LETTERS

Social evaluation by preverbal infants

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The capacity to evaluate other people is essential for navigating the social world. Humans must be able to assess the actions and intentions of the people around them, and make accurate decisions about who is friend and who is foe, who is an appropriate social partner and who is not. Indeed, all social animals benefit from the capacity to identify individual conspecifics that may help them, and to distinguish these individuals from others that may harm them. Human adults evaluate people rapidly and automatically on the basis of both behaviour and physical features[1–6], but the ontogenetic origins and development of this capacity are not well understood. Here we show that 6- and 10-month-old infants take into account an individual's actions towards others in evaluating that individual as appealing or aversive: infants prefer an individual who helps another to one who hinders another, prefer a helping individual to a neutral individual, and prefer a neutral individual to a hindering individual. These findings constitute evidence that preverbal infants assess individuals on the basis of their behaviour towards others. This capacity may serve as the foundation for moral thought and action, and its early developmental emergence supports the view that social evaluation is a biological adaptation.

Our experiments used two methodologies to assess 6- and 10-month-old infants' intuitions about social interactions: a choice paradigm[7–11] in which infants indicate preferences through their reaching behaviour, and a violation of expectation paradigm[12–16] that assesses infants' expectations via their looking times, capitalizing on the phenomenon that infants tend to look longer at unexpected or surprising events.

In experiment 1, infants saw a character (the 'climber', made of wood and with large eyes glued onto it) initially at rest at the bottom of a hill. During a habituation phase, infants saw events in which the climber repeatedly attempted to climb the hill, and on the third attempt was either aided up by a helper who pushed it from behind, or was pushed down by a hinderer (Fig. 1a; stimulus clips and Supplementary Methods are available at http://www.yale.edu/infantlab/socialevaluation and in the Supplementary Information). Infants saw alternating helping and hindering trials with looking time measured on each trial, until their looking time reached a pre-set criterion indicating they had sufficiently processed these events. Previous studies from our laboratory found that infants interpret similar, computer-animated events as instances of helping and hindering, and expect the climber subsequently to approach the helper and avoid the hinderer[15,16]. We asked here how infants themselves, as uninvolved and unaffected bystanders, evaluate helpers and hinderers. Will witnessing one individual's actions towards an unknown third party affect infants' attitude towards that individual?

In the test phase, our choice measure examined infants' attitudes towards the helper and hinderer. Infants were encouraged to choose between the two (that is, reach for one). Infants robustly chose the helper (14 of 16 10-month-olds, binomial probability test, one-tailed $P = 0.002$; 12 of 12 6-month-olds, $P = 0.0002$), indicating that they held distinct impressions of the two characters on the basis of their actions towards the climber (see Fig 2).

Our looking time measure replicated our previous studies assessing 9- and 12-month-olds' expectations about the climber's attitudes to the helper and hinderer[15,16], and extended this question to younger infants. Infants saw a new display containing climber, helper and hinderer (Fig. 1b). The climber alternately approached the helper (unsurprising) and the hinderer (a surprising action). Replicating our previous results, 10-month-olds looked longer at the latter event ($\text{mean}_{\text{hinderer}} = 4.96$ s, $\text{mean}_{\text{helper}} = 3.82$ s; paired t-test, $t(15) = 2.603$, two-tailed $P = 0.02$), indicating surprise when the climber approached one who had previously hindered it. Six-month-olds, however, looked equally to both events ($\text{mean}_{\text{hinderer}} = 5.7$ s, $\text{mean}_{\text{helper}} = 6.7$ s; $t(11) = 0.80$, $P = 0.44$), suggesting that they did not attribute to the climber distinct attitudes towards the two characters, despite themselves preferring helper to hinderer in our choice measure. This suggests that the capacity for social evaluation may develop before the ability to infer others' evaluations.

Our claim—that young infants evaluate others based on their social behaviour—entails that infants were responding to social, not superficial perceptual, aspects of our events. If infants of these ages prefer, for example, upward to downward motion, or pushing up to pushing down actions, then our subjects may have chosen the helper for these non-social reasons. To assess this, we conducted a second experiment in which infants saw events like those of experiment 1 except that the pushed object did not appear animate and goal-driven like our climber, but inanimate (Fig. 1c)—an entity to which social notions of helping and hindering do not apply.

