Claira: A Case Study in Prenatal Learning

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Full Text: Headnote ABSTRACT: Historically, most studies of prenatal learning have centered upon contingency reinforcements, habituation responses, and developmental outcomes. Very little research has examined the learning process during the prenatal period. This case study examines the behavioral responses of one prenate to an experimental curriculum. Significant movement responses are noted. The responses appear as an organized pattern which would imply that the prenate is capable of progressing from generality and abstraction, to specificity and discernment in the learning process. This learning process may well be unified, organized, and amodal in nature. Movement patterns imply that higher order variables help govern learning and are critical in the emergence of mental schema and regulations. Results from this study suggest that at the prenatal level, the beginning of cognitive schemes and regulations in mental operations exist. Responses during the prenatal period are compared to later developmental trends in infancy. ABOUT THIS PAPER: William Sallenbach teaches developmental psychology, conducts prenatal research, creates research instruments for pre- and perinatal psychology, and is a staff child therapist at the Gateway Center in Ketchikan, Alaska. His doctoral research in Claremont, CA was on the rehabilitation of neglected and abused children. William understands the creative tension in developmental psychology as it deals with the revolutionary data increasingly provided by prenatal psychology. In a brief but elegant paper (1991), he begins work on an improved theoretical framework to describe prenatal cognition and bonding. He weaves new insights, demanded by empirical findings, into the traditional mechanistic scheme of developmental psychology to reveal the true sophistication of prenatal learning. To push beyond old boundaries, he finds good company in Alfred North Whitehead, Andrew Meltzoff, William Emerson, and Daniel Stern. As he pursues this challenging subject in a longer paper (1993), he summons a wealth of clinical and experimental data to demonstrate the richness of the interactive learning process in which prenates and parents are engaged. He brings additional data from two instruments of his own, "The Prenatal Bonding and Temperament Outcomes Survey", a 60-item survey identifying 12 temperamental qualities in the first year of life that permits calculations of correlations between prenatal stress factors and temperament, and "Bonded Beginnings: A Tri-Level Curriculum for Prenatal and Postnatal Bonding and Learning" (unpublished). The unique reprint which follows reports daily observations of his daughter, Claira, from week 34-36 in utero. The amazing findings give us a window not only on the sentience of a third trimester prenate but a rare look at current theories in prenatal psychology. In making this intimate investigation, Sallenbach follows in the footsteps of two noted fathers who learned greatly by observing their own children, Charles Darwin (1888) and Jean Piaget (1936). Of course, those fathers never dreamed of starting before birth! INTRODUCTION By design, the field of pre- and perinatal psychology must eventually attempt to clarify and to define what is "innate" in the human condition. The frontier for this field is the exploration of humankind's original nature. Within this context, the areas of prenatal learning and bonding are challenged to examine the sources of learning, social interactions, and the etiology of development itself. Prenatal bonding and learning stand at the forefront of human social and mental origins at the most elementary levels. In an article describing the roots of social and cognitive development, Andrew Meltzoff (1985) has pointed out that developmental psychology has often hindered its own investigations by insisting on basic assumptions and misconceptions regarding infant development. As an example, Meltzoff points out that the prevailing scientific axiom regarding infant development is that the newborn is reflexive and asocial. Such views have been fostered and maintained in the traditions of Piaget, Bowlby's attachment theory, and psychoanalytic theory. In Piagetian psychology, mental

