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Helping, fast and slow: Exploring intuitive cooperation in early ontogeny

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ABSTRACT

Cooperative behavior is central to human societies. Human adults who reach their cooperative decisions more rapidly and independently of cognitive control display greater levels of prosocial behavior. This is taken to show that cooperation is guided by intuitive processes rather than by active control of selfish impulses. The current study investigated the emergence of intuitive cooperation in early human ontogeny. We measured helping behavior (latency and frequency) in a longitudinal sample of infants at ages 14 and 18 months. Between 14 and 18 months, the frequency of helping significantly increased and latency to help significantly decreased, suggesting advances in helping behavior during this period of development. Moreover, at 18 months and to some extent, even at 14 months, infants who helped more rapidly (as indexed by a shorter latency) acted more prosocially (as indexed by a greater frequency of helping) than infants who were slower to help. This link between latency and frequency of prosocial behavior was independent of infants' ability for inhibitory control and general sociability levels. Prosocial behavior thus begins to be governed by intuitive processes that operate independently of cognitive control early in human ontogeny. This informs our understanding of the nature and emergence of cooperative behavior by supporting accounts that assign a central role to intuition in the evolution of human cooperation.

1. Introduction

Much research has focused on the enduring question of why humans engage in acts of cooperative behavior towards genetically unrelated individuals (Fehr & Fischbacher, 2003). The empirical work available to date provides compelling evidence that cooperative behavior is deeply rooted in our biology. From a phylogenetic perspective, cooperative behavior is not unique to humans but is also seen in other animals including our closest living primate relatives, the chimpanzees (Horner, Carter, Suchak, & de Waal, 2011; Warneken, Hare, Melis, Hanus, & Tomasello, 2007; Warneken & Tomasello, 2007; Yamamoto, Humle, & Tanaka, 2012). From an ontogenetic perspective, cooperative behavior emerges early in development. For example, by as early as 14 to 18 months of age, human infants begin to help others in need, and do so across different cultures (Callaghan et al., 2011; Callaghan & Corbit, 2018; Dahl, 2015; Kärtner, Keller, & Chaudhary, 2010; Tomasello, 2019; Warneken & Tomasello, 2006; Warneken & Tomasello, 2007). Based on these comparative and developmental data (Grossmann, Missana, & Vaish, 2019), it has been suggested that it is in our nature to be cooperative (Hare, 2017; Tomasello, 2019).

Yet, there is much debate about the processes underlying cooperative behavior. On one side of this debate is the proposal that humans are inherently and intuitively selfish and that we need to exercise reflective control over our selfish impulses to enable cooperative behavior (Dewall, Baumeister, Gailliot, & Maner, 2008; Steinbeis, Bernhardt, & Singer, 2012; Stevens & Hauser, 2004). On the other side of the debate is the proposal that humans are inherently and intuitively cooperative and use reflective control to enable strategic and more selfish behavior. This is in line with the view that human cooperation, even with strangers, has been so vital to the success of the human species that it has evolved into a natural and early-emerging propensity (Warneken & Tomasello, 2009). In support of this intuitive account of cooperation, a recent line of research has demonstrated that cooperative decisions occur rapidly and independently of cognitive control (Rand, 2016; Rand & Nowak, 2013). For example, human adults who naturally tend to or are experimentally pressured to reach a decision quickly in behavioral economics games behave more cooperatively (Rand, 2016; Rand, Greene, & Nowak, 2012). Conversely, providing more time to deliberate during cooperative decision-making results in increased selfish behavior (Rand, 2016). These findings bolster accounts that some forms of cooperative behavior are governed by automatic (intuitive) rather than controlled (deliberate) processes (Rand & Nowak, 2013; Zaki & Mitchell, 2013). Strikingly, the pattern of fast cooperation independent of cognitive control has recently also been demonstrated in chimpanzees, further attesting to its intuitive nature and its deep evolutionary origins (Rosati, DiNicola, & Buckholtz, 2018). It should however be pointed out that the conclusions regarding the intuitive nature of cooperation based on correlational studies with adults using decision time measures has been challenged and has led to a new line of studies, indicating that response conflict, study design and

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participant characteristics may account for effects of decision time in cooperative tasks (see Evans & Rand, 2019, for review). Nonetheless, recent work indicates that decision time may function as a predictor of a person's cooperativeness, as people who cooperate more quickly tend to not only be judged as more trustworthy but can also be trusted more in an economic game (Jordan, Hoffman, Nowak, & Rand, 2016).

