

**Prenatal Perceptual Experience and Postnatal Perceptual Preferences:
Evidence for Attentional-Bias in Perceptual Learning**

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(Abstract)

Previous studies have indicated that concurrent multimodal stimulation can interfere with prenatal perceptual learning. However, the nature and extent of this interference is not well understood. This study further assessed this issue by exposing three groups of bobwhite quail embryos to (a) no unusual prenatal stimulation, (b) a bobwhite maternal call, or (c) a maternal call + light compound in the period prior to hatching. Experiments differed in terms of the types of stimuli presented during postnatal preference tests (Exp 1 = familiar call vs. unfamiliar call; Exp 2 = familiar compound vs. unfamiliar compound; Exp 3 = familiar compound verses unfamiliar call; Exp 4 = familiar call vs. unfamiliar compound). Embryos receiving no supplemental stimulation showed no preference between stimulus events in all testing conditions. Embryos receiving exposure to a unimodal call preferred the familiar call over the unfamiliar call regardless of the presence or absence of patterned light during testing. Embryos receiving concurrent audio-visual exposure showed no preference between stimulus events in Exp 1 and Exp 4, but did prefer the familiar call when it was paired with light during testing (Exp 2 and 3). These findings suggest that concurrent multimodal stimulation does not interfere with prenatal perceptual learning by overwhelming the young organism's limited attentional capacities. Rather, multimodal biases what information is attended to during exposure and subsequent testing. Results are discussed within an attentional-bias framework, which maintains that young organisms tend to initially process non-redundant compound events as integrative units rather than processing the components of the compound separately.

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Chapter 1

Introduction & Literature Review

One of the primary goals of developmental psychology concerns accounting for how young organisms gain knowledge and derive meaning from the continuous stream of sensory stimulation encountered during development. A number of theorists have proposed that innate knowledge structures (e.g., modules) provide the initial foundation necessary for the gathering and organization of information, thereby allowing for the subsequent construction of knowledge (Fodor, 1983; Pinker, 1994; Slater, 1995; Spelke, 1998). However, relying upon such nativistic explanations undercharacterizes the process of development, in that such approaches do little to actually explain *how* such skills and capacities develop (Lehrman, 1971; Oyama, 1985). An alternative approach to nativistic assumptions has emerged over the course of the last several decades. This so-called epigenetic approach (Gottlieb, 1997; Kuo, 1967) proposes that perceptual and behavioral responsiveness emerge through the organism's ongoing interactions with its physical, biological, and social environments (Gottlieb, 1992; Griffiths and Gray, 1994; Johnston, 1987; Lickliter and Berry, 1990).

If one assumes that the developing organism enters the world (at conception) without preexisting knowledge or information, then the manner in which perceptual systems come to successfully pick up and utilize information becomes an important empirical question. To address this question, investigators have begun to explore how developmental processes occurring during the course of individual ontogeny are structured to facilitate perceptual development and organization. In the general sense, this approach attempts to examine the dynamic relationship between the structure of the developing organism and the structure of its context or environment, both prenatally and postnatally.

Given that organisms are exposed to a continuous array of multimodal stimulation, it is essential that researchers gain an understanding into how young organisms develop the capacity to perceive their surroundings as unitary objects and events. Accomplishing this task necessarily involves elucidating intersensory functioning and relationships. Over three decades ago, Eleanor Gibson (1969) recognized the value of understanding intersensory development as it relates to the acquisition of knowledge and perceptual capacities. In the ensuing decades there has been a relative lack of studies examining this issue (Lewkowicz, 2000). Instead, investigators have continued to primarily focus their analyses on intramodal effects, while virtually ignoring how the activity in other modalities may influence the functioning of the modality under investigation (i.e., intersensory effects, Lickliter & Bahrick, under review). In recent years there has been an increase in the number of investigations addressing the development of intersensory relationships (see Lewkowicz & Lickliter, 1994; Lickliter & Bahrick, 2000 for reviews).

Intersensory effects during multimodal sensory exposure in epigenetic-based studies

One way in which to study intersensory relationships in early development involves assessing how concurrent activity in one sensory modality can influence the activity or functioning in other modalities. For example, it has been shown that avian embryos are able to demonstrate auditory learning in the late prenatal period. However, concurrent stimulation from a different modality (e.g., visual or vestibular) tends to disrupt this auditory learning capacity

(Gottlieb, Tomlinson & Radell, 1989; Honeycutt & Lickliter, 2000; Lickliter & Hellewell, 1992; Radell & Gottlieb, 1992). Specifically, these studies show that when avian embryos are exposed to an individual species-typical maternal call in the days prior to hatching, they will prefer this familiar maternal call over a similar but unfamiliar maternal call during postnatal simultaneous choice testing. However, when embryos are exposed to the maternal call concurrently with patterned (non-synchronized) light or enhanced vestibular stimulation, embryos fail to prefer the familiar maternal call during testing. Thus, concurrent activity in another modality appears to interfere with prenatal auditory learning. In light of these findings, investigators working in this area have suggested that concurrent multimodal stimulation somehow serves to disrupt embryos' attentional capabilities, rendering them unable to selectively attend (or respond) to features of the maternal call.

Intersensory effects during multimodal sensory exposure in intensity-based approaches

This interference-effect associated with concurrent multimodal (or compound) stimulation is interesting in that it stands in apparent contrast to findings from intensity-based approaches to perceptual development. T. C. Schneirla (1959) was among the first to propose that young (phylogenetically more advanced) organisms primarily organize their behavior on quantitative features of sensory stimulation. Modern variants of this approach maintain that organisms are initially sensitive to the overall effective intensity of sensory stimulation, and go on to claim that this quantitatively-based responding provides the foundation upon which qualitatively-based responding ultimately emerges (Turkewitz, Gardner & Lewkowicz, 1984; Turkewitz & Mellon, 1989). Evidence in support of this view has come from studies of cross-modal transfer in both infant rats (Kraebel, Vizvary & Spear, 1998; Kraebel & Spear, 2000) and infant humans (Turkewitz & Lewkowicz, 1980). Specifically, it has been found that a response to a stimulus in one modality can be transferred to a stimulus of an equivalent intensity in a different modality. When the intensity between the two stimuli differs there is no response transference, suggesting that the transference was mediated by stimulus intensity.

