Effects of Interpersonal Movement Synchrony on Infant Helping Behaviors: Is Music Necessary?

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Moving in synchrony with others encourages prosocial behavior. Adults who walk, sing, or tap together are later more likely to be cooperative, helpful, and rate each other as likeable. Our previous studies demonstrated that interpersonal synchrony encourages helpfulness even in 14-month-old infants. However, in those studies, infants always experienced interpersonal synchrony in a musical context. Here we investigated whether synchronous movement in a nonmusical context has similar effects on infant helpfulness. Fourteen-month-olds were bounced gently while the experimenter faced the infant and bounced with them either in- or out-of-synchrony. In contrast to our previous studies, instead of listening to music during this interpersonal movement phase while being bounced, infants listened to nonrhythmic nature sounds. We then tested infant prosociality directed toward the experimenter. Results showed that synchronous bouncing still encouraged more prosociality than asynchronous bouncing, despite the absence of music. However, helping was more delayed and fussiness rates were much higher than in our previous studies with music. Thus music may not be necessary for interpersonal synchrony to influence infant helpfulness, but the presence of music may act as a mood regulator or distractor to help keep infants happy and allow them to fully experience the effects of synchronous movement.

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Moving in time with others, or interpersonal synchrony, has social consequences. When adults walk, row, tap, dance, or sing in synchrony with one another, affiliative behaviors such as trust, cooperation, and ratings of likeability are encouraged (Anshel & Kipper, 1988; Hove & Risen, 2009; Reddish, Fischer, & Bulbulia, 2013; Tarr, Launay, Cohen, & Dunbar, 2015; Valdesolo, Ouyang, & DesSteno, 2010; Weinstein, Launay, Pearce, Dunbar, & Stewart, 2015; Wiltermuth & Heath, 2009). Even 4-year-old children who play together in a musical versus a nonmusical way are later more helpful and cooperative with one another (Kirschner & Tomasello, 2010). Also, children with poor prosocial skills who took part in weekly group music classes encouraging high levels of interpersonal synchrony, showed larger boosts in self-reported sympathy and prosociality compared to controls (Schellenberg, Corrigall, Dys, & Malti, 2015).

This effect of synchronous movement on social behavior has been shown to even influence infants. For example, 12-month-old infants are more likely to show a social preference for a synchronously over an asynchronously rocking animate toy in a nonmusical context (Tunçgenç, Cohen, & Fawcett, 2015). Furthermore, work in our laboratory has shown that interpersonal synchrony in a musical context actually encourages directed prosociality in 14-month-old infants (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014, 2016; Trainor & Cirelli, 2015). In these studies, infants were held in a baby carrier worn by an assistant, facing an experimenter. The assistant bounced them to the beat of a background song "Twist and Shout" by the Beatles. At the same time, the experimenter facing the infant either bounced in synchrony with how the infant was bounced, or out-of-synchrony (i.e., at a different tempo). Infants then performed instrumental helping tasks with that experimenter, during which the experimenter "accidentally" dropped objects that she was using to complete simple tasks. These tests of prosocial behavior were developed by Warneken and Tomasello (2006, 2007). On each trial, infants had a 30 s window in which to respond. During the first 10 s, the experimenter focused only on the dropped object. During the remaining 20 s, the experimenter involved the infant in the problem by alternating her gaze between the infant and object, and eventually naming the object. Infants who had been bounced synchronously handed back significantly more dropped objects than infants who had been bounced asynchronously (Cirelli, Einarson, & Trainor, 2014). Furthermore, infants who had been bounced synchronously helped more than asynchronously

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bounced infants particularly during the first 10 s of the 30 s response window in each trial. Helping in the first 10 s is considered "spontaneous" helping, because during this period the experimenter focuses only on the object. After the first 10 s, the infant is given social cues (e.g., the experimenter looks at the infant and the object) so helping during this period may reflect compliance as well as prosociality. An increase in spontaneous helping is interpreted as increased altruistic helping rather than compliance (Carpenter, Uebel, & Tomasello, 2013; Cirelli, Einarson, & Trainor, 2014).