In experiment 2, new groups of infants saw two characters (the helper and hinderer from experiment 1), on alternating trials, smoothly push up or down the hill, respectively, an inanimate object (the climber of experiment 1 but with eyes removed, and undergoing no self-propelled motion). Although the two characters' physical trajectories and respective effects on the pushed object were similar to those of the helper and hinderer in experiment 1, these events are not social interactions and cannot be viewed as instances of 'helping' and 'hindering'. Infants were then given a choice measure only.

If perceptual preferences, not social evaluations, drove infants' choices in experiment 1, similar preferences should be obtained here: infants should robustly prefer the pusher-up to the pusher-down character. However, neither age group did so. Six of twelve 10-month-olds chose the pusher-up, binomial probability test, one-tailed $P = 0.613$; four of twelve 6-month-olds did so, $P = 0.927$. These responses differed significantly from those in experiment 1 (10-month-olds, $P = 0.04$, Fisher's exact test; 6-month-olds, $P = 0.001$), in which infants overwhelmingly chose the pusher-up (helper) when this action was embedded in a social context, indicating that infants' preferences in experiment 1 were based on social, not perceptual, differences between helping and hindering events.

Infants' choice patterns indicate three possibilities: infants may positively evaluate an individual seen helping another (thus find the helper appealing); they may negatively evaluate an individual

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seen hindering another (thus find the hinderer aversive); or both positive and negative evaluation processes may be operative. We accordingly conducted a third experiment in which new groups of 6- and 10-month-old infants chose between a neutral character and a valenced character—either a helper (for infants in the helping/neutral condition) or a hinderer (the hindering/neutral condition).

In experiment 3 habituation trials, each infant saw either a helper or a hinderer acting on a climber as in experiment 1, and a neutral character which moved uphill or downhill in the same manner as the valenced character but did not interact with the climber (Fig. 1d). Infants in both conditions were then given a choice measure to assess their own preference for the neutral versus valenced character, and a looking time measure to assess their expectations of the climber's preference for the neutral versus valenced character.

In the choice measure, infants of both ages responded differently to the neutral character when it was paired with the helper than when it was paired with the hinderer (Fisher's exact test, two-tailed $P = 0.01$ for each age group). Infants in the helping/neutral condition systematically chose the helper (seven of eight 10-month-olds, binomial probability test, one-tailed $P = 0.035$; and seven of eight 6-month-olds, $P = 0.035$), whereas infants in the hindering/neutral group chose the neutral character (seven of eight 10-month-olds, $P = 0.035$; and seven of eight 6-month-olds, $P = 0.035$). That is, infants were both drawn towards helpers and independently inclined to avoid hinderers, revealing both positive and negative evaluations. Infants' choices were not based on general perceptual preferences: within each condition, the neutral and valenced characters enacted identical motion patterns; a preference for solitary action over interaction (or vice versa) would have generated across-the-board choice (or avoidance) of the neutral character in both conditions, not choice in one and avoidance in the other, as was observed. Infants' preference for the helper and aversion to the hinderer, then, are best explained as specifically social evaluations: a liking for those who act cooperatively to facilitate the goals of others, and a dislike of those who impede another's goals.

In our looking time measure, infants of both ages failed to discriminate the test events (climber approaching the neutral versus the valenced character (helper or hinderer), two-tailed *t*-tests, all *P*-values >0.3). Together with the looking time results from experiment 1 this suggests that 10-month-olds, although having expectations of how an individual will respond to two actors performing opposing actions, do not anticipate how an individual will respond to actors performing less-distinct actions.

Previous research has established that infants in the first half-year of life exhibit preferences for social individuals based on static perceptual features (for example, facial attractiveness, race)[17,18], and toddlers by 18 months of age spontaneously engage in cooperative helping behaviour[19]. The findings reported here constitute the first evidence that young infants' social preferences are influenced by others' behaviour towards unrelated third parties. The presence of social evaluation so early in infancy suggests that assessing individuals by the nature of their interactions with others is central to processing the social world, both evolutionarily and developmentally. The capacity for such evaluations can be seen as a biological adaptation: cooperative behaviour such as group hunting, food sharing and warfare can be beneficial to individual members of a group, but can only successfully evolve if individuals can distinguish free riders from cooperators or 'reciprocators', those willing to do their fair share[20,21]. Our findings suggest that preverbal infants may be sensitive to this distinction.