structures evolve form reflexive interactions. The infant is at best "egocentric" in social contests. Hence mental and social development takes a much later course of development. The view of the infant as egocentric has also been fostered by Bowlfay's attachment theory (1969) which sees attachment as evolving from reflexive interactions in a hierarchical progression. In the psychoanalytic tradition there is also the prevailing view that the infant is "asocial" or "autistic" in regard to social responsiveness (Mahler, Pine &Bergman, 1975). Each of these views sees the physiological processes as dominant over psychological processes. Looking at the area of prenatal learning, the same assumptions appear to be operating as well. Learning processes have most commonly been described in terms of habituation (Kisilevsky &Muir, 1991; Querleu, et al., 1981; Sakabe, et al., 1969), conditioning (Spelt, 1948; Van de Carr, 1988), and imprinting sequences (Salk, 1962; Logan, 1991). Serious efforts to explore prenatal learning began in the 1920's and 1930's. Peiper (1925) performed sonic startles to study fetal responses. The same line of research was continued by Forbes and Forbes (1927). Ray (1932) seemed amazed that prenates would react to the smacking together of two boards. Sontag and Wallace (1934) attempted to experiment with greater numbers and to secure tighter controls very variables. Spelt (1948) studied refractory time in the habituation-dishabituation process described by Forbes, Peiper and Ray. In these historical studies the main premise for prenatal learning involved physiological processes. They did not define the psychological processes at work for the prenate. There is also a growing body of research that attempts to understand the prenate as an intelligent and sentient being. This has been one of the main pursuits of David Chamberlain (1992, 1993, 1994). The work of Anthony DeCasper (DeCasper &Prescott, 1984) reveals a complexity of bonding and language processing during the prenatal period. In his work, Chamberlain (1992) has pointed to the surprising musical intelligence demonstrated by prenates. Peter Hepper (1988) has demonstrated that the prenates of mothers who listened to "soap opera" theme music during pregnancy showed a preference for the same music during the postnatal period. It has also been reported that unborn children respond favorably to portions of Vivaldi and Mozart, but with hyperactivity to rock music and other heavy classical compositions (Clements, 1977; Verny &Weintraub, 1991). Gellrich (1993) has even postulated that musical abilities developed prenatally can be enhanced and accelerated throughout early childhood. One could expound on a litany of works demonstrating memory and meaningful interactions during the prenatal period. Yet we still do not have a clear understanding of the psychological processes underlying these behaviors. It is the premise of this paper that the latter findings described above provide us with glimpses of the complexity and refinement of learning during the prenatal period. Rather than reflexive habit procedures, there may be a unified and "intelligent" organization of experiences. Physiological states are important in understanding learning, but we must be careful not to equate neurological functions with learning. Using one to describe the other may be like mixing apples and oranges (Bower, 1989). If we see learning only as a response to externally imposed methods measuring learning as increases in rates of response dependent upon contingent reinforcements, then we miss the richness of the processes underscoring such changes. Conditioning, operant learning, and habituation are important measurements of response, and I make use of them in this study. However, in studies with young infants one can also find research supporting the notion that intrinsic motivation is a primary reinforcer (Bower, 1989; Meltzoff, 1990; Papousek, 1979; Watson, 1967). In this view, learning involves the rudimentary formulation and testing of hypotheses by the young infant. In this case study, I present the idea that the prenate, especially during the last trimester, is in a learning state moving from abstraction and generalization to increased specificity and differentiation (Bower, 1989). These processes are unified, amodal in perception, and governed by higher-order variables that guide the infant toward hypothetical formulations about the uterine environment and the external world (Sallenbach, 1993). This paper is a case study of one prenate's learning strategies. It is intended to provide an in-depth analysis of those processes as reflected in one child. The report is not quantitative in nature, nor is it necessarily intended to be generalized to all prenates. There are methodological flaws which seemed unavoidable at the time. Despite all, it is hoped that this paper will help to clarify further the uncharted waters of learning at its earliest levels. METHODOLOGY The subject for this study

was a young female prenate named "Claira." The information is taken from careful and detailed accounts of learning episodes done with her. These data were obtained from the 34th through the 36th weeks of gestation. Six learning episodes were recorded utilizing 11 different learning activities. Some of the activities were repeated within a single episode. Information was also taken from several emotional bonding activities, and all of the activities were part of a specific educational curriculum. The compilation of the data had four main objectives: 1) to record the prenate's behavioral responses to specific learning activities; 2) to identify responses to both maternal and familial social cues; 3) to correlate observed behaviors with later early infant developmental skills; and 4) to evaluate any psychological processes evident in the prenate's responses. Each learning episode was videotaped. Responses were evaluated both immediately following a session and reviewed several times afterwards. Claira's body position was identified ahead of time so that movement responses could be carefully traced by using dolls. From these reviews and observations four main movement categories were determined. An obvious flaw in this approach is the potential for "observer bias." The mother was cognizant of the games and their objectives. There was also the risk of bias on the part of the father who was the author. The advantages of this arrangement, on the other hand, were that we were more familiar with the movement responses, were in a better position to provide feedback, and familiar enough to observe on a more intimate level. An alternative method would have involved high tech intervention, such as sonograms, but this would have been costly and did not seem consistent with the goals of the program. Since response detection was literally a "hands-on" approach, a third party reviewing the tapes would not have been able to detect intrauterine movements. Another alternative would have been to have a third party also providing hands-on detection. An attempt was made for a third party observation through the University of Washington, but Claira decided to "sleep through" all of our attempts to arouse her. These are typical problems encountered in this type of research. One of the ways we attempted to control for bias was to establish a baseline for behaviors prior to the learning sessions. Claira's wakefulness was usually indicated by generalized or specific movements. It was important not to confuse these movements with any intentional responses to the learning activities. Baseline was denned as a ten minute period when there was no activity evident. The baseline thus indicated a quiet-alert state and formed the stage for beginning the learning activities. Claira was responding to an experimental prenatal curriculum called "Bonded Beginnings" (Sallenbach, 1991). The program includes specific activities designed to promote bonding and learning during the prenatal and neonatal periods, particularly between the prenate and the family. Learning is viewed as part of the bonding process in this program. By linking the learning episodes to bonding, it was thought that the learning games could enhance development. There was no intent to accelerate development. The curriculum has three levels with specific games and activities for each one. The first level is "Bonding through Feelings," with the focus on the mother-infant relationship. It includes "sharing" activities such as story-telling, selected words/concepts, and relating simple sensory experiences from the mother to the prenate. Paramount to this level are the meditative skills needed to "tune-in" to the needs and states of the prenate and to be able to "distance" negative emotions that could influence the baby. The second level, "Bonding through Music," includes five musical selections that were professionally done for the curriculum. The musical component also reinforces feeling and learning activities as part of its design. Four of the arrangements are for the mother/family to sing along with the unborn. Beats and melodies reinforce basic vowel sounds and family interaction patterns. The fifth musical piece was intended for relaxation and stimulating awareness. It is a simple melody utilizing beats and dissonance. The third level is "Bonding through Learning." This unit includes six learning activities. The lessons introduce sequential awareness, auditory localization, visual perception, vowel sound discrimination, and vowel-consonant blends. These activities were repeated on the other two levels as well. A unique feature of the "Bonded Beginnings" curriculum is its "cross-modal" approach to early learning (Meltzoff, 1990). In this paradigm according to Meltzoff, perception is seen as amodal. Amodal perception refers to the infant's ability to take information from one sensory modality and transfer it to another modality. It involves complex mapping processes where there

