Joint Music Making and Prosocial Behavior in Preschoolers:

Lyrics, Vocal-Motor Imitation, & the Beat

By

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This work is dedicated to my family. To Park, my partner in this crazy ride, you make me better. You always believe in where I'm going, not just where I've been, and it makes me feel like the possibilities are endless. I am so happy to be riding with you.

To my daughters, Magnolia and Jona, you are my greatest joy. I am so proud of you every day, and I am doing my best to live, learn, and love so that you will always be proud of me too.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

When people make music together – whether they use only their own voices and bodies to create sound or they play instruments – they may experience a variety of social and emotional effects ranging from increased feelings of similarity, affiliation, and perceived closeness to an increased tendency to help or cooperate with their fellow music makers. Researchers have documented this phenomenon in adult participants engaged in activities ranging from group singing (Anshel & Kipper, 1988; Kreutz, 2014; Weinstein, Launay, Pearce, Dunbar, & Stewart, 2015) to vocal improvisation (Sanfilippo, Pearce, Stewart, & Launay, 2016) to drumming (Kokal, Engel, Kirschner, & Keysers, 2011), and ongoing research is attempting to specify not only the types of joint musical experiences likely to create these prosocial benefits, but also the mechanisms involved.

In particular, much attention has been paid to the possible role of interpersonal movement synchrony in blurring self-other boundaries between people engaged in joint music making. There is some evidence that active music making may impact children's social behavior in a similar way (Good & Russo, 2016; Kirschner & Tomasello, 2010), but the reliability and generalizability of this effect have not been established. Additionally, preschool-age children face perceptual and motor limitations which cause their musical interactions to look very different from those of adults, calling into question whether movement synchrony could play as significant a role in children's music making. Past studies showing prosocial behavioral effects of music making have not quantified the extent of movement synchrony achieved during the interaction. Another factor somewhat unique to young children's musical interactions is the ubiquity of singing over instrumental-only approaches, which raises the question of the potential impact of lyrical content on children's behavior. The current study consists of two experiments designed to examine children's helping and sharing behavior toward a previously unfamiliar adult subsequent to musical or non-musical play, as well as the impact of verbal content on behavior across conditions. Behavioral coding was used to explore how the type of interaction impacted children's joint movement, interpersonal movement synchrony, and engagement throughout the interaction.

Active Music Making and Children's Prosocial Behavior

We can operationalize active music making in this literature as using one's own body to create sound which is organized by a beat – a steady, repeating pulse. Joint music making, then, is doing this with at least one other person. A short list of studies has begun exploring the impact of joint music making on children's social behavior, with inconsistent findings. Kirschner & Tomasello (2010) showed that singing and moving to prerecorded music in the context of peer-play alongside an experimenter increased 4-year-olds' voluntary helping and cooperative problem-solving toward the involved peer. Kirschner & Ilari (2014) investigated 2- to 4-year-old children's prosocial behavior toward an adult experimenter following joint or solo drumming and found no effect of joint drumming versus solo drumming. Among older children (ages 6 to 10), Good & Russo (2016) found that group singing increased cooperation among peers as compared to group art or competitive games.

A small body of research with even younger children has focused on the behavioral effects of interpersonal synchrony in the context of music. Interpersonal synchrony refers to two or more individuals moving in unison, either through behavioral matching akin to mimicry or movement matched in time (Bernieri & Rosenthal, 1991), and the periodic pulse – or beat – associated with music offers a useful temporal framework for coordinating movement between individuals. A 2015 meta-analysis on prosocial effects of synchrony identified four studies of children for inclusion (Rennung, & Göritz, 2016). Among them was a series of experiments investigating 14-month-olds' helping behavior after being bounced either synchronously or asynchronously to a musical stimulus. The experiments showed that synchronous bouncing with an experimenter resulted in more spontaneous helping directed at the experimenter (Cirelli, Einarson, & Trainor, 2014) and that increased helpfulness extended to affiliates of the synchronous individual but not a neutral stranger (Cirelli, Wan, & Trainor, 2016). Although these studies elucidate the effects of a more passive form of engagement with music, being bounced rhythmically in an adult's arms is arguably a characteristic form of musical engagement for infants and toddlers. An additional study by Cirelli, Wan, Spinelli and Trainor (2017) tested whether the melodic elements of music were essential to this effect by using this paradigm with a beat-only stimulus; they found that although synchrony still facilitated helping behavior over asynchrony, markedly higher rates of participant attrition and fussiness occurred in the absence of music. Cirelli and colleagues concluded that although motor synchrony alone was sufficient to cue increased helping behavior, melodic elements may have mood-regulating benefits for toddlers that interact with motor synchrony in a musical context.

Movement Synchrony and Children's Prosocial Behavior

Other lines of work have isolated the effects of both passive and active movement synchrony on children's prosocial behavior, independent of a musical context. Interpersonal movement synchrony is often presumed to be the magic ingredient of music making, and indeed a large body of literature has shown prosocial behavioral effects of movement synchrony in adults (see Rennung & Göritz, 2016). For example, movement synchrony in adults has been shown to facilitate prosocial and cooperative behavior (Kokal, Engel, Kirschner, & Keysers, 2011; Valdesolo & DeSteno, 2011; Valdesolo, Ouyang, & DeSteno, 2010; Wiltermuth & Heath, 2009;) and increase feelings of affiliation, trust, and positive affect (Hove & Risen, 2009; Launay, Dean, & Bailes, 2013; Valdesolo & DeSteno, 2011; Valdesolo et al., 2010). Interpersonal synchrony with a partner has been shown to increase memory for that partner's face and utterances (Macrae, Duffy, Miles, & Lawrence, 2008) and reduce the perceived formidability of an antagonist (Fessler & Holbrook, 2014). Additionally, there is evidence that simply perceiving motor synchrony in animated stick figures increases participants' evaluations of rapport between the animated figures (Miles, Nind, & Macrae, 2009) and entitativity, or the extent to which a group of individuals is perceived as a cohesive unit (Lakens, 2010). A specialized type of musical synchronized movement which often occurs in large groups of individuals – synchronized singing – has been shown to increase measures of self-reported well-being and significantly increase levels of oxytocin, a hormone associated with stress reduction and social bonding (Kreutz, 2014), as well as increase pain threshold measurements and increase feelings of inclusion and connectedness (Weinstein, et al., 2015).

Recent studies of synchrony in children have shown that active synchrony in the form of a tap and clap game increased spontaneous helping in 4- to 6-year-olds (Tunçgenç & Cohen, 2016) and that passive movement synchrony delivered using a playground-style swing apparatus increased peer cooperation, intentional communication, and sharing in 4-year-olds (Rabinowitch & Meltzoff, 2017a; Rabinowitch & Meltzoff, 2017b). Because of this increasing evidence that movement synchrony alone increases prosocial feelings and behaviors in children, and the fact that musical activities are presumed to facilitate such synchrony due to the presence of a periodic pulse or beat, the prevailing view seems to be that when joint music making facilitates increases in prosocial behavior, interpersonal synchrony is the cause. Notably, these studies operationalize interpersonal synchrony to a high degree of precision such that slightly out-of-phase movements between individuals constitute asynchrony rather than synchrony. In a naturalistic joint music making interaction, some individuals (and most young children) may lack the motor coordination to truly sing or move in synchrony with one another, and small variations may matter. However, no study to date showing prosocial effects of music making in children of any age has quantified the degree of movement synchrony actually present in the music making interaction and examined its relationship with children's behavior. The current study aimed to address this gap in the literature.