The capacity to evaluate individuals by their social actions may also serve as a foundation for a developing system of moral cognition. Plainly, many aspects of a full-fledged moral system are beyond the

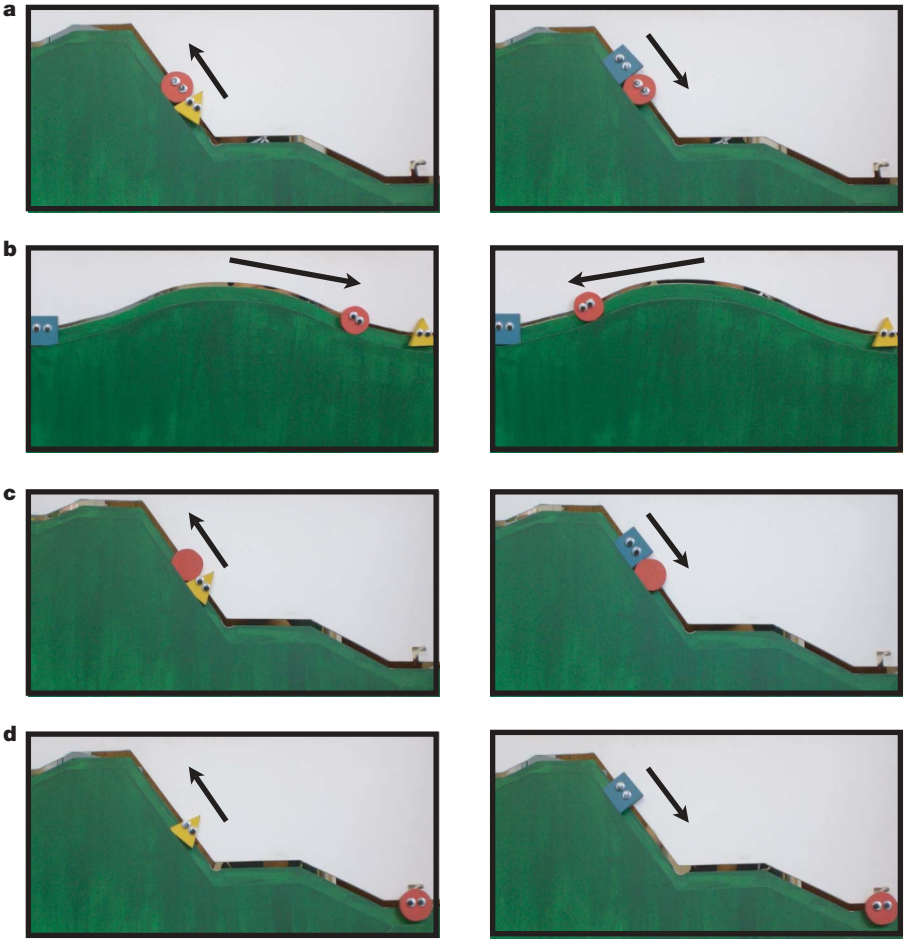

Figure 1 | Social interaction events shown to infants. **a**, Helping and hindering habituation events of experiments 1 and 3. On each trial, the climber (red circle) attempts to climb the hill twice, each time falling back to the bottom of the hill. On the third attempt, the climber is either bumped up the hill by the helper (left panel) or bumped down the hill by the hinderer (right panel). Infants in experiment 1 saw these two events in alternating sequence; infants in experiment 3 saw either a helping or hindering event in alternation with the corresponding neutral event depicted in **d**. **b**, Looking time test events of experiments 1 and 3. The climber moves from the top of the hill to sit with the character on the right (left panel) or the left (right panel). **c**, Pushing-up and pushing-down habituation events of experiment 2. An inanimate object (red circle) rests (left panel) at the bottom of the hill and is pushed up, or rests (right panel) at the top of the hill and is pushed down. Infants saw these two events in alternation. **d**, Neutral habituation events from helper/neutral (left panel) and hinderer/neutral (right panel) conditions of experiment 3. The neutral character, without interacting with the climber, traces a path identical to that of the helper (left panel) or hinderer (right panel). Each infant saw either the helping or hindering event depicted in **a**, in alternation with the corresponding neutral event.