From a developmental perspective, as mentioned above, human infants actively help others fulfill their goals beginning around 14 months of age, which is considered one of the earliest forms of cooperative behavior and thought to be based on an early existing prosocial motivation (Tomasello, 2019; Warneken & Tomasello, 2009). This emergence of prosocial behavior so early in human ontogeny has been taken as indirect support of intuitive accounts of prosociality under the assumption that young infants do not (and cannot yet) engage deliberative cognitive processes or inhibitory control (Zaki & Mitchell, 2013). However, to date, no research with human infants has directly examined whether the earliest emerging prosocial behavior is intuitive (i.e., fast and independent from inhibitory control) or deliberate (i.e., the result of infants' growing capacity to inhibit selfish impulses). The empirical evidence for the intuitive prosociality account thus draws almost entirely from adult participants. Yet adults have well-established, internalized norms of cooperation that they have been observing and practicing for years. They may thus be extremely quick to act prosocially not because human cooperation is inherently an intuitive process but because adults have been deeply socialized to behave prosocially. To obtain compelling evidence for the intuitive cooperation hypothesis, it is vital to test the hypothesis in early development, before children have been heavily socialized with the norms of cooperation (see Tomasello, 2019) or had a chance to practice them to the point of automaticity.

The current study sought to address this fundamental question about the nature of human cooperation. We measured helping behavior (latency and frequency) by adapting an established instrumental helping paradigm (Warneken & Tomasello, 2006, 2007) in a large longitudinal sample of infants at ages 14 and 18 months. Infants were given six opportunities to provide instrumental help to an adult. We hypothesized that if cooperative behavior is indeed governed by intuitive rather than controlled processes from early in ontogeny, then infants who respond faster in the instrumental helping paradigm will help more frequently than infants who respond more slowly. We also predicted that the hypothesized association between latency to help and helping frequency should emerge independently of infants' inhibitory control (as assessed through parental report).

Moreover, we explored recent suggestions that infants' prosocial behavior simply reflects infants' motivation to interact with others (Pletti, Scheel, & Paulus, 2017) rather than being driven by a genuinely prosocial motivation (Hepach, Vaish, Grossmann, & Tomasello, 2016; Hepach, Vaish, Muller, & Tomasello, 2017). We therefore assessed infants' general sociability through parental report. We hypothesized that early helping behavior would not simply be explained by infants' sociability and that the association between latency to help and helping frequency would exist independently of infants' sociability.

2. Materials and methods

2.1. Ethics statement

The study was approved by the Ethics Committee at the Medical Faculty, Leipzig University (236–10-23,082,010) and was conducted in accordance with the Declaration of Helsinki.

2.2. Participants

A total of 95 infants (47 females) participated in this longitudinal study. At the first time point infants were around 14 months of age (M_{age} = 432.88 days, SD = 9.57) and at the second time point infants were around 18 months of age (M_{age} = 556.18 days, SD = 12.88). All infants were of European descent, were born at standard gestational age (over 38 weeks) and had a normal birth weight (> 2500 g). Parents provided written informed consent prior to participation, and were compensated with travel money, a photograph of the infant and a toy at each visit.

2.3. Prosocial behavior

Instrumental helping behavior was assessed using paradigms adapted from a previously published study (Warneken & Tomasello, 2007). The experiment consisted of two situations (‘Pen’ and ‘Ball’) in which an experimenter required assistance obtaining an object that was out of reach. These two situations were chosen based on Warneken and Tomasello's (2007) finding that they - when compared to the other situations administered - produced the highest levels of helping behavior in 14-month-old infants, which corresponds to the youngest time point examined in the current longitudinal study. Each situation was presented three times, resulting in a total of six opportunities for the infant to help. The repeated presentation of one type of helping situation was based on Warneken and Tomasello's (2007) procedure and intended to generate variability in helping behavior among infants. Note that in both situations, helping latency did not decrease from trial 1 to trial 3 at either age tested (see Results for more detailed information).

