PNAS BRIEF REPORT | PSYCHOLOGICAL AND COGNITIVE SCIENCES OPEN ACCESS

Human infants are aroused and concerned by moral transgressions

Anja Kassecker[a], Stephan A. Verschoor[a,b,c], and Marco F. H. Schmidt[a,d,1]

Edited by Michael Gazzaniga, University of California Santa Barbara College of Letters and Science, Santa Barbara, CA; received April 20, 2023; accepted June 5, 2023

Humans reason and care about ethical issues, such as avoiding unnecessary harm. But what enables us to develop a moral capacity? This question dates back at least to ancient Greece and typically results in the traditional opposition between sentimentalism (the view that morality is mainly driven by socioaffective processes) and rationalism [the view that morality is mainly driven by (socio)cognitive processes or reason]. Here, we used multiple methods (eye-tracking and observations of expressive behaviors) to assess the role of both cognitive and socioaffective processes in infants' developing morality. We capitalized on the distinction between moral (e.g., harmful) and conventional (e.g., harmless) transgressions to investigate whether 18-mo-old infants understand actions as distinctively moral as opposed to merely disobedient or unexpected. All infants watched the same social scene, but based on prior verbal interactions, an actor's tearing apart of a picture (an act not intrinsically harmful) with a tool constituted either a conventional (wrong tool), a moral (producing harm), or no violation (correct tool). Infants' anticipatory looks differentiated between conventional and no violation conditions, suggesting that they processed the verbal interactions and built corresponding expectations. Importantly, infants showed a larger increase in pupil size (physiological arousal), and more expressions indicating empathic concern, in response to a moral than to a conventional violation. Thus, infants differentiated between harmful and harmless transgressions based solely on prior verbal interactions. Together, these convergent findings suggest that human infants' moral development is fostered by both sociocognitive (inferring harm) and socioaffective processes (empathic concern for others' welfare).

infants | human morality | moral development | moral–conventional distinction | sympathy

Long-term human cooperation depends heavily on individuals who care about norms that prescribe or proscribe certain actions in certain contexts (1). Some of these norms, typically called moral, deal with nonarbitrary issues (e.g., issues of harm, fairness) while others deal with arbitrary conventions (e.g., dress code, game rules) (2, 3). Discussions of how humans develop an understanding of distinctively moral issues can be at least traced back to philosophical debates following Plato and Aristotle in ancient Greece. Typically, proponents of rationalism and proponents of sentimentalism seem to be divided by an unbridgeable gap between moral judgment and motivation driven by sociocognitive or socioaffective processes (4, 5).

Here, we capitalized on the distinction of moral and conventional norms, well studied in children and adults (6), and used multiple methods (eye-tracking, observations of expressive behaviors) to probe the developmental origins of human moral cognition by assessing infants' ability to differentiate between prototypical harmful (moral) and harmless (conventional) violations. An abundance of research over the last decades has repeatedly found that by 3 to 4 y of age, children (from both Western and non-Western societies) categorize violations into conventional and moral ones [e.g., judging the latter as more serious, authority-independent, and generalizably wrong; (6, 7)].

To explore the cognitive and affective origins of human morality, we reduced verbal and task demands. We thus developed an eye-tracking paradigm to systematically investigate 18-mo-old infants' third-party expectations (measured by anticipatory looking) about, and their physiological arousal (measured by tonic change in pupil size) (8) and expressive behaviors (e.g., indicating empathic concern) (9, 10) in response to, actions in prototypical moral and conventional contexts. Given that prototypical moral violations involve a victim and are thus more serious than harmless conventional violations (e.g., eating chocolate mousse with fingers), they may evoke empathic concern for the distressed or harmed victim and lead to stronger emotional arousal in the observer (11). We thus predicted that infants would show i) enhanced physiological arousal (for relevant findings in adults and preschoolers, see ref. 8) and ii) more expressive behaviors indicating empathic

Author affiliations: [a]International Junior Research Group Developmental Origins of Human Normativity, Department of Psychology, Ludwig Maximilian University of Munich, 80802 Munich, Germany; [b]Department of Mathematics and Computer Science, University of Bremen, 28359 Bremen, Germany; [c]Institute for Psychological Research and Leiden Institute for Brain and Cognition, Leiden University, 2333 Leiden, The Netherlands; and [d]Department of Psychology, University of Konstanz, 78457 Konstanz, Germany

Author contributions: M.F.H.S. conceived and designed the research; A.K. and S.A.V. prepared the stimuli and performed research; A.K., S.A.V., and M.F.H.S. analyzed data; A.K. and S.A.V. contributed to the study design, processed the eye-tracking data; A.K. and M.F.H.S. wrote the paper with input from S.A.V.; and M.F.H.S. provided critical revisions.