Impact of Song Lyrics on Behavior in Children and Adults

Ever since Bob on Sesame Street encouraged kids to get to know "The People in Your Neighborhood" in 1970, media aimed at preschoolers has used musical segments to introduce and reinforce lessons about community, kindness, and emotional regulation. And while album releases may have made such songs available to some families in the past, the growing use of internet streaming services like Spotify and PBS Kids in recent years has made these songs and segments even easier for families to access and consume regularly. If you search for award-winning preschool educational program *Daniel Tiger* on Spotify, you will find 22,001 monthly listeners tuning in to hear songs aimed at helping children develop socio-emotional skills – songs like “Use Your Words,” “A Different Way is Okay,” and “Saying I’m Sorry is the First Step.” On Common Sense Media, a popular website for parents who wish to vet the content of movies, music, and media for their young children, parents who search under “best music for kids” can find a playlist called Strong Women in Music (Strong women in music, n.d.). The site says the playlist is appropriate for preschoolers, school-age kids, and tweens, and it includes Dora the Explorer singing “We Did It,” Queen Elsa from the blockbuster Disney movie *Frozen* singing “Let it Go,” and pop star Selena Gomez singing her empowering anthem “Who Says?” Even *Peppa Pig*, a preschool program often criticized for modelling less desirable behaviors like teasing peers and body-shaming the overweight Daddy Pig, features the occasional didactic tune like “The Recycling Song.” Thus, there seems to be a widely held assumption by parents and media-creators that these messages matter. Why expose children to songs about feelings, being a good friend, and building community unless there’s some kind of benefit? If there is a benefit in terms of children’s understanding of social and emotional issues or children’s behavior subsequent to engaging with socially didactic songs, it has not been demonstrated empirically.

This is a relevant gap in the literature because when children engage in music making, singing is almost always involved, and songs contain verbal content. If interpersonal synchrony is the driving force behind music increasing prosociality, then the content of the lyrics themselves may not matter. However, research on adult processing of song lyrics in a laboratory setting suggests that even passive exposure to prosocial lyrics increases prosocial affect and behavior in listeners (Grietemeyer, 2009; Greitemeyer, Hollingdale, & Traut-Mattausch, 2015; Grietemeyer & Schwab, 2014) and decreases aggressive thoughts (Böhm, Ruth, & Schramm, 2016), and these findings have been extended to more naturalistic settings and behaviors like tipping in a café (Jacob, Guéguen, & Boulbry, 2010). Though not specific to songs, a 2005 meta-analysis of the behavioral impact of prosocial children's media by Mares and Woodard showed consistent moderate positive effects for children watching prosocial content on TV (relative to antisocial content) according to measures of altruism, social interactions, and levels of stereotyping (95% confidence interval for effect size was .25 to .36). Notably, many of the programs examined feature music as a key didactic element (e.g. *Barney*, *Sesame Street*). Based on these findings, we cannot assume that the words children sing have no impact on their subsequent behavior, even though no studies with children have explicitly examined the impact of lyrics on prosocial behavior following music making. Therefore, another aim of Experiment 1 was to examine the impact of didactic verbal content on children's behaviors subsequent to a musical or non-musical interaction.

The current study consists of two experiments designed to examine preschool-age children's helping and sharing behavior toward a previously unfamiliar adult subsequent to musical or non-musical play. Experiment 1 established a paradigm for comparing sharing and helping after a brief experimental interaction, while also investigating the impact of verbal content on behavior across conditions. Experiment 2 investigated children's sharing and helping subsequent to a joint singing interaction that was either temporally regular or temporally irregular. Behavioral coding was used in both experiments to explore how the type of interaction impacted children's joint movement, interpersonal movement synchrony, and engagement throughout the interaction.

CHAPTER II

EXPERIMENT ONE

Introduction

Experiment 1 asked three key questions regarding music making in preschool age children. First, does joint music making result in greater willingness to share and help a previously unknown person than non-musical play? Second, does prosocial verbal content within the interaction (lyrics or poem text) result in more prosocial behavior than neutral content? And third, does naturalistic music making foster greater engagement, joint movement, and movement synchrony than non-musical play, and do these factors significantly predict children's helping and sharing behavior?

The experiment utilized a 2x2 design (see Figure 1) in which type of interaction (musical vs. non-musical play) and verbal content (prosocial vs. neutral) were varied. All comparisons were between subjects.

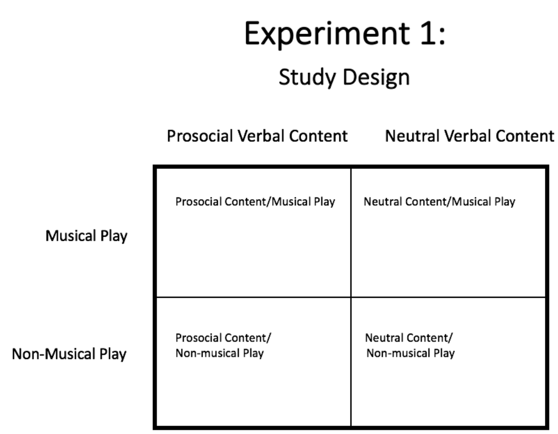

Figure 1.

Method

Participants

Sixty-two children (29 girls, M_{age} = 4;8, *SD* = 6.24, range: 47-75 months) participated, none of whom had begun kindergarten. Participants were randomly assigned to one of four groups: musical play/prosocial content, musical play/neutral content, non-musical play/prosocial content, and non-musical play/neutral content. Age and sex were distributed approximately equally across conditions. Children were tested both in the lab and in local pre-kindergarten classrooms in the greater Nashville, Tennessee area. Individual families were recruited through Studyfinder (www.studyfinder.com), a website affiliated with the Vanderbilt Kennedy Center which connects families with researchers, as well as through fliers posted at community spaces and word of mouth. Diagnosed developmental delay, lack of fluency in English, and significant hearing loss were established as exclusionary criteria in advance of recruitment. Four children were excluded from the final sample; reasons included video equipment failure (n=1), lack of fluency in English (n=1), and unwillingness to provide verbal assent (n=2). According to parental report, the sample was 38.3% White, 25% African American, 5% Asian, and 31.7 % Mixed/Other. The study was approved by the Vanderbilt Institutional Review Board, and parental consent and participant assent were obtained from all participating families.