In the first situation (‘Pen’), the experimenter sat at a table and drew a picture. The infant was placed on the ground in front of the table so that she could view the experimenter's actions. The experimenter then dropped her pen, making it appear accidental. For the first 10 s, the experimenter looked at and reached for the pen, but never touched it. In the next 10 s, the experimenter continued to reach for the pen but alternated eye contact between the infant and the pen. In the last 10 s, the experimenter reached, alternated eye contact, and said, “Oh, my pen!” This procedure was repeated twice, resulting in three trials for this situation. The entire procedure was video recorded and coded for infant helping frequency (the number of trials the infant picked up the pen and handed it to the experimenter), and latency (the duration between the pen hitting the ground and the moment the pen was handed back to the experimenter). The second situation (‘Ball’) involved the experimenter and infant (on parent's lap) seated at a table, facing each other. Three paper balls were in front of the experimenter (and out of the infant's reach), and three balls were located in front of the infant. Using tongs, the experimenter picked up the three balls in front of her and placed them in a box. The experimenter then reached for one of the balls on the infant's side but could not reach it. The experimenter looked at and tried reaching for the ball for 10 s. In the next 10 s, the experimenter continued to reach for the ball, alternating eye contact between the ball and the child. In the next 10 s, the experimenter continued to reach, alternated eye contact, and said, “Oh, my ball!” This procedure was repeated twice, resulting in three trials for this situation. Again, trials were coded for helping frequency (number of trials helped out of three trials) and for the latency to help.

Sessions were video recorded with three cameras, and all sessions were coded by a primary coder not involved in the experiment and blind to the hypotheses. A random sample of 25% of the sessions was coded by a secondary coder to establish inter-coder reliability. Coding for the target behavior (i.e., whether and when the infant handed over the pen) achieved perfect reliability, $\kappa = 1$.

The helping situations used in our study were closely based on helping situations validated in previous work against appropriate control conditions (see Warneken & Tomasello, 2007). Given that appropriate control conditions were used in previous work (and did not generally produce spontaneous helping behaviors in infants), we decided not to employ such control conditions in our design. We adapted selected experimental conditions from this previous study because we intended to examine variability in helping frequency and whether it can be predicted by helping latency. Our analysis relied on two variables computed on the basis of the infants' performance in the two helping tasks: (a) frequency of helping behavior displayed across the two tasks, which could range from 0 to 6 and (b) latency of helping behavior averaged across trials.

In addition, we assessed infants' inhibitory control, sociability and shyness at 18 months through parental report using the Early Childhood Behavior Questionnaire (ECBQ), which is an established, widely-used, developmentally stable and highly reliable instrument to examine fine-grained aspects of toddler temperament (Putnam, Gartstein, & Rothbart, 2006). The ECBQ has been specifically designed to assess various dimensions of behavioral temperament in children between the ages of 18 and 36 months, building on existing and validated instruments commonly used to study behavioral temperament during infancy and extending this approach into toddlerhood (Garstein & Rothbart, 2003). According to the ECBQ, 'inhibitory control' measures the capacity to stop, moderate or refrain from behavior, 'sociability' measures the tendency to seek and take pleasure in interactions with others and 'shyness' indexes slow and inhibited approach and/or discomfort in social situations involving novelty or uncertainty. Regarding the validity of the ECBQ parental measure, there is longitudinal work showing that effortful control measured through the ECBQ, which includes inhibitory control as reported here, is associated with experimental measures of attentional control in infants (Papageorgiou et al., 2014).