The authors declare no competing interest.

[1]To whom correspondence may be addressed. Email: marco.schmidt@uni-konstanz.de.

This article contains supporting information online at https://www.pnas.org/lookup/suppl/doi:10.1073/pnas.2306344120/-/DCSupplemental.

Published July 24, 2023.

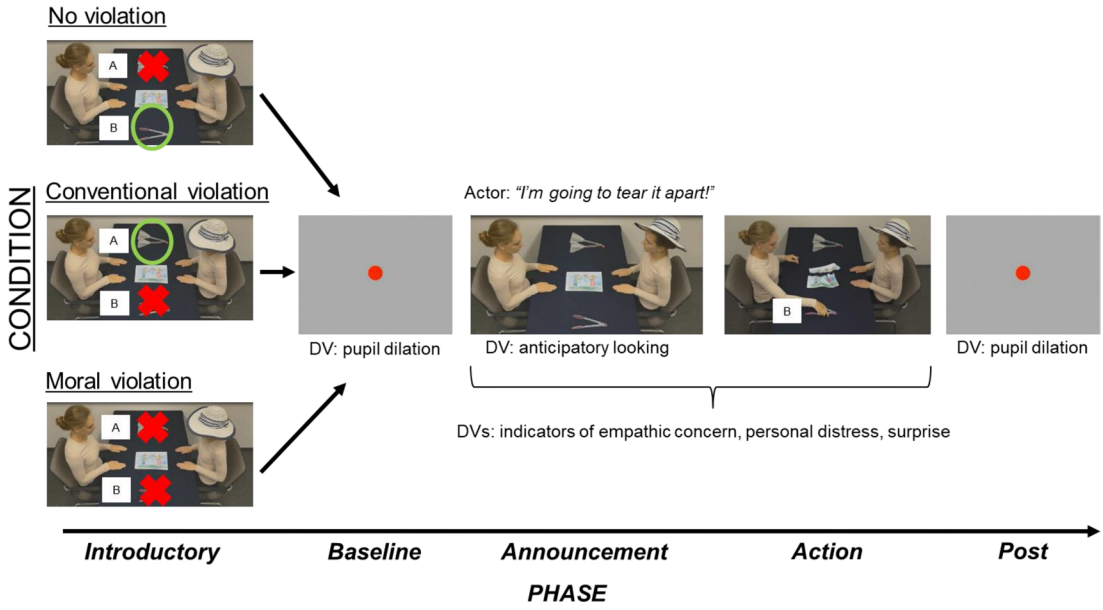

Fig. 1. Illustration of the experiment. The letters A (upper tool) and B (lower tool), the green circle (prescribed tool), and the red crosses (proscribed tool) are to illustrate the main differences in verbal discourse between conditions. The actor always took the lower tool B (action phase). Dependent variable (DV).

concern in response to a moral than to a conventional violation. We used nonaversive stimuli (the victim was not crying or showing overt cues of distress) to minimize the risk of causing personal distress in infants (10). Overall, we coded whether infants' expressions, vocalizations, and behaviors were indicative of personal distress, empathic concern (9, 10), or surprise (*SI Appendix*).

Across three different conditions (moral, conventional, no violation), infants (n = 24 per condition) watched the exact same visual scenes with two individuals (actor sitting left, instructor right; Fig. 1). We solely manipulated verbal interactions according to condition. Thus, the very same action (tearing apart of a picture with one of two available tools A and B; Fig. 1) constituted either i) no violation (using the correct tool), ii) a conventional violation (using the wrong tool), or iii) a moral violation (producing harm by destroying the picture which would make the instructor sad). Infants' pupil size was measured twice during identical neutral clips (Fig. 1), first in the baseline phase and second in the post phase to allow for computing the change (post—baseline) in pupil size for each infant (8, 12).