are equivalencies matched between what is perceived and the body transformations needed to make a felt response to the perception. In order to accommodate this position from a prenatal perspective some adaptations were made. Each of the learning activities is simultaneously presented in two or more perceptual modalities. For example, the light trajectory game "Over the Rainbow" is done by having the penlight pushed down, flashed, and vocally cued all at the same time. All of the other activities function in like manner. The simultaneity of multiple sensory cues helps the unborn to integrate the information. The program is conducted once or twice a day for a 5 to 10 minute period. This usually involves one of the musical pieces and a series from the learning level. The first level is structured to be done at any time. To date three families have used the program and the fourth and fifth families are currently using it. OBSERVING CLAIRA Responses to the learning activities were categorized by movement patterns. By carefully studying the movement, four main categories were recognized. Movements were tracked along the abdomen wall. The first category was hand/arm movements. In this category, Claira facilitated movement responses primarily with the hand, with additional movement through the wrist, lower forearm, elbow, and some shoulder extension. The movement(s) seemed to utilize an abducted upward move and repetition of flex-extension patterns. It was not possible to determine the extent of any finger movements independent of the hand and wrist.

Table 1
Frequency of Movement Patterns to Learning Domains

Response	*Baseline*	*Social*	*Lang.*	*Visual*	*Auditory*	*Music*
Hand/arm	1	6	4	2	1	2
Kicking	0	1	6	7	1	1
Rolling	0	1	3	3	5	5
Rhythmic	0	0	0	0	0	3

The second category was kicking movements. This category involved extension patterns with the knee and/or hip. It was not possible to determine to what extent head movements accompanied this pattern. A third category involved rolling movements. During the sampling, Claira's spine was positioned against the uterine wall. The rolling moved in an approximate 135 degree rotation from start and back again to point of origin. Often the pattern was repeated in succession. Hip movement may have been involved, and there did not seem to be much leg extension in this movement. The fourth category was rhythmic movements. These occurred only when music was played. The defining characteristic of this pattern was a "bouncing" effect from possible hip and/or upper torso movements. The action seemed to be sustained in a brief duration of a regularly recurring element. In the course of six sessions over a two-week period of recording, 11 different activities were tried, some with greater frequency than others. Several of the games were ongoing from the 28th week of gestation, and others were introduced as novelty preference during the audited period. The activities were organized into five major domains. The first was social, which included initial greetings from family members, brief conversations, and good-byes. The second was language. This included vowel sound discriminations. The third was visual and involved responses to penlight movements across the mother's abdomen. The fourth domain was auditory which involved localizing to the sound of a bell. The fifth domain involved responses to music. What is striking in the interactions is the possibility of separate and organized responses by Claira to the different types of learning activities. The results are shown in Table 1. Included in the table is also the baseline established prior to the sessions. The table implies that movement patterns can vary according to the learning activity set before the prenate. It is possible that Claira was reacting with a different movement pattern to each of the learning domains. The social games were met with hand movements, and the visual games were met with kicking movements. The auditory game inspired rolling movements, while responses to the music incorporated rolling and rhythmic patterns. There is the possibility that the hand movements were often used to specify a localized

