Contingency Effects of People and Objects on Subsequent Cognitive Functioning in Three-month-old Infants

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Abstract

Three month-old infants' responses to persons and objects who interacted with the infant at two levels of contingency were contrasted in two experiments. In experiment 1, contingent responding of people and objects was controlled. In experiment 2, the facial/vocal dynamics were controlled as well as contingent responding. In both experiments, contingent interaction had different effects on infants depending on whether the 'actor' was a person or an object. In addition, the contingency and person/object variables influenced infants' states of attention to a nonsocial stimulus on subsequent transfer tasks. Specifically, infants who experienced contingent interactions with people exhibited positive affect and exposed themselves to subsequent higher levels of stimulation than infants who experienced noncontingent interactions with people. These infants exhibited negative affective states and exposed themselves to very low levels of subsequent stimulation. In contrast, infants who experienced contingent and noncontingent interactions with objects did not show such variation in emotional expressions. Instead they produced primarily neutral facial expressions in all conditions and did not show very high nor very low levels of interest for the multi-modal stimulus on the subsequent transfer tasks. The discussion centers on the mechanism that allow infants to discriminate between contingencies provided by people and objects and that drive the results obtained on the transfer tasks.

Keywords: *Person-object distinctions; contingency; habituation*

Researchers studying infant-adult interactions have documented that very young babies are sensitive to the structure of their social encounters. A reciprocal, turn-taking dyadic structure appears to be an optimal form of social stimulation for the infant. Faced with a communicative adult, who responds in a contingent way to their gestures, 2–3 month-old infants will smile, vocalize, and alternate their gazes (Brazelton, Koslowski, & Main, 1974; Ellsworth, Muir & Hains, 1993; Kay, 1982;

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Lamb, 1981; Legerstee, Pomerleau, Malcuit & Feider, 1987; Legerstee, Corter & Kienapple, 1990; Murray & Trevarthen, 1985; Stern, 1977; Watson, 1972). In contrast, when confronted with an unresponsive or noncontingent adult, infants may produce negative vocal sounds and avert their gazes (Bloom, Russell & Wasserberg, 1987; Brazelton, 1979; Dunham & Dunham, 1990; Dunham, Dunham, Hurshman & Alexander, 1989; Ellsworth *et al.* 1993; Legerstee *et al.* 1987; Legerstee *et al.* 1990). Not only do these particular turn taking structures alter the affective state of the infant, but they have implications for the child's cognitive development. For instance, in the Dunham *et al.* (1989) study, 3-month-old infants that had received a contingent reinforcement schedule where the experimenter vocalized and touched the infants' feet each time the baby vocalized, responded with social behaviors (smiled and cooed), and on a subsequent transfer task showed more initial interest and habituated quicker to a multimodal stimulus than infants who had received noncontingent stimulation. These infants appeared distressed and showed little interest in a multimodal stimulus on the subsequent transfer task. These findings from experimental research have been supported by more descriptive studies of mother-infant interactions in which differences in social structures were found to be correlated with differences in infants' later cognitive styles (e.g. Ainsworth & Bell, 1974; Bakeman & Brown, 1980; Belsky, Rovine & Taylor, 1984).

The above findings have important implications for social and cognitive development. They suggest that certain *social* experiences can produce changes in three-month-old infants that generalize to cognitive functioning. It can be expected that if experienced continuously, inadequate interactive signals of either the infant or the caregiver could have long term consequences for further development.

A contingency view has been presented by Watson (1972; 1985) to explain how infants adapt to their social and nonsocial environments. In particular, Watson proposes that the infants' smiling and cooing arises as a response to the 'perception of a contingency' between infant behavior and rewarding environmental responses. In fact, any contingent response stimulus (social and nonsocial) will elicit attention and positive affect in infants, and any noncontingently acting stimulus may elicit inattention and neutral affect in the infant. However, if the infant has had contingent experience with the stimulus in the past and the nature of the stimulus becomes momentarily ambiguous or uncertain, fear and negative affect may arise. Watson further argues that it is the perception of a contingency that enables infants to distinguish between social and nonsocial objects, since people not only react to smiles, vocalizations and motor movements of infants with similar actions of their own, but their variable interactions are more arousing to babies than the immediate and perfect responses of objects.