Results

We expected infants to differentiate between the conventional and no violation conditions in their anticipatory looking toward the prescribed tools; we used linear models for continuous measures (*SI Appendix*). For mean anticipatory looking difference (Tool A—Tool B), we found a significant main effect of condition [$F(2,69) = 3.31$, $P = 0.042$, $\eta^2 = 0.09$; *SI Appendix*]. As predicted, planned follow-up analyses revealed that infants were significantly more likely to show anticipatory looks toward Tool A than toward Tool B in the conventional violation condition (mean = 0.16, SD = 0.48) than in the no violation condition (mean = –0.05, SD = 0.15), unstandardized beta coefficient *(B)* = 0.21, SE = 0.09, t = 2.42, P = 0.018, 95% CI (0.04, 0.38). This finding suggests that infants were sensitive to our experimental manipulation and built expectations according to the specific language (i.e., the instructions for the actor) used in the different conditions.

Regarding pupil diameter, to exclude that pupil size changes (post minus baseline phase) might reflect differences in how infants reacted physiologically to the verbal interactions in the three conditions during the introductory phase (e.g., the instructor used the word "sad" in the moral violation condition only), we placed the first baseline measurement of pupil size after the introductory phase (Fig. 1) to examine whether infants differed in pupil size across conditions during the baseline phase. Pupil size did not differ between conditions [$F(2, 69) = 1.19$, $P = 0.309$, $\eta^2 = 0.03$; *SI Appendix*]. Thus, in all conditions, the same prerequisites for the measurement of change in pupil size were met. For average change in pupil size (post minus baseline phase), we found a significant main effect of condition with medium effect size [$F(2, 69) = 3.32$, $P = 0.042$, $\eta^2 = 0.09$]. As predicted, infants showed a significantly larger increase in pupil size in the moral violation condition (mean = 0.16, SD = 0.19) than in the conventional violation condition (mean = 0.04, SD = 0.14), B = 0.12, SE = 0.05, t = 2.49, P = 0.015, CI (0.02, 0.21). Furthermore, there was no difference between the conventional and no violation (mean = 0.07, SD = 0.16) conditions, B = 0.03, SE = 0.05, t = 0.68, P = 0.500, CI (–0.06, 0.12) (Fig. 2). Mere expectation that others will follow commands (or surprise, enhanced attention; *SI Appendix*) cannot account for this pattern of results, because both types of transgressions should be unexpected as compared to the expected outcome in the no violation condition. These findings thus suggest that infants were more aroused in the moral as compared to the conventional violation condition, because they inferred harm and were responding with empathic concern.

Nonetheless, we sought to validate these findings by directly assessing infants' overt expressive behaviors indicating both empathic concern and personal distress (for surprise, see *SI Appendix*) after the actor's announcement to destroy the picture (i.e., before infants' pupil size was again measured in the post phase). We found that infants were significantly more likely to show expressions indicating empathic concern during the announcement and action phases (*SI Appendix*) in the moral violation condition (33% of infants) than in the other conditions (0%, conventional violation; 4%, no violation), Fisher's exact test, P = 0.0013 (*SI Appendix*). For personal distress, we did not find any difference between conditions and overall, only one infant showed signs of distress, Fisher's exact test, P = 1 (*SI Appendix*). These group-level findings were corroborated by individual-level analyses (*SI Appendix*).

Discussion

Investigating the developmental origins of our moral capacity may help explain how humans became an ultracooperative species. Adding to prior research on infants' preferences for prosocial over