3. Results

3.1. Age differences

Of the total longitudinal sample of 95 infants, 31 infants provided helping latency data (Grossmann et al., 2019) at both ages. We used data (Grossmann et al., 2019) from these 31 infants to assess age differences in infants' helping latency using a repeated-measures ANOVA, with age (14 and 18 months) as a within-subjects factor. Our analysis revealed that infants were significantly faster to provide help at 18 months ($M = 4.71$ s; $SD = 6.75$) than at 14 months ($M = 10.81$ s; $SD = 2.31$), $F(1, 30) = 25.38$, $p = 0.000021$, partial $\eta^2 = 0.458$ (see Fig. 1). In a second repeated-measures ANOVA, we assessed age differences in infants' helping frequency. Of the total longitudinal sample of 95 infants, 75 infants provided helping frequency data (Grossmann et al., 2019) at both ages (this number is higher than the number of infants who provided helping latency data (Grossmann et al., 2019) at both ages, because infants who participated in the helping task but did not provide help were included in this analysis and their helping frequency was scored as 0). This analysis revealed that at 18 months of age ($M = 3.16$; $SD = 2.72$), infants helped more frequently than at 14 months of age ($M = 1.73$; $SD = 1.91$), $F(1, 74) = 17.264$, $p = 0.000086$, partial $\eta^2 = 0.189$ (see Fig. 2). These results show that between 14 and 18 months, the frequency of helping significantly increased and latency to help significantly decreased, indexing advances in helping behavior during this period of development. Despite these quantitative differences between the ages, confirming prior work (Warneken & Tomasello, 2007), even 14-month-old infants displayed significant levels of helping behavior. Specifically, we conducted a one-sample *t*-test for the full sample of infants who generated helping frequency data (Grossmann et al., 2019) at 14 months, comparing helping frequency against zero (based on the assumption that, as seen in Warneken and Tomasello (2007)'s control condition, helping behavior does not occur spontaneously without the experimenter demonstrating a need for help). This analysis produced a significant effect: $t[76] = 7.98$, $p < 0.00001$, $d = 0.9$. Thus, even by 14 months, infants did show substantial helping behavior.

In an additional analysis, we computed a spontaneous helping rate at both ages. This was calculated as the percentage of trials on which any given infant helped before the experimenter first established eye contact with the infant (i.e., within the first 10 s of each trial; see Methods). A paired samples *t*-test revealed that the spontaneous helping

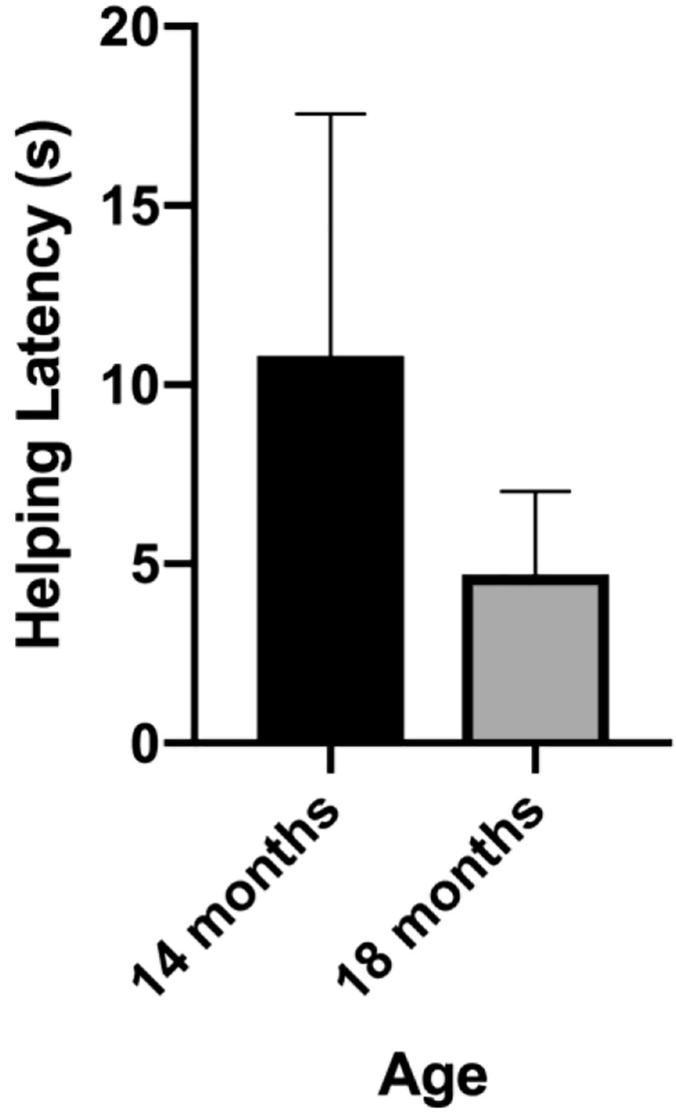

Fig. 1. Helping latency (Mean and SD) in seconds at 14 and 18 months of age. This illustrates that with age, infants were faster to help ($n = 31$).