Contingency theory has been generally supported. Watson (1972) and Watson & Ramey (1972) showed that infants can learn about contingencies involving nonsocial objects when in a controlled environment. They exposed 2-month-old infants to 10 minutes of noncontingent mobile rotation on each of 14 consecutive days. When the infants were subsequently brought into the laboratory and allowed to control the movements of a mobile they failed to learn the task. This was in contrast to the experimental infants. Their prior exposure to a contingent mobile over the same 2-week period facilitated learning of a subsequent contingency task. In another experiment, Watson supported his assertion that infants are more aroused by 'imperfect, but clear contingencies' by showing that the infant's kicking response increased when a) 50% of their responses were reinforced and b) they received 6 noncontingent responses per minute, but that virtually no increase in the kicking response was shown after continuous reinforcement.

Although it appears that recent data on transfer effects using social stimuli is fairly consistent in both naturalistic settings (Dunham *et al.*, 1989; Dunham and Dunham, 1990) and after extensive training practices (Decasper & Carstens, 1981), studies using nonsocial stimulation have failed to produce consistent evidence for transfer effects (Finkelstein & Ramey, 1977; Gekoski & Fagan, 1984; Millar, 1972; Ramey & Finkelstein, 1978). It is possible that differences are related to the many methodological differences between the nonsocial contingency studies. However, if this is so, then transfer task failures should be equally evident when social stimulation is used, since these studies had different methods also. A more plausible hypothesis has been proposed by Dunham *et al.* (1989, p. 1494). The authors found that infants in the control group who were confronted with a continuously rotating mobile did not produce negative or positive affect and on the transfer task showed more interest in the multimodal stimulus than infants in the noncontingent social group. The authors suggested that the 'use of *social* stimulation during the contingent-noncontingent pretreatment phases of the paradigm may be of critical importance in the transfer effects that [were] obtained'.

If by three months, infants are more sensitive to contingent responding of people than of objects (when the reinforcement schedule is controlled), then the infant's behavior cannot be a generalized response to activity levels as suggested by Watson (1985). Rather the infants' affective states may be the result of the dynamics of the communicative exchanges infants have with their social partners. Social interaction theorists characterize the early infant-caregiver exchanges as a dyadic system in which affective messages are exchanged between the partners so that they achieve their goals in coordination with each other (Bruner, 1973; Fogel, 1993; Murray & Trevarthen, 1985; Schaffer, 1984; Tronick, Ricks, Cohn, 1982). If the partner reacts in a responsive way to the infant's signals then infants will smile and vocalize, thereby expressing their satisfaction with the social interaction. However, if the partner fails to respond adequately to their gestures then infants become upset; if their distress signals fail to change the partner's behavior, they may withdraw from the interaction. These emotional changes of the infant are not only under immediate stimulus control, rather they persist and can be transferred to subsequent normal interactions with people and objects.

To find out whether infants react differently to contingently responding people and objects, and whether these interactions affect their subsequent performance, infants need to be observed in an experiment that will pit various levels of contingency of people and objects against each other in one experimental paradigm. As outlined above, few experiments have compared 3-month-old infants' reactions to contingently responding people and objects without subjecting them to extensive training periods that would have infants come to expect particular actions of certain stimuli as a function of the experimental paradigm rather than as a function of the infants' social history. In experiments using more naturalistic settings (Ellsworth et al., 1993; Fry, Rawling, Moore and Myers, 1983; Legerstee et al., 1990; Legerstee et al., 1987), contingency between people and objects was never properly controlled (mothers were instructed to act 'as they usually do at home'), nor were transfer tasks employed. Only the Dunham study contrasted infant's responses to people and an object, and measured the effect of the interactions on subsequent transfer tasks. However, the object was a continuously rotating mobile and hence it defined neither a contingent nor a noncontingent relation with any specific infant response.

Consequently, the present research investigated whether three-month-old infants responded differently to contingency treatments of people and objects. Two experiments were conducted in which: a) onset and offset of the person and object responses were made contingent upon the infant's response, b) person and object activity was noncontingently yoked to infants in the contingent performance, and c) each interaction was followed by a transfer task in which the infants visual interest in a multimodal stimulus was measured. The questions of interest with respect to these conditions were whether: a) the contingent person group will smile, coo and increase fixation times on the subsequent transfer task relative to the contingent object group, and b) the noncontingent person group will show distress and decrease its visual fixation time on the subsequent transfer task relative to the noncontingent object group. In experiment 1, contingency of people and objects was controlled. In experiment 2, the facial/vocal dynamics as well as contingency was controlled.

