longer periods of time in view of the dangers of prolonged lateral recumbancy in ruminants.

The behavior of the ticks released downwind of group A steers was markedly different from that of the ticks released downwind of group B. The latter ticks initially remained fairly motionless at or near the site of release and then gradually dispersed in all directions; many disappeared into the litter on the surface of the soil. Ticks of group A, in contrast, immediately started to move en masse toward the steers. The group A steers also attracted wild, unfed adults (both males and females) of *A. hebraeum* from distances of more than 3 m. Wild adults that were in the immediate vicinity (within 0.5 m) of either group of steers moved to the animals.

Large numbers of the marked adults attached to group A steers and few, if any, attached to group B steers (Table 1). Males and females were attracted in almost equal numbers to the steers of group A. The majority of the marked ticks attached in the immediate vicinity of the males that were already on the animals, thus increasing the sizes of existing clusters of ticks.

To show that the group B steers did not repel ticks, at the end of the second and third replicates, 20 prefed *A. hebraeum* male ticks were placed on each animal. The ticks attached without delay. Twenty unfed ticks (10 male and 10 female) were then released onto each of the steers in the proximity of these ticks. Within 5 minutes more than 90% of the unfed ticks had begun to attach.

Finally, an experiment was performed to determine whether or not AAP alone was responsible for the attraction of the ticks to the steers. Two tick-free steers that had been dipped in dioxathion 3 weeks before the experiment and were manually freed of ticks on alternate days, thereafter were sedated as above and brought to lateral recumbancy 1 m apart. An extract of AAP was prepared by shaking 200 fed males of *A. hebraeum* in 200 ml of diethyl ether. This was poured on selected sites (escutcheon, posterior of abdomen, hind feet) of one steer, and the other steer was left untreated. After the ether had evaporated 100 male and 100 female *A. hebraeum* marked with fluorescent dust were released 3 m downwind of the two steers. After 30 minutes the number of ticks attracted and attaching to either steer was counted.

Nearly half (41 male and 57 female) of the marked ticks responded with host-seeking behavior and most were attracted to the pheromone-treated steer (Table 2). The remainder burrowed into the upper layers of the soil. Some wild ticks in the vicinity of the experiment were also attracted to the treated steer. Some of these climbed onto the steer within 13 minutes after first being sighted 9 m away. Most male ticks, released or wild, attached to the treated steer within minutes of making contact with it. Both released and wild females were slower to attach and most were found moving about the animal or in its immediate vicinity, indicating that an additional factor, possibly clasping by fed males (*5*), stimulates their rapid attachment. Approximately half the ticks attaching to the treated steer did so on areas where pheromone had been applied.

Hess and de Castro speculated that pheromone-emitting males of a related species of tick, *A. variegatum*, may "bait a host or a herd" (*13*). That this is true, at least in part, for *A. hebraeum* is shown by our results. Further, our findings confirm that the presence of pheromone-emitting males allows the unfed ticks to discriminate between hosts on which adults have fed successfully (that is, suitable hosts) and hosts on which they have not (that is, potentially unsuitable hosts). The effect is apparently to reduce mortality in populations of *A. hebraeum* caused by unfed ticks attaching to unsuitable hosts. These findings also have economic and epidemiological implications. Cattle regularly treated with acaricides may pick up fewer unfed adults (*7*) and nymphs (*8*) than untreated cattle or wild hosts. The host-selection mechanism therefore minimizes the effectiveness of acaricides in reducing bont tick populations when large numbers of suitable wild hosts are available. It will also reduce the frequency of transmission of heartwater to acaricide-treated cattle and so may adversely affect immunity within cattle herds. Exposure to heartwater is particularly important in young cattle, which gradually lose their resistance to the disease beyond the age of about 1 month (*14*). Immunity to heartwater in cattle is thought to be transient unless reinforced by repeated exposure (*1*). The chances of young calves acquiring immunity to heartwater might be increased by treating them with AAP or infesting them with male ticks, thus making them attractive to infected unfed nymphs and adults.