An intensity-based approach has also been successful in accounting for the general finding that young organisms tend to respond to a multimodal (or compound) event as a single configural unit, whereas adults tend to process the individual elements of the compound separately (Spear & McKinzie, 1994). To understand why these age-related differences come about, it is necessary to describe the conditioning procedure in which these differences have been found. These differences in how infants and adults respond to compound stimuli have been most clearly demonstrated in potentiation and overshadowing phenomena found in Pavlovian conditioning studies. *Potentiation* (or potentiated learning) refers to the enhanced response to a stimulus when it has been conditioned in compound (with another stimulus) compared to when it has been conditioned alone. That is, when subjects are conditioned to a compound Stimulus AB and subsequently tested with Stimulus A alone, there is a greater conditioned response to Stimulus A compared to when subjects are conditioned to only Stimulus A. *Overshadowing*, on the other hand, refers to a reduced response to a stimulus when it is conditioned in compound when compared to it conditioned alone. That is, subjects show a diminished response to Stimulus A when it conditioned to the compound Stimulus AB, than when conditioned to Stimulus A alone. It has generally been found that infants are more likely to demonstrate potentiation, whereas adults are more likely to exhibit overshadowing (Spear & McKinzie, 1994). Thus, unlike the findings from epigenetic approaches in prenatal perceptual learning

where multimodal stimulation (maternal call + light) interfered with attention towards an element (maternal call) of the compound, intensity based approaches have found that compound stimulation can facilitate (rather than disrupt) sensitivity to a compound's elements.

Configuring based on stimulus intensity

It is believed that this facilitation is based on young organism's sensitivity to the amodal property of stimulus intensity (Mellon, Kraemer & Spear, 1991; Spear & Kucharski, 1984). To test this hypothesis, Mellon et al. (1991) conditioned preweanling (17 Days-old) and adult rats to a light + tone compound and tested them using a high-intensity tone. They reasoned that, if preweanlings attend to the conditioned stimulus (Light + Tone Compound) on the basis of intensity, then they should show a dramatic potentiation effect since the testing stimulus (High-Intensity Tone) would be more similar to the conditioned stimulus. Likewise, if adults attend to the qualitative features of the individual elements of the compound, then they should show dramatic overshadowing, in that the testing stimulus would be more dissimilar relative to the conditioned stimulus. Their results supported these predictions, suggesting that adults attend to the individual elements of the compound whereas infants tend to configure compounds. Moreover, these results indicate that one way in which infants can configure compounds is on the basis of the amodal property of intensity.

Comparing epigenetic- and intensity-based approaches

A fundamental difference between epigenetic- and intensity-based approaches concerns the role of stimulus intensity in influencing perceptual and behavioral responsiveness. In particular, whereas intensity-based approaches see intensity as *mediating* responsiveness (by being the basis of responding), epigenetic-based approaches view intensity as *moderating* responsiveness. As a case in point, the interference in prenatal auditory learning associated with concurrent multimodal stimulation discussed earlier can be eliminated by reducing the overall amount of stimulation made available to the embryo. In a series of experiments, Radell & Gottlieb (1992) reported that prenatal auditory learning can be disrupted when the delivery of the maternal call coincides with augmented vestibular stimulation (16 cyc/min). They then showed that when the amount of augmented concurrent vestibular stimulation was reduced (to 8 cyc/min), embryos were able to learn the familiar call. Thus, the overall amount of stimulation appears to moderate prenatal auditory learning such that learning is disrupted once stimulus intensity exceeds a certain threshold.

An attentional-bias approach

An alternative conceptual approach has recently been proposed which can be used to integrate many of the findings discussed above. This so-called "attentional-bias" hypothesis (Honeycutt & Lickliter, in press) was originally put forth to account for how young organisms respond to concurrent multimodal stimulation having previously encountered elements of the multimodal compound. It is important to note that intensity-based hypotheses can not explain how organisms respond to stimuli that they have previously encountered (e.g., language) (Turkewitz et al., 1984). That is, even very young organisms do not tend to respond to familiar stimuli on the basis of effective stimulus intensity but instead base their responding on other available features of sensory stimulation. The attentional-bias hypothesis seeks to remedy this problem by maintaining that prior exposure to a stimulus biases attention towards aspects of that stimulus when it is later presented in compound with another unfamiliar stimulus. As a case in

point, Honeycutt and Lickliter (in press) demonstrated that prior unimodal exposure to an auditory (or visual) stimulus biases attention towards aspects of the auditory (or visual) stimulus when it later presented in compound with an unfamiliar visual (or auditory) stimulus. Specifically, they found that when quail embryos are given exposure to an individual maternal call for 10 min/hr for 12 hr followed by multimodal exposure to a call + light compound for 10 min/hr for an additional 12 hr prior to hatching (call → call + light), embryos are able to learn the familiar call. Reversing the order of stimulation (call + light → call), despite equal amounts of multimodal and unimodal exposure, however, does not support prenatal auditory learning. Thus, it appears that previous exposure to the call biases attention towards aspects of the call when it is subsequently presented in compound with patterned light. In an additional experiment, they exposed a group of embryos to patterned light alone followed by multimodal (call + light) exposure (light → call + light). In this case, embryos failed to learn the familiar call presumably because attention was biased towards aspects of the patterned light during subsequent compound exposure. This bias in attention has also been found in intensity-based habituation-dishabituation investigations where rat pups were habituated to a visual stimulus (light) and tested with a light + tone compound (Kraebel & Spear, 2000). Although it was thought that when pups were habituated to light they would dishabituate to a light + tone compound based on in-equivalent intensities, they found instead continued habituation. It was concluded that prior exposure to the light led rat pups to selectively respond to aspects of the light despite it being presented in compound with a tone.

It is important to clarify what is meant by *attention* in the present work. Although the term attention has been used to refer to several different psychological phenomena (e.g., selective, executive function) (James, 1985; Rogers, Rousseau & Fisk, 1999; Ruff & Rothbart, 1996), the term attention used in the attentional-bias hypothesis refers exclusively to selective components of perceptual processes known as stimulus selection (Mellon et al., 1991). That is, organisms do not typically discriminate between objects and events based on all the available differences in features (e.g., size, color, shape), but instead respond to a select portion of these features (Hale, 1979). In this sense, the term attention used here refers to the process involved in how organisms select specific types of information from all the information available in their respective environments.

Expanding upon the attentional-bias hypothesis, it is proposed here that during initial exposure to unfamiliar events in the early periods of development, organisms typically attend to (i.e., attention is biased towards) intensity-based properties of sensory stimulation. This tendency diminishes as a result of prior experience with the relevant stimuli (e.g., Honeycutt & Lickliter, in press; Kraebel & Spear, 2000) or when the overall amount of stimulation exceeds a certain threshold (e.g., Radell & Gottlieb, 1992). For example, Kraebel et al. (1998) found no evidence of cross-modal transfer between stimuli of high-intensity which led them to propose some unspecified intensity threshold which when exceeded promotes a shift in how organisms selectively respond (or attend) to features of sensory stimulation. On their account, exceeding this threshold shifts organism' attention towards modality-specific properties of sensory stimulation. Thus, once the tendency to respond to quantitatively-based information diminishes, organisms' attention is then biased towards other properties of sensory stimulation (e.g., synchrony, duration, rate or modality-specific properties), with the overall amount/intensity of stimulation serving as a moderating factor.