Experiment 1

Method

Subjects. Fifty infants ranging in age from 82 to 102 days (*M* 90.3) living in a large Metropolitan city and surrounding areas took part in the study. Of this initial sample, 8 babies were excluded from the study due to excessive crying (4 boys and 2 girls) and experimenter error (2 girls). Thus a total of 42 infants (25 girls and 17 boys) were included in the analyses. All were term babies and healthy (Apgar ratings between 7–10) and came from lower to middle class families. SES was based on parental occupation. Sixty three percent of the infants had at least one sibling. The demographic characteristics of the infants are presented in Table 1.

Table 1. Demographic Information on Infants and their Families

	Infants in Experiment 1	Infants in Experiment 2
Age range of Mothers (in years)	24–35	24–36
Mean age of Mothers (in years)	30	31
Mean Schooling for Mothers (in years)	14	15.9
Age range of Fathers (in years)	28–45	28–47
Mean age of Fathers (in years)	34.5	34.2
Mean Schooling for Fathers (in years)	16.0	16.5
SES range (in classes)	Lower Middle–Upper Middle	Lower Middle–Upper Middle
Modal SES (in classes)	Middle	Middle

Apparatus and procedure. The sessions were videotaped in a laboratory. Babies were filmed when content, alert, and healthy (State 4, Wolff, 1966). Infants were seated in a special infant seat tilted upward at a 45 degree angle. One camera and zoom lens focused on the infant. It was fastened to the wall, behind and to the right of the adult. Another camera and zoom lens focused on the adult or the nonsocial object. It was mounted on a tripod, behind the curtain at the rear of the infant's chair.

The cameras were remotely controlled from an adjacent room. Information from both cameras were fed into a split-screen television so that the behavior of the infant could be coded without revealing which stimulus the infants were interacting with. Throughout the experiment, a Sony Walkman was worn by the adult. In the noncontingent conditions a series of 'beeps' were played from a pre-recorded tape signaling her to stimulate the infant. The interactions were timed by a research assistant in the control room. She signaled the beginning and the end of each period to the experimenter.

The procedure was patterned after the Dunham *et al.* (1989) experiment. All sessions began with the 5-minute interaction phase (pretreatment) followed by a 6 trial transfer task. Dunham *et al.* (1989) had found that 6 trials were sufficient to study habituation in the infants. The present experiment is different by including contingent and noncontingent object-interactions followed by transfer tasks. The infants were randomly assigned to each of the four two-phase conditions: 1) the contingent person – transfer group (CP), 2) the noncontingent person – transfer group (NP), 3) the contingent object – transfer group (CO), and 4) the noncontingent object – transfer group (NO). In the first phase of the procedure a female experimenter would administer the social and nonsocial pretreatments at a 30 cm distance. A white curtain surrounded her and the infant. Infants were filmed in interactions in which the onset and offset of the person and object stimulation was controlled by the onset and offset of the infant's vocalizations (synchronous reinforcement). In the CP pretreatment, the experimenter would sit facing the infant at a 30 cm distance. As soon as the infant vocalized, she would respond with a smile and the phrase 'Hi (baby's name), how is my little baby' for as long as the baby vocalized. In the NP pretreatment, she would respond to the infant according to a predetermined schedule that was independent of the infant's vocalizations. The schedule was yoked to a pattern of vocalizations of a previous infant in the person or object contingent group (their choice was determined randomly). In the interaction phase of the object condition, the female experimenter sat behind the curtain. She had placed her hand into a full rubber mask that was turned inside out to disguise the facial features. In order to match the complexity of a human face abstract features had been painted on the face that would move when the experimenter moved her hand inside the mask. In the CO condition, the experimenter would move the object, while playing a synthesizer that approximated the rhythm and prosodic qualities of the human voice in the social pretreatment. In the NO pretreatment, the experimenter again responded in a predetermined schedule that was independent of the infant's vocalizations. As before, the infant's interaction schedule was yoked to the pattern of an infant in either the CP or CO group. To ensure that the infant's responses were not a function of a specific stimulus, several different female experimenters and objects were used.

Immediately after the interaction sessions, the infants were administered the infant transfer task. Now, a 1-cm diameter red light was illuminated. It was fastened on top of the video camera that focused on the infant at a 80 cm distance. To enhance visibility of the stimulus light, the white curtain was changed to a dark blue and the lights were dimmed. An assistant was situated in the control room. She presented a computer generated auditory stimulus until the infant terminated fixation. The auditory stimulus consisted of a 67 dB wave tone which was repeated in a six-element pattern with 100-msec intervals between each element and 600-msec silent intervals between successive six-element patterns (see Dunham *et al.* 1989). During fixations, the light flashed on and off in temporal synchrony with the tone as long as the infants fixated the stimulus. When the infant stopped looking, the auditory stimulus stopped, while the light remained lit. When the infant resumed fixation this procedure was repeated until the infant completed 6 successive fixations.

