Infants Attribute Value± to the Goal-Directed Actions of Self-Propelled Objects

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Abstract

■ Motion is a fundamental source of information for basic human interpretations; it is basic to the fundamental concept of causality and, the present model argues, equally basic to the fundamental concept of intentionality.

The model is based on two main assumptions: When an infant perceives an object (1) moving spontaneously and (2) displaying goal-directed action, it will interpret the object as intentional and assign to it the unique properties of the psychological domain. The key property tested was: Do infants attribute value± to interactions between intentional objects using criteria specified by the model?

We showed infants (average age 52 weeks) computer-generated animations of spontaneously moving "balls," using looking time in a standard habituation/dishabituation paradigm. In two positive interactions, one ball either "caressed" another, or "helped" it achieve its goal; whereas in two negative interactions, one ball either "hit" another, or "prevented" it from achieving its goal. In keeping with predictions of the model, when transferred to a negative condition, infants who had been habituated on a positive condition showed greater dishabituation than those habituated on a negative condition. The results could not be easily explained by the similarity relations among the animations depicting the interactions.

The results suggest that well before the age when the child can ascribe mental states or has a "theory of mind," it recognizes the goals of self-propelled objects and attributes value± to the interactions between them. ■

INTRODUCTION

Infants' modules divide the world into the two basic domains of physical objects, and intentional or psychological objects. A consensus based on 20 years of research has established that infants understand the basic relations in which physical objects participate. For example, small objects cannot contain larger ones, unsupported objects fall, a small object is propelled by the impact of a larger object, a covered object when moved will reappear in the new location when the cover is removed, etc. (summarized in Baillargeon, 1995). Infants also understand that physical objects do not come apart as they move and that they trace a continuous path in space and time. Shown objects that deviate from these properties, infants will increase their looking time (Spelke, 1990). Further, an object that collides with another, propelling it forward, will be interpreted as "causal" by both infants (Leslie & Keeble, 1987) and adults, provided temporal and spatial contiguity exist between the collision and the launching (Michotte, 1963).

While there is consensus concerning the infant's analysis of physical objects, research in the domain of psychological objects has only begun (Dasser, Ulbaek, & Premack, 1989; Leslie, 1987; Premack, 1990; Premack & Premack, 1994). This article describes a model of the infant's analysis of the psychological domain and follows with a test of the model.

The model (Premack & Premack, 1995) emphasizes that two principal concepts are used by infants during this early period: goal directedness and value±. It further emphasizes that infants during this early period do not attribute the mental states of want and belief; they do not appear to have a theory of mind (Premack & Woodruff, 1978). Their understanding of psychological objects is far more simple.

These are the four basic assumptions of the model.

1. Although a physical object moves only when caused to move by another object, a psychological object starts and stops its own motion; it appears to be self-propelled.
2. Psychological objects display goal-directed action.
3. An infant who perceives an object that is both self-propelled and goal-directed automatically interprets the object as "intentional" and assigns unique properties to it.
4. Infants attribute value ± (either positive or negative) to the appropriate interaction between intentional objects.

Motion, not object qualities, activates the infant's modules in both the physical and psychological domains. The significance of motion has long been appreciated at both the psychophysical level—"The eye has evolved to function essentially as a motion-detecting system" (Johansson, 1975, p. 67)—and at the interpretive level—"the interpretation of movements is intimately connected with the interpretation of personality-traits of the actors" (Heider & Simmel, 1944, p. 256). The model tested here continues in that tradition.

GOAL-DIRECTED ACTION

How do young infants identify goal-directed action? According to the model, they use four properties: trajectory, target, greater than default values, and satisfaction.

1. Because a self-propelled object can move in many directions, its consistent movement in only one direction is significant. There is an interesting parallel between the trajectory of a moving object and that of both gazing and pointing. Infants by 11 months of age follow their mother's gaze; rather than look at her, they look where she is looking (Butterworth, 1990; Baron-Cohen, 1995). They react in essentially the same manner to pointing; rather than looking at the end of the finger (as many species do), they look where the finger is pointing. We argue that infants react in the same manner to the trajectory of a moving object as they do to that of gaze and pointing (i.e., by anticipating the target, whether it is a target being looked at, pointed to, or moved toward).