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The Perception of Intention

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Classical work on the perception of causality in humans is extended to the perception of intention. Two experiments explored the sensitivity of preschool children to intentional events that can be stated in terms of time and distance only. In habituation-dishabituation of attention tests, preschool children differentiated between intentional movement patterns of two balls and the nonintentional control events where the movements were desynchronized. Also, reversal of the roles of the balls produced more recovery of attention in the intentional case than it did in the nonintentional case.

EVENTS THAT LEAD TO THE PERCEPTION of causality can be stated in terms of place and time. For example, Michotte (*1*) showed that when two objects collide, provided the launching of one coincides temporally and spatially with contact by the other, the human adult perceives the relation as causal. Thus, contrary to Hume (*2*), perception of causality can be produced by even a single instance of the

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right kind; it does not depend on the repeated association between events. In recent work, the same claim has been extended to infants (*3*). Here we propose to do for the perception of intention what has already been done for that of causality: describe stimulus conditions, instantiated by the movements of balls, that lead to the perception of intention.

We used a habituation-dishabituation paradigm, preschool children, and stimulus material presented on short video films. The stimuli were generated "by hand." To emphasize that the perception of intention (like that of causality) depends not on domain-specific features of objects, we used abstract objects, two balls of different color. The larger (L) was 6 cm, the smaller (S) 5 cm in diameter. They were each attached to a 70-cm wooden rod (0.5 cm in diameter), which was moved by hand and videotaped so that not the hands but only the balls and part of the rods were visible on the film.

The basic movement consisted of a three-component pattern: base, deflection, and restoration of base (BDR). These three components can be instantiated in indeterminately many ways. We used three basic BDR patterns, which, with slight variations, made up all stimulus material. B1 consisted of: S entered the screen, followed by L; D1: S fell down a "cliff," performed frantic movements; R1: L moved towards S, carried S up, both left the screen. B2 consisted of: L and S entered the screen side by side, S moved forward, L lagged behind; D2: S moved quickly back to L, rubbed against L, moved forward again and returned even faster to L; R2: S rubbed against L, both moved forward, left. B3 consisted of: L lowered itself, remained motionless; D3: S moved toward L and touched it, whereupon L pushed S away; S moved again toward L and jumped upon it, L pushed S away; R3: L hit S and returned to its initial location, S rapidly left. In each case, at least one ball returned to the motion it made at the beginning.

Adults watching these scenes spontaneously label them, using such terms as "helping," "reassurance," and "irritation," respectively. We have used similar terms, for example, "frantic movements," strictly for the sake of communication. In fact, the content of B, D, and R consists of the movement of the balls, which can be described exhaustively in terms of time and distance.

Twenty-five children (15 boys, 10 girls, mean age = 56.7 months, SD = 8.9) served as subjects in experiment 1. They attended a nursery school in a middle-class neighborhood.

The stimuli consisted of two different experimental sequences, each composed of three different patterns. The two sequences differed in details only. In the corresponding control sequences, each ball moved in the same way as in the experimental sequence but the two were desynchronized, the bigger ball starting its sequence with component D in four sequences and with R in two sequences. Four different pairs of balls were used and their use in the experimental and control sequences was counterbalanced across subjects. The duration of the patterns varied between 23 and 66 s, but the duration of the experimental and corresponding control patterns were always the same. The videotapes were shown on a screen measuring 23 by 17.5 cm.

Each child participated in two sessions, spaced 2 to 7 days apart. The design (*4*) provided for both a within-subject comparison of looking times for the experimental and control sequences and a dishabituation measure for those subjects whose looking time declined at least 25% from the first to the second presentation of a habituation sequence (the habituation of attention). Looking time (seconds) was measured by either one or two experimenters who observed the subject behind a one-way screen and could not see which sequence was shown. Agreement between the two observers was 0.95. All statistical analysis was done on arcsin transformation of the original looking times.