A subsequent study replicated the effect of synchronous movement on infants' helping behavior and extended the finding by demonstrating that bouncing synchronously compared to asynchronously with one experimenter does not influence helpfulness directed toward a neutral experimenter uninvolved in the bouncing experience (Cirelli, Wan, & Trainor, 2014). However, in a third study, infants did extend their helpfulness towards a second experimenter, but only if this person was shown to be socially affiliated with the experimenter with whom the infant had been bounced synchronously (Cirelli et al., 2016; Trainor & Cirelli, 2015). This suggests that infants may use synchronous movement as a cue for social relationships. This third study is also important in that the second experimenter, with whom the infants performed the prosocial tasks, was blind to whether the infant experienced synchronous or asynchronous bouncing. In this study, we also found that the amount of time infants spent making direct eye contact with the bouncing experimenter during the interpersonal movement phase did not differ across movement condition (synchronous/asynchronous) and did not predict helping (Cirelli et al., 2016). In sum, these three studies show that synchronous movement can have profound effects on social affiliation early in development.

Our previous investigations of prosociality in 14-month-olds following interpersonal synchrony occurred in a musical context. The music heard by the infant was always present. The high predictability of musical beats in general (e.g., see Repp, 2006) makes music a very good context for synchronizing movements. However, whether music itself contributed to the increased prosociality observed in our previous studies, or whether synchronous movement in a nonmusical context leads to similar rates of infant helping could not be addressed in these previous experiments.

The social effects of interpersonal synchrony have been explored in both musical and nonmusical contexts. In musical contexts, adults who sing together later rate each other as more trustworthy (Anshel & Kipper, 1988), are more cooperative (Wiltermuth & Heath, 2009), experience increased pain thresholds (a proxy for endorphin release), and experience feelings of enhanced group cohesion (Weinstein et al., 2015). Similar results are seen when adults dance together in synchrony. After this experience, they are more cooperative (Reddish et al., 2013), can remember more visual details about one another (Woolhouse, Tidhar & Cross, 2016), experience increased pain thresholds, and have greater feelings of group cohesion (Tarr et al., 2015) compared to those dancing out-of-synchrony.

Affiliative effects have also been observed following interpersonal synchrony in nonmusical contexts. In the experiment by Tunçgenç and colleagues (2015) with 12-month-old infants, it was found that synchronous movement in a nonmusical context influenced infant preferential reaching. In adults, increased pain thresholds were found following rowing synchronously with others versus alone (Cohen, Ejsmond-Frey, Knight, & Dunbar, 2010). Cooperation is encouraged by walking synchronously versus asynchronously (Wiltermuth & Heath, 2009). Individuals who tap their fingers to an even pace matched by an experimenter later rate the experimenter as more likable compared to those who tap asynchronously (Hove & Risen, 2009). Action coordination was found to be more successful between individuals after they rocked in chairs synchronously versus asynchronously (Valdesolo et al., 2010). These studies demonstrate that interpersonal synchrony has social benefits even in nonmusical contexts.

Although the prosocial benefits of interpersonal synchrony have been shown even in the absence of music, engaging synchronously with others in a musical context may still be qualitatively different from interpersonal synchrony in a nonmusical context. More specifically, the presence of music may provide additional emotional benefits. There is evidence that in adults, music listening can reduce cortisol levels (Fukui & Yamashita, 2002) and increase opiate receptor expression (Stefano, Zhu, Cadet, Salamon, & Mantione, 2004), both physiological markers of stress reduction. Demos and colleagues (2012) reported that feelings of closeness between two participants was better predicted by how strongly each participant's movements were coupled to background music rather than to one another. These results highlight that moving to music in the presence of another person may encourage feelings of sharing an experience with that person, which may be more important than the actual degree of synchrony.