2. The target at which a trajectory is aimed can be either an object or a location. If it is an object, it could be either physical or intentional. The location could be the top of a hill that the intentional object seeks to climb or a break in an enclosure from which an intentional object seeks to escape. The model argues that these three targets—to contact/avoid another intentional object, to overcome gravity, to escape confinement—are salient for the infant.[1]

3. The model further states that infants have default values for "normal action." If the frequency/intensity of the object's motion exceeds these values, this further inclines the infant to interpret the action as goal directed.

4. Satisfaction refers to those conditions that bring goal-directed action to an end. The infant who understands goal as a satisfiable state expects certain conditions to terminate goal-directed action and would be surprised if, for example, an object that succeeded in escaping, reinstated its confinement.

Infants at different ages use combinations of these properties in recognizing goal-directed action. For example, although all infants use both trajectory and target, only older infants may recognize that goal is a satisfiable state.

When perceiving an object whose motion activates the two submodules, self-propelled and goal-directed, the infant makes the interpretation intentional. This leads the infant to place the object in the psychological domain and to expect the object to act differently from a physical object. For example, infants assign value± only when an intentional object acts on another intentional object, not when it acts on a physical object.

According to the model, the infant uses two criteria in distinguishing between positive and negative value±. The simpler criterion is based on intensity. The hard action of hitting (Figure 1) is coded negative; the soft action of caressing (Figure 2) is coded positive.

The second criterion is the functional equivalent of helping and hindering. When one object is engaged in goal-directed action—for example, seeking to escape confinement—a second object can be seen as helping or hindering the first object to achieve its goal. Helping is coded positive, hindering negative. Infants understand actions of this kind because of their demonstrated competence in the physical domain. For example, they can understand the physical consequences of one object lifting another (so that it can escape) or one object blocking the passage of another (so that it cannot escape).

In the present experiment, movements simulating the above cases, designed with the Macro-Mind Director program, were shown to infants on a computer monitor. We used the ball-like abstract figures shown in Figures 1 through 4 because the model is based on an analysis of spatio-temporal factors. This eliminates the infant's pos-

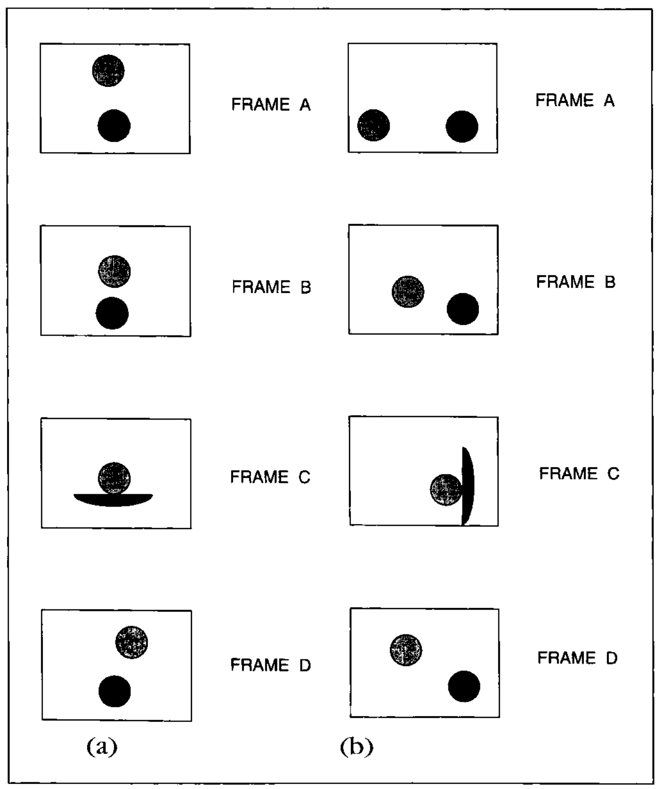

Figure 1. Four frames from the vertical Hit animation. Start at top and read down. See text for details. *(a)* Hit vertical; *(b)* Hit horizontal.

