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Revisiting the Prosocial Effect of Interpersonal Synchrony in Infants: A Study Under a Pre-Post Manipulation During the COVID-19 Pandemic

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Helping behavior emerges reliably in the second year of life. Recent evidence suggests that the experience of interpersonal synchrony may facilitate this behavior in infants. However, whether and how infants' helping behavior changes after experiencing interpersonal synchrony remain largely unexplored. To replicate and extend previous findings, the current study employed a pre-post manipulation design to examine the effect of interpersonal movement on infants' helping behavior. Fifteen-month-old infants participated in a helping tasks phase twice: once before and once after the manipulation of interpersonal movement (synchronous or asynchronous). Our primary analysis revealed no statistical significance in the prosocial effect of interpersonal synchrony. Methodological constraints and socio-environmental factors are discussed as potential possibilities for the current null finding. A preliminary analysis focusing on individual differences did reveal a significant relationship between infants' temperament traits of Negative Affectivity and the effect of interpersonal synchrony. Based on these findings, we discussed necessary methodological adjustments for future study and evolutionary implications of the prosocial effect of interpersonal movement in humans.

Keywords
infancy, helping behavior, interpersonal synchrony, temperament

Introduction

Humans are social animals. We routinely help others, share goods, and cooperate with each other. The ontogenetic roots of such human altruism are present early in development (Warneken & Tomasello, 2009). For example, Warneken and Tomasello (2007) demonstrated that 14-month-old infants could pick up and hand over an object, which was accidentally dropped by an adult experimenter. Later, at around 18 months of age, infants begin to provide a wider range of help, such as opening doors for others and helping stack objects (Warneken & Tomasello, 2006). While the precise mechanisms and motivations underpinning infants' helping behavior require further discussion (see Köster & Kärtner, 2019; Paulus, 2014 for a review), it is notable that these behaviors emerge even in the absence of explicit rewards or toward non-kin individuals.

In the last decades, one related topic that has received much attention is the influence of music or interpersonal movement on infants' helping behavior (e.g., Carpenter et al., 2013; Cirelli, Einarson, & Trainor, 2014; Kirschner & Tomasello, 2010). Findings from Cirelli, Einarson, and Trainor (2014) are particularly insightful because it suggests that even passive experience of synchronous movement can facilitate infants' helping behavior. While infants at the age of 18-month-olds cannot continuously and completely synchronize their movements with others (Yu & Myowa, 2021; Yu et al., 2022), Cirelli and her colleagues pioneered a method to manipulate experiences of spatiotemporal movement in younger infants by using a baby carrier (see Phillips-Silver & Trainor, 2005 for an original use of infants' passive bouncing experience). Utilizing this method, they demonstrated that 14-month-old infants who were bounced synchronously with an experimenter exhibited more spontaneous helping behaviors toward the experimenter, compared to infants who experienced asynchronous bouncing.

Relatedly, recent developmental studies are highlighting individual differences. Among the factors examined, infant's temperament traits have emerged as particularly important. Although Cirelli and her colleagues demonstrated the general prosocial effect of interpersonal synchrony, they also reported that infants with certain temperamental traits, such as less inclined to shy away or withdraw from novelty, exhibited higher rates of helping behavior (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014). Other research in children further suggests that temperament traits, such as sociability and shyness, are associated with the latency of helping behavior (Hammond & Carpendale, 2015; MacGowan & Schmidt, 2021). Given these individual differences in helping behavior, it is plausible that the prosocial synchrony effect on infants' helping behavior may also vary. Despite this theoretical expectation, whether and how infants' helping behavior dynamically changes after experiencing interpersonal synchrony remain largely

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unexplored.

In the current study, we first aimed to replicate and extend the key findings of Cirelli et al. (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014) by employing a pre-post manipulation design. Specifically, we administered the helping tasks phase twice—once before and once after each infant experienced either interpersonal synchrony or asynchrony with an experimenter. This procedure represents a critical modification of the original studies (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014), which conducted the helping tasks phase only once after the movement manipulation. Our modified pre-post manipulation design enabled us to examine the effects of both interpersonal synchrony and asynchrony on infants' helping behavior and to explore individual differences of the interpersonal movement effect. To preliminarily explore an association between infant's temperament traits and the prosocial synchrony effect, we collected parental reports via a questionnaire.

Consistent with the replication aim, we first hypothesized that infants who experienced synchronous bouncing will show a significant increase in the rate of overall helping behavior from the pre- to post-manipulation. Conversely, we hypothesized that the experience of asynchronous bouncing will show no significant changes in helping behavior, aligning with previous findings in adults (e.g., Hove & Risen, 2009). For the preliminary analysis on individual differences, we predicted that, if interpersonal synchrony acts as a social buffer for reducing social wariness, the synchrony effect will be pronounced in infants who are characterized as more fearful or shy (i.e., less inclined to help spontaneously) compared to their less fearful or shy counterparts.