Materials

In all conditions, after a brief warm up period, children were introduced to a toy puppet and told, "I made up a song/poem about my puppet! Would you like to hear it?" The two musical play conditions utilized the melody transcribed in Figure 2. The two prosocial content conditions utilized the following content (with the bolded refrain repeated twelve times) presented either in song or poem form:

I have something that I like
I would like to keep it
But I know the thing to do
Is be a friend and share it
Share, share, share, share
Be a friend and share it

The neutral content conditions utilized the following alternate lyrics (with the bolded refrain repeated twelve times) presented either in song or poem form:

I have something that I like
I'll tell you a secret
It can talk and laugh and play
It's my favorite puppet
La, la, la, la
It's my favorite puppet

Figure 2. Melody for Experiment 1 musical play conditions. Lyrics varied according to verbal content condition (prosocial or neutral).

Procedure

All participant testing was conducted by me in the role of primary experimenter and an undergraduate research assistant (RA). When children were tested in the lab, their parents were consented in the waiting room by the RA while I played with the child nearby. Because prosocial behaviors were measured relative to the RA, we ensured that the child and the RA did not interact prior to the experimental interaction. Parents also completed a parent questionnaire and a video consent document. When children were tested in a local preschool, all three forms (consent, video consent, and parent questionnaire) were completed in advance and returned to the school prior to the child's participation in the study. In both settings, parents were not in the room during the experiment itself, and all sessions were videotaped.

Assent. The experiment began with the experimenter and the child sitting down on the floor at a 90-degree angle from one another (leaving space directly across from the participant for the RA to sit after the warm-up period). The experimenter then obtained the child's assent to participate in the experiment using the following language. "Your mom and dad said it was OK for us to play some games together. If you decide you don't want to play, you can tell me and we'll stop. If you want to take a break we can do that too. Just tell me "I want to stop". Would you like to play with me today?"

Warm-up period. The experimenter introduced a laminated poster of a five-point pictorial likert scale (very sad, sad, neutral, happy, very happy), and explained that the picture could be used to show someone how you are feeling. The experimenter then familiarized the child with use of the scale by having a brief conversation about favorite foods, followed by several questions about the child's feelings about meeting new people and singing. During this time, the RA was in the corner of the same room, engaged in an unrelated task. This conversation between the participant and the experimenter served primarily as an ice breaker for the experimental interaction, and children's responses to these questions will not be reported further.

Introduction of research assistant and puppet. The experimenter then asked, "Can my friend, ______, play with us?" before inviting the RA to sit across from the child. The experimenter then said, "I brought a special toy, and I'd like to show it to you guys. Would you like to see it?" before bringing out a furry dog puppet and making it bark, talk, and play for approximately thirty seconds. The experimenter then offered the puppet to both the child and the RA to hold and play with before putting it away.

Experimental interaction. The experimenter then said, "Would you like to know something neat? I made up a song/poem about my puppet! Would you like to hear it?" At this point the experimenter either sung or spoke the song or poem, depending on the experimental condition. In the two musical play conditions (musical play/prosocial content and musical play/neutral content), the twelve refrains of the song were divided into three segments. In the first, the experimenter sang, encouraging the RA and the child to sing along for four repetitions (saying, "Now here's the part we can sing together!"). Next, the experimenter asked the RA and the child to sway from side to side in a seated position, demonstrating the movement before saying, "let's sway and sing this time" and singing the refrain four more times. Finally, the experimenter said, "would you guys like to play shakers while we sing?" and offered a basket of egg shakers to both the child and the RA, encouraging each to take two. Then the experimenter clapped the shakers on her knees to the beat while singing the refrain four final times.

In the non-musical play conditions (non-musical play/prosocial content and non-musical play/neutral content), the experimenter simply recited the poem at a tempo intended to match the sung tempo. The twelve repetitions of the refrain were divided into two segments of four and eight repetitions, respectively. For the first four repetitions, the experimenter spoke the words while the child and RA simply listened. Next, the experimenter said, "would you guys like to play shakers?" and offered a basket of egg shakers to both the child and the RA, encouraging each to take two. The experimenter then said, "there are lots of ways to play shakers!" before beginning to play haphazardly with the shakers while reciting the refrain eight more times. The RA and the child were thus engaged with the shakers while the experimenter recited the refrain, but no attempt was made by the experimenter or the RA to synchronize with a beat, each other, or the spoken refrain. In both musical play and non-musical play conditions, the RA attempted to engage the child and make eye contact with him or her throughout the interaction.

Sticker sharing task. The sharing measure consisted of the experimenter distributing stickers unevenly (seven for the child and one for the RA) and then pretending to be all out of stickers. Verbal prompts were given ten seconds apart, culminating in a direct request for the child to share his or her stickers with the RA. After collecting the shakers, the experimenter reached into an envelope and brought out two small sheets of colored paper, saying, "Here is a sheet of paper for each of you, and here are some stickers. Let's wait until you both have stickers before we start to play with them, OK?" The experimenter then placed the two sheets of paper in front of the child and the RA and proceeded to bring out stickers one at a time, giving the child seven identical stickers and the RA a single sticker. The experimenter then looked into the envelope, saying, "uh oh, we're all out of stickers!" The RA then looked sadly at his or her stickers, saying "Oh Man!" The experimenter waited ten seconds and then gave a tiny knock on the floor if no sharing had occurred, prompting the RA to say "I wish I had more stickers. I love stickers" while still looking sadly at her sticker. The experimenter then waited ten more seconds, and if no sharing had yet occurred, gave a tiny knock to prompt the RA to say "will you share your stickers with me?" to the child. This direct request was the first point at which the RA made direct eye contact with the child within the sticker sharing task. The experimenter then waited ten more seconds and then gave a tiny knock if the participant had not initiated sharing, indicating that the child would be coded as a zero (see Appendix C for sticker sharing coding criteria). The experimenter kept her attention on the empty envelope and the timer for the duration of sticker task, also not making eye contact with the child. If the child initiated sharing by giving one or more of his or her stickers to the RA at any point, the prompts ceased. After the child had reached a stopping point in sharing, either by beginning to place his or her own stickers on the page or by saying something indicating that he or she was done (e.g. "now we both have four stickers!"), the experimenter ended the segment, saying "now let's put our stickers on our pages!"

The sharing task always occurred directly after the experimental interaction and was immediately followed by the helping task. The order of the two tasks did not vary between participants.

Helping task. The helping task consisted of the RA spilling a cup of colored pencils, as if by accident, and giving a series of successive prompts spaced ten second apart, culminating in a direct request for the child's help in picking them up. After the sticker task was complete, the experimenter said, “would you guys like to color with colored pencils on your sticker pages? Oh good. Here are some pencils for you (giving a solo cup full of twelve colored pencils to child), and I have another cup for you (in the direction of the RA). I need to grab something from the other room, but let me get you some pencils (to the RA).” At this point the experimenter walked to a point approximately six feet away where a second cup of pencils was waiting. The RA got up and followed the experimenter, who then handed off the cup, saying, “I’ll be right back” before leaving the room. As the experimenter left the room, the RA pretended to “drop” the cup of pencils, saying “oh man, I dropped the pencils,” before beginning to pick them up one by one, slowly. After ten seconds, the RA said, “it’s going to take forever to pick up all these pencils.” After ten more seconds, the RA asked, “Will you help me pick up the pencils?” This direct request was the first point within the helping task at which the RA made direct eye contact with the child. If the child initiated helping, the prompts ceased; helping was defined as getting up, picking up at least one pencil, and either giving it to the RA or putting it in the RA’s cup (see Appendix D for coding criteria). After collecting the spilled pencils, the RA and child returned to their spots on the floor and colored on their sticker sheets. The experimenter returned once this had occurred, and the coloring then continued for about three minutes before the experimenter encouraged both the child and the RA to complete their pictures, ending the task. When the pencils had been put aside, the RA said, “thanks for playing with me!” before getting up and leaving the room. The experimenter and the child then continued with the post-interaction measures.