In infants, musical context may also contribute positively to social and emotional behavior. Infant-directed singing, for example, delays distress in 7- to 10-month-olds separated from their parent (Corbeil, Trehub, &

Peretz, 2015). Infants were placed in a sound booth with the parent sitting out of sight. Using a between-subjects design, infants listened to infant-directed speech, adult-directed speech, or infant-directed singing over loudspeakers. Infants in the infant-directed singing condition lasted more than twice as long before displaying distress compared to infants in either of the speech conditions (Corbeil et al., 2015). In a related study, Trehub, Ghazban, and Corbeil (2015) reported that mothers soothed their distressed 10-month-old infants more quickly and reduced infant arousal when using singing versus speech. Musical intervention has also been successful in reducing bouts of inconsolable crying in premature hospitalized infants (Keith, Russell, & Weaver, 2009). Together, these studies suggest that music may be a useful mood-regulator or distractor for distressed infants. This mood-regulation effect may be an important component of musical engagement that contributes positively to infants' experiences in addition to the contribution of interpersonal synchrony.

In the present study, we investigate whether interpersonal synchrony versus asynchrony in a nonmusical context promotes helpfulness in 14-month-old infants. The effect of synchrony on infant preferential reaching in a nonmusical context (Tunçgenç et al., 2015) supports our hypothesis that synchronous movement in a nonmusical context will also influence infant helping, which is a much more cognitively demanding and complex social behavior. We are also interested in qualitative differences in infant helping following nonmusical synchrony using a methodology that has already been used in a musical context.

To test our questions, infants participated in two experimental phases: 1) an interpersonal movement phase, during which an assistant held the infant and bounced him/her gently at a constant rate with nature sounds playing in the background, while an experimenter facing the infant bounced at either the same or at a faster rate, and 2) the prosocial test phase, during which the infant was given the opportunity to hand accidentally dropped objects back to the experimenter, who needed them to complete a task. The procedure and participant sample closely matches those used by Cirelli and colleagues (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014, 2016). The critical difference is that instead of listening to music during the interpersonal movement phase, infants listened to nonrhythmic nature sounds (such as rushing water, wind-rustled leaves). We hypothesized that interpersonal synchrony in such a nonmusical context would still encourage prosociality. We were further interested in whether infants' experiences differed in any way from those in our previous studies where infants were bounced to music in the interpersonal synchrony phase.

Method

PARTICIPANTS

Forty walking infants (22 girls; M age $= 14.6$ months; $SD = 0.4$ months) were recruited using the Developmental Studies Database at McMaster University. Of these 40 infants, 40% (16 infants, 10 girls) did not complete the procedure due to excessive fussiness. Of these babies, 5 were too fussy when placed in the carrier to even begin bouncing, 8 were bounced in the synchrony condition, and 3 in the asynchrony condition but become too fussy to continue before the bouncing phase ended. Fussy babies were replaced so that 12 babies (gender balanced) completed each condition (synchrony, asynchrony). The average age of these remaining 24 infants was 14.6 months, $SD = 0.3$ months. The McMaster Research Ethics Board (MREB) approved all experimental procedures. Informed consent was obtained from all parents.

PROCEDURE

Phase 1: Interpersonal movement phase. When infants arrived at the laboratory with their parent(s), the experimenter obtained parental consent and asked parents to fill out a demographics questionnaire as well as three scales (approach, smiling, and activity) from the Infant Behavior Questionnaire (Rothbart, 1981). The assistant, who would later be holding the infant, interacted with the child and introduced him/her to the objects that would later be used during the prosocial test phase (i.e., a clothespin, a marker, and a crumpled paper ball).

Everyone then moved into the sound-attenuating chamber where the experiment itself would take place. The parent was asked to help place the infant in the carrier (Infantino Flip 2012 Infantino LLC) worn by the assistant, so that the infant faced outwards. The parent(s) then sat on a chair in the corner, out of the infant's line of sight. The experimenter stood facing the assistant and infant, about 4.5 feet away.