In light of the attentional-bias approach outlined above, it is plausible that exposure to concurrent non-synchronous multimodal stimulation does not necessarily disrupt attentional functioning but instead leads young organisms to configure the compound, which may or may not take place on the basis of intensity. That is, configuring may take place on the basis of some other feature(s) of sensory stimulation beyond stimulus intensity where intensity would serve as a moderate what types of features infants attend to. However, previous investigations have not addressed this possibility. In particular, despite providing embryos with a call + light compound during prenatal exposure, previous investigations (Gottlieb et al., 1989; Honeycutt & Lickliter, in press; Lickliter & Hellewell, 1992; Radell & Gottlieb, 1992) have used only maternal calls during testing. Given the propensity for young organisms to configure compound events, it is plausible that the inclusion of patterned light during testing may be necessary to allow for preferential responding. In other words, for embryos exposed to a call + light compound to demonstrate a postnatal preference both elements of the compound must be made available during testing.

Design of the present study

The present study is designed to further explore these issues and further test the attentional-bias hypothesis in four related but separate experiments. Experiments differed according to the types of stimuli used during postnatal simultaneous-choice testing. Experiment 1 follows the format of previous studies (Gottlieb et al., 1989; Honeycutt & Lickliter, 2000; Lickliter & Hellewell, 1992; Radell & Gottlieb, 1992) by simultaneously presenting the familiar maternal call and the unfamiliar maternal call during testing (Familiar Call vs. Unfamiliar Call). Experiment 2 provides patterned light along with each maternal call, forcing subjects to choose between the familiar compound and an unfamiliar compound (Familiar Call + Light vs. Unfamiliar Call + Light). Experiments 3 and 4 are included to further tease apart the effects of light on responding. Specifically, whereas testing in Experiment 3 includes the familiar compound and unfamiliar call alone (Familiar Call + Light vs. Unfamiliar Call), Experiment 4 includes the familiar call alone and an unfamiliar compound (Familiar Call vs. Unfamiliar Call + Light).

In addition, each of the four experiments utilized three separate groups of bobwhite quail that differed in terms of the type of stimulation they were exposed to in the day prior to hatching. One group (Naïve Control) was not exposed to any unusual auditory or visual stimulation during the late prenatal period. A second group was exposed to a maternal call alone (Unimodal Call), while a third group received concurrent multimodal exposure to a maternal call and patterned light (Call & Light).

Hypotheses

According to the attentional-bias hypothesis, when initially exposed to unfamiliar stimuli, young organisms should primarily attend to intensity-based features of sensory stimulation. On this view, it is predicted that Naïve Controls will demonstrate a preference when there are differences in intensity between the testing stimuli (Experiments 3 and 4), but will show no preference between testing stimuli of equivalent intensities (Experiments 1 and 2). Also, it is predicted that subjects exposed to the maternal call alone (Unimodal Call) will prefer the familiar call in each of the four experiments. This prediction is based on the attentional-bias notion that prior experience with a stimulus will bias attention towards that stimulus when it is later

presented in compound with an unfamiliar stimulus. Thus, the addition of the light during testing should have no effect on subjects' responses. Finally, subjects concurrently exposed to a maternal call and light are expected to prefer the familiar call only when it is presented in compound with patterned light (Experiments 2 and 3), otherwise they are expected to show no preference between testing stimuli (Experiments 1 and 4).

Chapter 2

General Method

Certain features of the experimental design are common to all experiments. These shared features are described prior to presenting the particular details of each individual experiment.

Subjects

Subjects were 240 incubator-reared bobwhite quail embryos (*Colinus virginianus*). Fertile, unincubated eggs received weekly from a commercial supplier were set in a Petersime Model I incubator which maintains a temperature of 37.5°C and a relative humidity of 85-90%. After 20 days of the 23 day incubation period, the eggs were transferred to a hatching tray located in the bottom of the incubator. To control for possible variations in developmental age, only those chicks that hatched on day 23 were used in this study. To control for possible between-batch variation, subjects for each experimental condition were selected from at least 3 different hatches (i.e., weeks) of eggs. The only sounds available to the incubating embryos were embryonic and postnatal vocalizations of broodmates in addition to the background low-frequency noise emitted by the fan and motor of the incubator. Following hatching, subjects were placed in large plastic tubs located in a sound-attenuated room that is illuminated by 100-W brooder lamps. These lamps were suspended above the plastic tubs and served to maintain an ambient air temperature of 30°C. Food and water were continuously available throughout each experiment except during testing.

Procedure

On day 22 of the 23 day incubation period eggs were selected from among the batch of eggs on the hatching tray. It is at this time (24 hr prior to hatching) that the embryo's bill normally penetrates the air space on the large end of the egg, producing a visible indentation (or "pip") on the outer shell of the egg. Once eggs showed these pips they were placed in Hovibator portable incubators which permitted the delivery of auditory and visual stimulation. Following hatching, the chicks were placed in the plastic rearing tubs described above.

Each experiment contained three experimental conditions. These groups differed according to the type(s) of sensory stimulation that they encountered prior to hatching. One group (Naïve Control) was reared without exposure to a maternal call nor patterned light. A second experimental group (Call Alone) was exposure to an individual maternal call (Call B; for discussion of the maternal calls, see Testing section below) in batches of 10-12 embryos for 10 min each hour during the 24 hr period prior to hatching. Auditory stimulation began on the first half of the 22nd day of incubation and continued across the first half of the 23rd day of incubation. The recording of the maternal call was broadcast through a speaker connected to an amplifier that received input from Sony portable compact disc player. The sound intensity of the maternal call inside the incubator was adjusted to a peak intensity of 65 dB as measured by a Bruel & Kjaer Model 2232 sound level meter. A third group (Call & Light) underwent the same experimental procedures as the previous group with the exception that these embryos were also exposed to patterned light concurrently provided with the delivery of the maternal call. The temporally patterned light (maximum flash energy = 4 W/s) flashed at a rate of 1 cycle/second and was not precisely synchronized with rate or pattern of the maternal call. Special care was

taken to ensure that the light did not alter the ambient air temperature or humidity within the incubator.

Testing

Testing occurred at 24 hr (\pm 1hr) after hatching. The testing procedure took place in a circular arena, 160 cm in diameter, surrounded by a wall 24 cm in height. The walls of the apparatus were lined with foam to attenuate echoes and covered by an opaque black curtain to shield the observer from the subject's view. The floor of the arena was painted black. Two rectangular approach areas (32 x 15 cm) on opposite sides of the arena were demarcated by green stripes painted on the floor. These approach areas represented 5% of the total area of the arena. Mid range dome-radiator speakers were hidden behind the curtain in each of the two approach areas. Each speaker received input from a Tascam Model 122-B cassette tape recorder located on a control table. The experimenter sat at this table and observed the subject's activities through a large mirror positioned above the testing arena. A system of stopwatches was used to record the latency and duration of response, as described below.