place in response to the social games. There are two potential explanations for this phenomenon. One is that her size may have prohibited much variation. Another is that the social games may have evoked an associated location for interactions. Language games elicited a range of movements, but the dominant one was kicking. Considering the nature of the language games, these responses may reflect a diverse organization. Games involved speaking a vowel sound with a visual cue (pen light) reinforcing one specific vowel sound. In this regard, the activities blended the social, visual and auditory domains. We can only speculate that the varied discrimination in movement responses showed a degree of differentiation and discrimination in the learning games. Likewise, what is not reflected in Table 1 is the organized progression in the movement patterns. This is as striking as the information just discussed. The rolling patterns seen during the auditory games actually accounted for the localization of the sound source. In other words, by the third and fourth sessions, Claira was consistently using rolling to locate the bell sound. This infers a searching behavior, and such behaviors are often prerequisites for later object memory and object permanence (Sophian, 1980). Progressive organization was also seen in the visual games. In the first three sessions, Claira responded to the light by kicking. In later sessions she responded to the light by turning toward (rolling movement) the moving light trajectory and actually touching the light source with her hands! Both the examiner and the mother reported this response. There was one light activity that tested Claira's ability to search and locate a sequenced light source, but the responses were inconclusive as to whether Claira was attempting to locate the most recent place of disappearance. Organized progression of movement indicates an increase in specificity and discrimination. The rolling movements reflected this progression as well. This response was seen in Claira's reactions to the music. The initial sessions involved rolling movements while the later sessions produced rhythmic movement patterns. Toward the end of the recorded sessions, Claira kept tempo with the beat for about 10 seconds. A couple of weeks later (after the audited segments reported here), she increased the synchronized tempo movement for almost 45 seconds during a single session. Table 2 illustrates the specification and development in movement patterns as tracked.

Table 2
Claira's Movement Specification Patterns to Categorical Stimuli and Organized Responses

Stimulus category	*Initial movements*	*Specific organized pattern*	*Purpose/ goal*
Visual	kicking➞➞➞rolling and movements	touching	localize light source
Auditory	hand/kicking➞rolling		localize to sound source
Music	rolling➞➞➞➞rhythmic pattern		synchronize body movements to beats

On several occasions novel changes were introduced into the activities. Claira's first reaction was to become still. For example, we would randomly do the vowel sound sequence without the penlight to reinforce to targeted sound of [a]. During the initial sessions Claira would become still; by the later sessions she would give partial movement to the identified sound without the penlight. In the later trials, Claira demonstrated an ability to anticipate the [a] sound (which usually followed a sequence of other vowel sounds). She would kick just before the [a] sequence was sounded. Another interesting point in these activities was Claira's potential to respond to distal perception over proximal perception (Bower, 1989). We noted that Claira was able to locate the light source in a moving trajectory when the penlight was pushed against the abdomen. Reflected in this activity is an awareness of an object in the face of its absence after a brief delay; there was an approximate 1.6 to 2 second delay between flashing sequences. In one of the bell games, the activity was performed in bathtub with the bell

clangor moving light on the water's surface. Within the water medium, Claira correctly turned to the sound source both on the right and left sides. This was accomplished on the very first trial. Her response was a quick roll and rotation in the direction of the sound. Similar responses were noted on the other two levels of the curriculum. The movement patterns were not tracked as closely as the learning level. However, we can provide some descriptions of those patterns. For the first level, "Bonding through Feelings," sharing time activities such as story-telling, commentaries on sensory experiences, poetry, and so on, were met with light movements of both the arms and legs. These movements were repetitive, soft, and flowing. The "tuning-in" exercise of the first level usually produced small movements with Claira's hands. Her mother described the experience of this exercise as similar to a strong "psychic connection" with Claira. She said that this activity created an intense bonding with Claira. "Distancing," the mother's separation of her negative feelings from the unborn, also met with positive results. During the two-week period audited there were four occasions that produced high stress for the mother. One was a kitchen flash fire which triggered a past burn trauma, reawakened memories of a miscarriage, distress with children, and distress with spouse. As the mother felt her anxiety and/or agitation, Claira would respond with aggravated, short, quick movements. On each occasion the mother "tuned in" to Claira's emotional state and then used "distancing" to separate her emotions from Claira's perceived state. With each attempt, the short, quick movements almost instantaneously ceased and Claira returned to a quiet and calm state with no agitated movements. The second level, "Bonding through Music," also showed specific responses on Claira's part. In the curriculum there are four musical arrangements involving family sing-alongs. These musical pieces act as a bridge between the social bonding and the learning activities. Claira responded to these musical pieces with gentle hand movements. In many ways the movement was similar to the responses to the social games in the third level. A summary of the movement responses to the feeling and musical activities is presented in Table 3. The movement responses may indicate a differential response between activities that promote attachment and those that isolate and separate from the bonding process. These movements are similar, if not the same, as the social responses in the learning activities. Again, we are presented with the possible scenario of an "intelligent" response pattern to appropriate emotional states surrounding the prenate. The main musical arrangement was a piece entitled Suite Beginnings which used only four notes within a strong sixty cycle beat. Dissonance was built into the arrangement at selected bars in order to stimulate discernment on Claira's part. This melody was played for the unborn at quiet and calm times. Here that we saw more rhythmic and rolling movement responses to the music.