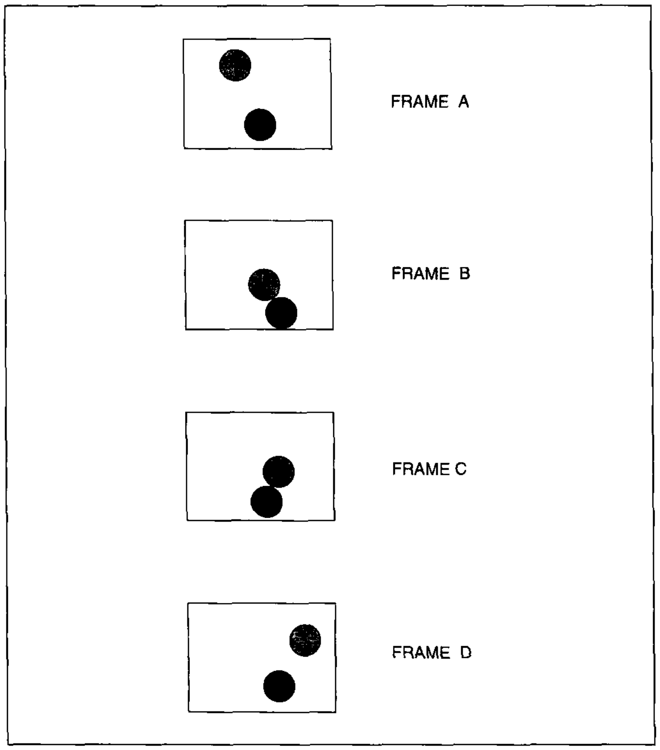

Figure 2. Four frames from the Caress animation. Start at top and read down. See text for details.

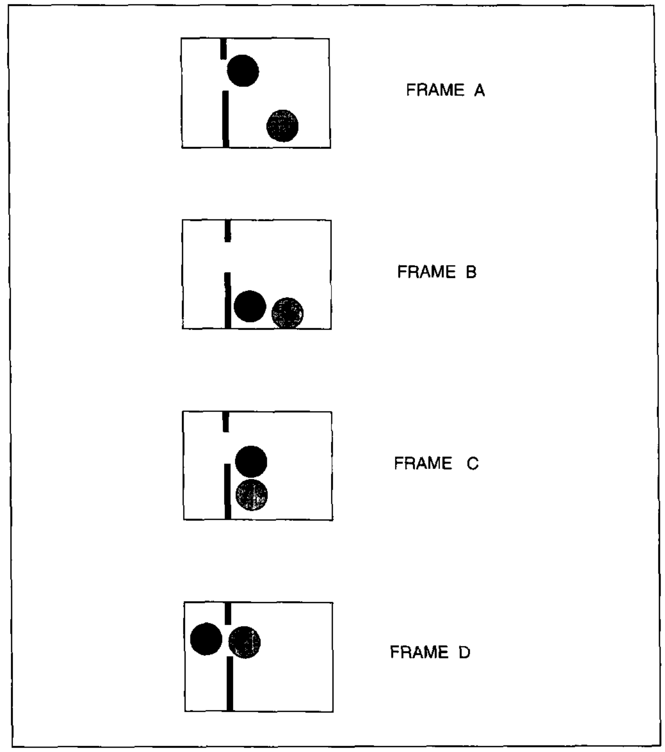

Figure 3. Four frames from the Help animation. Start at top and read from down. See text for details.

sible use of information based on the features of natural objects.

In Hit (Figure 1) the gray ball pursues and strikes the black ball seven times before the two balls disappear from the screen. In Caress (Figure 2) the gray ball follows and gently rubs the black one seven times before both leave the screen.

Figures 3 and 4 illustrate Help and Hinder, respectively. Both figures show a black ball-like object rise and fall (three times) along a vertical line. The ball reaches a different height each time but consistently falls short of the break in the line. While this is the literal content of Figures 3 and 4, an adult viewer interprets the action as that of an object trying to escape.

Both Figures 3 and 4 contain a second (gray), spontaneously moving object that too is seen as goal directed. The gray ball contacts the black, moving it either toward (Figure 3) or away (Figure 4) from the break in the line. In this case, an adult viewer interprets the action of the gray as helping or hindering the black ball achieve its goal. The importance of the attribution of helping and hindering is that they lead directly to the attribution of value±—positive in the case of helping and negative in the case of hindering.