Testing involved placing each subject in the arena equidistant from the two approach areas. All birds were given an individual 5-min simultaneous choice test between two variants of the bobwhite maternal assembly call (referred to as Call A and Call B). Each call emanated from one of the speakers located in the two approach areas. These two maternal calls were recorded in the field and have been shown to be similar in phrasing, call duration, repetition rate, dominant frequency, and frequency modulation (Heaton, Miller, & Goodwin, 1978). The sound intensity of each call was adjusted to peak at 65 dB (fast response), measured at the point where the chicks were introduced in the arena. The locations of the maternal calls (Call A and Call B) presented during testing were counterbalanced across individual trials to prevent possible side-bias.

In three of the four experiments patterned light was provided in compound with one or both of the maternal calls. The light emanated from Realistic strobe lights that rested atop and between two wooden poles suspended above the testing arena. The strobe lights were positioned directly above (\approx 1ft) both approach areas and when in use were adjusted to flash at a rate of 1 cyc/sec as during previous periods of stimulus exposure.

Each subject was tested only once. Subjects were scored on both the latency of approach and the duration spent in each of the two approach areas. Latency was defined as the amount of time (in seconds) that elapsed from the onset of the trial until the subject entered an approach area. Duration was defined as the cumulative amount of time (in seconds) the subject remained in an approach area. A chick that did not enter either approach area received a score of 300 s for latency (i.e., the length of the trial) and 0 s for duration, and was considered a non-responder. A "preference" for a given stimulus was scored if a chick stayed in an approach area for twice the time spent in the opposing approach area. "No preference" for a stimulus was scored if a chick approached both areas during a trial without showing a preference for either. These measures of preference constitute the primary dependent variable.

Data Analyses

The data of interest in each experiment were (1) differences in the latency of approach, (2) differences in the duration of time spent in each approach area, and (3) an individual

preference assigned to any subject that stayed in an approach area for more than twice as long as the other. The differences in latency and duration of approach were evaluated using the Wilcoxin matched-pairs signed-rank test. Individual preferences were evaluated by the Chi-square test. Significance levels of ($p < .05$ (two-tailed)) were used in all analyses.

Chapter 3

Experiment 1

Introduction

To begin to explore the effects of sensory stimulation on prenatal perceptual learning, it was necessary to replicate previous findings (Honeycutt & Lickliter, in press; Lickliter & Hellewell, 1992) demonstrating prenatal auditory learning under unimodal conditions and intersensory interference under concurrent multimodal conditions. Testing for each subject in this experiment, as in the previous studies, involved a simultaneous choice between two bobwhite maternal calls. To show that bobwhite quail hatchlings do not naturally demonstrate a naïve preference for either variant (Call A and Call B) of the maternal call, one group of hatchlings was tested having received no unusual prenatal sensory stimulation. A second group was tested having been exposed to one variant of the maternal call during the day prior to hatching. Based on previous findings (Gottlieb et al., 1989; Honeycutt & Lickliter, in press; Lickliter & Hellewell, 1992; Radell & Gottlieb, 1992), it was expected that this group would prefer the familiar call over an unfamiliar call during postnatal testing. These previous reports also led to the prediction that prenatal auditory learning should be disrupted when the call is concurrently presented with augmented stimulation in another sensory modality. Thus, to demonstrate this multimodal interference effect, a third group of embryos was concurrently exposed to a maternal call and patterned light prior to hatching.

Method

Sixty bobwhite quail embryos, divided into 3 experimental groups ($n = 20$), served as subjects. One group of embryos was reared without exposure to either variant (Call A and Call B) of the maternal call (Naïve Control Group). A second group of embryos was exposed to an individual maternal call (Call B) in groups of 10-12 for 10 min each hr for the 24 hr period prior to hatching (Call Alone Group). Auditory stimulation began on the second half of the 21st day of incubation and continued across 24 hr through the second half of the 22nd day of incubation. The recording of the individual maternal call was broadcast through a speaker connected to an amplifier that received input from a Sony portable compact disc player. The sound intensity inside the incubator was adjusted to a peak intensity of 65 dB as measured by a Bruel & Kjaer Model 2232 sound level meter. All the normally occurring acoustic components of the maternal call were present and unaltered. A third group underwent the same experimental procedures of Group 2, with the exception that embryos were exposed to patterned light that was concurrently provided with the delivery of the maternal call (Multimodal Group). These subjects were exposed to both a maternal call (Call B) and patterned (i.e., flashing) light for 10 min/hr for the 24 hr prior to hatching. The temporally patterned light (maximum flash energy = 4-W/s) flashed at a rate of 1 cycle/sec and was not precisely synchronized with the maternal call. Special care was taken to insure that the presence of light did not alter the ambient air temperature or humidity within the incubator. Each group was tested at 24 hr after hatching in a simultaneous choice test between the two individual maternal calls (see General Methods for details).

Table 1: Preference Scores for Subjects Tested 24 hr Following Hatching.

<i>Experiment 1</i>					
Condition	n	n-responding	Unfamiliar Call	Familiar Call	No Pref.
Naïve Control	20	19	8	6	5
Call Alone	20	20	2	13*	5
Multimodal	20	20	6	8	6
<i>Experiment 2</i>					
Condition	n	n-responding	Unfamiliar Call + Light	Familiar Call + Light	No Pref.
Naïve Control	20	19	9	6	4
Call Alone	20	20	1	13*	6
Multimodal	20	19	3	12*	4
<i>Experiment 3</i>					
Condition	n	n-responding	Unfamiliar Call	Familiar Call + Light	No Pref.
Naïve Control	20	20	8	9	3
Call Alone	20	20	4	12*	4
Multimodal	20	20	1	15*	5
<i>Experiment 4</i>					
Condition	n	n-responding	Unfamiliar Call + Light	Familiar Call	No Pref.
Naïve Control	20	19	7	7	5
Call Alone	20	20	1	15*	4
Multimodal	20	19	4	7	8

* $p < .05$ (Chi-Square Test)

Table 2: Latency and Duration Scores for Chicks in Simultaneous Choice Tasks.