The experimenter held a button box, and triggered the start of the interpersonal movement phase via a button press connected to Presentation software running on a Windows XP computer. This program initiated 140-s of stimulus presentation. During this phase, infants listened to a 140-s recording of nature sounds (rushing waters, wind-rustled leaves) compiled on an open-source sound mixing website (naturesoundsfor.me). These nature sounds were played through a Denon amplifier (PMA-480R) connected to an audiological loudspeaker (GSI) 6.5 feet from the right side of the infant.

During this phase, the experimenter and assistant holding the infant listened to "bounce instruction tracks" through Denon AH-D501 headphones. These instruction tracks contained woodblock sounds overlaid on pink noise. The assistant and experimenter were trained to bounce by bending at the knees with their feet firmly on the ground so that the lowest part of their bounce lined up with the woodblock sound. In the synchronous condition, both the assistant and experimenter listened to the "bounce instruction track" at 50 beats per minute (bpm). In the asynchrony conditions, the assistant listened to the 50 bpm track while the experimenter facing the baby listened to it at 70 bpm, so that her movements were faster. Infants were randomly assigned to one of these two movement conditions before arriving at the laboratory. Gender was counterbalanced across conditions. These rates of bouncing match those used in our previous experiments (Cirelli, Wan, & Trainor, 2014, 2016). Our original experiment (Cirelli, Einarson, & Trainor, 2014) used both faster and slower bouncing for different infants in the asynchrony condition. Since no differences were found between infants bounced faster versus slower, in the present experiment we used only faster bouncing by the experimenter in the asynchronous condition. The experimenter facing the baby was instructed to smile at the infant and try to make direct eye contact throughout the interpersonal movement phase.

Phase 2: Prosocial test phase. Once the interpersonal movement phase ended, the infant was taken out of the carrier and the assistant left the room. The experimenter then performed three instrumental helping tasks (3 trials in each task) with the infant. These tasks were developed by Warneken and Tomasello (2006, 2007) and have been used in our previous studies on infant social behavior following interpersonal synchrony (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014, 2016).

The three tasks consisted of 1) the clothespin task, during which the experimenter pinned dishcloths onto a small clothesline using plastic clothespins, 2) the marker task, during which the experimenter used different colored markers to draw a picture of a flower on a 2.5-ft high table, and 3) the paper ball task, during which the experimenter threw paper balls from a jar into a bucket that was placed on a 2.5-ft high table. The order of the three tasks was counterbalanced across gender and movement condition. Each task began with the experimenter successfully demonstrating the goal once (e.g., successfully pinning up the first corner of the dishcloth). Then, the test trials began.

During each of the nine test trials, the experimenter dropped the object (a clothespin, a capped marker, or a paper ball) that was being used to complete the task. She then reached for the object for 30 s. During the first 10 s, the experimenter focused her gaze only on the object. During the next 10 s, she alternated her gaze between the object and the infant. During the final 10 s, she continued to alternate her gaze between the object and the infant, and also vocalized the objects name (e.g., "My clothespin!"). The trial ended either when 30 s had elapsed, or when the infant picked up and handed the object back. The experimenter then successfully used either the retrieved object (if it had been handed back) or an alternate object to complete her task before progressing onto the next trial or task.

DATA CODING

Two mounted cameras (a Canon PowerShot SD1000 and a GoPro HERO3+) recorded the experimental procedures, and these videos were later used to code helpfulness. There were two raters, each blind to infants' interpersonal movement condition while coding. Raters viewed the tapes and recorded whether infants handed back the objects on each of the nine trials. Infants received 1 point for handing the objects back within the 30-s trial window, and received 0.5 points for handing the objects back after the 30-s window had ended but before the next task began. Overall helping rate was calculated as (score[task 1] + score[task2] + score[task 3]) / (3 tasks X 3 trials) X 100%. The time it took infants to hand objects back was also recorded, and used to calculate a separate score for spontaneous helping (helping within the first 10 s of the trial) and delayed helping (helping after the first 10 seconds). Inter-rater reliability was high, $r = .99$, $n = 24$, $p < .01$.