Post-interaction measures. The post-interaction measures consisted of a three-item measure of affiliation for the RA and a content comprehension check. Affiliation for the RA was assessed with the following questions, presented in random order:

1. How much fun did you have playing with ___ (RA)? Lots, a little fun, or no fun at all?
2. How much would you like to play with ___ (RA) again? Not at all, a little bit, or very much?
3. How much do you like ___ (RA)? A little bit, very much, or not at all?

To test children's comprehension for the verbal content presented in the poem or song, the experimenter then showed the child two pictures at a time (a two-alternative forced choice task), saying, "Do you remember the song we sang (poem I told you)? Can you tell me what the song/poem was about by choosing one of these pictures? Was the song/poem about this or this?" The four pairs of pictures for each content condition (prosocial content and neutral content) appear in Appendix A and B respectively. The position of the correct answer in each pair of pictures was counter-balanced across participants. After completing this measure, the experimenter ended the experiment, saying "thanks for playing with me today!"

Measures

Measures 1 through 5 (listed below) were coded from video by a research assistant blind to experimental condition. In a subset of ten participants whose sharing and helping was double-coded, there was a single instance of disagreement; this data point was discussed and ultimately omitted due to experimenter error during the task.

Measures 6 and 7 were coded from video by three trained research assistants who reached at least 90% reliability on a set of test videos. Twenty percent of the final sample of participant videos were double-coded, and average inter-rater-reliability was .924.

Spontaneous sharing. Participants' willingness to share was coded based on how many successive prompts were required before sharing occurred (see Appendix C). From these codes, we also determined whether sharing was spontaneous (occurring before the participant was asked directly), delayed, or nonexistent.

Overall sharing. The number of stickers shared by each participant was recorded. Overall sharing reflected whether or not at least one sticker was shared, regardless of how many prompts were required.

Spontaneous helping. Participants' willingness to help was coded based on how many successive prompts were required before helping occurred (See Appendix D). From these codes, we also determined whether helping was spontaneous (occurring before the participant was asked directly), delayed, or nonexistent.

Feelings of affiliation for research assistant. Participants' affiliation for the RA was calculated as a mean of their responses to three questions (on a scale of 1 to 3) where higher numbers indicate greater affiliation.

Content comprehension. A number correct (out of four) was recorded for each participant (see Appendix A and B).

Participant engagement. Participants' engagement in the experimental interaction was quantified using interval coding (in 5-second bins) to assess the proportion of time the child was (1) smiling and (2) looking at either the experimenter or the RA. For coding purposes, the experimental interaction began when the puppet was introduced and concluded when the shakers were put away.

Joint movement, movement synchrony, and singing. For the length of the experimental interaction (defined above), joint movement, movement synchrony, and singing were quantified using interval coding (in 5-second bins), yielding a proportion.

Results

Effect of Type of Interaction on Prosocial Behavior

Sharing. Based on past studies showing that synchrony and music increased spontaneous prosocial behavior but not delayed prosocial behavior (Cirelli et al., 2014; Kirschner & Tomasello, 2010), I initially examined spontaneous sharing, which was defined as sharing before the child was directly asked to do so. A Fisher's Exact test for association was conducted between type of interaction and spontaneous sharing due to the small sample size and categorical nature of the variables. Fisher's Exact test (1-sided) showed a non-significant association between type of interaction and spontaneous sharing, $p = .375$. I then looked at overall sharing separately to see whether the type of interaction impacted children's willingness to share at all, regardless of how long it took them to do so. A Fisher's Exact test (1-sided) showed a significant association between type of interaction and overall sharing, $p = .049$ (see Figure 3). Only 6/31 (19.35%) children in the musical play group failed to share any stickers, even after being asked directly, while 13/31 (41.94%) of children in the non-musical play condition failed to share. A Fisher Z test of the two proportions (1-tailed) shows a statistically significant difference, $z = -1.9291$, $p = .027$; a higher proportion of children in the non-musical play group refused to share any stickers, even after being asked directly.

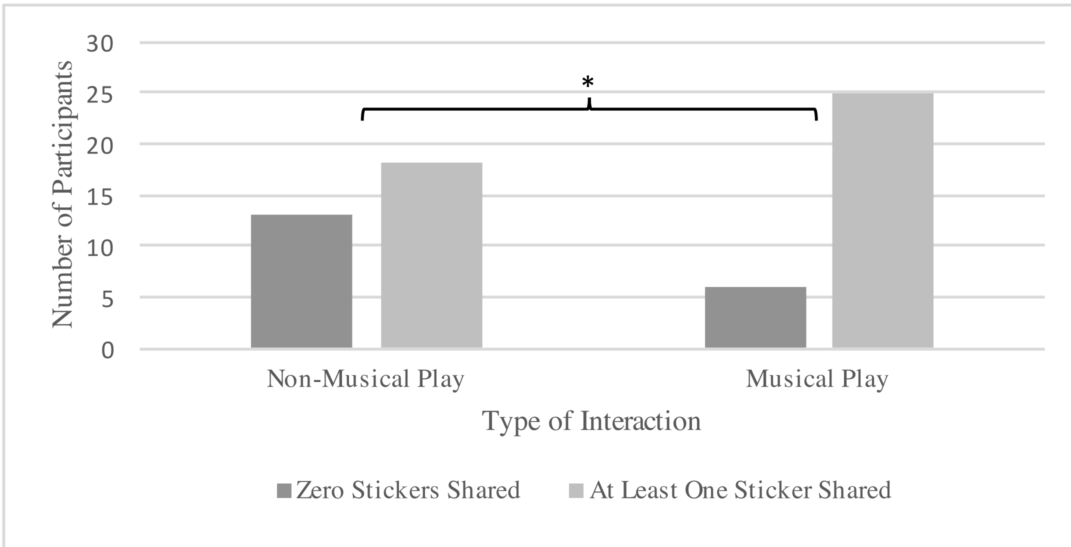

Figure 3. Overall sharing.

Helping. A Fisher's Exact test (1-sided) was conducted between type of interaction and spontaneous helping, which was defined as helping which occurred before the child was directly asked to help. The test showed a significant association between type of interaction and spontaneous helping, $p = .047$ (see Figure 4). Almost 71% of children in the musical play conditions (22/31) helped without being asked directly, as compared to 46.67% in the non-musical play conditions (14/30).

