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Infant Perception of a Causal Event

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Two experiments investigated 6- and 10-month-old infants' perception of launching events. According to Michotte (1963), spatial and temporal features of such events define them as either causal or noncausal. These features should cue the direct perception of causality early in life. The present experiments examined the development of the perception of these features and the encoding of events as either causal or noncausal. In Experiment 1, infants did not demonstrate a natural preference for causal or noncausal events at either age. In Experiment 2, a habituation-dishabituation paradigm was used to examine infants' ability to discriminate among these events. The results indicated that infants at 10 months, but not 6 months, discriminated the events on the basis of causality. The younger infants appeared to respond to the individual objects in the events, but not to the relationship between objects. In general, the results tended to support a model that assumes that infants' perception of a causal event appears gradually late in the first year of life and may depend upon the type of objects included in the event.

The perception and understanding of causality has recently been recognized as an important aspect of early cognitive development (e.g., Bullock, Gelman, & Baillargeon, 1982; Leslie, 1984). In order to understand the way the world works, infants must learn to relate certain objects to one another (e.g., those that reflect cause and effect) and to ignore relations among other objects. Two alternative views can be posited about how infants come to recognize that certain relationships are causal. On the one hand, Leslie (1984), extrapolating from Michotte (1963), suggested that the detection of causal relationships between objects is based on the direct perception of features inherent in the relationships themselves, and that infants should be able to detect and use these features quite early in life. An alternative view, extrapolated from the pattern perception liter-

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ature (Cohen, 1988), would be that infants come to perceive the causal nature of events as a result of their general perceptual development, and that the perception of objects as independent units may be a prerequisite for a later perception of the causal relationship between objects.

In the view advanced by Michotte (1963), the perception of causality is a result of the direct perception of the physical relationship between the actions of objects. According to Michotte, features of the relationship act as cues to the perceptual system that the event is causal. When these features are not present, the actions are not seen as causally related. Based on his study of adult perception of animated events—events where dots seemed to cause other dots to move—Michotte concluded that adults cannot help but see some situations as causal. Although he was not a developmental psychologist, Michotte nevertheless hypothesized that this causal percept would be available prior to the onset of language.

Recently, Leslie (1984) has attempted to extend Michotte's views developmentally by examining infant sensitivity to the causal relationship of launching sequences, events in which one object approaches a second, stationary object, makes contact with it, and remains stationary while the second one is "launched" into motion. In his studies, Leslie habituated infants between 6 and 7 months of age to a causal or noncausal event, based on the features specified by Michotte (1963), and tested the infants' discrimination of different versions of these events. The causal version was a direct launching in which the first object made contact with the second, which in turn moved immediately upon contact. There also were several noncausal events; all involved violations of some spatial and/or temporal aspect of the direct launching event. According to Michotte, these spatial and temporal features should be essential for specifying an event as causal. For example, imposing a short delay between the time of the first object's contact and the second object's movement should result in the perception of the event as noncausal.

Leslie's strongest evidence for infants' causal sensitivity came from one experiment in which infants were tested either on a discrimination between causal and noncausal events or on a discrimination between two noncausal events (Leslie, 1984). These discriminations involved both a spatial and temporal change. If infants were responding to changes in either spatial and/or temporal features, one would expect no differential dishabituation. Leslie found that infants tested on the causal/noncausal discrimination dishabituated more than those tested on the noncausal/noncausal discrimination. He inferred from these results that infants between 6 and 7 months of age are sensitive to the causal nature of the relationship between moving objects.

Unfortunately, there is a potential confound in the design of the previous experiment. Leslie did not provide evidence to rule out a priori preferences for any of the event sequences. In one condition, for example, where infants were habituated to a noncausal event, they looked an average of 10 s longer on the first habituation trial than the infants in other conditions. This longer looking poses a problem, because the key comparisons of the study previously described involved this event. Therefore, it may be that the significant differences Leslie found resulted from an a priori preference for this noncausal event.