<i>Experiment 1</i>				
Condition	Latency		Duration	
	Unfamiliar Call	Familiar Call	Unfamiliar Call	Familiar Call
Naïve Control	75.0 (30-138)	81.0 (37-300)	87.0 (30-207)	34.0 (0-84)
Call Alone	49.5 (23-124)	78.0 (20-97)	18.0 (6-64)	63.5* (52-98)
Multimodal	33.5 (17-121)	30.0 (15-59)	46.0 (9-63)	46.5 (30-100)
<i>Experiment 2</i>				
Condition	Latency		Duration	
	Unfamiliar Call + Light	Familiar Call + Light	Unfamiliar Call + Light	Familiar Call + Light
Naïve Control	75.0 (30-138)	127.5 (42-300)	69.0 (25-201)	34.0 (0-84)
Call Alone	33.5 (15-168)	35.0 (26-83)	29.5 (3-49)	57.5* (46-87)
Multimodal	102.5 (42-300)	28.5* (18-86)	15.0 (0-36)	62.5* (34-151)
<i>Experiment 3</i>				
Condition	Latency		Duration	
	Unfamiliar Call	Familiar Call + Light	Unfamiliar Call	Familiar Call + Light
Naïve Control	110.0 (33-226)	78.0 (36-238)	21.5 (5-137)	37.0 (4-99)
Call Alone	75.5 (40-300)	28.5* (18-44)	11.0 (0-50)	61.5* (32-107)
Multimodal	55.5 (22-274)	39.0 (27-74)	22.5 (0-40)	69.5* (50-137)
<i>Experiment 4</i>				
Condition	Latency		Duration	
	Unfamiliar Call + Light	Familiar Call	Unfamiliar Call + Light	Familiar Call
Naïve Control	109.0 (51-272)	98.5 (55-258)	44.0 (1-74)	35.0 (5-74)
Call Alone	61.5 (14-266)	23.0* (13-61)	16.5 (1-39)	77.5* (54-112)
Multimodal	65.5 (25-183)	44.0 (20-102)	50.5 (15-1055)	58.0 (15-79)

Median Scores are shown in table. Interquartile ranges shown in parentheses.

* $p < .05$ (Wilcoxin Test)

Results and Discussion

Results are depicted in Table 1 and Table 2. These results were consistent with previous findings (Honeycutt & Lickliter, in press; Lickliter & Hellewell, 1992), and confirm that when quail embryos are not exposed to any unusual sensory stimulation they do not prefer ($\chi^2 = .74$, $p = .692$) either variant of the bobwhite maternal call during testing 24 hr after hatching. This group likewise did not show differences in the latency of approach or in the amount of time spent (i.e., duration) near each call. On the other hand, embryos given prenatal exposure to one variant of the maternal call (Call B), demonstrated a significant preference ($\chi^2 = 9.7$, $p = .008$) for this familiar call (Call B) over an unfamiliar call (Call A) during testing. Although there was a significant difference in the amount of time (duration) spent near the familiar call ($\chi^2 = 0.4$, $p = .025$), unlike previous findings, there were no significant differences in the latency of approach. Embryos given exposure to an individual maternal call delivered concurrently with patterned light failed to demonstrate a preference for either maternal call. This group also did not show any differences in their latency or duration of approach to either stimulus event.

These findings indicate that concurrent visual stimulation can interfere with prenatal auditory learning. Based on these and similar findings, it has been proposed (Lickliter & Hellewell, 1992; Radell & Gottlieb, 1992) that concurrent multimodal stimulation leads to a momentary or transient (rather than a long lasting) dysfunction in attention, rendering the embryos unable to selectively attend to the acoustic information under these bimodal exposure conditions. The next experiment was designed to further explore the nature of this multimodal interference effect.

Chapter 4

Experiment 2

Introduction

The results from Experiment 1 are consistent with the notion that concurrent multimodal stimulation during the prenatal period can disrupt embryos' attentional functioning. However, a potentially crucial stimulus element (patterned light) was not included during testing, serving to confound this conclusion. That is, despite Group 3 in Experiment 1 being exposed to a call + light compound, they were tested with only one element of the compound (the call). It may be that in order to demonstrate a preference for the familiar stimulation subjects require the presence of both elements of the compound during testing. To begin to explore this issue, the present experiment was identical in design to Experiment 1, with the exception that patterned light was provided with each of the maternal calls during testing (Familiar Call + Light vs. Unfamiliar Call + Light).

Predictions based on the intersensory interference hypothesis would argue that embryos given multimodal exposure should not prefer the familiar stimuli during testing, given that attention during prenatal exposure is thought to be disrupted. Also, given that multimodal exposure is likely to disrupt attention, embryos receiving exposure to the call alone should also fail to prefer the familiar call when it is presented in compound with patterned light. That is, despite having learned the call, the Call Alone group should be unable to demonstrate a preference for the familiar call because it is presented concurrently with patterned light during testing. In contrast, predictions based on the attentional-bias hypothesis (see Introduction) suggest that both the Multimodal Group and the Call Alone Group should demonstrate a preference for the familiar stimuli, in that selective attention is not presumed to be disrupted but rather biased towards features of the familiar stimulus event..

Method

60 bobwhite quail served as subjects. These subjects were divided into three groups (Naïve Control; Call Alone; Multimodal) as in Experiment 1. All experimental procedures were identical to those used in Experiment 1, with the exception that patterned light (1 cyc/sec) was provided with each of the maternal calls during testing (see General Method for detail). Testing took place 24 hrs after hatching as in Experiment 1.

Results and Discussion

As shown in Table 1 and 2, results indicate that subjects who did not receive any unusual sensory stimulation prior to hatching (Naïve Control group) did not prefer ($\chi^2 = 2.0$, $p = .37$) either compound stimulus event used during testing. Latency and duration scores support this finding, in that there were no significant differences in the latency or duration of approach between stimulus events. Chicks exposed to an individual maternal call alone (Call B) prior to hatching significantly preferred ($\chi^2 = 10.9$, $p = .004$) the Call B + light compound over the unfamiliar Call A + light compound during testing. Although this Call Alone group spent a significantly ($p = .009$) larger duration of time near the familiar Call B compound, they did not significantly differ in their latency of approach to either stimulus event. Embryos exposed to the Call B + light compound also significantly ($\chi^2 = 7.68$, $p = .021$) preferred the familiar Call B +

light compound over the unfamiliar compound during testing, and showed shorter latency ($p = .036$) and longer duration ($p = .014$) scores in favor of the familiar compound.

These data suggest that the inclusion of patterned light during testing is required in order for embryos who were concurrently exposed to a maternal call and light to demonstrate a postnatal preference for the familiar stimuli. Contrary to the tenets of the intersensory interference hypothesis, this finding suggests that attention is not rendered dysfunctional during prenatal exposure to concurrent multimodal stimulation. Instead, there appears to be a shift or bias in what features of sensory stimulation embryos attend to during prenatal multimodal encounters. In this case, attention is biased towards wholistic features of the compound, rather than being focused on the individual elements of the compound, which is consistent with the attentional-bias hypothesis.

These data also indicate that the inclusion of patterned light during testing does not appear to interfere with the ability of hatchlings to demonstrate a preference for a maternal call that was encountered prior to hatching. That is, postnatal multimodal stimulation does not disrupt subjects' attentional to and preference for familiar events. Although this finding is not consistent with the intersensory interference hypothesis, it does support the attentional-bias notion concerning the effects of prior experience. Specifically, prior exposure to a stimulus (e.g., Call B) subsequently biases attention to aspects of that stimulus when it is later presented in compound with an unfamiliar stimulus (Call B + Light).