Behavioral categories: interaction phases. Four infant measures were coded independently from the video tapes in real time. The duration of the babies gazes, vocalizations, positive, negative and neutral facial expressions were coded during the person and object interaction phases. Gazes were coded when infants' visual attention was directed at the object or face or the person. Vocalizations were coded when the infants made vocal sounds. Crying and physiological sounds were not included. Positive facial expressions were coded when babies raised their eye brows and the corners of their mouth, with the mouth either open or closed. Negative facial expressions consisted of a furrowed brow and/or pouting (i.e. corners of the mouth turned down). Neutral facial expressions were coded when infants had neither a positive nor negative facial expression.

All behaviors were coded by research assistants naive to the experimental hypotheses. All behaviors (except the vocalizations), were coded without sound. The right side of the screen was covered so that only the responses of the babies were visible. When the vocalizations were coded the screen was turned off and only the sound was audible. Although the coders could hear the social versus nonsocial sound, they were naive to the expected hypothesis and could therefore not influence the study one way or the other.

One group of observers would code the nonverbal behaviors and another group would code the verbal behaviors. Each group consisted of 2 observers, of which one would code all the sessions, and the other would code 30% of the data to assess for reliability. Kappas were .81 for Vocalizations; .82 for Gaze; .80 for Positive-, 82 for Negative-, and .86 for Neutral facial expressions.

Behavioral categories: transfer phase. Coding of the tapes for the transfer task was done by measuring the time that infants spent fixating the light stimulus on each of the infant controlled stimulus presentations. A fixation was defined as any look at the stimulus 1 sec or longer in duration, and fixations were terminated by a look away of 1 sec or longer. These parameters have been used reliably in other studies (Colombo & Horowitz, 1985; Colombo, Mitchell, O'Brien & Horowitz, 1987). Again, one observer coded fixation time from the videotapes and a second observer calculated interobserver reliability on 30% of the data. Cohen's kappa was .83.

Results

Interaction data. Infant responses were submitted to a repeated measures MANOVA – General Linear Models Procedure (between subject design) that would evaluate the effect of Contingency (Contingent, Noncontingent), and Stimulus (Person, Object) as independent variables. Tukeys HSD were used to compare the group means for each of the independent variables. Means and standard deviations of infant responses are presented in Table 2.

Vocalizations. A Stimulus × Contingency interaction $F(1, 38) = 6.90$, p .012 and subsequent Tukeys revealed, that infants in the CP group produced more vocalizations (M = 98) than infants in the CO (M = 63) and NO groups (M = 42) between which there was no significant difference. The least amount of vocalizations were produced by infants in the NP group (M = 25).

Gazes. A significant Stimulus × Contingency interaction $F(1,38) = 15.28$, $p <$ .001 and subsequent Tukeys revealed that infants in the NP group gazed significantly less at the stimulus (M = 121) than infants in the CP (M = 202), CO (M = 190) and NO (M = 227) groups.

Affect. A significant Stimulus × Contingency interaction $F(1, 38) = 5.50$, $p <$ .024) for *negative affect* and subsequent Tukeys showed that infants in the NP group appeared more distressed (M = 33) than infants in the CP group (M = 3), or in the CO (M = 9) and NO (M = 12) groups.

A significant interaction ($F(1,38) = 4.84$, $p < .034$) and Tukeys revealed that infants in the CP group produced significantly more *positive affect* (M = 52) than infants in the NP group (M = 16). Significantly little positive affect was produced to contingently (M = 4) and noncontingently (M = 6) moving objects.

A significant main effect ($F(1, 38) = 22.7$, $p < .001$) revealed that infants in the object groups exhibited more *neutral affect* (M = 284) than infants in the person groups (M = 226).

Transfer tasks. To determine whether their prior experience with the various person and object contingency tasks would lead to variations in performance on the subsequent transfer tasks, the infant fixation times for the 6 trials were submitted to a mixed model MANOVA (linear models procedure) that would evaluate the effect of the pretreatment phase (Contingent, Noncontingent) and Stimulus (Person, Object), and the within subject variables Trials (6). Tukeys (HSD) were used to compare the group means for each of the independent variables.