Also, in other experiments from that same article, Leslie (1984) found that infants did discriminate between two different noncausal events and in many cases their dishabituation was not significantly different from the dishabituation of other infants to causal versus noncausal events. This pattern of results, in contrast to that of the previous study, would indicate that infants are discriminating among specific features of the events, but not necessarily among changes in causality per se. Based upon this second set of findings, Leslie concluded, contrary to Michotte's hypothesis, that the discrimination of events by 6½-month-old infants may not result simply from encoding events as causal or noncausal. Rather, events seem to fall on a continuum of causality and infants respond to the differences among them in terms of the events' positions on this continuum. Thus, the evidence from Leslie's own work is unclear as to whether or not 6- to 7-month-old infants perceive simple events as causal.

An alternative to Leslie's explanation would be the view that infants gradually come to recognize the causality of events as their general perceptual ability develops. It may be that parallels exist between the perception of static visual displays and the perception of dynamic events. Recent studies in infant categorization have revealed that young infants attend primarily to the parts of static displays, whereas older infants notice the relationships among these parts and respond to the displays as wholes (e.g., Cohen & Younger, 1984; Younger & Cohen, 1986). For example, Younger and Cohen (1986) found that infants at 4 months of age recognized pictures of animals in terms of specific features, such as the type of tail, head, or legs, and that they had to be 7 months of age before they were able to group those features into entire animals. This research provides evidence, at least with static pictures, that some types of visual perception may develop beginning from the processing of simpler aspects of displays, to the processing of more complex or integrative ones.

Because these studies have been carried out using static displays, it remains to be investigated whether the perception of dynamic events, involving movement and change over time, also develops from the attention to independent parts to the attention to the relationships among the parts. The introduction of movement has been shown to have a strong impact on how young infants perceive the parts of a single object (Kellman & Spelke, 1983). For example, Kellman and Spelke found that 4-month-old infants responded as though parts of a rod were connected only if those parts moved together behind a stationary occluder. In contrast, the infants did not perceive the rod as parts of a unified whole when it was stationary behind the occluder. Apparently, movement of a realistic object helps young infants unify disparate parts of that object.

Movement may help the infant perceive an object as a whole (as opposed to a collection of features or parts), but at what age do infants perceive events involving multiple objects as unified wholes? It may be that by 6 or 7 months of age infants see the individual objects as wholes, but do not consider the causal relationship between those objects. Processing the event as a whole may be a more developmentally sophisticated achievement. Thus, this theoretical position would predict that the development of the perception of event sequences may parallel that found for the perception of static displays, but at an older age. Younger infants may attend only to the parts of the display, that is, the objects, but it may not be until later in development that infants are able to recognize the critical relationship among those objects.

The following studies were designed with the previous conceptual framework in mind. The basic design and stimuli were patterned after Leslie (1984), but with the following important modifications:

1. Infants at two ages were tested in order to facilitate the discovery of any developmental trend that might exist during the last half of the first year of life. The ages of the infants, 6 and 10 months, were chosen because of the findings in the infant literature that infants do not respond to complex objects as wholes until approximately 6 or 7 months of age (Younger & Cohen, 1986).
2. Complex, real objects were used in the events. Leslie's objects, simple, suspended red and green squares moving across the screen, ordinarily would not be seen in the real world. In the current study, real toys were manipulated to create the event sequences. Using complex, real objects in these sequences may facilitate infants' recognition that a causal relationship exists. On the other hand, since the objects were more complex than those used by Leslie, younger infants may have trouble forming an impression of the object as a whole, and it may not be until later in infancy that perceivers are able to respond to the global characteristics of event sequences involving complex objects.

EXPERIMENT 1

Infants' visual preferences for four types of event sequences were examined in this experiment. There were two possible outcomes:

1. Infants may prefer one type of event over the others. If infants notice that some, but not all events are causal, they may show a consistent preference for either the causal or noncausal versions. Such a result would suggest that the infants were organizing the events on the basis of their causality. Even if they do not prefer causal or noncausal events, they may have a natural preference for some events over others. Although such a result would provide little evidence regarding the perception of causality, it would indicate an

ability to discriminate the events on the basis of one or more specific features.
2. Infants may display no consistent preference. Although such an outcome would also provide little evidence regarding the perception of causality, these event sequences could be used in a later habituation study without danger of a priori preferences contaminating the results.