In the real world, Help and Hinder differ in their similarity to Hit and Caress because in the real world helping actions go with soft gestures and hindering actions go with harsh ones. But in the animations, Help and

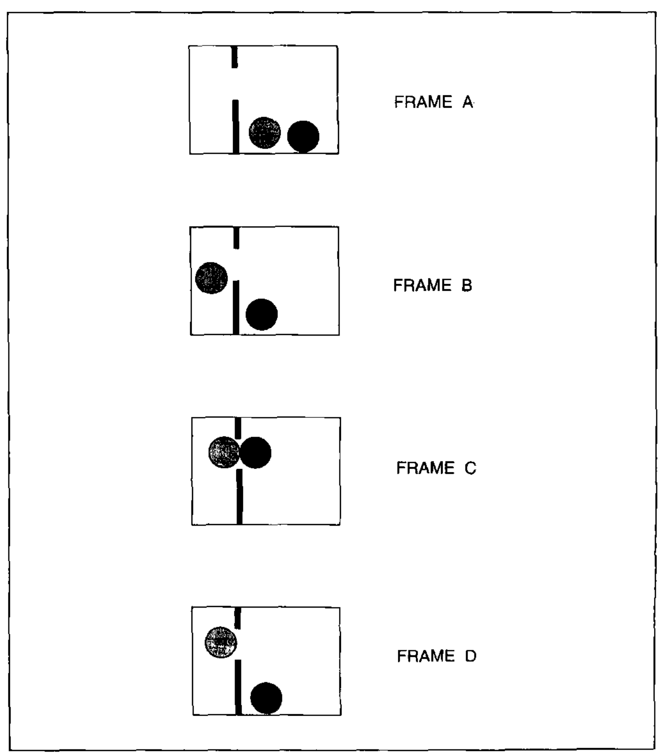

Figure 4. Four frames from the Hinder animation. Start at top and read down. See text for details.

Hinder were programmed so that the contact between the gray and black ball in both Help and Hinder was of the same intensity.

In the choice between making the contacts either hard or soft, we chose soft. Therefore the gray ball both helped and hindered the black ball with the same gentle pushes. The impression of gentleness was achieved in two ways. First, the gray ball moved at a low velocity when contacting the black ball. Second, when the black ball was contacted, it did not undergo deformation. Notice that when hit, but not when caressed, an object undergoes deformation (compare Hit and Caress in Figures 1 and 2; only the recipient of hitting shows deformation).

In testing the model, we used a standard habituation/dishabituation paradigm, with looking-time as the measure. Four independent groups of infants were each habituated on one of the four main value conditions above and then were all transferred to the same second condition. Infants who find the second condition different from the first will dishabituate (i.e., show a marked recovery in looking time) whereas if they find the second condition like the first, they will show little recovery.

In particular, if an infant assigns a negative value± to both Hit and Hinder, when habituated on Hinder and transferred to Hit, he or she will show little recovery. But if an infant assigns a positive value± to both Caress and Help, when habituated on either Caress or Help and transferred to Hit, he or she will show appreciable recovery. In other words, transfer from positive to negative will produce greater recovery than transfer from negative to negative.

The dishabituation condition to which all four groups were transferred was Hit-horizontal (H). The design provides four comparisons: (1) Hit-vertical (V) to Hit (H), (2) Caress to Hit (H), (3) Help to Hit (H), and (4) Hinder to Hit (H).

METHOD

Subjects

Sixty infants, varying in age from 42 to 60 weeks, with an average age of 52 weeks, were randomly assigned to the four main groups. Infants were obtained from two middle-class Paris nurseries, and adapted to the experimenters for 2 weeks prior to the experiment. Four of the sixty were lost because of fussing, crying, etc., giving a total of fourteen infants per group.

Testing was conducted in a dimly lighted room in each nursery. Infants were seated in a reclining chair placed about 60 cm in front of a 12-in. computer monitor housed in the front panel of a three-panel screen that isolated the infant from the rest of the room. The infant was photographed with a low-light intensity camera (mounted above the computer) through an aperture in the screen; he or she was observed on a TV monitor by the experimenters who sat on the opposite side of the screen and were not visible to the infant. Two experimenters timed the infant's looking response, using a 1-sec look-away criterion. When the infant looked away from the animation for one or more seconds, the experimenters removed their finger from the key. The agreement between experimenters for a random subsample of infants was .94.

Procedure

The animations were generated by the Macro-Mind Director program. Each animation had a duration of 7 to 8 sec and was cycled continuously; the balls left the screen at the end of an animation and then returned immediately to repeat the animation. The animations were presented in this continuously repeating manner until the infant completed 10 looks. The infant was then immediately shown the second, or dishabituation, animation, which was also repeated continuously until he or she completed 6 looks.