A three way Trial × Stimulus interaction $F(5, 190) = 4.35$, $p < .001$ and Tukeys revealed that during Trial 1 and Trial 2 infants in the CP group fixated the stimulus longer than infants in the object groups (between which there was no significant difference). Infants in the NP group showed the least amount of visual interest (see figure 1).

The results of experiment 1 showed that infants found the CP group most stimulating and the NP group most distressing and that the experience with these pretreatments affected their interest in subsequent stimulation. Since people and objects acted in a continuous way to the infants' vocalizations their differential responsiveness could not be due to different schedules of contingencies. However, it could be argued that infants attend selectively to people because they have a general preference to attend to human faces. They may have learned that interesting events occur where faces are and thus the faces may have acted as an 'attention magnet' (Watson, 1972). For instance, Watson (1972) suggests that the social behaviors noted in infants may be elicited by a silent face right side up in front of the infant, because infants have associated contingency games with it. To address this issue, the next experiment was performed using the same scenario as study 1, except for the following: a) the stimuli moved in a *silent* way to the infants' responses, b) the object had

Table 2. Mean Proportional Durations per Minute and Standard Deviations of Person and Object Conditions at Contingent and Noncontingent Levels when Vocalizations (Experiment 1) or Gazes (Experiment 2) were reinforced

		Experiment 1			Experiment 2		
Response	Condition	N	Mean	S.D.	N	Mean	S.D.
Gaze	CP*	11	202.0	53.3	10	166.1	30.09
	NP*	10	121.2	42.6	13	117.6	46.2
	CO*	11	190.0	56.7	10	243.0	43.2
	NO*	10	227.5	39.7	13	242.0	51.4
Vocalizations	CP	11	98.7	46.9			
Melodic	CP				10	105.0	43.0
Vocalic	CP				10	14.0	7.8
Vocalizations	NP	10	25.1	18.7			
Melodic	NP				13	34.7	19.1
Vocalic	NP				13	78.6	37.4
Vocalizations	CO	11	63.4	28.2			
Melodic	CO				10	1.7	1.8
Vocalic	CO				10	52.3	32.1
Vocalizations	NO	10	42.4	27.1			
Melodic	NO				13	1.9	1.8
Vocalic	NO				13	55.0	21.0
**Neg. Affect	CP	11	2.7	3.2	10	19.7	14.2
	NP	10	33.4	32.8	13	52.7	35.8
	CO	11	8.6	14.1	10	7.4	9.4
	NO	10	11.9	14.0	13	5.2	5.3
**Pos. Affect	CP	10	52.0	49.9	10	95.0	39.2
	NP	11	16.0	11.1	13	44.7	23.4
	CO	10	4.0	9.0	10	6.2	11.7
	NO	11	6.2	11.5	13	3.6	2.4
Neutral Affect	CP	10	245.0	49.7	10	177.4	51.7
	NP	11	208.7	53.4	13	202.5	53.9
	CO	10	286.3	19.3	10	282.6	26.4
	NO	11	282.1	19.7	13	290.7	8.8

*CP = Contingent Person
*NP = Noncontingent Person
*CO = Contingent Object
*NO = Noncontingent Object
**Neg = Negative
**Pos = Positive

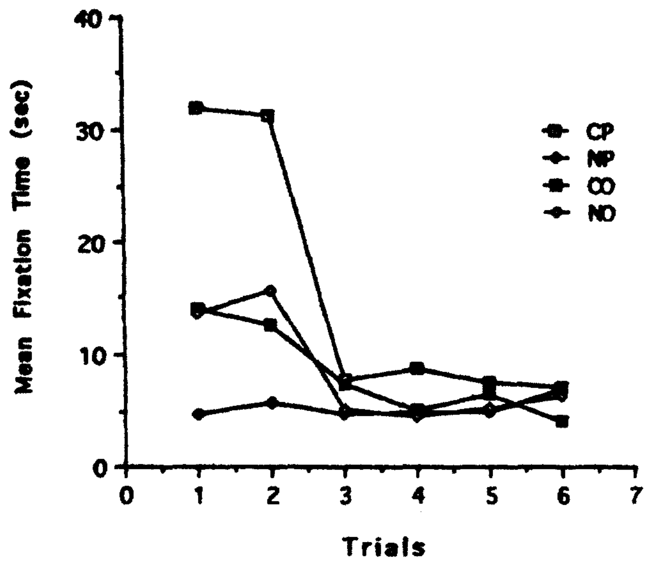

Figure 1. Mean fixation time during 6 consecutive infant-controlled habituation trials following exposure to contingent person (CP), noncontingent person (NP) and contingent object (CO) and noncontingent object (NO) in Experiment 1.

facial rather than abstract features, and c) the infant was required to look at the stimulus face in order to receive a response (in experiment 1 the referent responses were vocalizations). Earlier work had shown that looking occurred more frequently than vocalizing. This higher response rate may make the difference between the person and object and contingent and noncontingent variables more pronounced.