An analysis of variance on kind of sequence (experimental and control) by exposure (first and second) revealed a significant effect of both factors: looking scores of experimental and control sequences differed significantly [$F(1,24) = 5.9$, $P = 0.023$]. The mean score for looking at the former was 59.39 (SD = 15.54) and 52.32 (SD = 14.71) at the latter. Looking scores declined from the first exposure to the second [$F(1,48) = 76.5$, $P < 0.001$]. The difference in looking scores for the two kinds of sequence was confirmed on an individual basis: 18 children looked longer at the experimental than at the control sequences (mean score of the experimental habituation sequences compared to mean score of corresponding control sequences), 5 showed the opposite pattern ($P < 0.05$, binomial test, one-tailed). Two children looked equally at both kinds of sequences. Six children habituated to both kinds of sequence, 11 additional subjects habituated to one kind. For these subjects recovery scores were calculated as looking score on viewing dishabituation sequence minus looking score of second exposure to the habituation sequence. A planned comparison of these scores showed that, as predicted, looking increased significantly more when the dishabituation sequence was preceded by a different kind of sequence than where it was preceded by the same kind [$t(21) = 2.57$, $P = 0.009$, one-tailed]. The mean score of recovery in the former case was 12.45 (SD = 9.20, $n = 11$) and 2.46 (SD = 9.43, $n = 12$) in the latter. Overall, then, there is evidence that the children reliably differentiated the experimental from the control events.

Our basic claim is that the critical stimulus consists of the pattern: base, deflection, and restoration of base. Is the BDR pattern critical? Given that one can find, on an intuitive basis, adequate exemplars of B, D, and R, one can use these exemplars to test the claim concerning pattern. In the next experiment we tested this claim by comparing the effect of the would-be critical BDR with the reverse, RDB, in the following way. After habituating the subject to either BDR or RDB, we then carried out a role reversal. That is, the ball that had been the instigator of the action became the recipient of the action, and vice versa. We predicted that role reversal would have a strong effect in the case of BDR, a weak or negligible effect in the case of RDB. If one perceives intention in the interaction between two objects, then a reversal in role is important, and should lead to considerable recovery from habituation. On the other hand, if one does not perceive intention then such a reversal is of little consequence and should produce commensurately little dishabituation.

For experiment 2, 32 children, 19 boys and 13 girls, were divided into two age groups (mean age of the younger = 39.4 months, SD = 4.3, $n = 16$; mean age of the older = 60.0 months, SD = 5.4, $n = 16$). Three subjects of each group had participated in the previous experiment, all others were new.

The first experimental sequence of the previous experiment was used again in the second experiment. It was reproduced twice with one new pair of balls, once as a copy of the original sequence and once with the roles of the big and small ball reversed. The two control events consisted of the same components but rearranged in the order RDB.

The same design was used as in the previous experiment: each child participated in two sessions, in one of which he or she was shown the experimental (BDR) sequence twice, followed by the same sequence with the balls in reversed roles. In the other, the RDB sequence and the balls in reversed roles were shown. BDR and RDB session were counterbalanced within the age groups, as were the pairs of balls and their initial roles.

An analysis of variance on kind of sequence (BDR and RDB) by exposure (first and second) showed a significant decline in looking from the first to the second exposure in both age groups [$F(1,30) = 51.0$, $P < 0.001$, older group; $F(1,30) = 32.6$, $P < 0.001$, younger group] but no effect of the kind of sequence [$F(1,15) = 0.05$, $P > 0.1$ and $F(1,15) = 0.04$, $P > 0.1$, respectively] nor a significant interaction. The mean score for looking at the BDR sequence for the older group was 53.78 (SD = 15.95) and for the younger 47.45 (SD = 12.90). The respective scores for the RDB sequence were 53.17 (SD = 18.02) and 48.08 (SD = 13.84). Recovery scores were calculated as in experiment 1. Planned comparisons of these scores showed that the older children did not differentially dishabituate to the role reversals of the BDR and RDB sequences [$t(13) = 0.466$, $P > 0.1$]. The recovery scores were 6.45 (SD = 5.94, $n = 9$) and 7.99 (SD = 6.79, $n = 6$). In contrast, the younger age group showed significantly more dishabituation to the reversed roles of the BDR sequence than to the role reversals of the RDB sequence [$t(20) = 2.497$, $P = 0.01$, one-tailed]. The recovery scores were 5.37 (SD = 8.58, $n = 11$) and 3.61 (SD = 8.28, $n = 11$). The latter result is confirmed on an individual basis: eight of the nine younger subjects who habituated in both their sessions dishabituated more to the experimental role reversal than to the control role reversal ($P < 0.05$, binomial test, one-tailed). Such a comparison is not possible for the older children because only two subjects habituated in both sessions.