In order to examine the consistency of the experimenter's behavior across conditions, two separate raters blind to the hypotheses and conditions watched videos showing only the bouncing experimenter (assistant and infant were cropped out) during the interpersonal movement phase. 30 s clips of this experimenter, starting 60 s into each infant's interpersonal movement phase, were shown to the raters. These raters were instructed to watch each video and then, using 10-point Likert scales, rate how happy, smiley, attentive, interactive, and connected to her bounce partner this experimenter seemed. These raters also answered a forced-choice question asking if the experimenter in each video was bouncing in synchrony or out-of-synchrony with the out-of-view bounce partner. Neither

TABLE 1. *Objects Handed to Experimenter (Helping) Across Tasks and Bounce Conditions*

Movement Condition	Clothespin	Paper Ball	Marker	Total Helping
Asynchronous	0.50 (0.34)	0.45 (0.31)	0.36 (0.28)	1.32 (0.75)
Synchronous	1.42 (0.32)	1.13 (0.37)	1.46 (0.40)	4.00 (0.86)

Note. Average number of objects handed back is reported here, with SEM shown in parentheses. Maximum score for individual tasks is 3 objects. Maximum score for total helping is 9 objects.

rater rated experimenter behavior differently across the two movement conditions on any of the scales (all *p*'s > .24). In addition, neither rater was able to correctly identifying the movement condition at a level above chance ($p = .84$ for both raters). This supports our assumption that experimenter behavior was consistent across interpersonal movement conditions.

Results

Using a predetermined *z*-score outlier cut-off of $\pm$ 2 for overall helping rate, one infant (a female in the asynchrony condition) was excluded from the analysis as an outlier.[1] No significant correlations were found between infant overall helpfulness or early or late helpfulness and parent-rated IBQ scores on smiling, activity, or approachability (all *p*'s > .38). There was no main effect of task (clothespin, marker, paperball) on overall helping rate ($p = .77$), and so tasks were collapsed in the following analyses. Task and overall means across bounce conditions are shown in Table 1.

OVERALL HELPING

An independent samples *t*-test was used to compare overall helping rates across the two movement conditions (synchrony/asynchrony). Infants bounced synchronously with the experimenter handed back significantly more objects than infants bounced asynchronously with the experimenter (44.6% > 14.6%), $t_{(21)} = 2.33$, $p > .05$, $d = 1.02$ (See Figure 1). Infants from the synchrony condition helped 29.86% more than infants from the asynchrony condition, difference score 95% CI [3.21%, 56.52%].

To illustrate the consistency of this effect across individual participants, the number of infants in each of the two movement conditions who helped on more than 50% of the trials was calculated. For the synchrony condition, 58% of infants helped on more than half of trials, while for the asynchrony condition, only 9% of infants helped on more than half of trials, $\chi^2(1, N = 23) = 6.14$, $p < .05$.

[1] Given the large between-subjects variability in this measure of infant helping, this predetermined outlier cut-off is often used in our lab. When this infant is included in the analyses, overall helping differences across movement conditions do not quite reach significance, $p = .12$, but statistical decisions about delayed/spontaneous helping differences across movement condition remain unchanged.

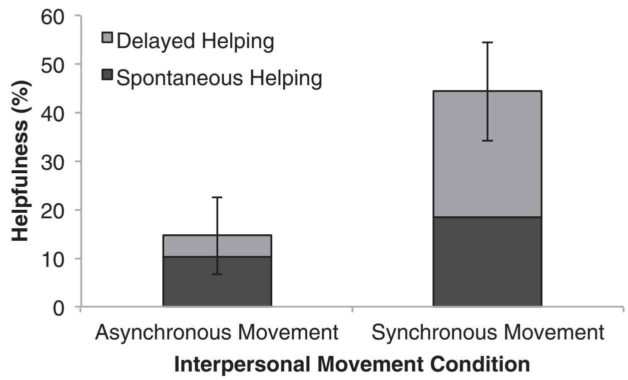

FIGURE 1. The average percentage of objects handed back to the experimenter as a measure of helpfulness ($\pm$ SEM of overall helping). From this graph, overall helping, spontaneous helping (within first 10 s of trial) and delayed helping (after first 10 s of trial) can be seen. Infants from the synchronous movement condition helped significantly more overall than infants in the asynchronous movement condition. This was specifically driven by a boost in delayed helping following interpersonal synchrony (no effect of spontaneous helping).