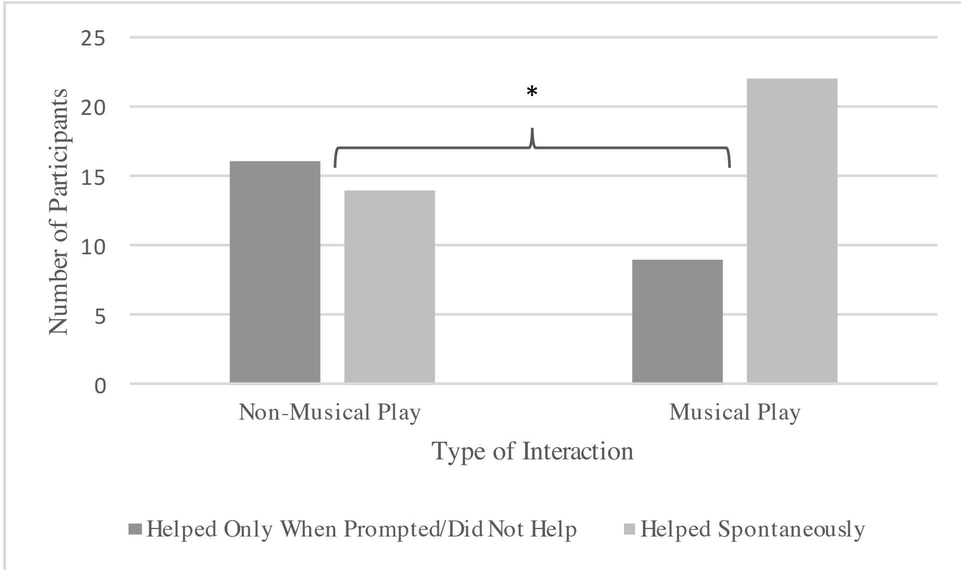

Figure 4. Spontaneous helping.

Effect of Verbal Content on Prosocial Behavior

Sharing. A Fisher's Exact test (1-sided) for association between lyrical condition and spontaneous sharing showed a non-significant association, $p = .625$. A Fisher's Exact test (1-sided) for association between lyrical condition and overall sharing also showed a non-significant association, $p = .291$.

Helping. A Fisher's Exact test (1-sided) showed a non-significant association between lyrical condition and spontaneous helping, $p = .457$.

Comprehension of verbal content. Although the lyrical manipulation did not produce any behavioral changes, comprehension scores demonstrated uniformly high comprehension for the content across prosocial and neutral conditions, with all four groups averaging at least 3.25 out of 4 possible correct answers, which is well above chance (2/4). A two-way Analysis of Variance (ANOVA) examining Type of Interaction by Verbal Content showed no significant effects of either on children's comprehension of the song or poem (Type of Interaction: $F(1,58) = .055$, $p = .815$; Verbal Content: $F(1,58) = .055$, $p = .815$), and no evidence of a statistical interaction ($F(1,58) = .412$, $p = .523$).

Social Engagement

To test whether the type of interaction affected children's engagement, I used one-way ANOVA with Welch's *F* statistic due to unequal variances between the groups. A statistically significant difference was found in gaze directed at a social partner, Welch's $F(1, 51.507) = 5.059$, $p = .029$, showing that children in the musical play conditions were looking at the experimenter or the RA significantly more than children in the non-musical play conditions (see Figure 5). There was no difference in the proportion of time spent smiling between musical and non-musical play groups, Welch's $F(1, 58) = .003$, $p = .957$ (see Figure 5).

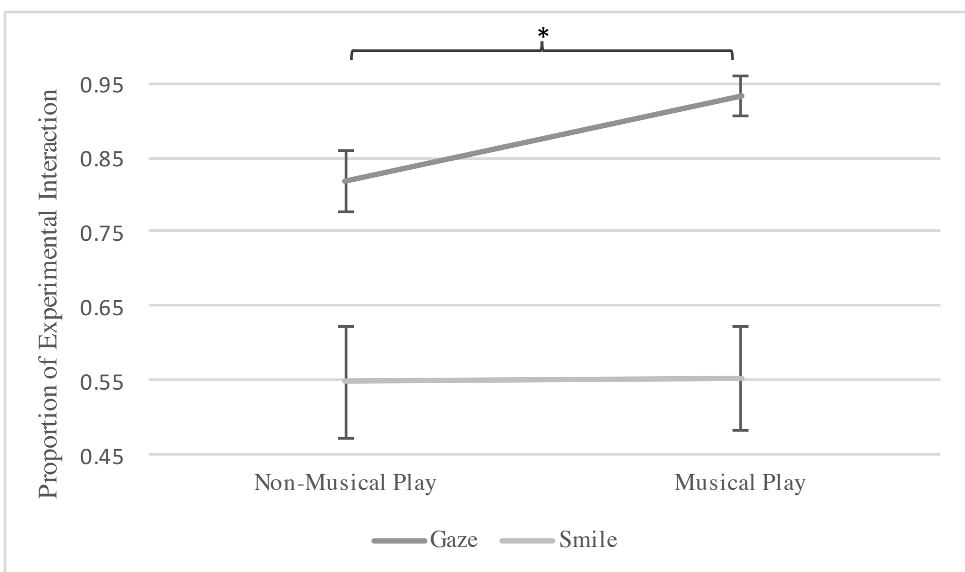

Figure 5. Participant engagement. Error bars represent standard error of the mean.

Musical Engagement

A statistically significant difference was found in joint movement (measured relative to the RA), Welch's $F(1, 44.737) = 172.961$, $p < .01$ (see Figure 6). There was no synchronous movement or singing found in the non-musical play condition at all. Thus, naturalistic musical play did in fact result in significantly more singing, synchronous movement, and joint movement than non-musical play. Even in the musical play condition, however, where the mean proportion of time spent in joint movement was nearly 50%, the mean proportion of time spent in movement synchrony was only 27%, indicating that naturalistic musical play produced nearly twice as much joint movement than precise movement synchrony in the current sample of preschool-age children.

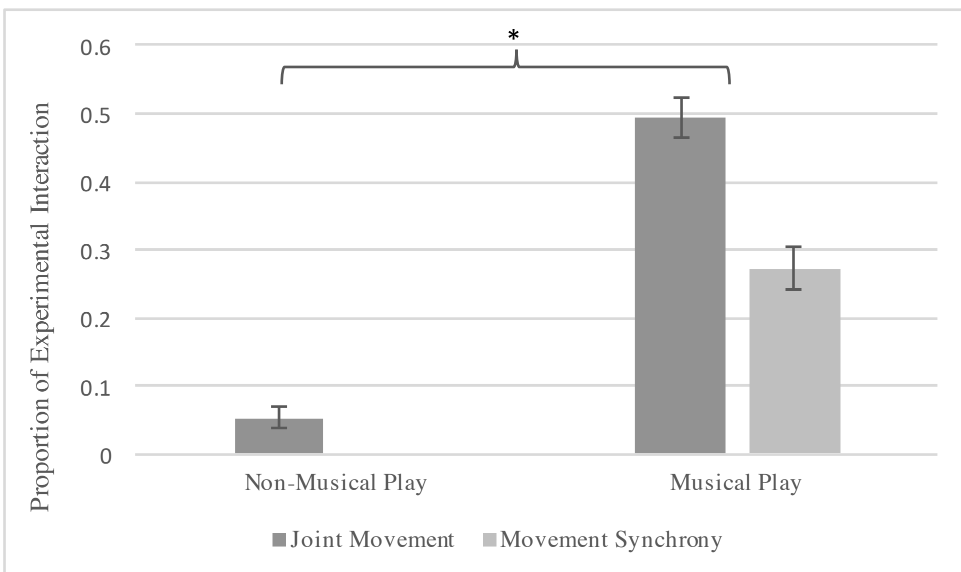

Figure 6. Joint movement and synchrony. Error bars represent standard error of the mean.