Method

Participants

The minimal sample size was determined as 30 participants based on the previous study because the primary aim of the current study was to replicate and extend the findings of Cirelli et al. (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014). Thirty-six infants participated and they were randomly assigned either to the synchronous or asynchronous condition (18 infants for each condition; synchronous: mean = 15.43 months or 469.39 days, range = 425–512 days, *SD* = 24.59 days, 13 boys; asynchronous: mean = 15.38 months or 467.78 days, range = 433–521 days, *SD* = 25.99 days, 10 boys). Four additional infants who participated in this study were excluded from the data analysis because of procedural mistakes (n = 3) or excessive fussiness (n = 1). Infants were recruited from a database operated by Kyoto University, Japan.

Procedure

As shown in Figure 1, the experiment was conducted under a pre-post manipulation design. Helping tasks phase was administered twice—once before and once after the manipulation of interpersonal movement (see Supplementary Materials for detailed procedure and Apparatus and Stimuli subsection).

(a) Helping Tasks Phase

Four helping tasks were divided into two sets: Set A for the stick and block tasks and Set B for the ball and clothespin tasks. For half of the infants, Set A was performed first in pre-manipulation and Set B in post-manipulation, and vice versa for the other half. Three trials of each of the four tasks were performed, resulting in a total of 12 trials. Note here that the current total number of trials was the same as in the previous study (Cirelli, Wan, & Trainor, 2014).

In all helping tasks, Experimenter A started the trial after getting the infant's attention. The trial was 30 seconds long, during which Experiment A performed the following actions: 1) Experimenter A dropped an object while exclaiming "Ah!" and looked at the object for 10 seconds, 2) In the next 10 seconds, Experimenter A kept looking at the object and made a gesture expressing that the object was out of reach, 3) In the next 5 seconds, Experimenter A alternated between looking at the object and the infant while making the same gesture, 4) In the last 5 seconds, Experimenter A said, "Oh, my [object name]" while looking at the object and making the same gesture (see Supplementary Materials for more details of each task and how each trial terminated).

(b) Interpersonal Movement Phase

Experimenter B held the infant facing outward using a baby carrier (Colanhug AB, Aprica). After the infant's position was stabilized, Experimenter A and B performed synchronous or asynchronous bounces to the metronome sound for 140 seconds (i.e., repetitive knee bending and stretching movements; see Supplementary Materials for bouncing tempo for each condition and etc.).

(c) Questionnaire

To assess infants' temperament traits, the Japanese Revised Infant Behavior Questionnaire was used (Nakagawa & Sukigara, 2005; see Gartstein & Rothbart, 2003 for IBQ-R), which consists of 191 items for assessing three factors from 14 subscales (see Supplementary Materials for details on how the questionnaire was performed).

Data Processing

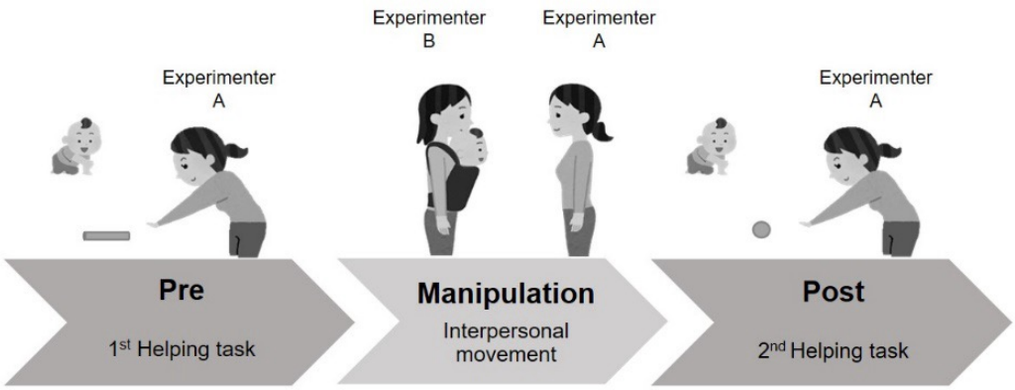
(a) Helping Rate

Experimenter A and two independent raters coded the infants' behavior and scored 1, 0.5 or 0 point for each trial. Each infant's score was divided by the full score of six for each phase (see Supplementary Materials for more details on scoring and etc.).