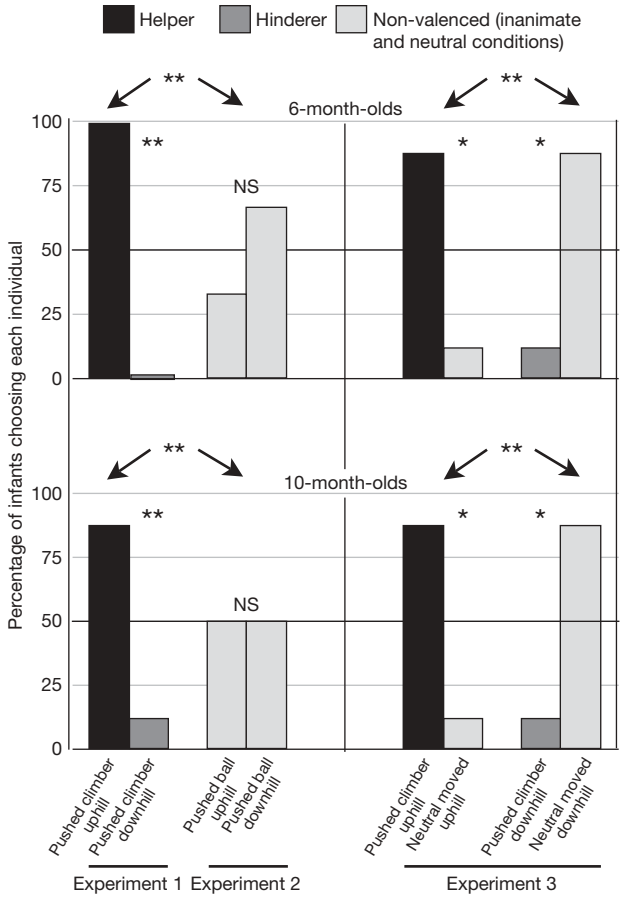

Figure 2 | Choice results. Percentage of infants choosing each character across experiments 1, 2 and 3. NS, not significant. Asterisk, one-tailed $P < 0.05$; double asterisk, $P < 0.05$.

grasp of the preverbal infant. Yet the ability to judge differentially those who perform positive and negative social acts may form an essential basis for any system that will eventually contain more abstract concepts of right and wrong. The social evaluations we have observed in our young subjects have (at least) one crucial component of genuine moral judgements: they do not stem from infants' own experiences with the actors involved. Our subjects had no previous history with our characters, nor did they themselves experience any consequences of these characters' actions. Their evaluations were made on the basis of witnessed interactions between unknown individuals: the infant, as an unaffected, unrelated (and therefore unbiased) third party, is nonetheless rendering a judgement about the value of a social act.

Our findings indicate that humans engage in social evaluation far earlier in development than previously thought, and support the view that the capacity to evaluate individuals on the basis of their social interactions is universal and unlearned[22–24]. Determining the complexity of this understanding—for instance, do infants prefer to interact with agents who punish hinderers over those who reward them—will require further research.

METHODS SUMMARY

Subjects were healthy full-term infants recruited from the greater New Haven area and tested in K.W.'s Infant Cognition Laboratory at Yale University. Ten-month-olds ranged from 9 months 12 days to 10 months 16 days; 6-month-olds from 5 months 3 days to 6 months 17 days.

Habituation events occurred in a display (122 cm wide, 66 cm high) containing a green incline with 43-cm elevation from base to top. Characters were blocks (9 cm × 9 cm × 1 cm) with large (2.5-cm diameter) 'googly eyes' (with the exception of the eyeless object in experiment 2). The looking time test display (122 cm × 66 cm) contained a hill with 14-cm elevation from base to top.