Table 3
Movement Responses for Feeling and Musical Activities

Activity	*Movement response*
"Sharing time" activities	slow gentle movements of arms and/or legs
"Tuning-in" awareness activity	small hand movements
Maternal agitation	sharp, quick, and hard movements
"Distancing" activity	cessation of hard movement & return to quiet state
Family sing-alongs to prenate	gentle hand movements

When Claira first confronted the dissonance in Suite Beginnings she would stop and become still. It took her about one week to integrate the musical discrepancies into her movement patterns. When she did so, she would continue the movement during the dissonance so as to have continuity during the next bar. Suite Beginnings was first played postnatally for Claira when she was 2 weeks old. A quiet and alert time was selected. The recorder was off to the side of the room. When started, Claira glanced in the direction of the sound. As the music continued she responded with gentle rhythmical arm movements, possibly similar to her in

utero response movements. The movement continued without regard to the dissonance parts when encountered. Claira was born in September 1991. The labor lasted for five hours. She was delivered under water and at home with the assistance of a licensed midwife. Claira weighed 10 1/2 pounds, was 23 inches long, and had a head circumference of 17 1/2 inches. Of all of the postnatal information on Claira, perhaps the most interesting has been the observation of her movement patterns. Here we would like to draw attention to specific hip movements. The pattern involved a bouncing effect similar in description to some of the prenatal rhythmic movements. Without the intensive prenatal coding done, this pattern may have gone unnoticed or been seen merely as a "reflexive" pattern. As Claira was learning to crawl all of the succeeding stages of crawling were preceded or interrupted by this movement. It was only at the point of forward crawling and alternating limb patterns that this early movement pattern disappeared. It reappeared briefly when Claira began preparations for walking at eight months of age. It seemed that the movement was an attempt to mediate new milestones, but then became superseded by the new patterns once mastered. This particular movement seemed to decrease sharply as Claira moved from primitive to the learned reflex patterns. This scenario may indicate that the prenatal organizational patterns became integrated into greater degrees of specification with later motoric milestones. The same movement was used to communicate as early as one month of age. When held and shown a particular event or object, Claira would begin using this movement scheme after a short period. This seemed to be Claira's way of indicating boredom and that she wanted to move to another experience. The movement scheme appears to have been part of a communication process. DISCUSSION What seems to emerge from this case study of Claira is that prenatal learning is more complex and involved than current research would indicate. Habituation is one technique used to study memory functions in prenates and early infants (Friedman, 1972; Fagan, 1984). Habituation methods demonstrate differential responses to both novel and familiarized stimuli as a means of ascertaining if the baby does remember a familiar stimulus (Sophian, 1980). Another method is contingency reinforcement to elicit certain learning responses (Rovee-Collier, 1984). In both of these paradigms the stimulus is externally imposed. Both methods look for changes in specific rates (visual, heart, sucking behavior, etc.). Habituation and contingency reinforcement were evident in the study of Claira. She did learn to recognize and to respond to the [a] sound when reinforced with the penlight. She was able to respond to the social games by pushing back on the abdomen wall. The introduction of novel stimuli was met with pauses or cessation which could have reflected confusion or surprise. All of these responses are consistent with a habit/procedural type of memory system. Indeed this is well within the Piagetian view that the earliest learning is primarily sensorimotor. However, there are elements in this study implying that prenatal learning is more than a conditioned response. One was the apparent progressive organization of movement patterns. In addition to changes in rates, we can also see changes in patterns of activity (Bower, 1989). As Bower has pointed out: "We should be looking for a change in pattern of activity, a change to a pattern that shows systematic increases in activity and systematic pauses in activity" (p. 58). The difference in changes may signal a shift from external to internal motivation regarding learning. At some primitive level, the unborn is drawn into relationship with his/her actions in the pursuit of "understanding." Evident in the case study of Claira were systematic changes in activity and pauses. Claira refined her responses to auditory stimuli from a general rolling to the localization of the sound source. The same progression was observed in the visual games when Claira first responded with kicking movements and then by rolling toward the source and touching it with her hand. The pauses in response to the dissonance in the musical piece were met by a new pattern of activity. In each of these examples the stimulus was not changed, although there were changes in her patterns of activity. The inviting question is whether there is also a non-habit/non-procedural system of memory functioning at this early learning level. In his work on imitation with very young infants, Meltzoff (1990) has argued for an innate non-habit memory system, particularly as it involves imitation and representational thought. As Meltzoff points out: "There may never be a time that the human infant is confined to a purely habit/procedural mode. In a very real sense, there may be no such thing as an exclusively 'sensorimotor period' in the normal human infant"