Method

Subjects. Twenty-four subjects participated in Experiment 1. There were twelve 6-month-old infants (*M* age: 25.56 weeks) and twelve 10-month-old infants (mean age: 43.17 weeks) all recruited from the Austin area. An equal number of males and females were in each age group. Names were obtained through birth announcements published in the local paper and parents were contacted by letter and then by telephone.

Stimuli. The stimuli were four videotaped event sequences. All events took 4 s to complete and were repeated 5 times in a trial. Three types of sequences involved the movement of a "push 'n go" plane toward a "push 'n go" dinosaur. In each of these events, each toy moved for 1 s. One was a causal event (direct launching) and the other two were noncausal (delayed launching and launching-without-collision). A fourth type of event involved the movement of a single pull toy, a toy jalopy, that moved for a total of 2 s. All toys were on wheels. There were two versions of each event type—one where the action progressed from left to right, and the other where the identical action moved from right to left. Thus, there were four different event types, but eight different stimuli.

In the direct launching event, the plane approached the dinosaur and made contact with it. The dinosaur then immediately moved toward the end of the screen while the plane remained at rest at the center of the screen. In this way the necessary parameters outlined by Michotte (spatial and temporal contiguity) were preserved; according to Michotte, adults would assert that the plane "caused" the dinosaur to move. Both the delayed launching and launching-without-collision events violated one of these parameters and therefore were noncausal. In the delayed launching event, after the plane stopped, both toys remained stationary for one second before the dinosaur began to move. Thus the temporal aspect was violated. In the launching-without-collision event, the plane stopped at a distance of 1 in. (or approximately 1° visual angle) from the dinosaur before the dinosaur moved, but there was no delay. Thus only the spatial requirement was violated.

The fourth type of event involved the movement of a single toy, a jalopy, across the same distance as the total distance travelled by the two toys in the three launching events. The jalopy also travelled in the same amount of time as the toys in the other three events. Pictures of the toys used in these events are shown in Figure 1.

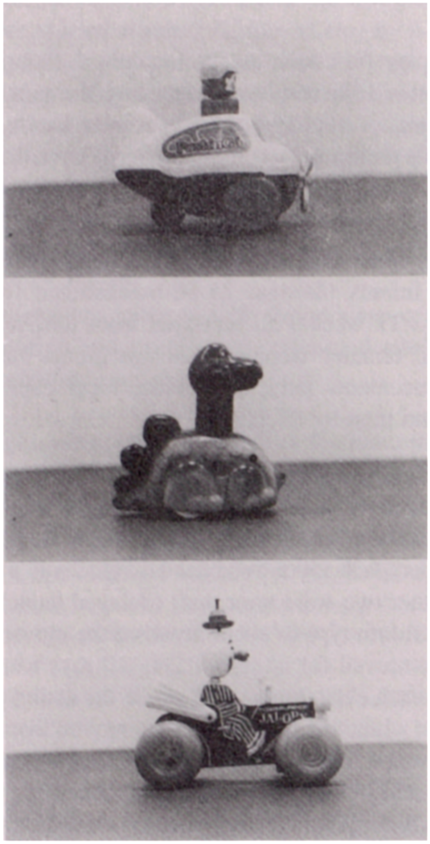

Figure 1. Pictures of the toys used in the events. The airplane and dinosaur were used for the causal and noncausal events. The jalopy was used for the novel event.

Apparatus. The research was conducted in adjacent experimental and control rooms. Event presentation and the recording of infant looking time were controlled by an Apple II Plus computer in the control room. A video interface card was added to the computer to allow it to search for and play the appropriate event on a Sony video cassette recorder. The observer used a 13 in. monitor and a second VCR, also in the control room, to record infant looking times on-line and later to establish inter-observer reliability. The actual events were displayed in the experimental room on a 25 in. Sony color monitor placed on a table. The height of the table was approximately 70 cm from the floor and the monitor was approximately 100 cm from the infant. A blinking light, also controlled by the computer, was located at the center, bottom section of the screen. In addition, the infant was observed via a closed circuit television camera placed in front of and just below the table with the monitor. The camera was tilted up at approximately a 54° angle to capture the infant's face, and was adjusted for each infant. The camera lens was approximately 5 cm below the level of the monitor and 50 cm from the infant. A floor to ceiling black screen placed across the room just in front of the camera obscured all irrelevant stimuli from the infant. The screen had two holes cut in it, one for the monitor and one for the lens.