Infants sat in parents' laps; parents were instructed not to interfere with infants. Parents of all infants in experiment 2 and 6-month-olds in experiment 3 were additionally instructed to close their eyes during choice measure. Infants received habituation trials until (1) looking time on three consecutive trials (after the first three) decreased to half that on the first three trials or (2) 14 trials were presented. End-of-trial for habituation and looking time test trials occurred when (1) the infant looked away continuously for 2 s or (2) 60 s had elapsed. A coder blind to the identities of the characters monitored infants' looking times and administered the choice measure. A second coder independently coded a random 25% of subjects of each age group in each experiment; coders achieved 98% positive agreement on both measures.

The following were counterbalanced across subjects in each experiment and age group: identities of helper/hinderer (experiment 1), pusher-up/pusher-down (experiment 2) and valenced/neutral characters (experiment 3); order of habituation events; order of choice and looking time measures (experiments 1 and 3); positions (left/right) of characters in choice and in looking time trials; order of climber's approach in looking time test trials to helper/hinderer (experiment 1) and valenced/neutral character (experiment 3).

Full Methods and any associated references are available in the online version of the paper at www.nature.com/nature.

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Supplementary Information is linked to the online version of the paper at www.nature.com/nature.

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METHODS

Experiment 1: helper versus hinderer. Subjects were 16 10-month-olds (8 girls; mean age 9 months, 26 days; range 9 months, 14 days to 10 months, 16 days) and 12 6-month-olds (5 girls; mean age 6 months, 5 days; range 5 months, 18 days to 6 months, 17 days). Four additional infants (two 10-month-olds) were excluded owing to parental interference (two) or procedure error (two). Subjects in all experiments were healthy full-term infants.

Infants sat in parents' laps before a table with a curtain at the far end (165 cm from the infant), which could be lowered to occlude a display stage (122 cm wide, 66 cm high) with a white background and a green 'hill' or incline protruding 10 cm, which rose from lower right to upper left corner of the display (43 cm from lowest to highest point). It had a small 'plateau' one-third of the way up and a second at the top. Characters were wooden blocks 9 cm × 9 cm with 'googly eyes'. For 10-month-olds, the climber was a yellow triangle; helper and hinderer were a red square and a blue circle (counterbalanced). For 6-month-olds, the climber was a blue circle; helper and hinderer were a yellow triangle and a red square.

The curtain was first raised and lowered three times with the climber at the base of the incline. Habituation trials then began. The climber climbed to the lower plateau, 'danced' (jiggled up and down) for 2 s, then attempted twice to reach the upper plateau, each time falling back to the lower plateau. On a third attempt, the climber was either pushed to the top by the helper, or pushed to the bottom by the hinderer. In helping events, the helper entered the display from the lower right, moved up the incline and bumped the climber twice, each time pushing him farther up until the climber reached the upper plateau. The climber subsequently 'danced' while the helper went downhill and exited; the climber then became stationary. In hindering events, the hinderer entered from the upper left, moved down the incline and bumped the climber twice, each time pushing him farther down. The climber then tumbled end-over-end to hill bottom and remained stationary, while the hinderer moved back up the hill and exited. Total event duration was 11 s.

A coder blind to the identities of helper and hinderer recorded infants' looking to the stationary climber. Infants' looking was measured from helper/hinderer's exit until end-of-trial, reached when (1) the infant looked away continuously for 2 s, or (2) 60 s elapsed. The curtain dropped to occlude the display between trials. Infants saw helping and hindering trials in alternating sequence until (1) the summed looking times on three consecutive trials after the first three dropped to less than half the summed looking on the first 3 trials, or (2) 14 trials had elapsed. Both age groups habituated in an average of 9 trials.

Infants were then given choice and looking time test measures. Choice: the coder presented the infant with the helper and the hinderer 25 cm apart on a white board, and asked "would you like to pick a toy?" Infants' choice was defined as the character touched first, as judged by the (blind) coder, with the constraint that the infant had to be looking at the toy during or immediately preceding the touch (to exclude possibly accidental touches during board exploration, and so on). All infants in experiment 1 made identifiable choices. Looking time: the test display contained a shallow symmetrical test hill (122 cm × 66 cm, rising 14 cm from lowest to highest point). The climber sat at the top centre of the hill, with the helper and hinderer resting at the bottom left and right of the hill. The climber moved back and forth (10 cm each way) along the crest of the hill twice, then danced (2 s) at the top centre. Test trials then commenced. The climber partially approached, retreated, then fully approached to rest next to the helper or hinderer (on alternating trials); infants' looks to the now-stationary characters were then recorded.