(p. 20). An interesting phenomenon in this study has been Claira's response to object constancy. Object permanence is not expected until much later, generally around 6 months of age. Contemporary research has shown that this skill is often preceded by the infant's memory and search for an object (Moore &Meltzoff, 1978; Diamond, 1985; Weilman, 1985; Harris, 1987) even though there may be no awareness of the object's independent existence. Claira's localized movement to the bell and her following the light trajectory with her hand would seem to represent this type of behavior. The time lag between light flashes was 1.5 to 2 seconds in duration. Obviously there was enough memory for the object that Claira was also able to locate it. In a real sense, Claira was attempting to recreate the object through her own actions (Sophian, 1980). A further indication of this was her puzzlement when the light was not used to reinforce vowel sounds in a novelty presentation of an activity. During the initial trials of this activity she would hear the [a] sound and see it reinforced with the flashlight. On selected occasions the light was absent, causing some consternation on Claira's part. Later she was able to adapt to the change by touching the abdomen even though the light was not flashed. This was not a consistent pattern, but its presence over several trials indicated her "awareness" of the association pattern, and its presence over several trials indicated her "awareness" of the association between touch and the [a] sound. It would appear from the study that the prenate's perception of the world and ability to respond is a unified perception and not one governed by mere reflexive action. How then does the prenate perceive? Contemporary developmental research (Stern, 1985; Bower, 1989; Meltzoff, 1990; Sallenbach, 1993) sees the young infant as amodal in perception. This refers to the infant's ability to take in information from one sensory modality and transfer it to another sensory modality (Stern, 1985). Thus, the infant is able to "map" visual and auditory cues to his/her own felt response. Bower (1989) sees the young infant as living in a perceptual world determined by "higher-order variables." These variables are not tied to the particulars of any one sense but can be presented in two or more senses. So strong is this process that when information is presented in a form common to two or more sense modalities, the information "will be registered as events in the psychological world of the newborn" (p. 36). Meltzoff refers to this amodal style as cross-modal functioning in the neonate (1990). Information is transferred from one sensory mode to another. It involves a complex mapping process where equivalences are matched between what is perceived and the body transformations needed to make a felt response to the perception. This model can be applied to the apparent imitative skills in very young infants (Meltzoff &Moore, 1978). Never having seen his/her face (and for some the first time exposure to adult facial gestures), the young infant sees a stranger perform a tongue protrusion and is able to imitate it. In the Meltzoff model, the infant takes in the visual information, feels the transformation in the body, and reproduces the action. Such representational transformations certainly infer a non-habit/non-procedural memory system as the transformations operate more from recall than from a contingency reinforcement. It may very well be that Claira's movement patterns represent a cross-modality response to the learning activities. The "Bonded Beginnings" activities purposefully provided two or more sensory modalities as the delivery system. The stimuli were perceived and then transformed into tactile and motoric responses by Claira. At the limited level of investigation for this study, we can only report on her responses as tactile or motor. Further research into auditory and visual transformations would be worth investigating.

Table 4
Claira's Learning Domains and the Cross-Modal Mappings Suggested

Learning domain	*Sensory input*	*Mapping*	*Movement coordinates*
Social	auditory/tactile	tactile	wrist, elbow
Language	auditory/visual/ tactile	tactile	knee/hip/(some wrist)
Visual	visual/tactile	tactile	knee/(some hip?)
Auditory	visual/auditory	tactile	shoulder/spine/hip
Music	auditory	tactile	shoulder/spine/hip