Procedure. Subjects were seated on their parents' laps facing the large video monitor. Parents were instructed not to watch the events and were given opaque glasses to wear to reduce, if not eliminate, their tendency to watch.

At the beginning of each trial, the light at the bottom of the screen began to blink at an on-off rate of .2 s. As soon as the infants looked at the light, the observer pressed a key on the computer that began the video tape. When the infants began to fixate the screen, the observer pressed a different key that turned off the light and began recording the fixation time; when the infants looked away, that key was pressed again to indicate the end of the fixation. Each event continued for the full 20 s duration and infants could look at it as often as they wished during that time. This procedure continued until all eight stimuli had been presented. Each infant saw the stimuli in a different random order.

Results

A 2 (Age) × 8 (Stimulus) mixed ANOVA was run on the log 10 fixation times to the events (logs were used to normalize the distribution of scores and to make the results comparable to Experiment 2). Age was the between-subjects factor and the eight different stimuli were the within-subjects factor. Only the main effect for age was significant, $F(1,22) = 5.648$, $p < .05$. This age difference resulted from the 10-month-old infants looking slightly longer overall than the 6-month-old infants. Neither the main effect for stimulus, $F(7,154) = .627$, nor the Age × Stimulus interaction, $F(7,154) = 1.240$, even approached significance.

Discussion

Aside from the result that older subjects, for some unknown reason, preferred looking at the events longer than the younger ones, there were no other significant differences. Apparently, the visual preference measure alone was not sensitive enough to reveal either a tendency to organize the events into causal versus noncausal categories or to discriminate the events from one another. However, since no preferences for specific events were found in this experiment, the events could be used in a habituation task similar to the one employed by Leslie (1984) without the danger of some a priori preference contaminating the results. That was the purpose of Experiment 2.

EXPERIMENT 2

This second experiment was carried out in order to examine in greater detail how infants at 6 and 10 months of age process events that are either causal or noncausal. Infants in Experiment 2 were habituated to either a causal or noncausal event and then tested on all four of the events used in Experiment 1.

It was predicted that if infants were sensitive to the causality of the event sequences, they would dishabituate more to novel events that differed from the habituation stimulus in terms of causality than to novel events that did not differ in causality. Alternatively, if infants were sensitive to the spatial or temporal relationship between the objects in the events, but not to causality per se, they should notice any change in these relationships and dishabituate to all launching events except the one to which they had been habituated. Finally, if infants were sensitive to the specific objects and perhaps to their motions, but not to the relationship between objects, they should not dishabituate to either of the novel launching sequences because the same toys are involved; they should instead dishabituate to the single-movement event because it involves a novel toy.

Method

Subjects. Sixty-four full-term normal infants, who had not been in Experiment 1, participated in this experiment. There were thirty-two 6-month-old infants (mean age: 26.18 weeks) and thirty-two 10-month-old infants (mean age: 43.5 weeks). Equal numbers of males and females were tested at each age.

Stimuli. The stimuli were the same as those used in Experiment 1. All eight stimulus events were used in this habituation experiment. The three types of launching events, the causal direct launching, and the noncausal delayed launching and launching-without-collision, were used as habituation as well as test sequences. The fourth type of event, the single object event, was used as a novel control event in the test.

Apparatus. The apparatus was the same as in Experiment 1.

Procedure. The general procedure also was the same as in Experiment 1. Once again, a blinking light was presented during the inter-stimulus interval to focus the infant's attention toward the screen; when the infant looked at the blinking light, a videotaped event sequence was presented. However, unlike Experiment 1, on each trial the sequence was repeatedly presented only until the infant looked away for at least .5 s.[1] If the infant did not look away, the sequence was repeated 5 times for a total of 20 s.