A second coder independently coded a random 25% of subjects, achieving 99% agreement with the first coder on looking time and 100% on choice for both age groups.

The following were counterbalanced across subjects in each age group: (1) colour/shape of helper and hinderer; (2) order of helping and hindering habituation events; (3) order of choice and looking time measures; (4) positions of helper and hinderer in choice and in looking time trials; and (5) order of 'approach-helper' and 'approach-hinderer' looking time trials.

Experiment 2: pushing inanimate object uphill versus downhill. Subjects were 12 10-month-olds (eight girls; mean age 10 months, 2 days; range 9 months, 14 days to 10 months, 22 days) and 12 6-month-olds (6 girls; mean age 6 months, 1 day; range 5 months, 15 days to 6 months, 17 days). Two additional 6-month-olds were excluded from the final sample owing to procedure error (1) and fussiness (1).

Stimuli were as in experiment 1 except that to create the 'object' stimulus, the eyes of the climber stimulus from experiment 1 were removed so that it appeared inanimate. Helper and hinderer stimuli from experiment 1 were used as pusher-up and pusher-down stimulus characters. Events were as in experiment 1 except that the object, unlike the climber in experiment 1, underwent no self-generated motion, and the pusher-up and pusher-down smoothly pushed the object all the way up (down) the incline from its starting location at bottom (top). Event duration was 11 s. In addition to being instructed not to interfere with their infants, parents were instructed to keep their eyes closed during the choice measure.

A second coder independently coded a random 25% of subjects of each age group; the two coders reached 100% agreement on choice, for both the 6- and 10-month-olds.

The following were counterbalanced across infants within each age group: (1) colour/shape of pusher-up and pusher-down; (2) order of habituation events; and (3) position of pusher-up and pusher-down in choice.

Experiment 3: valenced (helper/hinderer) versus neutral character. Subjects were 16 10-month-olds (eight girls; mean age 9 months, 27 days; range 9 months, 12 days to 10 months, 14 days) and 16 6-month-olds (eight girls; mean age 5 months, 28 days; range 5 months, 3 days to 6 months, 16 days). Eight additional infants (one 10-month-old) were excluded from the final sample owing to a procedure error (three), fussiness (two) and failure to make an identifiable choice (three). Half the subjects in each age group saw helping and neutral events, half saw hindering and neutral events.

For 10-month-olds, the climber was a blue circle; valenced and neutral characters were a red square and a yellow triangle. For 6-month-olds, the climber was a red circle; valenced and neutral characters were a yellow triangle and a blue square.

During habituation, half the infants (randomly chosen) in each age group saw helping and neutral events on alternate trials, half saw hindering and neutral events. Helping and hindering events were as in experiment 1. During neutral trials in the helping/neutral condition, the climber 'danced' for 2 s at the bottom of the incline (lower right), then sat motionless. The neutral character then entered from the lower right, bypassed the climber, and traced the same path as the helper, performing the same motions but not interacting with the climber. During neutral trials in the hindering/neutral condition, the climber 'danced' for 2 s at the lower right then sat motionless. The neutral character then entered from the upper left and traced the same path as the hinderer, performing the same motions without interacting with the climber.

Infants then received choice and looking time measures. In the choice measure, infants were presented with the valenced (helping or hindering) and neutral characters. In the looking time measure, the climber approached valenced and neutral characters on alternating trials.

A second coder independently coded a random 25% of subjects of each age group; the two coders reached 98% agreement on looking time and 100% agreement on choice, for both the 6- and 10-month-olds.

The following were counterbalanced across infants within each age group and condition: (1) colour/shape of valenced and neutral characters; (2) order of habituation events; (3) order of choice and looking time measures; (4) position of neutral character in choice and in looking time trials; and (5) order of 'approach-valenced' and 'approach-neutral' looking time trials.