Collectively, the results from this experiment support predictions based on the attentional-bias hypothesis. However, the influence of patterned light during testing remains unclear. Specifically, patterned light used in this experiment was constant for both sets of testing stimuli, and as such, did not provide a basis for differential responding. As a result, differences in responding can only be attributed to differences in auditory information. The remaining experiments are designed to further explore the role of augmented visual stimulation in influencing perceptual and behavioral responsiveness.

Chapter 5

Experiment 3

Introduction

The previous experiments established that the addition of patterned light provided in addition to the maternal calls presented during testing can permit perceptual and behavioral responsiveness to stimulus events that are not evident using the maternal calls alone. According to the attentional-bias hypothesis, subjects receiving multimodal stimulation during the prenatal period attend to features of the compound as a whole, and as such, require both elements of the compound during testing in order to show a preference. The current experiment further explores this assumption by testing subjects using the familiar compound and an unfamiliar maternal call (Call B + Light vs. Call A). Based on the attentional-bias hypothesis it is predicted that subjects in the Call Alone and Multimodal groups will prefer the familiar stimulus event. That is, attention of embryos in the Call Alone group will be biased towards the familiar call despite the inclusion of patterned light during testing. Subjects in the Multimodal group will likewise prefer the familiar compound given that both elements of the compound will be presented as a unit during testing. Furthermore, the attentional-bias account also expects subjects who are not exposed to any of the testing stimuli (Naïve Control Group) to make a preference based on available quantitative (intensity) differences between the testing stimuli.

Method

60 bobwhite quail served as subjects. These subjects were divided into three groups (Naïve Control; Call Alone; Multimodal) as in Experiments 1 and 2. All experimental procedures were identical to those used in the previous experiments with the exception that patterned light (1 cyc/sec) was provided with Call B (familiar call) alone during testing. A second strobe light was positioned directly above Call A (unfamiliar call) but did not emit any light. Testing took place 24 hrs after hatching as described in the General Methods.

Results and Discussion

Results revealed that subjects in the Naïve Control condition did not prefer ($\chi^2 = 3.1, p = .212$) (see Table 1) either stimulus event during postnatal testing. Analyses of latency and duration of approach (see Table 2) further supported this finding. Subjects exposed to an individual maternal call prior to hatching (Call Alone) significantly ($\chi^2 = 6.4, p = .041$) preferred the stimulus event containing the familiar call during testing, and showed shorter latencies ($p = .004$) and longer durations ($p = .023$) in favor of the familiar call. Subjects who received prenatal concurrent exposure to a maternal call and light (Multimodal) also significantly ($\chi^2 = 13.3, p = .001$) preferred the familiar compound. Although, this group did not differ in terms of latency of response, subjects did display significantly a longer duration of response ($p < .001$) to the familiar call.

In contrast to the prediction based on the attentional-bias hypothesis, the finding that naïve subjects who were not given any exposure to the stimuli prior to testing did not prefer either testing stimulus events suggests that these subjects were not influenced by the available quantitative (intensity) or qualitative differences between these stimulus events. In other words, despite differences in intensity and quality (auditory vs. audio-visual) between testing stimuli,

this group of subjects did not appear to preferentially distinguish between these events. Thus, the addition of the light during testing does not appear to influence their responsiveness.

The patterns of responsiveness exhibited by subjects in the Call Alone and Multimodal conditions are consistent with the attentional-bias hypothesis. Embryos exposed to an individual maternal call preferred this call over an unfamiliar call during testing despite the familiar call being presented in compound with patterned light, again suggesting that light does not interfere with their preference for the familiar stimulus. Likewise, given that both elements of the familiar compound were present during testing, those subjects who were concurrently exposed to a maternal call and patterned light prior to hatching were able to demonstrate a preference for this familiar event. However, it could be concluded that subjects in the Multimodal condition preferred the familiar compound simply because it contained both auditory and visual information whereas the other testing stimulus event contained only auditory information. The following experiment was included to address this issue.

Chapter 6

Experiment 4

Introduction

According to the attention-bias hypothesis, in order for the Multimodal Group to show a preference for the familiar compound both elements of the compound must be available and intact during testing. The current experiment was designed to examine whether or not these subjects respond to unique qualitative features of the compound encountered prenatally, or whether their responses are primarily based on more general quantitative features of a compound event. Specifically, testing in the present experiment involved simultaneously presenting the familiar call alone and the unfamiliar call paired with patterned light (Call B versus Call A + Light). Under these conditions, it was expected that subjects in the Call Alone Group, as in the previous experiments, will prefer the familiar call. However, subjects in the Multimodal condition were expected to show no preference between testing stimulus events, in that the elements of the familiar compound (encountered prior to hatching) were not present as a unit during testing. Should the Multimodal group demonstrate a preference for the unfamiliar compound, then the data would suggest that subjects are more sensitive to quantitative features of sensory stimulation available during concurrent multimodal stimulation. That is, their preferences would be attributed to having a call + light compound, regardless of the qualitative acoustic features of the call (Call A vs. Call B).

Method

60 bobwhite quail served as subjects. These subjects were divided into three groups (Naïve Control; Call Alone; Multimodal) as in the former experiments. All experimental procedures were identical to those used in the previous experiments, with the exception that patterned light (1 cyc/sec) was provided with Call A (unfamiliar call) alone during testing. A second strobe light was positioned directly above Call B (familiar call), but did not emit any light. Testing took place 24 hrs after hatching.

Results and Discussion

Data analyses (see Table 1 and 2) revealed that subjects in the Naïve Control condition did not prefer ($\chi^2 = .42$, $p = .81$) either stimulus event presented during testing. Analyses of latency and duration scores further supported this lack of preference. Subjects in the Call Alone condition displayed a significant preference ($\chi^2 = 16.3$, $p < .001$) for the familiar call, as well as shorter latency ($p < .001$) and longer duration ($p = .037$) scores. However, subjects in the Multimodal condition, unlike in the two previous experiments, failed to demonstrate a preference ($\chi^2 = 1.37$, $p = .505$) for either testing event, and likewise did not show significant differences in latency and duration scores.

These findings provide additional support for the attentional-bias hypothesis. In particular, it seems that hatchlings exposed to a call + light compound prior to hatching require that both elements of the familiar event be presented as a unit during testing in order to display a preference. Decomposing the familiar event into its individual elements during testing did not appear to support a basis for differential responding, even when subjects were provided a similar auditory event paired with the familiar visual event (Call A + Light). Thus, during periods of

prenatal multimodal exposure, embryos' attention appears to be biased towards unique features of the compound as a whole, rather than to its individual elements. This result is consistent with the general finding that infants tend to configure compound events during early development (Spear & McKinzie, 1994).