Results

All statistical analyses were carried out on the original looking times normalized by arctan transformation. The four groups declined significantly over the course of the habituation trials ($F(1, 52) = 10.87, p = 0.001$) but did not differ significantly in either looking time on the first three trials ($F = 0.64, p = 0.59$, *ns*) or on the last trial ($F = 0.42, p = 0.74$, *ns*). Given that groups did not differ on looking time on the last habituation trial, we analyzed recovery of looking by comparing groups across four trials, last Habituation Trial and three Test Trials, in a Groups (4) × Trials (4) ANOVA.

There was a significant main effect of Groups ($F(3, 52) = 0.52, p = 0.018$), and of Trials ($F(1, 52) = 30.61$, $p = 0.0001$) but not of the Groups × Trial interaction ($F = 1.07$, *ns*). Comparison of pairs by the Fisher LSD test showed that both Help (alpha = 0.01) and Caress (alpha = 0.05) recovered significantly more than both Hinder and Hit.

In Figure 5, looking time is plotted for the first and last three habituation trials, as well as for the three dishabituation trials, with group as the parameter. All four groups (Caress, Help, Hit, and Hinder) visibly decline over the habituation trials but do not differ in doing so. Clearly, however, they differ over the dishabituation trials, and they do so despite the fact that on dishabituation trials they are all shown the same animation (viz., Hit-horizontal); nonetheless, their initial recovery and total looking varies markedly.

The groups differ because of what they were shown before the dishabituation trials. Groups habituated on

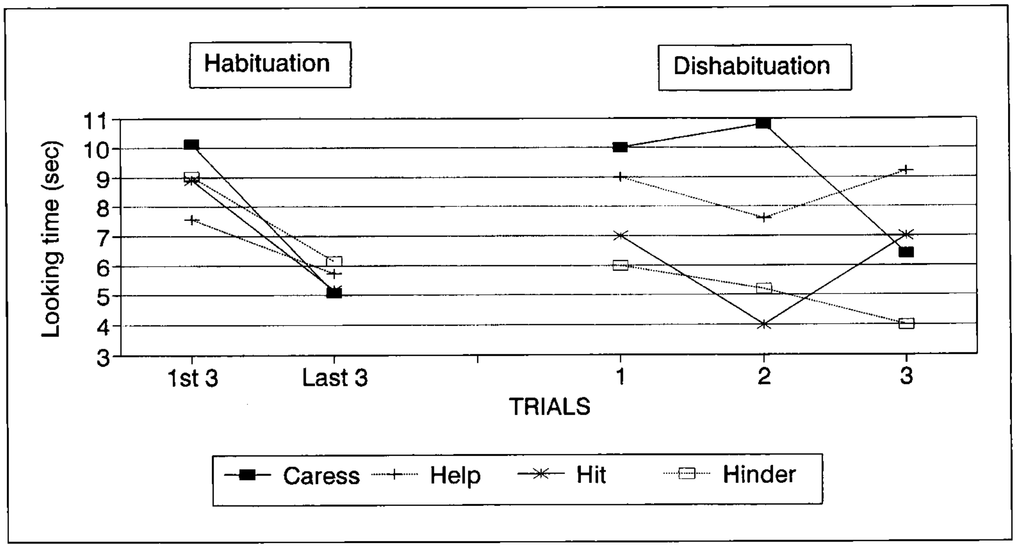

Figure 5. Looking time plotted over trials with group as a parameter. See text for explanation.

positive conditions show both markedly greater initial recovery (first dishabituation trial) and total looking time (three dishabituation trials) than groups habituated on negative conditions. For instance, looking times for the two positive groups, Caress and Help, averaged over the three dishabituation trials were 9.07 sec and 8.60 sec, respectively, whereas those for the two negative groups, Hit and Hinder, were 6.00 sec and 5.07 sec, respectively.

Consider again the results for the original habituation trials; they make an important point. The infants spend as much time looking at the negative conditions as at the positive—they show no preference for one over the other. Thus, looking time averaged over the first three and last three habituation trials is 7.13 sec for positive (Caress + Help) and 7.33 sec for negative (Hit + Hinder) ($F = 0.34, p = 0.564$ *ns*).