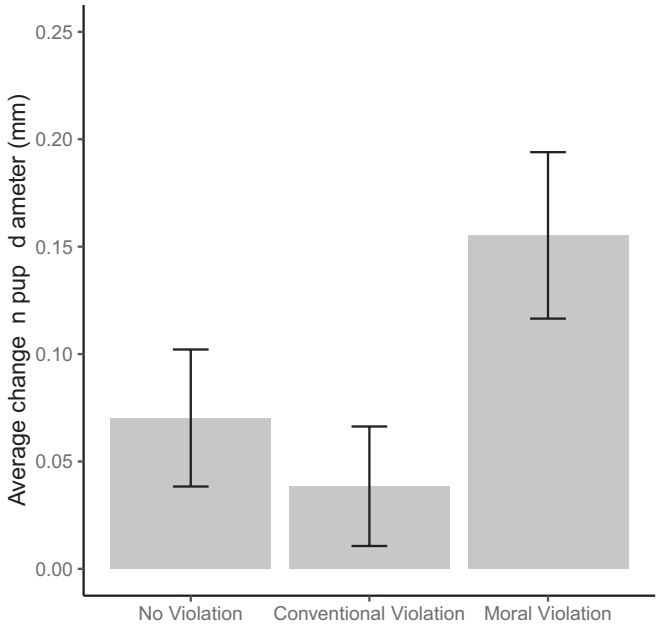

Fig. 2. Average change in pupil diameter (post minus baseline phase) as a function of condition. Error bars represent SEM.

antisocial actions (13) and in line with integrative approaches to moral cognition and development (14, 15), the present study goes beyond the simple dichotomy between sentimentalism and rationalism and provides evidence that both socioaffective and sociocognitive processes play a key role in early moral cognition: Based solely on the verbal and social interactions of two actors and without witnessing intrinsically harmful behavior, infants inferred distinctively moral (harmful) actions and differentiated between moral and nonmoral (conventional) rule-violating events in their physiological arousal and expressions of concern.

Important questions pertain to the generalizability of the present findings across human cultures and across contents [e.g., moral issues related to fairness (2)]. It may be, despite considerable variation between (and within) cultures regarding which behaviors are subject to moral norms (16), that harm plays a special role in constituting moral cognition (3, 17, 18), which might make it likely for norms against unprovoked harm to emerge. Moreover, future research could assess whether infants consider cues of intentionality (e.g., intentional vs. accidental harm), given that a perpetrator's intentions typically matter more for moral than for conventional issues (3, 6, 13). Last, the current findings need to be replicated in larger samples.

In summary, using multiple methods, our study yielded convergent findings and suggests that before children speak about their attitudes toward different types of norm violations, already infants start to differentiate between simple harmful (moral) and harmless (conventional) violations in their descriptive expectations, physiological arousal, and expressive behaviors. Human moral cognition thus has deep developmental roots and the human capacity to understand actions as distinctively moral may be fostered by an early empathic concern for the well-being of others.

Materials and Methods

Seventy-two 18-mo-old infants (M = 18 mo, 6 d; range = 17 mo, 15 d to 19 mo, 12 d; SD = 0.41; 34 girls, 38 boys) participated in the study. Eleven additional infants were tested but excluded due to fussiness (n = 2) or experimenter error (n = 9). Informed consent and a questionnaire regarding general health and development were obtained. All infants were healthy full-term without prenatal or perinatal complications. This research was conducted in accordance with the Declaration of Helsinki, the ethical guidelines of the German Psychological Society (DGPs) and the American Psychological Association (APA), and approved by the local ethics committee of the Ludwig Maximilian University of Munich.

The eye-tracking experiment consisted of five phases: i) introductory, ii) baseline, iii) announcement, iv) action, and v) post (for the phases of the experiment and the dependent measures recorded, see Fig. 1; for a similar approach, see ref. 8, and *SI Appendix* for details). An instructor told an actor (Fig. 1) not to destroy a picture at all (which would make her sad; moral violation condition) or to destroy it with an upper Tool A (conventional violation condition) or with a lower Tool B (no violation condition; Fig. 1). Thereafter, in the announcement phase, the actor first announced to destroy the picture, which was followed by a still phase (7.35 s) whose first three seconds were used to measure infants' anticipatory gaze toward Tool A and Tool B (*SI Appendix*). In the action phase, the actor grasped the lower Tool B and destroyed the picture.

Detailed materials and methods are provided in *SI Appendix*. Video stimulus materials are available in *SI Appendix, Materials and Methods*. Anonymized data and further illustrations are available via Open Science Framework (https://osf.io/wqmj2/).

Data, Materials, and Software Availability. Anonymized data have been deposited in OSF (https://osf.io/wqmj2/) (19).

ACKNOWLEDGMENTS. We thank the anonymous reviewers and all participating infants and parents. Portions of this work were part of the doctoral thesis of A.K.; M.F.H.S. was supported by a grant from the Elite Network of Bavaria, an initiative of the Bavarian State Ministry for Education, Science, and the Arts.

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