Experiment 2

Method

Subjects. Fifty-seven infants ranging in age from 82 to 102 days ($M = 90$) took part in experiment 2. Of this initial sample 11 babies were excluded from the study due to excessive crying (3 males and 1 female) and experimenter error (2 girls and 5 boys). Thus a total of 46 infants (20 males, 26 females) were included in the analysis. Again, all were term babies and healthy, and came from lower to middle class families (see table 1). Fifty eight percent of the infants had one or more siblings.

Apparatus and procedure. The infants were submitted to the same person and object interaction phases, followed by transfer tasks. This time, the object was a puppet (same size as a human head) with big black eyes, a red smiling mouth (lips turned up) and a protruding nose. Each time the infants gazed at the person or the puppet, they would shake their smiling faces smoothly back and forth (just like mothers do when they talk to their babies) without making sounds, until the baby turned away its gaze. The puppet was manipulated by an experimenter who either moved the puppet contingently or noncontingently (yoked to a previous contingent interaction of another baby). The experimenter was invisible to the baby in the puppet condition.

Behavioral categories: interaction phases. Again gazes, smiles, neutral and negative facial expressions were coded independently from the video tapes. In order to shed more light on the contingent/noncontingent and person/object dimension the vocal responses of the baby were divided into two types of sounds: melodic or 'speechlike' and vocalic or 'nonspeechlike'. The melodic sounds had in previous work been shown to occur significantly more to contingently responding people than the vocalic sounds. The vocalic sounds increased to noncontingent people instead

(Bloom *et al.* 1987; Dunham *et al.* 1989). Melodic vocalizations were defined as relatively long vocal sounds with varied pitch contours and oral resonance. Vocalic vocalizations were sounds of shorter duration, uniform pitch, and nasal resonance. Both types of sounds were defined as discrete, voiced sounds occurring within one aspiration. If segmented sounds occurred within one aspiration, they were treated as belonging to one utterance. Wheezes, sneezes, coughs and cries were not included in the vocalization count.

Behavioral categories: transfer phase. The procedure for the transfer task in Experiment 2 was the same as that followed for Experiment 1.

Results

Interaction data. The infant behaviors of study 2 were also submitted to repeated measures MANOVA – General linear models procedure (between subject design) in order to evaluate the effect of Contingency (Contingent, Noncontingent), Stimulus (Social, Nonsocial) as independent variables. Tukeys HSD was used again to compare group means for the independent variables.

Visual attention. A significant Stimulus × Contingency interaction $F(3, 42) = 23.38$, $p < .001$ and subsequent Tukeys indicated that infants in the NP group ($M = 117$) gazed significantly less than infants in the CP group ($M = 166$), but infants in the object groups gazed significantly longer ($M = 243$ and M 242) than infants in the person groups.

Affect. A significant Contingency × Stimulus interaction $F(1, 42) = 12.35$, $p < .001$, showed that infants in the CP group ($M = 95$) produced significantly more *positive affect* than infants in the NP group ($M = 44$), infants in the CO and NO object groups ($M = 6$ and $M = 4$ respectively) produced the least amount of smiles.

A Contingency × Stimulus interaction $F(1, 42) = 7.88$, $p < .008$ and subsequent Tukeys indicated that infants in the NP group ($M = 53$) produced significantly more *negative affect* than infants in the CP group ($M = 20$). Infants in the CO ($M = 5$) and NO groups ($M = 7$) rarely produced negative facial expressions.

A main effect of Stimulus $F(1, 42) = 67.02$, $p < .001$ showed that infants in the object groups ($M = 285$) produced more *neutral affect* than infants in the person groups ($M = 190$).

Vocalizations. When the vocalizations were coded as melodic and vocalic sounds (speechlike and nonspeechlike respectively, Bloom *et al.* 1987) and analyzed, a Contingency × Stimulus interaction $F(1, 42) = 28.03$, $p < .000$ and Tukeys revealed that infants in the CP group produced significantly more melodic sounds ($M = 105$) than infants in the NP group ($M = 35$). Very few melodic sounds were produced by infants in the object groups ($M = 1.7$ and $M = 1.9$). In contrast, a Contingency × Stimulus interaction $F(1, 42) = 26.44$, $p < .001$ and subsequent Tukeys showed that infants in the NP group produced significantly more vocalic sounds ($M = 78$) than infants in the CO ($M = 52$) and NO ($M = 55$) groups. Infants in the CP groups produced the least amount of vocalic sounds ($M = 14$). These results replicate those of Bloom *et al.* 1987 and Dunham *et al.* 1989 with social stimulation and extend them to nonsocial stimulation.