Discussion

Do the results support the model? The principal alternative is that the results can be explained by the similarity relations among the animations. To formally eliminate this alternative, we need to be able to parameterize the animations and represent each of them with a set of figures. A computer program automatically providing such measures for any set of parameters is available for the PC, but not yet for the MacIntosh. Lacking such a program, we have dealt with similarity in an alternate manner. In one approach, we informally equated the similarity between two test conditions and a standard, and in a second, we put similarity and value± into competition.

In the first approach, we exploited the fact that the actions constituting Help and Hinder are alike and different from that of Hit (about equally different). In Hit, the gray ball pursued and struck the black one; by contrast, in Help and Hinder the two balls neither pursued nor struck one another but appeared initially in separate locations on the screen. The black ball tried unsuccessfully to escape through the break in the vertical line. To this point, the action in Help and Hinder was nearly identical; then the actions diverged.

In Help, the gray ball placed itself below the black one, lifted it up to the level of the break, and enabled it to pass through, whereas in Hinder, the gray ball stationed itself on the far side of the break, blocked the passage of the black ball, and prevented it from passing through.

These actions differed from that of Hit because in Hit the black ball did not show goal-directed action independent of the gray ball. It could not. There was no third object on the screen—no vertical line, for example—that it could take as a target and toward which it could show goal-directed action. The only goal-directed action of the black ball was that of escaping from the gray one.

Although Help and Hinder were alike and both were about equally unlike Hit, the dishabituation on Hit was far greater following habituation on Help than on Hinder. Because we cannot explain this difference in terms of the parameters we have discussed, we appeal to a different level of explanation, not to the parameters per se but to the interpretation the infant assigns to them. If, as the model assumes, the infant assigns a negative value± to both Hinder and Hit (while assigning a positive one to both Caress and Help), this similarity in value± will explain the dishabituation results as the similarity in physical parameters will not.

In a second approach to similarity, we put similarity and value± into competition. Which factor, similarity or value±, will determine the infant's dishabituation? Suppose we test an infant on habituation and dishabituation conditions that are physically similar yet different in value±. If the physical factor is dominant, when infants are exposed to a condition highly similar to the one on which they are habituated, they should show little recovery. On the other hand, if value± is the dominant factor, the infants will show appreciable dishabituation despite the similarity between the two conditions.

The present experiment contains two comparisons that bear directly on this question. Consider that not only are Help and Hinder very similar, as discussed above, but that the same is true of Caress and Hit; they resemble one another far more than either resembles Help or Hinder. The action in both Hit and Caress is extremely simple—one ball contacts the other with either blows or caresses—and this simple action contrasts with the more complex actions of Help and Hinder. In terms of physical similarity, the four animations divide naturally into two groups, Hit and Caress forming one group and Help and Hinder forming another.

But the dishabituation results cannot be predicted from the similarities between the animations. For instance, Caress is far more like Hit than it is like Hinder, yet dishabituation on Hit is notably greater following habituation on Caress than following habituation on Hinder. This, of course, is predictable from the model: the transition from Caress to Hit involves a change in value±, whereas the transition from Hinder to Hit does not.

Not only are the habituation/dishabituation patterns not predictable from consideration of physical similarities, they occur in opposition to these considerations. When infants are habituated on Caress and then transferred to Hit, they encounter animations that are more alike than when they are habituated on Hinder and transferred to Hit. Were similarity the major determinant of dishabituation, infants transferred from Hinder to Hit should show greater dishabituation than those transferred from Caress to Hit. In fact, they do the opposite.

Evidently, when value± and similarity are put into opposition, value± overrides similarity. Not only does the difference in value± that the infant attributes to the habituation and dishabituation conditions determine amount of dishabituation, but this difference overrides differences in similarity.

Intensity vs. Help/Hinder

The model specifies two determinants of value, intensity and the Help/Hinder contrast. Which is the more powerful? To the adult viewer, Help/Hinder overrides intensity when the two determinants are put into opposition. Helping carried out with hits or hard contacts, remains positive; hindering carried out with caresses or soft contacts, remains negative. This was true for the infant's reading of the animations—at least for the negative case where we have a test—and not only for the adult's reading. As the results indicate, the infants evidently attributed a negative value to Hinder despite the fact that the gray ball used gentle motions in blocking the escape of the black ball. Nevertheless, although overridden by Help/ Hinder, when differences in intensity are presented alone, they are a determinant of value± in their own right.