Bower (1989) makes an observation relevant for this study. He feels that the muscles and joints can act as higher-order variables in amodal perception. In other words, information taken in via one sense, say visual, can be fed into proprioceptive coordinates and shared with other modalities. This view is shared by Meltzoff (1985, 1990) in the idea of active intermodal mapping (AIM), wherein neonates can, at some level of processing, apprehend the equivalence between body transformations they see and body transformations of their own that they "feel" themselves make. The adult's gesture would truly act as a model against which infants would compare their responses. (1990, p. 6) Claira's learning style may well reflect this complex transformation system. By way of illustration, Table 4 outlines the cross-modality coordination with the proprioceptive coordinates during the learning activities. In no way should this "map" be construed as a generalization for all prenates. What it does suggest is that for Claira, the proprioceptive coordination may have been an important ingredient in the integration of cross-modal functioning. One very quickly gets the "picture" that the body as a whole acts as an integrating force and maintains hierarchical dominance over individual sensory modalities. It would appear that the prenate lives in a world of perceptual unity and is certainly not fragmented in perceiving the internal or extrauterine worlds. Perhaps the body and its various components provide a causal connection for very early learning (Sallenbach, 1993). This connection has been referred to as somatic efficacy and is the basis for "soma-sensory" learning during the prenatal period (Blum, 1993; Sallenbach, 1993). The importance of the body in prenatal learning should not be a surprise. The first trimester is dominated by the differentiation and specification of body systems, yet the fetus is engaged in meaningful and volitional movement patterns (Chamberlain, 1993). In its purest sense, the prenate represents the total integration of mind and body. If indeed the prenate uses proprioceptive coordinates, then an interesting question arises: can the unborn child retain memory of episodic, or single occurrence events (Tulving, 1987)? If the answer is positive, then perhaps the proprioceptive coordinates and cross-modal functioning would serve as a non-habit memory system and one that might be able to access a specific personal experience. Treatment around prenatal and birth trauma would suggest that this is true. Emerson's work (1989) in this area has been a landmark. Emerson strongly believes that trauma is often retained in the joints and deep tendon tissues of the infant. The body can easily reactivate the birth trauma "memory" through a birth-simulating massage technique. This clinical viewpoint would imply that the body, acting as a higher-order variable, could maintain the traumatic memory in the joints and tissues that were directly impacted. Another point to consider is that birth represents movement in its most authentic form. When this movement pattern is impacted, the experience may reverberate both physically and emotionally throughout those areas where the inhibition originated. For the portion of the curriculum reported in this study there were no direct attempts to trace any rudimentary form of representational thought. Yet it seems that the presence of such forms would be a crucial feature in determining a non-habit memory system for the prenate. To assess accurately imitative behaviors certain criteria would have to be met (Meltzoff, 1990). The prenate would have to produce a behavior after a brief delay. Such an act would need to be initiated by the prenate. An

imitative act would not involve previous motor practice. With these criteria, imitative skills are more closely aligned to cued-recall than habituation, contingency reinforcement, or novelty preference (Meltzoff, 1990). Given that the prenate is in a non-visual and closed unit, it is very difficult to meet these criteria. There were times when Claira seemed to come close. One was her quick ability to respond to the social games. In one game, the father pushes down on the abdomen and identifies himself saying, "Hello, Papa's here!" Accompanying each syllable is a push on the maternal abdomen. The movement was slow and deliberate so as to allow for any reciprocal response during the interaction. Within the first three trials, Claira was pushing back. The game was incorporated into the beginning of each session. This game was also done much earlier than the audited period for this study so that its presence at this time had all of the appearances of a contingency reinforcement. Yet within the first half-hour after birth, Claira was able to imitate a tongue protrusion. It would seem the imitative process is at work for the late term prenate in anticipation of this newborn skill. This is certainly an area worthy of further research and refinement of methodology. I have attempted to show that many movement responses infer a progression in their organization with a purposeful outcome. Such a progression indicates internal organization. If so, then there exists the strong possibility that the prenate is utilizing internal motivation in learning. Many of the games involved contingency reinforcement. Familiarized responses by Claira entailed recognition and anticipation to the activities. Anticipation still falls within a contingency model as part of a procedural response. Anticipation can indicate internal motivation and representation and appears as mental regulation. In the Piagetian framework, a regulation is part of the equilibration process necessary for the building of mental schemes. A regulation occurs when the reaction to an action is modified by the original action (Piaget, 1978). The regulation can be either a correction (negative feedback) or a reinforcement (positive feedback). The regulation emerges from some type of disturbance, either as resistance to an obstacle or as a "gap" in the mental schema to explain an event. Both types of corrections seem to have been displayed by Claira in regard to following the light trajectory and in keeping rhythm with the musical beat. Since we are still investigating the existence of regulations in prenatal cognition, we will refer to her responses as regulatory formations-at least an elementary development in a compensatory direction. It would appear that the regulatory formation is a step beyond a habitual condition. Anticipatory reactions do not constitute a correction per se (Sallenbach, 1993). A regulation is not apparent when: 1) there is a repetition of an action with no modification; 2) when the disturbance leads to the cessation of an action; or 3) when the subject engages in an activity in another direction (Piaget, 1978). As Claira responded to following and touching the light source in the trajectory game, she was creating a function that moved retroactively, moving from the results to the starting point. In regard to reestablishing a synchronized beat with the musical arrangement, Claira was creating a proactive formulation leading to new corrections. In each event, the response was greater than a habitual response based on simple recognition or anticipation. Anticipation may be the leading step towards a regulatory formation and the development of mental schemes, but unless the above conditions are met, it will remain at a procedural level. This paper has been centered on the learning strategies for Claira although the bonding process was the main purpose of the curriculum used. Some words about that are appropriate here. The success of the activities for the first level, "Bonding through Feelings," demonstrated Claira's emotional responsiveness to the mother and family. Notice the important role played by movement in the bonding process as well as in the learning activities. Some of the responses reported in this paper reflected emotional states and resolutions to emotions. Movement also filled the role of communication and increased the bonding relationship between Claira and her parents. These patterns imply that the prenate may be demonstrating an elementary sense of self. Clinicians tend to see the unborn child's identity as totally contained within the mother's identity. The movement patterns and their varied usages could indicate that there is truly a primal awareness of separation. Rather than seeing the unborn's identity as totally contained in the mother's, we feel that the information in this study suggests that there is a mutual inclusiveness between child and parent. The experiences of the mother can be contained within the emotional life of the unborn when the fetus is capable of maintaining an elementary sense of