The difference in the outcome for the young and older children parallels a comparable difference in children's reactions to picture stories presented in and out of order. Older children respond in the same way to both orders, evidently able mentally to restore the disordered case, but young children do not (*5*). They are flummoxed by the disordered sequence. In particular, the intentionality they normally attribute to the characters, for example, "he's afraid of him because he hit him," is replaced by static descriptions, such as "he's here and he's over there" (*ibid.*). Our data appear to duplicate this outcome: the older children appear to perceive intention in both BDR and RDB, because they need only the appropriate elements, and can order them themselves. By contrast, younger children can perceive intention only in the properly ordered case.

Can we say that what the child perceives when he looks at an appropriate case of BDR is intention? Spontaneous comments, though infrequent, tend to comply with the intentional interpretation. We reserve formal treatment of the verbal approach for later and turn now to a consideration of the alternatives.

The habituation-dishabituation results established that the several tokens of BDR all produced a common perception. If that perception is not intention, what is it? Did the child perceive the experimental sequences as causal, the control as noncausal? We need to distinguish between two senses of causal. Causal in the physical sense can be eliminated. The stringent conditions that Michotte (*1*) showed to be needed for the perception of physical causality were not contained in either kind of sequence. Moreover, suppose such patterns were present; they would have been equally present in both the BDR and RDB cases. Thus, the children would have had either to perceive causality in both cases or noncausality, and neither outcome could account for the difference between the BDR and RDB results.

There is, however, a second sense of causal. Ball L hit ball S *because* S made it angry; S rushed back to L *because* it was afraid; and so on. "Because" in these constructions does not refer to physical causality, defined by the temporal-spatial contiguity of two appropriate actions; but to psychological causality, defined by an inferred change in the internal state of one object brought about by either an inferred change in the internal state of another object, the action of another object, or both. This sense of causality is what we mean by intention, and is the sense that we believe distinguished the experimental and control sequences. Animate/inanimate can be eliminated as a possible alternative for intentional/nonintentional. The movement of the individual balls in the experimental and the control conditions did not differ. In the first experiment, the two cases differed only in synchrony, and in the second, not even in synchrony but only in the order of the BDR pattern.

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Composition of the Earth

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New estimates of solar composition, compared to earlier measurements, are enriched in Fe and Ca relative to Mg, Al, and Si. The Fe/Si and Ca/Al atomic ratios are 30 to 40 percent higher than chondritic values. These changes necessitate a revision in the cosmic abundances and in the composition of the nebula from which the planets accreted (which have been based on chondritic values). These new values imply that the mantle could contain about 15 weight percent FeO and more $CaMgSi_2O_6$ than has been supposed. Geophysical data are consistent with a dense, FeO-rich lower mantle and a $CaMgSi_2O_6$ (diopside)-rich transition region. FeO contents of 13 to 18 weight percent appear to be typical of the mantles of bodies in the inner solar system. The oldest komatiites (high-temperature MgO-rich magmas) have a similar chemistry to the derived mantle. These results favor a chemically zoned mantle.

MOST WORKERS HAVE ASSUMED that the sun, planets, and chondritic meteorites are all derived from the solar nebula and that they contain approximately the same ratios of the refractory condensable elements. Carbonaceous chondrite abundances have generally been taken as an appropriate guide to the composition of the condensable material in the solar system and the planets. Chondritic and solar values have both been used in compilations of the cosmic or solar system abundances (*1*). Satisfactory models of Earth can be obtained from these cosmic abundance tables (*2*). The inferred FeO content of the mantle for a chondritic Earth is low because nearly all of the iron resides in the core.

Type 1 carbonaceous chondrites (CI)

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