[1] The .5 *s* minimum look away time was controlled by the computer. The observer simply pressed a key whenever the infant initiated a look and the same key again whenever the infant

Table 1. Experiment 2: Experimental Design for each Age Group

		Test Events			
Habituation Event	N	**Familiar**	**Novel**	**Novel**	**Novel**
Direct launching (causal)	16	Direct (causal)	Delayed (noncausal)	No collision (noncausal)	New toy (noncausal)
Delayed launching (noncausal)	8	Delayed (noncausal)	Direct (causal)	No collision (noncausal)	New toy (noncausal)
No collision (noncausal)	8	No collision (noncausal)	Direct (causal)	Delayed (noncausal)	New toy (noncausal)

The design of Experiment 2 is shown in Table 1. The experiment was divided into habituation and test phases. During the habituation phase, each infant was presented with either a causal (the direct launching) or noncausal (the delayed launching or the launching-without-collision) event. Habituation criterion was met when the mean looking time in any block of four trials dropped to 50% of the mean looking time in the first block of four trials.

After the habituation criterion, or after the completion of 20 habituation trials, each infant was tested on the direct launching event, delayed launching event, launching-without-collision event, and the fourth event involving the movement of a single novel toy across the screen. In this test phase, the habituation stimulus always followed immediately after criterion was met, followed by the two novel launching events (the order was counterbalanced across subjects), and finally the novel single-movement event.

The primary observer recorded the looking time for all infants. A second independent observer recorded the looking time via videotapes for 16 of the infants. Neither observer could see the particular event the infant was watching. Average inter-observer reliability for these 16 infants was $r = .96$.

Results

The first analysis was conducted to test for an actual decrease in attention to the launching event received during the habituation phase and to the totally novel toy events (this analysis was essential in order to infer on the other tests that infants would look longer at the more novel events). Log looking times were entered into a three-way ANOVA with habituation event (causal versus noncausal) and age (6 vs. 10 months) as the between factors, and trials (first habituation trial, last habituation trial, familiar test trial, and novel test) as the within factor. The

terminated the look. If the key was pressed twice within the .5 *s*, the computer discounted the second press. The .5 *s* minimum was included to prevent blinking or very short term distractions from turning off the stimulus. A longer minimum look away time, such as 2 *s*, was not used because it would disrupt an important contingent aspect of the procedure, namely that whenever the infant looked away from the monitor, the picture would go off.

analysis revealed a significant main effect for trials, $F(3,180) = 139.316$, $p < .001$, and a significant Age by Trial interaction, $F(3,180) = 3.926$, $p < .01$. The source of the main effects and interaction are shown in Figure 2.

The main effect for trials was examined further with a series of correlated t tests. To test for habituation, looking times to the *first hab* and *last hab* trials were compared to those of the *fam test* trial. (The difference between the first and last habituation trials was not evaluated since infants were run to a criterion, and this difference would have to be significant.) The comparison between the *first hab* and the *fam test* was significant, $t(63) = 12.284$, $p < .001$, indicating that infants looked significantly less at the familiar stimulus even after the habituation criterion was met.

The second relevant comparison was between the *last hab* trial and the *fam test*. Because infants were run to a criterion, some of the decrease in looking could have been artifactual (Cohen and Menten, 1981). Thus infants may have somewhat longer looking times to *fam test* than to *last hab* simply from a regression to the mean. This comparison was significant, $t(63) = -2.265$, $p < .05$, indicating that some regression did occur. However, as indicated by Figure 2, the amount of increase from *last hab* to *fam test* was slight. These comparisons taken together indicate that although infants recovered slightly to the familiar test event, they were still looking considerably less on the familiar test than they were on the first habituation trial.