Transfer task. In order to determine whether the different pretreatment procedures would lead to variation in performance, the infants' visual fixations of study 2 were analyzed the same way as study 1.

A three-way Trial × Contingency × Stimulus interaction $F(5, 210) = 23.10$, $p < .001$ and Tukeys showed that during Trial 1 infants in the CP group ($M = 32$) fixated the stimulus longer than infants in the object groups (CO, $M = 14$; NO, $M = 14$) between which there was no significant difference, infants in the NP group showed the least amount of interest in the stimulus ($M = 5$). This difference was also significant for Trial 2 (CP, $M = 31$, NP, $M = 6$; CO, $M = 13$; NO, $M = 16$). None of the other trials showed significant differences among the groups of infants.

In sum, the results of experiment 2 closely paralleled those of experiment 1. Despite changes in the facial and auditory aspects of the stimuli, infants in the social groups smiled and produced more speechlike vocalizations to contingent people, and showed more distress and nonspeechlike vocalizations to noncontingent people. Again, no regulation of affect was noted to objects.

Discussion

The main purpose of this set of studies was to determine whether young infants have different interactions with people and objects when the objective properties of the two classes (contingency, facial/vocal dynamics) are controlled, and whether these interactions have different effects on subsequent cognitive functioning. The analyses of the data from both studies clearly indicated that the referent responses, vocalizations (study 1) and gazes (study 2), were not the same in the contingent and noncontingent situations involving people and involving objects. Similar patterns of interactions also occurred with adjunct responses, gazes (study 1) and vocalizations (study 2) and facial movements. In both experiments, the character of the infant reactions appeared to reveal the socialness of the infants, they gazed at noncontingently moving objects (curious things), but smiled and 'talked to' responsive people. However, not any kind of social interaction made infants happy. If the person was insensitive and reacted when the infant was not attentive, infants became upset. Movements of objects did not have such an effect on the babies. This differential responsiveness to people and objects remained whether the person made sounds or was quiet and whether the object had facial features or not.

The data across all measures of infant performance in these two experiments were not completely consistent, which may be due to the variation in procedures and the fact that independent groups were used. Overall, infants in the NP group in study 2 vocalized more than in study 1. It is possible that the *sounding* stimulus in study 1 suppressed the production of the infants' vocalizations since it may have clashed with that of the noncontingently vocalizing adult (Berger & Cunningham, 1983). Similarly, infants in study 2 gazed less at contingently responding people than infants in study 1. Overall, infants gazed more than they vocalized and consequently received more stimulation of people in experiment 2 than in experiment 1. By turning away their gazes infants may have attempted to modulate the excessive input of the adult (Field, 1979). Infants in experiment 2 also appeared to produce more smiles and negative faces to contingently responding people. A look at the tapes revealed that infants in both the contingent and noncontingent conditions began to smile as soon as they saw the smiling faces of people. However, they appeared to have become frustrated toward the end of the interaction, perhaps because people refrained from talking with them, which may have increased their negative facial expressions. Tronick *et al.* (1982) would suggest that the alternation between positive and negative moods within one session supports the idea that these young infants are goal oriented. The goal in the noncontingent condition would be to change the adult's way of communicating into a dyadic or contingent way, and in the contingent condition to make the adult speak rather than interact in a silent way.

In both experiment 1 and 2, infants that had experienced contingent interactions with a person remained positively engaged on a subsequent cognitive task. In contrast, those that experienced noncontingent interactions with a person lowered their interest to the stimulus on the transfer task. No such regulation of emotion was noted toward the objects, instead infants exhibited neutral affect during the interactions, and neither very high nor very low levels of interest to the multimodal stimulus on the subsequent transfer task. Thus, infants' social interactive experience affected the infant's emotion which was then carried forward into the next task. The finding that infants differentiated between contingent relationships of people and objects, but that only the response contingent stimulation of persons affected their subsequent performance on a cognitive task, suggests that the transfer effects that were obtained were dependent upon the quality of the *social* stimulation infants received and less on their overall ability to perceive a contingency or to process information. Presumably, the contingent and sensitive interactions of *people* create a positive mood which then increases the infant's motivation to learn. On the other hand, insensitive interactions of people disturbs infants and interferes with subsequent learning.