rate significantly increased with age (14 months: $M = 72.3\%$; $SD = 27.2\%$; 18 months: $M = 88\%$; $SD = 17.5\%$; $t[24] = 2.28$; $p = 0.032$, $d = 0.45$), further supporting the age effects reported above. Yet at both ages, infants' spontaneous helping rate was significantly > 50% as revealed by one-sample *t*-tests performed for each age group separately (14 months: $M = 70.5\%$; $SD = 26.2\%$; $t[36] = 4.75$, $p = 0.000032$; 18 months: $M = 88\%$; $SD = 17.5\%$; $t[60] = 17.2$, $p < 0.000001$). This indicates that at both ages, infants were more likely to help spontaneously (before eye contact with the experimenter) than after receiving eye contact.

In both helping situations used helping latency did not change with repetition (3 trials for each situation, see Methods). Specifically, repeated measures ANOVAs carried out at 14 and 18 months of age, using repetition (trial 1, trial 2, trial 3) and situation ('Pen', 'Ball') as within-subjects factors and helping latency as the dependent variable showed no effect of repetition (14 months: $F(2, 4) = 0.509$, $p = 0.635$; 18 months: $F(2, 80) = 1.469$, $p = 0.236$). Note that the number of 14-month-olds in this analysis (i.e., the number of 14-month-olds contributing helping latency information from all 3 trials in both situations) is very low ($n = 3$, compared to $n = 41$ at 18 months). Thus, at least at 18 months, we can be confident that helping latency did not significantly change with repetition, ruling out learning or shaping of

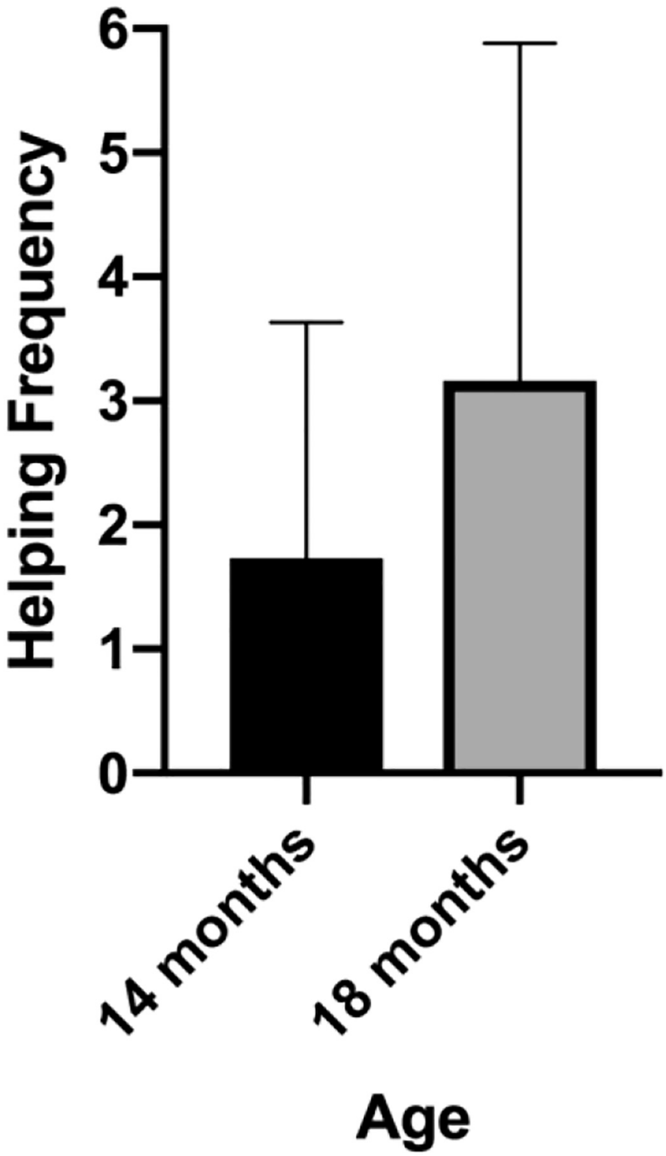

Fig. 2. Helping frequency (Mean and SD), representing the number of trials helped (out of six possible helping trials) at 14 and 18 months of age. This illustrates that infants' helping behavior becomes more frequent with age ($n = 75$).

the helping response during the experiment.