(b) Temperament Scores

Following to Gartstein & Rothbart (2003), we calculated scores for three factors (Surgency/Extraversion [SUR], Negative Affectivity [NEG], and Orienting/Regulation [REG]): SUR represents the temperament to approach people or objects or to display a smile or active physical movement; NEG represents the temperament, such as crying when a desire is not met or responding with surprise or distress to sudden or new stimuli; REG represents the temperament that maintains attention to one target or prefers contact with caregivers (see Supplementary Materials for subscales of each factor).

Figure 1
A pre-post manipulation design of the current experiment. The helping tasks phase was conducted twice, once before and once after the manipulation of interpersonal movement phase. Infants were assigned either to synchronous or asynchronous condition during the manipulation.

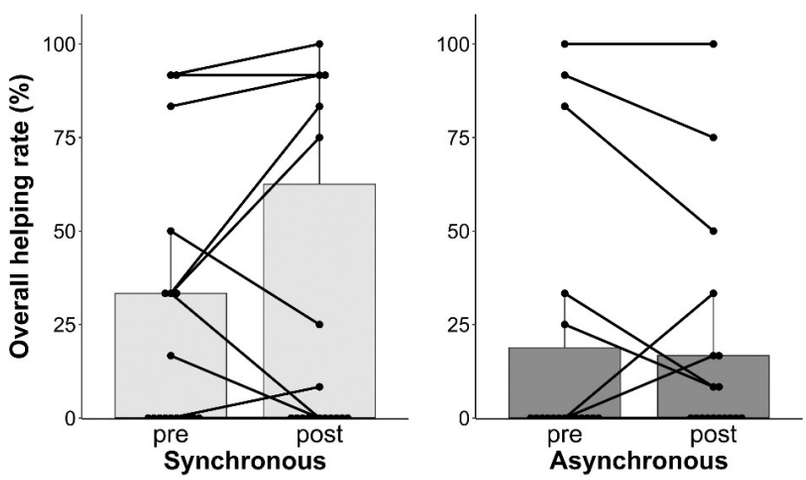


Results

To confirm the prosocial synchrony effect under the current pre-post manipulation design, we first examined whether and how infants' overall helping rate changes after experiencing interpersonal synchrony or asynchrony (Figure 2). The Wilcoxon signed-rank tests showed no significant differences in the overall helping rate between the pre- and post-manipulation in both synchronous (V = 15, p = .71, r = .06) and asynchronous (V = 18, p = .55, r = .10) conditions. This indicates that the effect of interpersonal synchrony on infants' helping behavior was not detectable in the current modified experimental paradigm. Further examination in each time window also showed no significant effect of interpersonal synchrony or asynchrony (Figure 3). No gender differences were found in the effect of interpersonal synchrony or asynchrony on infants' overall helping behavior (synchronous: W = 21, p = .25, r = .27; asynchronous: W = 28, p = .23, r = .29).

As a preliminary analysis, a nonparametric correlation analysis with the three factors of temperament traits (SUR, NEG, and REG) and the amount of change in the infants' overall helping rate between the pre- and post-manipulation was conducted to examine individual differences on the effect of interpersonal synchrony or asynchrony. In the synchronous condition, we found that NEG scores were significantly associated with the amount of change in the overall helping rate (Figure 4; ρ = .65, p < .01), indicating that infants with higher NEG scores tended to have an increased overall helping rate after experiencing interpersonal synchrony. No significant correlations were found between the other temperament traits and the amount of change in the overall helping rate (SUR: ρ = −.11, p = .64; REG: ρ = −.28, p = .27). In the asynchronous condition, none of the temperament traits were significantly associated with the amount of change in the overall helping rate (SUR: ρ = −.23, p = .38; NEG: ρ = −.01, p = .96; REG: ρ = .02, p = .93).

Figure 2
Infants' overall helping rate during pre- and post-manipulation in synchronous and asynchronous conditions. Each dot and line represent the helping rate of each infant.



Note: The upper quartiles and whiskers were only visible in the figure, due to the high number of non-responsive infants in the current study (showing no helping behavior throughout the experiment).

Figure 3
Infants' helping rate in each time window during pre- and post-manipulation in synchronous and asynchronous conditions: (A) 0–10 seconds, (B) 10–20 seconds, (C) 20–25 seconds, (D) 25–30 seconds, and (E) 30– seconds. Each dot and line represent the helping rate of each infant.