SPONTANEOUS AND DELAYED HELPING

Independent samples *t*-tests were used to compare helping rates for both spontaneous (within the first 10 s) helping and delayed (between 11 and 30 s) helping across movement conditions. There was no effect of movement condition on spontaneous helping, $t_{(21)} = .87$, $p = .40$. However, there was a strong effect of movement condition on delayed helping, $t_{(16.44)} = 3.20$, $p < .01$, $d = 1.58$ (See Figure 1). Infants from the synchrony condition displayed delayed helping on $M = 25.83\%$ of the trials, while infants from the asynchrony condition displayed delayed helping on only $M = 4.55\%$ of trials, difference score 95% CI [7.05%, 35.53%]. This suggests that the effect of movement condition on overall helping is specifically driven by a boost in delayed helping following interpersonal synchrony. Infants in the synchrony condition helped the experimenter significantly more than infants in the asynchrony condition, but the increased helping took place late in the trials.

FUSSINESS RATES

There was a surprisingly high fussiness rate in this experiment. Out of the 40 infants who came in for testing, 16 (or 40%) of them were too distressed to complete the interpersonal movement phase. This rate is high compared to the rates in our previous studies (17% in Cirelli, Einarson, & Trainor, 2014; 25% in Cirelli, Wan, & Trainor, 2014; 16% in Cirelli et al., 2016). Parent-rated IBQ scores for the infants who made it through the experiment versus those who were too fussy to continue did not differ for composite scores of smiling, $t_{(37)} = 0.52$, $p = .60$, approach, $t_{(37)} = 1.97$, $p = .28$, or activity, $t_{(37)} = 3.52$, $p = .73$. However, the response to one particularly relevant question ("When introduced to a strange person, how often did the baby cling to a parent?") did differ across these two groups, $t_{(37)} = 2.07$, $p < .05$, $d = 0.68$. Infants who made it through the experiment were rated on a scale of 1 to 7 as being less likely to cling to a parent (median score = 4; *about half the time*) than infants who were too fussy to continue (median score = 6; *almost always*). It should be noted that parents fill out the IBQ during or after the procedure, so how the infant responded to the experimenters might have influenced parent responses. However, parents were instructed to respond based on how infants have behaved in the past week.

Discussion

These results demonstrate that 14-month-old infants display more helpfulness towards a synchronously moving partner compared to an asynchronously moving partner, even in a nonmusical context. This suggests that the effect of interpersonal synchrony on infant helping is not a music-specific effect, even early in development. This is in line with the findings on infant preferential reaching by Tunçgenç et al. (2015). At the same time, we found interesting differences between the results in the present study and results from previous studies where general procedures were very similar except for the presence of music during the initial interpersonal movement phase. First, the effect on overall helpfulness in this sample was specifically driven by a boost in delayed helping (helping after 10 s into each trial). In our previous studies (Cirelli, Einarson, & Trainor, 2014; Cirelli et al., 2016), it was spontaneous helping (helping within the first 10 s) that was especially increased by interpersonal synchrony. Spontaneous helping has been interpreted as representing more altruistic helpfulness (Carpenter et al., 2013; Cirelli, Einarson, & Trainor, 2014). This, along with the surprisingly high drop out rate due to fussiness in the current sample (40%), suggests that infants were overall more distressed when listening to environmental sounds during the bouncing than those who had been bounced in a musical context. Considering the fact that music has been found to delay fussiness and regulate infant mood (Corbeil et al., 2015), we interpret our late helping rates and higher fussiness rates as evidence that infants were less content in the present experiment than they were in our previous studies.