3.2. Latency-frequency association

Our main analysis examined the association between latency and frequency of infants' helping behavior. Specifically, we tested the prediction that infants who are faster in helping others will display greater levels of prosocial behavior as reflected in a higher frequency of helping. For this purpose, we conducted linear regression analyses (entry method) for both ages, in which we entered helping latency as the predictor variable and helping frequency as the dependent variable. This analysis revealed that at 18 months ($n = 61$), infants who displayed shorter latencies to help provided help more frequently than infants who displayed longer latencies to help, $ß = -0.519$, $t = -4.663$, $p = 0.000018$. At 14 months ($n = 47$), the linear regression analysis revealed a similar pattern (negative association) as at 18 months, but this effect was not statistically significant at the younger age, $ß = -0.154$, $t = -1.046$, $p = 0.301$.

We performed an additional exploratory analysis assigning the maximum latency score (30 s) to those infants who did not help (i.e., had a helping frequency score of zero) and repeated the regression analysis at both ages. This was done in order to probe whether the latency-frequency association effects are robust when including infants who did not help (i.e., who received a helping frequency score of zero) in the regression analysis and in order to find out whether the absence of the latency-frequency association at 14 months is perhaps due to the smaller sample size at this age. This analysis revealed that at both ages infants who displayed shorter latencies to help provided help more frequently (14 months: $n = 77$; $ß = -0.669$, $t = -7.739$, $p < 0.000001$; 18 months: $n = 95$; $ß = -0.937$, $t = -25.79$, $p < 0.000001$). Note that this is only an exploratory analysis using a latency replacement method that does not reflect actual behavior; we therefore caution against any strong conclusions based on these results.

At 18 months, we performed a multiple linear regression analyses (entry method), in which we entered helping latency, inhibitory control, sociability and shyness as the predictor variables and helping frequency as the dependent variable. This analysis showed that the negative association between helping latency and frequency exists independently of infants' inhibitory control, sociability and shyness as rated by the primary caregiver (see Table 1). More specifically, inhibitory control, sociability and shyness were entered into the multiple regression as additional predictors (independent variables), which allowed us to assess the link between helping latency and frequency when controlling for these variables. In fact, the regression analysis revealed that inhibitory control was significantly negatively associated with helping frequency, $ß = -0.263$, $t = -2.317$, $p = 0.024$, showing that infants with greater inhibitory control helped less frequently than infants with lower inhibitory control (see Table 1). There was no significant association between infants' sociability or shyness and helping frequency.

Underlying data (Grossmann et al., 2019) are available through the Open Science Framework: https://osf.io/wa3nb.

4. Discussion

The current study tested the intuitive cooperation hypothesis by examining the early development and cognitive characteristics of prosocial behavior in human infancy. Our findings indicate that helping behavior advances between 14 and 18 months by becoming faster and more frequent. Confirming our central hypothesis, we observed that at 18 months and to some extent, even at 14 months, infants who

Table 1
This shows the results of the multiple linear regression at 18 months of age ($n = 59$) with helping frequency as the dependent variable and helping latency, inhibitory control, sociability and shyness as predictor (independent) variables entered into the regression model.

	Unstandardized coefficients		Standardized coefficients	t	Sig.	95.0% Confidence interval for B	
	B	SE	Beta			Lower bound	Upper bound
Helping latency	−0.236	0.051	−0.513	−4.594	0.000026	−0.236	0.051
Inhibitory control	−0.407	0.175	−0.263	−2.317	0.024	−0.407	0.175
Sociability	0.098	0.155	0.072	0.634	0.529	0.098	0.155
Shyness	0.185	0.188	0.112	0.981	0.331	0.185	0.188