By responding differentially to people and objects despite the stimuli's contingent movement or facelike features, infants showed to possess rudimentary categories of the two classes. This finding is consistent with other reports that infants at this age differentiate between people and objects (see Legerstee, 1992 for a review of these studies). There are a variety of explanations for the early organization of social and nonsocial categories in young infants. For instance, it could be argued that the perception of a contingency initially defines social for infants, but that the history of contingency learning (variable social reinforcement versus immediate nonsocial reinforcement) from birth to three months creates a difference in 3-month-old infants' reactions to nonsocial objects. However, it is difficult to see how the infant can form social and nonsocial categories through a process of differential conditioning. Although by 3 months of age infants may have had ample practice playing contingency games with people, it is likely that in the natural world infants would have little experiences with objects to perceive and analyze 'perfect and clear contingencies' given their limited abilities to act on objects. Watson (1972, p. 1087) himself states that 'during the first two to three months, the combination of slow response recovery and short contingency memory prohibits [the infant of] becoming aware of contingencies between his behavior and its stimulus effects in the *physical* environment'.

The hypothesis that the perception of a contingency provides the basis for social learning in infants is further difficult to support since the idea essentially assumes infants to be asocial at birth. However, there is ample evidence to indicate that the neonate comes equipped with certain predispositions to respond to people (Schaffer, 1984). On the perceptual level, neonates eagerly search for a human voice rather than a nonhuman sound (Brazelton, 1979), and appear sensitive to the emotional expressions of others (Field, Woodson, Greenberg & Cohen, 1982). They are responsive to the synchrony of auditory and visual aspects of adult vocalizations (Spelke & Cortelyou, 1981), and imitate facial expressions of people but not of objects simulating these gestures (Legerstee, 1991). More striking is the infants' response organization. Gazing has been found to be a mechanism to stimulate communication in adults. Not only do young infants alternate their gazes, thereby establishing the cyclical framework of face-to-face interactions (Stern, 1977), but adults communicating with infants naturally respond in a contingent manner to the eye contact of their infants, thereby allowing for mutual sharing of expressions of arousal and affectivity (Schaffer, Collis & Parsons, 1977). When people fail to respond, infants become upset, the infant's distress cannot be related to the absence of 'contingent responding' to which the infant has become accustomed, because infants do not show distress when mother is engaged with another adult (Murray and Trevathen, 1985) or when a previously contingent object becomes immobile (Legerstee *et al.* 1990). These studies and the present findings would suggest an alternative interpretation, namely, that rather than having an innate ability to perceive contingencies, infants are born with predispositions that allow them to process information about the social world differently from that of the physical world (Bruner, 1973; Karmillof-Smith, 1992; Legerstee, 1997). These specific predispositions enable young infants to interpret actions differently depending on whether the actor is a person or an object, and to appreciate in some primitive way that humans not only act contingently and independently (Mandler, 1992; Watson, 1972) but also according to certain social rules (Legerstee, 1997; Spelke, Phillips & Woodward, 1995). If these rules are violated, infants become upset, which affects their performance during subsequent normal social interactions and on cognitive tasks. However, this does not mean that the infants' early social responses are the product of an understanding of the social behaviors of others. The infant's behavior is an objectively social action whose meaning is implicit in the action, though not objectively cognized by the infant. Although contingent interaction with people may reinforce the perceived differences between people and things, this is not sufficient for the understanding of what a person is. It is the interpretation of the infants' actions by people that provides the infant with social knowledge, since the adult alters the form of the input and makes it meaningful to the human infant. As a consequence, the significance of social behavior internalized in the adult comes to be internalized in the infant. Thus, the early predispositions do not define social for the infant, rather they direct the attention of the infant to proprietary inputs that are relevant to human existence. This early period is followed by reciprocal interactions with people, and increasingly by more sophisticated forms of exchanges. It is through these intersubjective forms of interaction that a conceptual understanding of a person is constructed (Chapman, 1992; Legerstee, 1997).

In summary, the present studies show that by 3 months, infants expect people to behave differently than objects. Their relationships with people appear complex and colored by emotions. These emotions can be strong and may enhance or interfere with subsequent cognitive processes. The emotions aroused by objects are less intense and do not appear to affect subsequent cognitive functioning. These findings would acknowledge the idea that rather than having to be conditioned to become social, the child's socialization is set in motion at the very start of life.

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