A second set of t tests was conducted to verify that infants dishabituated to the novel test event. The difference between looking to *fam test* and *nov test* was

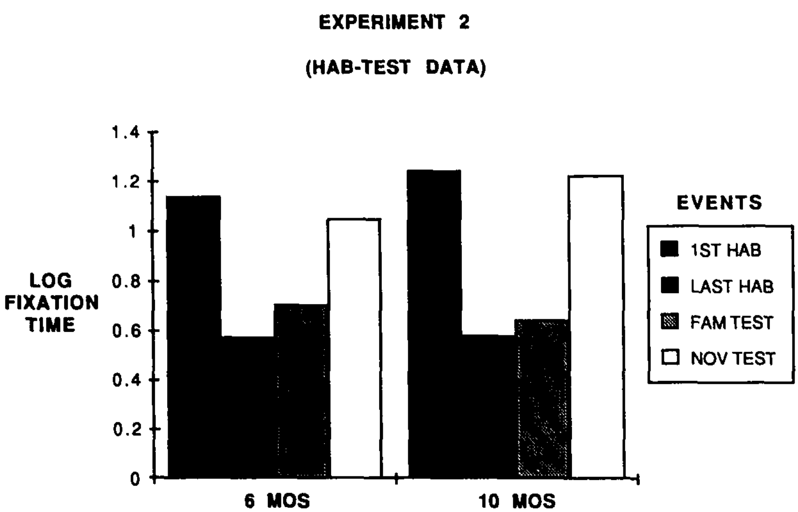

Figure 2. Log 10 fixation times of 6- and 10-month-old infants to habituation test stimuli in Experiment 2.

significant, $t(63) = -11.121$, $p < .001$, as was the difference between *last hab* and *nov test*, $t(63) = -14.917$, $p < .001$. These two significant differences indicated that infants did dishabituate to the novel stimulus. Moreover, the difference between looking time to the *first hab* and the *nov test* was not significant, indicating that the infants looked about as long to *nov test* as they had looked initially to *first hab*.

The source of the Trials by Age interaction was also examined. Basically, the same pattern of significant differences across trials emerged for both ages. The only significant differences between the two age groups were that the 10-month-olds looked longer than the 6-month-olds on *first hab*, $t(60) = 2.277$, $p < .05$, and on *nov test*, $t(60) = 4.163$, $p < .001$, but not on *last hab* or *fam test*. The Trials by Age interaction thus replicated the finding from Experiment 1: Older infants look longer than younger ones at events to which they had not been habituated. In general, the results from this set of analyses indicate that at both ages infants habituated to the launching event they had seen repeatedly and dishabituated fully to the totally novel event they had not seen previously.

The most pertinent analysis examined log looking times to the three launching events only, leaving out the novel, single movement event. Once again age (6 vs. 10 months) and habituation event (causal vs. noncausal) were entered into the ANOVA as between factors, and trials (causal vs. noncausal 1 vs. noncausal 2) was entered as the within factor. (For infants who had been habituated to a noncausal event, noncausal 1 referred to the event they received during habituation and noncausal 2 to the novel noncausal event. For infants habituated to the

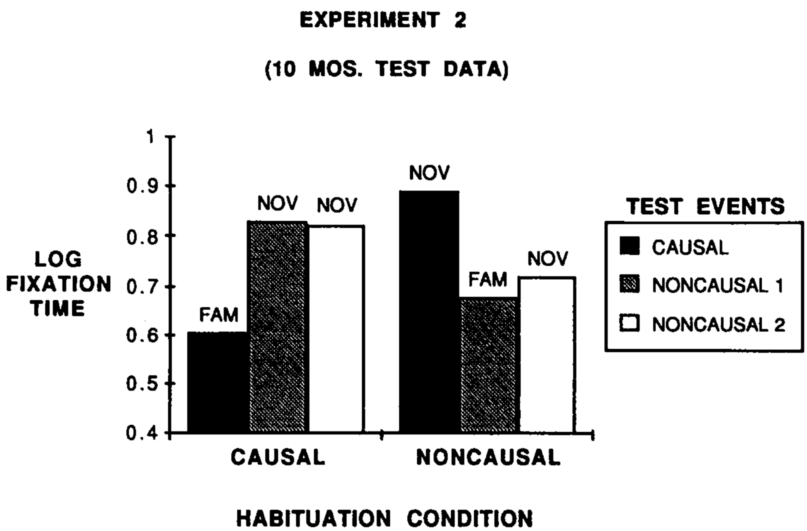

Figure 3. Log 10 fixation times of 10-month-old infants to familiar and novel launching events in Experiment 2.