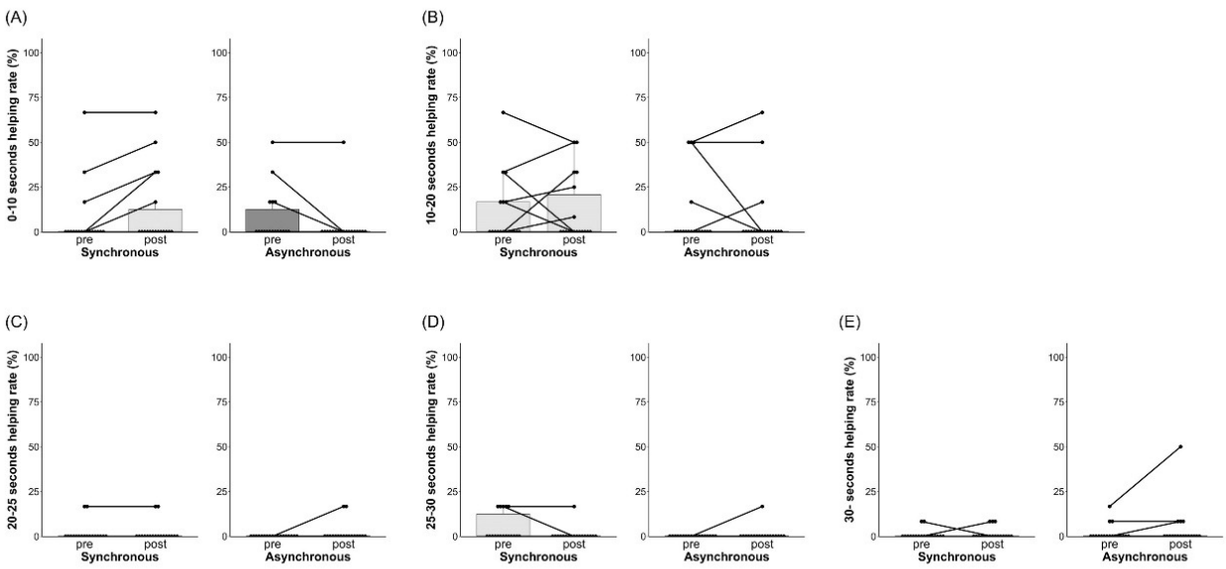
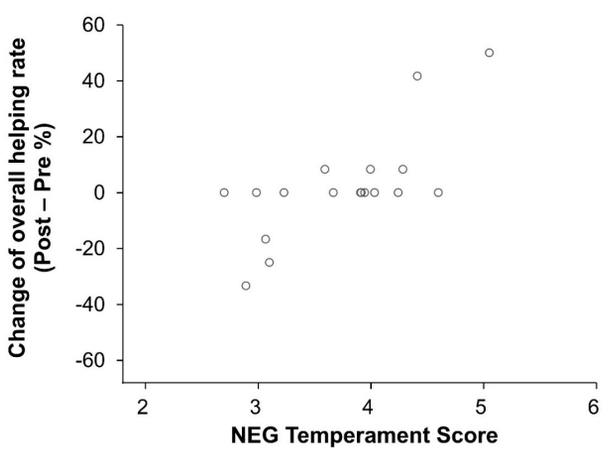


Figure 4
Scatterplot of NEG temperament scores and the amount of change (Post - Pre %) in infants' overall helping rate between pre- and post-manipulation in synchronous condition. Each dot represents each infant.



Discussion

The present study primarily aimed to replicate and extend the findings of Cirelli et al. (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014), which reported a prosocial effect of interpersonal synchrony on infants' helping behavior. To achieve this, we employed the pre-post manipulation design where the helping tasks phase was administered twice—once before and once after the manipulation of interpersonal movement. This procedural modification was intended to provide a clearer delineation of the effects of both interpersonal synchrony and asynchrony on infants' helping behavior and to allow for the exploration of individual differences. Contrary to our hypothesis, the primary analysis revealed no statistical significance in the effect of interpersonal synchrony on infants' overall helping behavior. Interestingly, our preliminary analysis focusing on individual differences did reveal a significant association between infants' temperament scores of Negative Affectivity (NEG) and the degree to which interpersonal synchrony influenced their helping behavior.

Unlike previous studies in human infants (Carpenter et al., 2013; Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014; Cirelli et al., 2016; Tunçgenç et al., 2015) and in adults (Chartrand & Bargh, 1999; Hove & Risen, 2009; Valdesolo & DeSteno, 2011; Wiltermuth & Heath, 2009), we were unable to find significant prosocial synchrony effect. However, when we considered only spontaneous helping (0–10 seconds into trial), infants in the synchronous condition showed an increasing trend in helping behavior, with no infant showing a decrease in this specific time window. This may be in line with the previous studies (Carpenter et al., 2013; Cirelli, Einarson, & Trainor, 2014), suggesting interpersonal synchrony or mimicry facilitates especially infants' fast helping.