Chapter 7

General Discussion

The present study examined how early perceptual abilities can be influenced by exposure to unimodal and multimodal stimulation during the prenatal period. Results revealed that bobwhite quail embryos given no unusual sensory stimulation prior to hatching (Naïve Control) show no preference between stimulus events in each of the four experiments, even under conditions when differences in stimulus type and intensity were available (Experiment 3 and 4). Embryos exposed to an individual species-typical maternal call for 10 min/hr for the 24 hr prior to hatching (Call Alone) preferred this familiar maternal call over a similar but unfamiliar call in each of the four experiments, regardless of the presence or absence of patterned light. Thus, the inclusion of augmented visual stimulation during testing appeared to have no effect on perceptual and behavioral responsiveness in these two groups of embryos. However, embryos that were provided exposure to an individual maternal call presented concurrently with patterned light (Multimodal) preferred the familiar call only when it was presented in compound with patterned light during testing (Experiments 2 and 3). Decomposing this familiar compound into its individual elements (Experiments 1 and 4) eliminated differential responding. For this group, the addition of visual stimulation dramatically influenced subjects' responses to familiar stimuli.

The primary goal(s) of the current study was to (a) demonstrate that concurrent multimodal stimulation encountered prenatally does not necessarily disrupt attentional functioning, and (b) to provide an alternative account of prenatal perceptual responsiveness which more adequately captures the dynamics of perceptual processes during exposure to unimodal and multimodal sensory stimulation. According to the intersensory interference hypothesis (Gottlieb et al., 1989; Lickliter & Hellewell, 1992; Radell & Gottlieb, 1992), concurrent multimodal sensory stimulation can yield a transient deficit or dysfunction in attention, rendering embryos unable to attend to available stimulus information. The results displayed by embryos in the Multimodal condition in the present study do not support this hypothesis, in that chicks consistently showed a preference for the familiar compound during testing thereby suggesting that they were attending to features of the compound during prenatal exposure.

The attentional-bias hypothesis promoted here seems to account for most of the observed results obtained in this study. This hypothesis attempts to address both the “what” and the “how” questions surrounding early perceptual development. That is, it is intended to account for the types of information young organisms are sensitive to (the “what”) and how this sensitivity changes as a function of current conditions and experiential history. Specifically, this hypothesis holds that attention shifts or is biased towards different properties of sensory stimulation depending on the type (stimulus features and relationships), timing (age and order-dependent) and amount (intensity and duration) of stimulation encountered. For example, the results of the present study, as well as those of Honeycutt and Lickliter (in press), show that prior exposure (order-dependent timing) to a certain type of stimulus (e.g., maternal call) during the prenatal period (age-dependent timing) tends to bias attention towards features of the familiar stimulus when it is later presented in compound with an unfamiliar stimulus (e.g., light).

The present study suggests that encountering concurrent multimodal sensory stimulation in the absence of prior exposure to any element of the multimodal compound does not necessarily overwhelm attentional functioning, but instead tends to bias embryos' attention to unique elements of the compound. Whether or not infants' attention is biased towards the individual elements of the compound or the compound as a unit depends on the overall amount of stimulus intensity. This finding is consistent with the notion that young organisms are more likely than adults to unitize or configure a compound stimulus (Spear & McKinzie, 1994). However, unlike previous reports (Mellon et al., 1991; Spear & Kucharski, 1984) suggesting that this configuring process is based on overall (additive) stimulus intensity, the results from the current study indicate that configuring may be based on stimulus properties, which specify unique features of the compound. For example, if responding to a compound event was based solely on stimulus intensity, then the Multimodal group would have preferred the unfamiliar compound over the familiar call alone during testing in Experiment 4 since the overall intensity of the unfamiliar compound was equivalent to the intensity of the compound encountered prior to hatching. However, the Multimodal groups showed no preference between the stimulus events during testing in this experiment, suggesting that subjects attended to unique features of the compound prior to hatching. It is important to note that the amount of stimulus intensity determines what types of sensory features infants will attend to. For example, at low levels of intensity, infants tend to respond to the individual elements of a multimodal compound (e.g., see Radell & Gottlieb, 1992), whereas at higher levels as in the present study infants tend to respond to the compound as a unit. It should be kept in mind that the present study only demonstrates the possibility of configuring during the late prenatal period and describes under what stimulus conditions configuring is likely to favor a given stimulus compound over another in precocial avian embryos. Further research with different conditions and species will be required to address the generalizability of the present findings.

It may be that configuring or unitizing a compound event is a function of the amount (or lack) of redundant properties or relationships between the elements of the compound. The concurrent multimodal stimulation used in this study and others like it (Gottlieb et al., 1989; Honeycutt & Lickliter, in press; Lickliter & Hellewell, 1992; Radell & Gottlieb, 1992) did not share many redundant features. That is, there was a lack of temporal synchrony, rate, and duration across the auditory and visual stimulation provided embryos, thereby limiting the amount and nature of amodal information present during exposure to the maternal call. It is possible that the process of configuring compound stimuli may be limited to non-redundant (or less redundant) stimulus events early in development. Increasing the redundancy between the two events (e.g., by temporally synchronizing the call and light) could possibly shift attention away from features of the compound as a whole (configuring) and towards redundant amodal properties (such as rate or duration), which in turn would likely enhance responding to the familiar call even in the absence of the light. Work is currently underway examining this possibility.

At this point it is possible to begin to integrate the findings surrounding how stimulus intensity and redundancy can influence the effects of concurrent multimodal stimulation on prenatal perceptual functioning. In the general sense, this integration views intersensory redundancy as mediating, and overall intensity as moderating, perceptual responsiveness. The influences of redundancy and intensity can be understood in terms of perceptual thresholds. In

particular, there appears to be a perceptual threshold based on the amount of intersensory redundancy. Specifically, when there is an absence of redundant features (e.g., exposure to non-concurrent call and light), the influence of one (e.g., light) stimulus has no effect on learning aspects of the other (e.g., call) (see Gottlieb et al., 1989; Lickliter & Hellwell, 1992). As redundancy increases (e.g., co-occurrence of call and light), attention is biased towards unique features of the compound (configuring). At higher levels of redundancy, attention is likely biased towards these shared redundant features which leads to potentiated learning. Higher levels of redundancy used here refers to spatio-temporal co-occurrence plus some other redundant feature. For example, Mellon et al. (1991) demonstrated potentiated learning of a stimulus in rat pups when that stimulus was originally conditioned in compound with another stimulus. In this case, the compound stimulus used in conditioning was redundant in that the elements not only co-occurred but each element was also associated with (or “redundantly predicted”) an unconditioned stimulus. Likewise, in quail embryos, preliminary data suggests that concurrent exposure to a maternal call that is temporally synchronized with light leads to potentiated learning of the call (Lickliter, Bahrick & Honeycutt, forthcoming).