Predictors of Prosocial Behavior

Within the musical play conditions (n=29), I tested whether singing, joint movement, and synchrony correlated with helping and sharing behavior. If the relation between music making and prosocial behavior holds in future studies, any of these could be examined as potential mediators of the effect. Additionally, I wondered whether joint movement might have more predictive power than synchrony due to the low percentage of time children actually produced synchronized movements with adults in the musical play condition. Spearman Rank Order Correlations were used since helping and sharing data are ordinal, and I used one-tailed significance tests since I had directional hypotheses. I found a statistically significant correlation between joint movement and helping ($r_s = .332$, $p = .039$), but not between joint movement and sharing ($r_s = -.146$, $p = .225$). I found that synchrony was not significantly correlated with helping ($r_s = .270$, $p = .079$), or sharing ($r_s = .137$, $p = .239$). Singing was also not significantly correlated with either helping ($r_s = .126$, $p = .257$) or sharing ($r_s = -.063$, $p = .372$), and gaze was significantly correlated with helping ($r_s = .343$, $p = .034$), but not sharing ($r_s = -.145$, $p = .226$). Thus, gaze and joint movement emerged as potential mediators for helping, but not sharing behavior, while singing and synchrony did not predict either behavior within the musical play group.

Discussion

Naturalistic music making involving singing and movement between a preschool-age child and two unfamiliar adults was associated with more subsequent spontaneous helping and overall sharing than non-musical play, regardless of verbal content. This corroborates the general finding of Kirschner & Tomasello (2010) that music making increases prosociality among children of the same age and shows that the increase in prosocial behavior extends to an unfamiliar adult. The experiment also shows that the finding generalizes to a different musical interaction and that explicitly prosocial verbal content does not impact children's behavior as compared to neutral content. The findings add to existing literature by offering an analysis of child engagement, joint movement, and synchrony within the musical and non-musical play conditions to build stronger hypotheses about the mechanisms by which musical play may facilitate prosocial behavior in children, and how these mechanisms may differ from those present in music making among adults.

Differences Between Sharing and Helping

One key question which emerges from this experiment is why sharing and helping behaviors did not show the same pattern following music making. Musical play was associated with more spontaneous helping and overall sharing, but not spontaneous sharing as predicted. Past work has shown that synchrony and music-making in children increased spontaneous prosocial behavior, but not delayed (or overall) prosocial behavior (Cirelli, Einarson, & Trainor, 2014; Kirschner & Tomasello, 2010). This tendency to look for changes in initial prosocial impulses reflects the origins of this line of research in the concept of collective effervescence, a term originated by Émile Durkheim in 1912 to describe feelings of unity and cohesion that arise among community members after joint action (Collins, 2014). If the mechanism by which joint movement increases prosocial behavior is a feeling which arises following that experience, it is reasonable to look for the strongest effects to emerge in spontaneous rather than delayed behavior, as past researchers have done. In fact, a 2015 study demonstrated evidence for what researchers called an “ice-breaker effect” of singing on social bonding; groups of unfamiliar individuals who sang together experienced faster social cohesion than non-singing groups although the closeness of both types of groups evened out over time (Pearce, Launay, & Dunbar, 2015). One could argue that an increase in spontaneous helping and sharing is consistent with music making having an ice-breaker effect. We found evidence of this increase in spontaneous helping behavior, which is consistent with past research.

However, there was no parallel increase in spontaneous sharing. Only overall sharing, or whether or not a child eventually chose to share at least a single sticker, showed a significant association with Type of Interaction. According to a theoretical model put forth by Dunfield (2014), helping and sharing represent distinct subtypes of children’s prosocial behavior due to the different motivations driving the two behaviors. Dunfield describes helping as an attempt to alleviate the negative state of instrumental need, while sharing is motivated by unmet material desire. Accordingly, recent work on the behavioral effects of synchrony in preschool-age children has differentiated between sharing and other prosocial behaviors like cooperation, suggesting that allocating goods may be uniquely context-dependent as compared to more goal-directed collaborative behaviors (Rabinowitch & Meltzoff, 2017b). Indeed, the only studies investigating experimental manipulations designed to impact sharing have shown mixed results. For example, Kirschner and Ilari (2014) found no effect of joint drumming on two to four-year-old children’s sharing behavior, while Rabinowitch & Meltzoff (2017b) found increases in generosity following both synchronous and asynchronous movement in four-year-olds. Good and Russo (2016) showed that group singing among primary-school aged children did increase sharing in the context of a Prisoner's Dilemma game, but the effects only emerged over the course of twenty trials. This is consistent with our finding of an association between musical play and overall sharing.

One possible explanation for why musical play could increase spontaneous helping, but not spontaneous sharing is that the cognitive demands involved in preschoolers allocating goods may override any affective change fostered in the course of musical play. Many children in the study appeared to count the stickers as they were distributed by the experimenter, and almost half of the children who eventually shared (21/43, or 48.84%) distributed the stickers equally between themselves and the RA. This is consistent with a 2015 study by Posid, Fazio, & Cordes showing that children of this age typically share the same proportion of stickers (approximately 48%) regardless of how many they receive. In this age group, the inclination to distribute goods evenly between recipients may be quite established and difficult to overcome, and the counting needed to accomplish even distribution may place cognitive demands on children that preclude spontaneous shows of prosociality in this circumstance.

The Role of Synchrony in Promoting Prosociality

My analysis of joint movement and synchrony within the musical play condition raises interesting questions about the role of movement synchrony in facilitating prosociality in children. It suggests that musical play in preschoolers may not actually elicit very much precise movement synchrony, although it does elicit joint movement. In other words, even though musical play resulted in significantly more joint movement than non-musical play, that movement was only perceptibly "in synch" for a fraction of the length of the interaction. Since I did observe differences in prosocial behavior based on type of interaction, this raises several interesting possible explanations.