causal event, both noncausal events were novel, and noncausal 1 and noncausal 2 were assigned randomly.) Arranging the events in this manner allowed for a direct test of the main question of this study: At what age do infants organize launching events on the basis of their causality? If infants at either age organize them into causal versus noncausal events, then those habituated to the causal one should dishabituate to both noncausal ones. On the other hand, infants habituated to either of the noncausal events should dishabituate to the causal event but not to the other noncausal one. In other words, the prediction would be for a Habituation Event × Trials two-way interaction. Alternatively, if the perception of causality occurred more at one age than at the other, the prediction would then be for an Age × Habituation Event × Trials three-way interaction.

The only significant result was the latter three-way interaction, $F(2,120) = 4.366$, $p < .02$. The interaction revealed that infants at 10 months, but not 6 months, responded in a way consistent with a causal interpretation. As can be seen in Figure 3, infants in the older age group who were habituated to the causal, direct launching event, increased their looking to both noncausal events. On the other hand, older infants who were habituated to a noncausal event increased their looking to the novel causal event but not to the novel noncausal event.

Subsequent correlated t tests confirmed the preceding results. Ten-month-old infants in the noncausal condition dishabituated significantly to the novel causal stimulus, $t(15) = -3.028$, $p < .01$, but not to the novel noncausal stimulus,

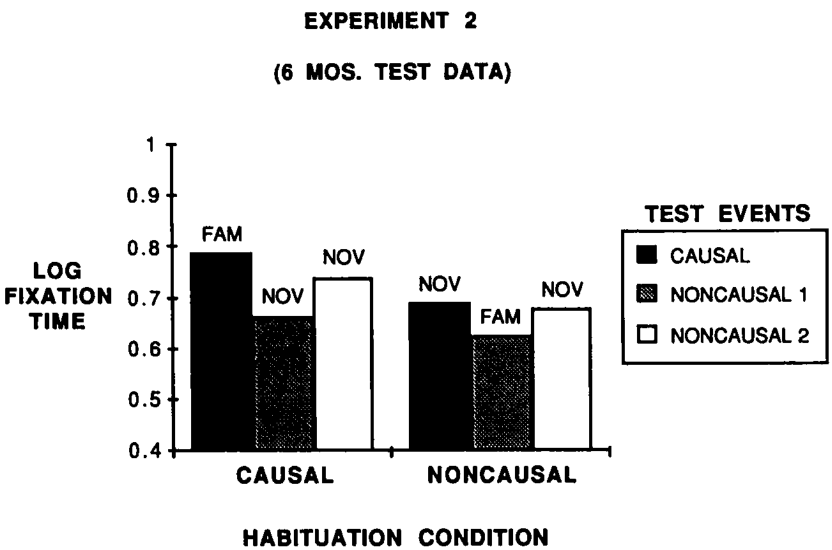

Figure 4. Log 10 fixation times of 6-month-old infants to familiar and novel launching events in Experiment 2.

$t(15) = -.401, p = .69$, while 10-month-olds in the causal condition dishabituated to both noncausal stimuli, although only one t test reached significance beyond the .05 level, $t(15) = -2.340, p < .05$; $t(15) = -1.773, p = .09$.

In contrast, no significant differences on causal versus noncausal test events were found for the 6-month-old infants. As can be seen in Figure 4, in neither habituation condition did these infants look reliably longer at either of the novel test events than at the familiar one they had received during habituation.

Discussion

The results of this second study clearly supported the conclusion that infants at 10 months of age, but not 6 months, perceived the causality of the launching sequences. The evidence comes from the assymetry of the 10-month-old infant's performance on the causal and noncausal test events. When habituated to the causal event, the 10-month-olds dishabituated to both novel noncausal ones, but when habituated to a noncausal event, they dishabituated only to the novel causal event and not to the novel noncausal one. This pattern of results occurred even though there was greater physical dissimilarity between the two noncausal events than between either noncausal event and the causal one. The two noncausal events differed from one another on two dimensions, space (1 in. separation vs. no separation) and time (1 s delay vs. no delay). In contrast, the noncausal events differed from the causal one only on a single dimension, either space or time. Thus, even though the 10-month-olds had to be sensitive to these dimensional differences to determine whether or not the event was causal, they used that information to organize the events on the basis of causality, not on the basis of dimensional differences per se.