The intensity of the contacts contained in Hit/Caress may not be the only information the infant can use. Probably the infant also uses the recipient's reaction to being hit or caressed. For example, in the animations the recipient undergoes deformation when hit but not when caressed. In addition, the recipient moves away from the donor when hit but not when caressed (consequently, the average overall distance between the two objects is less in Caress than in Hit).

Although we speculate that infants can use this information, the speculation has not yet been tested. A test requires that we separate the actions of the donor and recipient and determine whether the infant can "predict" one from the other. For example, we show the infant only the behavior of an object that is hitting (caressing) another and then show it a recipient that is reacting either to being hit or to being caressed. Conversely, we show it only the action of an object that is being hit (caressed) and then show it a donor that engaged either in hitting or caressing. If infants understand the relation between the action of the donor and recipient, they should be surprised when the two do not agree. For instance, when shown an object that is reacting to being caressed, they should be surprised if shown a donor that is engaged in hitting, and vice versa.

First-Order vs. Second-Order Goals

Caress and Hit involve first-order goals, one intentional object seeking to contact another such object either positively or negatively, whereas Help and Hinder involve second-order goals, one intentional object whose goal is to help or hinder another object achieve its goal. Do infants, in identifying a first- and second-order goal make the same kind of analysis? Do they use the same information?

The first-order goal of the black ball, which is to escape confinement, can be readily identified by a trajectory-target analysis: The ball moves repeatedly on the same trajectory toward the same target, the break in the line. But can the second-order goals of the gray ball, which is to help or hinder the black ball, be identified in the same manner?

A trajectory-target analysis is effective in the case of helping; in that case, too, the gray ball takes the black ball as its target and largely duplicates the trajectory of the black ball. In the case of hindering, however, the trajectory of the gray ball is not as simple or important; the important action of the gray ball is placing itself in the passageway and blocking the escape of the black ball. In hindering, therefore, infants must identify the goal of the gray ball largely by considering the action of the gray ball relative to the goal of the black ball and by understanding the physical consequences of blocking.

In making such an analysis do infants only attribute goals or do they also attribute the attribution of goals? For example, who attributes the goal of escape to the black ball? The infant alone or does the infant attribute this attribution to the gray ball?

The present experiment cannot answer this question, not having been designed for this purpose; one needs an experiment specifically designed to answer the question, such as the following:

We place the black ball in an enclosure containing not one exit but two. The black ball tries unsuccessfully to escape from the first exit, abandons its attempt, and moves in the direction of the second exit. The gray ball reacts in either of two ways.

In one scenario, the gray ball anticipates the black one and places itself in a blocking position at the second exit well before the black ball arrives. In a second scenario, the gray ball shows no anticipation and does not block the second exit until well after the black ball is already there.

Suppose that younger infants do not react differently to the two scenarios, but that older infants do: They are surprised if the gray ball does not anticipate the black one. This would indicate that older infants not only attribute the goal of escaping to the black ball, but that they also think that the gray ball too attributes this goal to the black ball.

But does the ability to anticipate the action of the black ball really demand that the gray ball attribute a goal to the black one? Couldn't we explain this on a simpler basis, for example, by the simple inductive assumption that the gray ball will repeat itself, doing again what it did before? That even young infants would make inductive assumptions of this kind is entirely reasonable.

But notice that this argument is untenable. The infant could anticipate the behavior of the black ball on an inductive basis because the black ball, although changing its trajectory, preserves its goal. It cannot, however, anticipate the behavior of the gray ball on an inductive basis because the gray ball cannot go to the second exit in advance of the black ball unless it can predict the black ball's behavior (i.e., know where the black ball will go once it abandons the first exit). And if the black ball, when abandoning the first exit, provides no directional cues as to its next move, the gray ball will be unable to anticipate the black ball.

The finding that infants are surprised by the failure of the gray ball to act in an anticipatory manner would indeed support the claim that infants attribute to the gray ball the attribution of escape to the black ball. Moreover, this argument does not entail the claim that infants attribute mental states; a goal is not a mental state.

It is doubtful that infants as young as those tested here attribute mental states to an intentional object; we agree with others (e.g., Poulin-Dubois & Shultz, 1988) that direct evidence for such a claim does not exist. At 1 year of age, infants already attribute goal and value±, as the present evidence indicates, but not want and belief. The mental state account is, of course, the standard philosophical account of intentionality (e.g., Bennett, 1978; Dennett, 1978; Harman, 1978), and while this account may apply to adults or older children, it need not apply to infants.