Two primary reasons may account for the current statistical non-significance. Firstly, the procedural modification—conducting the helping tasks phase twice—could have introduced order effects, such as practice or fatigue effect. However, we consider this possibility is relatively low because Cirelli, Wan, and Trainor (2014), which introduced four different helping tasks sequentially (the total number of trials was the same with the current study), reports no significant order effects in 14-month-old infants. Instead, we consider socio-environmental factors is more compelling possibility. The current data collection was conducted between August and December 2020, during the initial peak of the COVID-19 pandemic in Japan and globally. In April 2020, Japan had

declared a state of emergency and restricted face-to-face communication. Infants raised during this unique period likely had limited opportunities to interact with unfamiliar adults. Consequently, these infants may have exhibited increased reluctance to help an experimenter who met for the first time on the experiment day. Köster et al. (2019), which used the same database for participants' recruitment with the current study, supports this claim. They examined helping behavior in 16-month-old infants raised in pre-pandemic Japan, and demonstrated 55.9 percent of helping rate in an instrumental helping task (i.e., cup task). This contrasts sharply with the current helping rate in the pre-manipulation (21.3 percent; a combined result across two conditions). This suggests that the current statistical non-significance for examining the prosocial synchrony effect may be due to the acute socio-environmental factors rather than the procedural modification nor general cultural factors. Future research should prioritize collecting additional data from infants born and raised in a post-pandemic environment to clarify the current possibility.

As we hypothesized, asynchronous bouncing showed no significant effect on infants' helping behavior. However, when we again considered spontaneous helping (0–10 seconds into trial), infants showed a decreasing tendency with no infants showing an increase in this specific time window. While interpersonal asynchrony is typically reported to have a neutral effect in adult research (see Hove & Risen, 2009), further investigation is warranted to fully confirm the asynchrony effect in infants.

A preliminary correlational analysis demonstrated the relationship between infants' temperament traits and the effect of interpersonal synchrony on infants' helping behavior. Specifically, infants with higher scores on Negative Affectivity (NEG)—which includes subscales of sadness, distress to limitations, fear and etc.—tended to show a greater increase in helping behavior after experiencing synchronous bounces. One potential interpretation is that interpersonal synchrony may have reduced the fear or anxiety associated with high NEG scores, thereby disinhibiting and facilitating the subsequent expression of helping behaviors. Despite of this finding, we acknowledge that the interpretation requires caution due to the current limited sample size for detecting individual differences. Our future study will aim to recruit a larger sample to determine the robustness of this finding and to further elucidate the underlying mechanisms of the prosocial synchrony effect in humans.

A scope of the current study carries significant evolutionary implications, suggesting that the adaptive functions of interpersonal movement may be shared with other social animals, such as non-human primates. Supporting evidence is provided by Paukner et al. (2009), which demonstrated that capuchin monkeys exhibit increased affiliation and social interaction (i.e., token exchange) toward human experimenter who imitate their behavior. Combined with empirical research on imitation recognition in great apes (Haun & Call, 2008; Nielsen et al., 2005) and evidence on facial mimicry (Myowa et al., 2004), contagious behavioral matching (Anderson et al., 2004; Onishi et al., 2025) and interpersonal synchrony in chimpanzees (Yu & Tomonaga, 2015; 2016; see Yu et al., 2018 for a review), this finding suggests that the prosocial effect of interpersonal movement may have deep evolutionary origins within the primate lineage.

The current pre-post manipulation design provided an empirical data on whether and how interpersonal movement influences 15-month-old infants' helping behavior. This design provided a crucial preliminary step toward identifying factors that may account for variability in infants' behavior. Future research should continue to consider individual differences in temperament traits by assessing physiological changes, such as heart rate, skin temperature, and sweating as well as cultural differences in parenting style and socio-environmental factors. Finally, collecting a larger sample remains a priority to establish the robustness of the prosocial synchrony effect and its modulation by individual differences.

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Author contribution

Kaho Todoriki: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing – original draft (equal), Writing – review & editing (equal). **Lira Yu:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Software, Validation, Visualization, Writing – original draft (equal), Writing – review & editing (equal). **Masako Myowa:** Conceptualization, Funding acquisition, Resources, Supervision, Writing – original draft (supporting), Writing – review & editing (supporting).

Ethical statement

This study was approved by the Ethics Review Committee of the Kyoto University Psychological Science Unit (approval number 1-P-23). Informed consent was obtained from all parents of the infants before the experiment.

Data accessibility

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Supplementary material

Electronic supplementary materials are available online.

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