separation. If boundaries are obscure, then there is the possibility that the unborn's needs will become fused with the mother's needs. When the bonding process includes appropriate boundaries and a healthy interactive model, then the unborn derives security and self-awareness from the containment within the mother. The sense of self is part of a grander process of specification within the prenatal period. What constitutes the learning process during the prenatal period? We believe that the information in this study demonstrates that the prenate, like the neonate, is moving from a process of generalization and abstraction about experiences to specificity and discrimination. This is also the same process described by Bower (1989) in examining the learning styles of very young infants. This process is unified, often governed by higher-order variables in an amodal perceptual field. The body in its joints and deep tissues is very instrumental in facilitating this learning process. There should be little doubt that the unborn child is a sentient being, on whatever level, capable of participating in the life that surrounds him or her. IMPLICATIONS The most obvious implication from this and other studies is that more research is required in order to understand prenatal learning and bonding processes. At best, we have only begun to appreciate the learning modalities active during the prenatal period. Rather than proceeding along theoretical constructs using antiquated research models, we need to be attuned to what the prenate is capable of experiencing. Such an approach needs to avoid both the mystification of the prenate and simplistic assumptions. The information from this study suggests that we look at the prenatal paradigm as etiological and epigenetic in regard to later infant cognitive development. For instance, does object permanence have a prenatal correlate in regard to object awareness? Claira was able to localize to a specific place during certain activities. Both object awareness and spatial awareness infer relevant memory functions toward an object knowledge. The information in this study suggests that there is a continuous line of development to object permanence from the prenatal period. Further exploration of memory functions would be very important in clarifying this aspect. Means/ends behavior may also have an etiological aspect during the prenatal period. The prenate is very familiar with the use of his/her uterine "toys," namely the fluid, the placenta, and the umbilical cord. There is ample documentation that the unborn are occupied with them. This study suggests there is an elementary awareness of action which enables participation in games. Spatiality is another developmental area worthy of further investigation during the prenatal period. Information from this study indicates that under certain circumstances visual and auditory perception may be distal as well as proximal. As such, Claira was able to locate objects and movement in space. Perhaps the most intriguing aspect would be the presence, or predisposition, of early imitative skills during the late prenatal period. This study did not focus specifically on this skill, but some of the responses point to this possibility. This is especially plausible when one considers that imitative abilities have been discovered in premature and full term babies only minutes old. Claira herself imitated facial gestures when 30 minutes old. Perhaps paramount for further research (and an item only slightly discussed in this paper) is the connection between prenatal cognitive and social development. For Claira, learning was within a social and familial context. Bonding is a term describing the intensity and degree of relations within an interactive model. Research that attempts to look at prenatal imitative skills could provide us with a better understanding of the close relation between social and cognitive development. Within this exchange is the young child's acute interest in adults. We hope this case study of Claira provides a broader understanding of the complexity and depth that characterize prenatal learning. It is important that we not limit our understanding by use of limited research methodologies. Usually, prenatal studies focus on neurological functions, contingency behaviors, and developmental outcomes. Such descriptions are not the best paradigms for denning learning and psychological processes. Perhaps by understanding better the origins of our interests, we can look differently at our paradigms for learning. References REFERENCES Blum, T. (1993). Prenatal intervention and human proto-development. In T. Blum (Ed.), Prenatal perception, learning, and bonding. Hong Kong: Leonardo. Bowlby, J. (1969). Attachment. 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