One is *the continuum model*; perhaps the relation between joint movement and prosociality in preschool-age children is not all or nothing, and instead is characterized by increases in synchrony corresponding to increased prosociality. In other words, perhaps precise synchrony is best, but partial or intermittent synchrony may still be meaningful in its ability to elicit prosocial behavior. We can think about what I quantified as joint movement as "a dose" of movement synchrony, which is more powerful than none, but less powerful than more precise motor coordination or synchrony (see Figure 7). Perhaps it is also the closest thing to synchronized movement that children of this age can execute in a naturalistic musical setting. The continuum model is consistent with research showing that synchrony produces increases in children's prosocial behavior as compared to asynchrony (Cirelli, Einarson, & Trainor, 2014; Cirelli, Wan, & Trainor, 2014; Rabinowitch & Meltzoff, 2017a; Rabinowitch & Meltzoff, 2017b; Tunçgenç & Cohen, 2016), but it does suggest that there is gray area between lack of joint movement and synchrony that should be explored. According to the continuum model, one would expect precise movement synchrony to have a more pronounced effect on subsequent prosocial behavior than joint movement which is less synchronized, a possibility which I explore in Experiment 2.

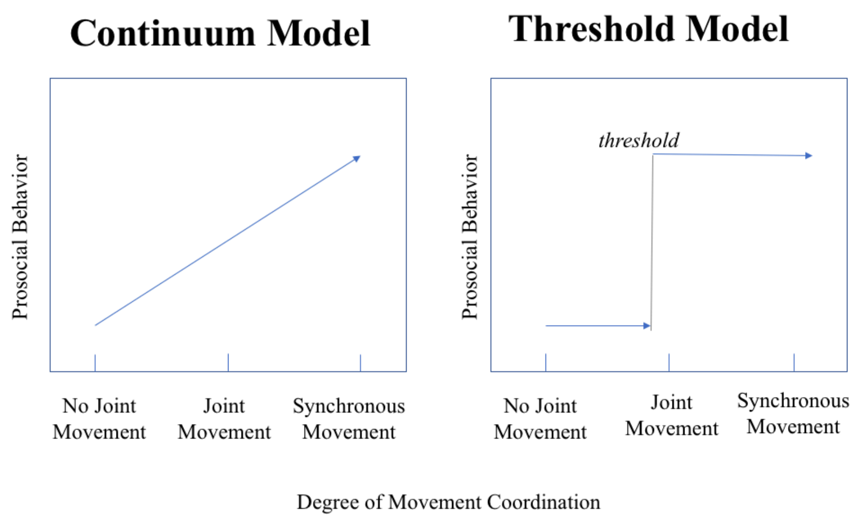

Figure 7. The continuum model and the threshold model.

A second possibility is that joint movement, or simply doing the same physical motions, satisfies a minimum necessary threshold of synchrony above which there is no detectable difference in markers of social bonding or prosociality. I refer to this as *the threshold model* (see Figure 7). Perhaps the bar for what constitutes synchrony is lower for preschoolers, who exhibit high variability in their ability to synchronize with a social partner (Kirschner & Ilari, 2014), which the authors found was partially explained by their access to music in social contexts. A 2015 study of children's ability to coordinate their drumming with an age-matched peer found that when 2, 3, and 4-year-old children drummed with a peer, they tended to produce "bouts" of drumming interspersed with long pauses (Endedijk, Ramenzoni, Cox, Cillessen, Bekkering, & Hunnius 2015). The authors chose to operationalize interpersonal coordination as overlapping bouts of drumming, and they found that the length of these overlapping bouts increased with age. They did not specify any improvement in precise synchrony, presumably because they did not see any. From the vantage point of the current experiment, what they termed coordinative drumming is what I coded as joint movement.

According to this model, there should be a threshold of effortful joint movement which should produce the same changes in subsequent prosocial behavior as precise synchrony. If non-synchronized joint movement is enough to produce changes in prosocial behavior, however, why wouldn't asynchronous conditions reliably produce prosocial behavioral changes as well? In fact, there are isolated cases in which this is true to some extent, providing some support for the threshold hypothesis. A recent study of the effects of synchrony on 4-year-old children's sharing behavior showed that both synchronous and asynchronous movement conditions – both of which could be termed joint movement conditions – resulted in increased sharing (Rabinowitch & Meltzoff, 2017b). Similarly, Cirelli, Einarson, & Trainor (2014) showed that although synchronous bouncing of 14-month-old infants produced more instrumental helping than asynchronous bouncing, congruent movement synchrony had the same effect as mirrored synchrony. Thus, there may be particular contexts or prosocial measures for which joint movement of any kind produces increases in prosociality, in support of the threshold model.

Although the aforementioned research showing that asynchronous joint movement does not result in increased prosocial behavior in children is difficult to reconcile with the threshold model in the abstract, one key difference is that children in the current study were agents of their own movement. The two examples cited above (Cirelli, Einarson, & Trainor, 2014; Rabinowitch & Meltzoff, 2017b) involve experiments in which children's movement was manipulated by the experimenter (either in a swing apparatus or a baby carrier) creating passive movement synchrony. In the current experiment, however, preschoolers were limited by their own ability to synchronize their movements and voices with others. A 2006 study in which children and adults were asked to tap along with a beat and continue tapping once it stopped found that 4- and 5-year-olds were only able to reliably maintain the established tempo within a small range centered around a 337 millisecond inter-onset-interval, or approximately 178 beats per measure (McAuley, Jones, Holub, Johnston, & Miller, 2006). The study also showed that the tempo range within which children could entrain with some consistency expanded with age; McAuley and colleagues refer to this tempo range as an entrainment region. Even within the preferred entrainment region for this age group, however, 4- and 5-year olds' performance on a continuation tapping task was significantly more variable than the performance of older children. The tempo of the song in the musical play conditions in the current experiment was somewhat flexible, but it started around 120 beats per measure, which corresponds to a 500 millisecond inter-onset-interval. Thus, it is not surprising that children did not reliably coordinate their movements with the beat of the music in the current experiment.

Despite limitations that prevent children this age from achieving precise movement synchrony, however, joint movement in the current experiment may reflect "attempted synchrony" or even "perceived synchrony" on the part of the child. Notably, a 2016 meta-analysis examining interpersonal synchrony and prosocial behavior identified intentionality as a moderator for effects of synchrony on prosocial behavior, showing that prosocial behavioral effect sizes were larger when synchrony was established intentionally rather than incidentally (Rennung & Göritz, 2016). One interpretation of this is that there is some value added from an individual or multiple individuals setting an intention to synchronize. Although adults who set such an intention may be able to execute while preschoolers may not, the intention may be relevant in both cases.

A third possible explanation, which is not mutually exclusive with the threshold or the continuum model, is the *perceived synchrony model*, in which an additional or alternative mechanism driving increased prosociality following musical play is children's perception of how well they synchronized their movements and vocalizations with the experimenters rather than the actual synchrony produced. This could explain why joint movement – perhaps children's best attempt at synchrony – predicts helping. Joint movement is likely correlated with children's intention to synchronize. We did not measure children's perceptions or their intentions regarding synchrony, and indeed it would be difficult to rely on children's self-reports at this age. Nevertheless, it may be that children who enthusiastically participated in the movement and singing elements of the experimental interaction also thought they did a better job than those who did not participate as consistently. Recent work has shown that synchrony not only increases prosocial behavior, but also increases feelings of similarity and closeness in children (Rabinowitch & Knafo-Noam, 2015), but to the extent that children perceive this synchronous movement with another, the perception itself could be driving prosocial sentiment and behavior. Perceived synchrony and achieved synchrony (as reflected in the continuum and threshold explanations) are certainly not mutually exclusive contributors to children's prosociality, and it could be that both play a role. The perceived synchrony explanation cannot be empirically evaluated in the current study, but I view it as potentially significant and therefore worthy of mention.