Indeed, the philosophical account does not apply to young children. Such an account, based simply on an analytical argument (one that would derive all action from a combination of want, belief, and rationality) is not supported by evidence. If individuals want an item and believe they can attain it by a specific act, then, says the philosopher, provided they are "rational," those individuals will carry out that act.

If this is a tenable argument, we must still ask, To whom does the argument apply? Aside from the philosopher, who else attributes these states in explaining personal action and those of others? Who are the "folk" to which this would-be "folk psychology" applies?

The philosopher's account erroneously treats want and belief as inextricable states, an error forced by the insistence that all action derives from want, belief, and rationality. The evidence indicates that want and belief are states of decidedly different complexity, have a different ontogeny, and are not always attributed together. For example, young children attribute want only, on many occasions, until reaching the age of perhaps 3 1/2 to 4, after which they routinely attribute both want and belief (summarized in Bartsch & Wellman, in press). There is no known species or developmental stage in which we find the opposite pattern, attribution of belief but not of want.

Emotion

The present results support a principal assumption of the model: Infants automatically attribute value± to the interaction between intentional objects. What is the nature of this evaluation—this assignment of positive and negative value? Is it an emotional process or a process that differs from emotion in certain specifiable features? A major problem in dealing with emotion is that the state has not been characterized with sufficient precision so that we can say whether an item is or is not an instance of emotion.

Fortunately, there are tests that could be used to determine whether the attribution of value± is distinctive or is like any other evaluative or emotional process. Basically, the tests depend on comparing the effects of preference with those of value±.

As we have seen, shifting the infant who is habituated on an interaction of one value± to an interaction of the opposite value± produces dishabituation. Will we obtain the same effect if the infant is shifted, not to an interaction of the opposite value, but to an item that is either preferred or dispreferred? In other words, is preference the same kind of thing as value±? Can one be substituted for the other? More specifically, will preference substitute for positive value± and dispreference for negative value±?

To test this we must first locate items that infants prefer. They appear to have the same preferences as do adults for attractive and unattractive faces (Samuels & Ewy, 1985) and for speech vs. nonspeech sounds (Fernald, 1989). They may prefer smiles to frowns and cooing to crying. Indeed, they may prefer success to failure, so that they will look longer at an animation in which an intentional object, for example, succeeds (rather than fails) to escape confinement.

Given a set of preferred and dispreferred items, we can then carry out the diagnostic tests. Habituate the infant on either a positive or negative interaction and then shift it, not to an interaction of the opposite value, but to a preferred or dispreferred item. If value± is like any other emotional or affective process, individuals shifted from positive interactions to dispreferred items should show greater dishabituation than those shifted to preferred items and conversely for those shifted from negative interactions to preferred or dispreferred items.

There is already reason to suppose that preference cannot be substituted for value±. For example, in the present tests infants showed no preference for positive over negative cases (compare with the "Results" section). This is compatible with the argument that it is not preference that makes an item positive or dispreference that makes it negative. Positive and negative are determined by the rules for intensity and Help/Hinder, not by preference. On this argument, individuals who are shifted to preferred and nonpreferred items should show, not differential dishabituation, but an equal amount of dishabituation whether shifted from a positive interaction or a negative one. Which is to say, value± is a domain-specific factor that applies only to the interaction between intentional objects, whereas preference is a domain general factor that applies to all items.

CONCLUSIONS

The present model claims that the psychological domain is based on an analysis of motion that takes into account the goal directedness of apparently self-propelled objects. Infants interpret as intentional those objects that are both self-propelled and goal directed; they assign unique properties to the interactions between them. Infants assign positive or negative value± to the interactions, using either of two criteria specified by the model: intensity of contact or the functional equivalent of helping or hindering. This view is supported by the results of the looking-time experiment. When shifted to a negative interaction, infants habituated on positive interactions showed more dishabituation than those habituated on negative interactions. The results could not be easily explained by the similarity relations among the animations.

Is the attriubtion of value± an emotional process? An answer to this question awaits studies in which an attempt is made to substitute positive value± for preferred items and negative value± for dispreferred items. That value± and preference cannot, however, be equated is already suggested by the finding that infants look equally long at both positive and negative animations.

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Note

1. Since trajectory and target are separable factors, we can ask: which is the more powerful? for example: a long frequently taken trajectory that lacks a visible target, or a short seldom taken trajectory that has a visible target?

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