responded more rapidly (as indexed by a shorter latency) to a person in need of help acted more prosocially (as indexed by a greater frequency of helping) than infants who were slower to respond to a person in need of help. Our results also showed that this link between latency and frequency of prosocial behavior exists independently of infants' ability for inhibitory control. These findings suggest that prosocial behavior is governed by intuitive processes that operate independently of cognitive control from remarkably early in human ontogeny. The pattern observed in the current results aligns well with the intuitive cooperation framework, which stipulates that cooperation is typically advantageous in everyday life and critical in our evolutionary history (Bear & Rand, 2016). Our findings add importantly to this account by demonstrating that well before children are deeply socialized into the norms of cooperation and before their prosocial behavior is heavily ritualized or automatized, they evince intuitive rather than deliberate cooperation. In fact, the current results may be taken to suggest that critical development occurs during infancy that begins to establish cooperative intuitions underpinning prosocial habits. Moreover, the current results complement and extend an existing line of work showing that, by around 2 years of age, toddlers are intrinsically motivated to help others and want to see their needs being met (Hepach, Haberl, Lambert, & Tomasello, 2017; Hepach, Vaish, & Tomasello, 2012; Warneken & Tomasello, 2008). Together with these previous findings, the current results point to an early-developing and intuitive propensity for engaging cooperatively.

Importantly, our findings support the intuitive cooperation hypothesis by providing the first evidence from infants in a live behavioral paradigm for a phenomenon that has to date primarily been observed during economic games with adults. Moreover, our results show that the association between helping latency and frequency exists independently of infants' inhibitory control, which further supports the notion that intuition rather than deliberation and cognitive control shape helping behavior from early in ontogeny. In fact, we found that inhibitory control was significantly negatively associated with helping frequency, showing that infants with greater inhibitory control helped less frequently than infants with less inhibitory control. This finding stands in contrast to the idea that self/cognitive control is central for the emergence of cooperation, but is in line with recent findings showing that infants who engage brain systems involved in cognitive control (dorsolateral prefrontal cortex, dlPFC) more strongly when viewing somebody in distress at 7 months display reduced prosocial behavior in an instrumental helping task at 14 months (Grossmann, Missana, & Krol, 2018). The current findings, in conjunction with previous work with infants, may thus suggest that rather than only being independent from cognitive control, prosocial tendencies among infants might be reduced with greater cognitive control. Our analysis further shows that the association between inhibitory control and helping frequency exists independent of sociability or shyness, suggesting some specificity of this effect. We caution, however, that this study was not specifically designed to test the relation between cognitive control and prosocial behavior; more research is thus needed to explicitly examine this relation in early development, including by employing appropriate experimental controls and age-appropriate behavioral measures of cognitive control.

Our study also allowed us to examine suggestions that infants' behavior in instrumental helping tasks such as the one used here simply reflects infants' motivation to interact with others (Pletti et al., 2017) rather than being genuinely driven by cooperative or altruistic motivations (Hepach et al., 2016; Hepach, Vaish, et al., 2017). Our results show that 18-month-old infants' general sociability (and shyness) as measured through parental report was not linked to the frequency of prosocial behavior, speaking against the notion that infants' behavior in the helping task is simply a reflection of their general sociability levels or tendency to interact with others. Similarly, our results also show that it is not the case that infants who are seen as less shy (or less inhibited) engage in greater levels of helping behavior. This suggests that helping behavior at 18 months of age may be independent not only from inhibitory control but also from general differences in sociability and shyness among infants. Though not conclusive, the observed independence of helping behavior from other cognitive and social abilities hints at infants' genuinely prosocial orientation (Grossmann, 2018; Hepach et al., 2012). In future work, it will be important to examine other potentially contributing factors, which might explain individual differences in helping behavior, especially in the context of recent findings suggesting a link between attachment and helping behavior in 3- to 5-year-old children (Beier et al., 2019).

It is important to point out some limitations of the current study. First, our measures of inhibitory control, sociability and shyness depended upon parental report. While the instrument we used is established and widely used in developmental research, it is not a direct experimental measure of these constructs. However, we chose to use this parental report measure because experimental procedures to measure inhibitory or cognitive control in infants are still being developed (Holmboe, Bonneville-Roussy, Csibra, & Johnson, 2018). Nonetheless, future work examining the developmental origins of cooperative behavior in infancy should attempt to incorporate direct experimental measures of inhibitory control, sociability and shyness in infants.

