the total stimulus patterns, it would be worthwhile to test Jeffrey's hypothesis by prolonging the habituation phases to see whether habituation will occur on the basis of more than a single cue after the saliency of each individual stimulus feature has been sufficiently reduced.

Cohen's findings are useful in that they reveal, in accordance with Jeffrey's proposition, the way in which a behavioral change evolves at various levels of attentional processing. From Jeffrey's proposition one would expect to obtain an indication of multiphase responding under habituation. It would be reasonable to expect an attentional decrement to repeated presentation of a simple cue. With complex stimuli certain features would habituate first, during which an attentional measure would revel a response decrement, but as more and more cues become involved in a single scanning process, it would be possible to obtain a response increment during this phase of the habituation process because more time would be required for habituation to occur to a bigger unit of stimulus cues. With habituation measures, then, not all the habituation curves are likely to show the gradual decrement of a typical forward habituation curve, nor will all backward habituation curves inevitably show peaks before terminating habituation. The present explication of the serial habituation hypothesis is to indicate that Cohen's findings with complex checkerboard patterns, namely the two distinctive phases of habituation, as well as his findings with the simple checkerboard stimuli, namely the attentional decrease over trials, support Jeffrey's account of perceptual development, which outlines the manner in which information is processed at multi-level serial habituation.

Jeffrey's (1976) recent two-system account of habituation is of particular relevance to the identification of the conditions under which habituation occurs on the basis of a single cue and on that of more than a single cue given various stimulus features, respectively. According to Jeffrey, there are a limited set of features that activate the target arousing system and a simple response decrement occurs with repeated exposure to such stimuli. This attentional process is linked primarily to basic alimentary or defensive needs. It only is after the target response has been habituated to the grosser features of a stimulus that the information processing system is aroused by the more complex stimulus features.

There has been a series of studies that indicates that various stimulus parameters differentially control the attentional process. The following empirical evidence appears to be in accord with the two system account of habituation proposed by Jeffrey. Simple stimulus variables such as size of the stimulus easily affect arousal component of attention while more complex stimlus variables such as number of the stimulus elements control attending behavior itself (Cohen, 1972); and infant's initial stimulus preference influenced by simple stimulus features (e.g., size) gradually wanes with age while the visual preference influenced by more complex features of the stimulus (e.g., number or contour) increases with age (Karmel, 1969; Fantz & Fagan, 1975). Considering that the typical habituation experiment involves nothing but a stimulus object (or a simple alternative stimulus such as a light for the infant to look at for a short period of time), Jeffrey's new proposition also has the advantage of explaining why the infant returns to the stimulus pattern to look at more complex and less salient inside cues, after he has attended to the simple border cues and has turned away from the stimulus pattern.

An explanation of habituation in terms of a memory model (Cohen, 1973; 1974) would be a "static" account of the habituation process if the model does not disclose a manner in which a behavior change comes about. This kind of "configural" account of habituation would require yet another model for an explanation of a behavioral change. A vital point to note with a memory model of habituation (the same

as with a neurological model) is that the memory (or the neurological representation) of a stimulus object can only be detected by processing programs that, in turn, must be indicated by some behavioral evidence.

Following the rationale of Jeffrey's model for perceputal development, the final form of serial habituation to a stimulus object would be a minimal orderly scanning that indexes a behavioral change. What produces the behavioral index at the final stage of the serial habituation will be the last stimulus processing program. Depending on all the levels of scanning processes involved, one would expect to obtain various features of processing programs that must have occurred before the final from of the stimulus processing has resulted which can be indicated by a minimal orderly scanning. Any figurative representation of the stimulus complex, which is a result of habituation, might be called by various names such as "neurological model," "memory trace," and etc. Habituational process itself, however, can not be explained by these terminologies or in terms of these concepts. An essential merit of Jeffrey's hypothesis as a mechanism for perceptual development is that the model reveals the operational, instead of the static, aspect of the human information processing program, with the specification of behavioral indexes for a hierarchical evolvement of behavior change. It will be useful in the sense of economy to have more behavior theories such as the one proposed by Jeffrey.

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