The high fussiness rate in the present sample (40%) also makes it difficult to directly compare helpfulness rates to those recorded in our previous studies. While the population of infants recruited for this experiment match those of our previous experiments, it is likely that infants who actually *completed* the procedure in the present study were qualitatively different from our previous studies due to the high fussiness rate. More specifically, because of the high fussiness rate, one might have predicted that since only the infants who were rated as less likely to cling to their parent made it through the experimental procedure, helping rates would have been artificially inflated. Surprisingly, however, overall helping rates were numerically lower than in our previous samples. The previous samples came from the same participant pool, infants were of the same age as in the current study, sample sizes per condition were the same, and procedures were very similar. In the present study, helping rates following interpersonal synchrony averaged 44.6%. We found higher rates in our previous studies (50.6%, 61.3%, and 65.67% respectively for Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014, 2016). These lower helping rates, especially from a sample rated to show less parental clinginess, are consistent with our interpretation that infants were less content in the present study than in our previous studies involving music.

The way that interpersonal synchrony encourages prosociality is still a matter of debate. Some scholars suggest that our attention is directed towards those who move in synchrony with us, and that by attending to and learning more about these individuals we feel more comfortable with them (Macrae, Duffy, Miles, & Lawrence, 2008; Woolhouse et al., 2016). Others suggest that interpersonal synchrony leads to an overlap in our perception of self and others. This overlap increases perception of self-similarity and encourages feelings of empathy (Overy & Molnar-Szakacs, 2009; Valdesolo & DeSteno, 2011). It has also been proposed that neurohormonal mechanisms are at play, and that interpersonal synchrony triggers the release of oxytocin and/or endorphins, both related to social bonding (Freeman, 2000; Tarr, Launay, & Dunbar, 2014). While the present study does not attempt to disentangle these proposed mechanisms, it does highlight the importance of considering the socioemotional consequences, both cognitive and neurohormonal, of interpersonal synchrony and musical engagement as having separate but potentially interactive effects.

In sum, these results suggest that infants direct helpfulness towards synchronously moving partners, even in a nonmusical context. However, without music, infants are less content and are slower to display this helping behavior. This supports the idea that while music may not be necessary for the increased prosocial effect of synchronous movement, music acts as a mood regulator or distraction from distress.

Music also creates a natural context in which interpersonal synchrony can be achieved with others (in the present experiment, movement synchrony was achieved by the artificial means of having the assistant and experimenter listen to a beat track on headphones) because of our propensity to move to the underlying beat in music (for example, see Patel & Iversen, 2014; Repp, 2006; van der Steen & Keller, 2013; Trainor, 2015). When individuals in a group all align their movements with the underlying beats in the same piece of music, they end up aligning their movements with one another by default. Therefore, musical contexts create a setting within which interpersonal synchrony is easily achieved, and where mood-enhancing effects of music may complement and contribute to the social benefits of interpersonal synchrony. This combination of providing a context that fosters 1) social bonding and 2) emotional regulation may explain why music is a special and important social tool. This is likely why musical behaviors such as singing and dancing are present in social situations in which the goal is to feel affiliated with others, such as at parties, religious ceremonies, weddings, funerals, and in the military. The present study shows that even early in development, both synchronous movement and music contribute to prosocial behavior and interpersonal affiliation.

Author Note

Consent was obtained from parents, as per the McMaster Research Ethics Board (MREB) guidelines. L.K.C. was the primary researcher and L.J.T. the senior researcher but all authors contributed to the ideas, analyses, and writing of the manuscript. L.K.C., S.J.W., and C.S. tested the participants, along with Susan Marsh-Rollo, who we would like to formally acknowledge and thank. We also thank Trenton Coleman, Abi Kirubarajan, and Mimi Deng for rating videos, as well as Haley Kragness for comments on an earlier draft. This research was funded by a grant from the Natural Sciences and Engineering Research Council of Canada to L.J.T. (RGPIN-2014-0470) and by the Social Sciences and Humanities Research Council to L.K.C.

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