Furthermore, our measure of prosocial behavior, though well established in infants (Callaghan et al., 2011; Warneken & Tomasello, 2006; Warneken & Tomasello, 2007), is different from the measures used with adults in the intuitive cooperation line of research. In particular, research with adults has employed single-shot economic games and presented adults with prosocial or selfish choices, whereas infants in our study had the opportunity to repeatedly engage in helping behavior towards the same adult experimenter and there was no selfish option apart from not helping the experimenter. The repeated nature of the interaction with the experimenter may be a limitation in our study as previous work with adults suggests that this can shift behavior towards being more strategic, deliberate, and selfish (Peysakhovich & Rand, 2015; Reiter, Hilbe, Rand, Chatterjee, & Nowak, 2018). Importantly, however, children do not show signs of reciprocity in their helping behavior until later in development, typically by age 3 (Warneken & Tomasello, 2013), which renders the possibility of such strategic behavior less likely. Moreover, we did not find any effects of repeating trials on helping latency, indicating that repetition did not affect infants' readiness to engage in helping behavior. It may nonetheless be useful for future work with infants and young children to systematically manipulate single versus repeated interactions and more importantly to directly compare between prosocial and selfish choices. Note as well that the current analysis is limited to one specific type of helping behavior, namely instrumental helping in out-of-reach contexts. Thus, the current approach needs to be extended to other forms of prosocial behavior such as, for example, sharing and comforting (Dunfield, 2014; Svetlova, Nichols, & Brownell, 2010).

In addition to the predicted association between helping latency and helping frequency, we found that between 14 and 18 months of age, the frequency of helping significantly increased and latency to help significantly decreased, indicating developmental change towards greater generosity and efficiency in helping behavior during this period of development. These advances in helping behavior seen between 14 and 18 months in the current study occur at a time in development when infants display significant improvement in their ability to: (a) coordinate their actions when cooperating towards a common goal (Warneken & Tomasello, 2007) and (b) understand and respond appropriately to another person's desires as a form of mental state reasoning (Repacholi & Gopnik, 1997). It is thus possible that cognitive advances in perspective taking facilitate prosocial behavior by allowing infants at 18 months to more effectively keep track of what another person wants. Most critically, the advances in helping behavior reflected in our findings are occurring at an age (18 months) when instrumental helping behavior is observed across different cultures, and well before cultural differences in prosocial behavior and cooperation linked to differing fairness norms have been shown to emerge (Callaghan et al., 2011; Tomasello, 2019).

We note, however, that the developmental changes seen in the current study may well be quantitative (rather than qualitative) because even at 14 months, infants in the current study displayed significant levels of helping behavior and helped spontaneously before being prompted by eye contact through the experimenter. Furthermore, the finding that helping latency was significantly negatively associated with helping frequency at 18 months but not at 14 months might in part be explained by the smaller number of infants providing latency data (Grossmann et al., 2019) at 14 months than at 18 months. Support for this comes from our additional exploratory analysis in which we increased the number of infants to be included by assigning the maximum latency (30 s) to infants who did not help and found that the helping latency and frequency association effect was already apparent at 14 months. Together, our findings bolster prior conclusions that simple instrumental helping is well within the capacities of 14-month-old infants (Warneken & Tomasello, 2007), and tentatively hint that even this very early helping may be governed by intuitive processes.

In conclusion, the current study provides evidence for the intuitive cooperation hypothesis by showing that early in human development, prosocial behavior is fast and independent of inhibitory control. Indeed, our results reveal a novel pattern indicating that greater inhibitory control was associated with reduced levels of helping at 18 months, raising important questions about the role of cognitive control in the early development of cooperative behavior. The current results also show that associations between helping latency and frequency at 18 months exist independent of other behavioral traits such as infants' sociability and shyness, which makes it unlikely that early prosocial behavior is simply a basic manifestation of a tendency to interact with others. Together, this adds an essential developmental component to theoretical accounts that assign a critical role to intuitive processes in the evolution of human cooperation and, in concert with previous work with infants, attests to an early developing prosocial orientation. Our study lays the foundation for future work to chart the developmental origins and cognitive characteristics of cooperation in early ontogeny.

Author contributions

T.G., M.M., and A.V. conceived of and designed the study. M.M. collected and coded the data. T.G. analyzed the data. T.G. and A.V. wrote the manuscript and M.M provided comments.

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