Although intensity-based approaches view intensity as a mediating factor (Mellon et al., 1991; Spear & McKinzie, 1994; Turkewitz & Mellon, 1989; Turkewitz et al., 1984), the integration of the findings presented here suggests instead that intensity more likely *moderates* perceptual responsiveness. Here again the influence of intensity is best understood in terms of thresholds. When the overall intensity does not exceed a certain perceptual threshold, then prenatal concurrent multimodal stimulation does not appear to bias attention relative to when the stimuli are non-concurrent (Radell & Gottlieb, 1992). Exceeding this threshold increases the influence that one source of stimulation (e.g., visual) has on responding to the other source (e.g., auditory). The exact nature of this influence, however, depends on the redundant relationships between the stimuli in question.

Having outlined the attentional-bias hypothesis, it seems useful to compare and contrast this approach to other related hypothesis available in the literature. For example, it may be argued that the findings generated in this study can be explained as reflecting the operation of some form of priming or other memory-related mechanisms (e.g., cueing). Although this study does not conclusively rule out these alternative explanations, it does provide some reason to question these accounts on both empirical and theoretical grounds. First, it could be argued that for those chicks who were exposed to the call + light compound prior to hatching, the addition of light during testing represents a cue that somehow triggers the memory of the familiar call, which then allowed the subjects to demonstrate a preference for the familiar call (Experiments 2 and 3). Despite its initial appeal, this explanation does not adequately account for the failure of these hatchlings to prefer the familiar maternal call in Experiment 4. Subjects in this experiment were also exposed to patterned light during testing, and although the light was spatially removed from the familiar call, they could nevertheless potentially attend to the familiar call in the presence of patterned light. Thus, although the cue was available during testing, it apparently failed to bring forth the memory trace of the familiar call. It seems more parsimonious to characterize the present findings within an attentional-bias framework in which the multimodal compound was responded to as a unique spatio-temporal event.

Taken at face value, the concept of attentional-bias is somewhat similar to notions of priming. However, a closer comparison reveals that the theoretical underpinnings between these two approaches are largely incompatible. For example, it has recently been proposed that priming is in fact a bias in responding (Ratcliff & McKoon, 1996). On this view, prior encounters with an item biases subsequent processing of that item towards certain responses and away from others. Furthermore, the biasing process is thought to reflect temporary modifications in perception, identification and decision. Working within this information processing (IP) approach, the goal becomes to explain how “processing” occurs in general and how information is transformed over time in particular. In contrast, the attentional-bias approach advocated here rejects IP approaches on theoretical grounds (e.g., see Gibson, 1979; Reed, 1987; Shaw & Bransford, 1977). In particular, IP accounts tend to adopt a stimulus-response framework in which the organism is assumed to be a passive entity that comes to construct percepts and knowledge from fundamentally meaningless sensory inputs. This IP view focuses on how the organism transforms, stores and recalls information it has constructed. This line of thinking ultimately reflects and promotes troublesome and unnecessary dichotomies in psychology (e.g., organism vs. environment, mind vs. body, perceiving vs. knowing, and perception vs. action). Rather than focusing on how information is transformed over time, the attentional-bias approach seeks to explain how sensitivity to information (available in the environment) changes across time. In addressing this focus, one need not rely upon as many ill-defined hypothetical variables (e.g., perceptual systems vs. memory systems vs. cognitive systems) as the IP approach. Instead, the focus is placed on the process of perceptual responsiveness, in which selective attention is a major indicator and component.

The overall objective of this study was to begin to examine the processes by which perceptual systems come to pick up and utilize information embedded in the continuous stream of multimodal sensory stimulation within which the organism develops. An initial step in addressing this issue involves describing the types of information young organisms are sensitive to and how this sensitivity changes as a function of prior experience. The attentional-bias hypothesis promoted in this study attempts to characterize part of this structure by describing how prior experience might influence subsequent sensitivity to sensory stimulation. For instance, it may be that very early periods of development allow for a relative increase in the number of opportunities to encounter unimodal sensory stimulation, which in turn can provide both stability and transformation for how (non-redundant) multimodal events are perceived later in development. In this case, stability refers to organisms’ sensitivity to familiar stimulus events despite concurrent stimulation from unfamiliar events, whereas transformation refers to organisms’ sensitivity to familiar events as providing a foundation through which different stimulus properties can be used as a basis for responding. The attentional-bias approach also argues that attention to stimulus properties, even prenatally, is rarely disrupted completely, except during exposure to extreme amounts of sensory stimulation (Sleigh & Lickliter, 1997). Rather, attention is seen to be biased to different properties of sensory stimulation, depending on related variables such as the timing, amount, and type of stimulation provided or denied. This observation points to the integrity of perceptual systems as active and adaptive information gathering systems even in the period prior to birth or hatching.

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VITAE

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Degrees:

M.S. Virginia Polytechnic Institute and State University, *in progress*
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Employment:

December 1999 - Present Coordinator for Dr. Robert Lickliter's Lab in Developmental Psychobiology (20 hr)

Aug. 1999 – Dec. 1999 Graduate Teaching Assistant (12 hr): Virginia tech: Department of Psychology
Research Assistant for Dr. Robert Lickliter (8 hr)

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Publications & Articles in Preparation:

Lickliter, R., Bahrick, L. E., & Honeycutt, H. (in preparation). Intersensory redundancy facilitates prenatal perceptual learning in bobwhite quail embryos.

Honeycutt, H. & Lickliter, R. (in press). Order-Dependent Timing of Unimodal and Multimodal Stimulation Affects Prenatal Auditory Learning in Bobwhite Quail Embryos. Developmental Psychobiology

Eisler, R.M., Franchina, J. J., Moore, T. M., Honeycutt, H., Rhatigan, Deborah L. (2000). Masculine gender role stress and intimate abuse: Effects of gender relevance of conflict situations on men's attributions and affective responses. Psychology of Men & Masculinity, 1(1), 30-36.

Papers Presented at Scientific Conferences:

Honeycutt, H & Lickliter, R. (2000, November). Prenatal sensory experience and postnatal perceptual preferences: The Patterns that connect.

Honeycutt, H. & Lickliter, R. (1999, November). Effects of unimodal vs. multimodal stimulation on prenatal auditory learning in bobwhite quail embryos. Paper presented at the 32nd Annual Meeting of the International Society for Developmental psychobiology: Coral Gables, FL.

Moore, T.M., Honeycutt, H., Rhatigan, D.L., Eisler, R.M., & Franchina, J.J. (1999, November). Effects of masculine relevance on men's responses to intimate conflict situations. Paper presented at the 33rd Annual Convention of the Association for Advancement of Behavior Therapy: Toronto, Canada

Conferences and Symposia Attended:

2000 Annual Meeting of the International Society for developmental Psychobiology: New Orleans, LA.

1999 Annual Meeting of the International Society for developmental Psychobiology: Coral Gables, FL.

Awards:

2000 Sandra G. Wiener Developmental Psychobiology Student Investigator Award from the International Society for developmental Psychobiology

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