Six-month-old infants, on the other hand, generalized their habituation to all test events involving the same objects they had seen during habituation. They dishabituated only to the novel event with the novel object. They did not respond to changes in the causality of the events, or to the subtle differences in timing or spatial relationships involved in those events. While one cannot conclude from negative results that these younger infants were incapable of perceiving causality, there certainly was no evidence for their perception of causality in this study. On the other hand, there was evidence that they were perceiving changes in the grosser physical characteristics of the objects, or the change from two objects (in the launching sequences) to one object (in the totally novel event).

GENERAL DISCUSSION

The discrepancy between the current results and Leslie's previous findings needs to be considered more fully. It will be recalled that Leslie (1984) found that by 7 months of age infants discriminated between launching events and perhaps even among changes in causality. In the current study, 6-month-old infants did not discriminate between events that were very similar to those used by Leslie. One explanation for the discrepancy in the results of the two studies is that the infants in Leslie's study were slightly older (28.93 weeks) than those in the current study (26.18 weeks). It may be that critical development in the sensitivity to causal relationships occurs during these three weeks. It is possible, although improbable, that this age difference contributed in a major way to the differences between the two studies.

The types of stimuli used in the two studies also differed. Leslie used simple moving squares while the present study used realistic toys. It may be that with more complex and realistic objects, younger infants will tend to concentrate on properties of the objects themselves and not on the event as a whole. Younger and Cohen (1986) have shown that while 7-month-old infants can respond to pictures of complex objects as integrated wholes, they have difficulty relating those objects to an abstract category. It may well be that the younger infants in the current study had a similar problem forming a causal relationship among the objects. It may also be that use of simple squares such as those presented by Leslie will facilitate young infants' perception of differences among launching events, and perhaps even the causality of those events.

The results of the two studies reported in this article suggest that the causality of event sequences involving real objects may not be attended to until late in the first year of life. These results allow more definitive conclusions about infant perception of causal events than can be drawn from earlier studies. First, the studies provide evidence of discrimination of events in the absence of a priori preferences. That is, it can be concluded unequivocally from the present research that infants at 10 months of age can discriminate between causal and noncausal events and that this discrimination is not the result of a preference for one event over the others. As reported earlier, other studies such as Leslie (1984) have not properly controlled for the possibility of differential preferences.

Second, by testing two different ages, the present experiments represent the first attempts to examine the development of the perception of causal event sequences during the first year of life. The results were consistent with the view that this development parallels other areas of infant visual perception or information processing. Cohen (1988) has proposed that infant information processing develops through a repeating series of steps characterized by a change from processing independent parts to unifying those parts into an integrated whole. Those wholes at one age may then be used as parts in more complex or abstract wholes at a later age. For example, there is evidence (Cohen & Younger, 1984) that at 6 weeks infants process a simple angle as separate line segments, but at 3 months see it as the relationship between the lines, that is, as the angle itself. Other evidence (Younger & Cohen, 1986) indicates that at 4 months infants process a complex drawing of an animal in terms of its constituent parts, while at 7 months they process it as the relationship among its parts, that is, as a unique animal or object. Results from the present experiment suggest a third step in this developmental sequence occurring between 7 and 10 months of age: the transition from processing the specific objects of an event to processing the relationship between those objects (in this instance, a causal relationship).

Whether or not one accepts the developmental model proposed by Cohen (1988), it is clear that the present results do not support the view that the perception of causal events necessarily occurs early in life. If one assumes that Leslie's (1984) results actually did not demonstrate infant perception of causal events at 7 months of age, the present findings would tend to indicate the gradual stepwise construction of that perception from 7 to 10 months of age. On the other hand, if one assumes Leslie's results did demonstrate infant perception of causal events using simple squares at 6 or 7 months of age, at the very least the present results would indicate that this perception interacts with the type of objects used in the event sequence. In either case, it would be difficult to argue that the perception of this type of causality was automatic in infants younger than 10 months of age.

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