The fact that music facilitated prosociality despite very little precise movement synchrony, together with the correlational finding that joint movement and gaze alone predicted helping behavior, suggests that precise movement synchrony does not play as essential a role as predicted. Alternatively, perhaps other elements of musical play promote prosociality even in the absence of movement synchrony. The distinctions between attempted, perceived, and achieved synchrony may matter less among adults, who are more able to control their movements and thus are more likely to show alignment between the three. Disentangling the relation between attempted synchrony, perceived synchrony, and achieved synchrony in children's music making, however, is an important area for future study.

The Role of Verbal Content in Children's Musical Engagement

There was no evidence of an effect of verbal content on sharing and helping, suggesting that in the context of this brief experimental interaction, hearing didactic content did not affect children's behavior. Given my prediction that explicitly didactic lyrics about sharing might prime children's subsequent sharing and helping behavior, why did the lyrical content have no effect? Consider the following four possible explanations. The first is that the content manipulation may have been too transparent and felt overly prescriptive or "preachy" to the children. After all, the directive to share with others is one that is ubiquitous in early childhood settings, so the message of the prosocial verbal content conditions was hardly new to children. It is possible that in the context of this experiment, verbal content may function similarly to "normative preaching," in which an adult states what should be done, but does not directly instruct the child – a type of instruction which has been shown to have inconsistent effects on children's sharing behavior (Bryan & Walbek, 1970; Grusec, Saas-Kortsaak, & Simutis, 1978; Rushton, 1975). This study may simply extend the finding that normative preaching does not increase children's prosociality, even when the normative preaching is embedded within a novel song. Interestingly, despite the lack of behavioral difference between verbal content conditions, the high comprehension scores in all conditions indicate that children were very aware of the verbal content of the song or poem in the experimental interaction.

A second possibility is that the experimental manipulation was not strong enough to impact children's subsequent behavior. Often, studies of lyrics in adult populations contrast prosocial content with antisocial or explicitly negative content (e.g. Fischer & Greitemeyer, 2006), whereas the current experiment contrasted didactic content with neutral, but still positive content. On one hand, it would be ethically problematic to teach children to sing a song about being mean to a friend, or even just keeping all your stickers for yourself. On the other hand, the empirical evidence from this experiment suggests that it would not necessarily change children's behavior. One possible direction for continuing to explore the impact of lyrics on children's sharing and helping behavior would involve creating a more extreme contrast between verbal content conditions.

A third possibility is that song lyrics may require scaffolding by adults much like "morals" of traditional fables in a dialogic reading sense. Sandra Calvert and colleagues have examined children's memory for educational material presented in songs, as well as their verbal comprehension of the material (Calvert, 2001; Calvert & Billingsley, 1998; Calvert & Tart, 1993). They found that after limited exposure (hearing a song once or several times in a single sitting), material presented embedded within songs may be more easily remembered, but less understood than the same material presented verbally (Calvert, 2001). However, multiple exposures to a particular song over time may facilitate representation, rehearsal, and retrieval of educational material (Calvert & Tart, 1993). Therefore, even though the comprehension measure indicated that most children know what the song or poem was about, the information may not have impact their own behavior implicitly via the same mechanisms at play with adults (i.e. accessibility of prosocial feelings or thoughts).

And the fourth possibility is that the experimental interaction was simply too short for children to process the verbal content in a way that would alter their subsequent behavior. Speaking specifically of the musical conditions, the experimental interaction as designed would have provided very strong evidence for verbal content and lyrics influencing children's behavior, but the fact that no effect emerged may simply highlight how idiosyncratic the design was compared to how children typically consume music and media. Often, musical messages occur in the context of children's shows or albums consumed repeatedly over weeks or even months. Many children's enjoyment of music and media is of the binging variety; they repeatedly watch single episodes of *Daniel Tiger* or *Sesame Street*, or they request the same song in the car every morning for weeks on end. Research has shown that preschool-age children actually interact and learn more from educational content after repeated viewing of the same episode (Crawley, Anderson, Wilder, Anderson, Williams, & Santomero, 1999) and that music can aid retention of lyrics over verbally presented material (Morrongiello & Roes, 1990). From the current experiment, we can conclude that a brief engagement with a didactic song did not influence preschoolers' behavior. It is absolutely possible, however, that the verbal content of songs which children hear repeatedly, learn, and then sing themselves, may be processed in a deeper and more meaningful way. An essential future direction for examining the role of educational children's music – both independent of and embedded within children's programming – is examining children's comprehension for and retention of lyrics, as well as their subsequent thinking about the messages presented in song.

CHAPTER III

EXPERIMENT TWO

Introduction

Experiment 1 showed that musical play resulted in more spontaneous helping and overall sharing that non-musical play, but that movement synchrony proved less important than simply engaging in joint movement for predicting helping. This raised the possibility that non-synchronized joint movement was acting as a mediator between music making and helping. As noted previously, although musical play did result in more overall sharing, neither joint movement nor synchrony proved to be a significant statistical predictor of sharing. In designing Experiment 2, I still elected to include the sharing measure for consistency and ease of comparison between Experiments 1 and 2.

I wished to create an interaction which preserved joint movement in the context of musical play while making it very difficult or even impossible to synchronize, thus disentangling joint movement from synchronized joint movement. In order to accomplish this, I manipulated the beat of the musical stimulus. What is so special about the beat? Defined more formally, the beat (sometimes called the tactus) refers to a perceived pulse marking off equal durational units (Dowling & Harwood, 1986), and it is often described as the basic unit of time, or the rhythm listeners tap their foot to. Importantly, recent research has shown that individuals adapt to large tempo fluctuations when listening to music, so the beat need not be perfectly isochronous to be trackable by the listener

(Rankin, Large, & Fink, 2009). In other words, a beat must be perceived as metrically regular, but it need not be perfectly isochronous to do so. It is also critical to note that beat perception lies on a continuum in which some music creates a strong sense of beat (e.g. house music and classic rock) and other music a weaker sense (e.g. experimental jazz). The strength of the perceived beat depends on whether or not it aligns with perceptual accents in a rhythm, or a sequence of stressed and unstressed beats. The beat itself need not be played on a particular instrument like a drum or a tambourine; any rhythm will imply an underlying beat. However, “stronger” beats (those which align with rhythmic elements or are explicitly indicated by a metronome) are associated with better rhythmic memory and reproduction (Patel, Iversen, Chen, & Repp, 2005). Perception of the beat often leads to spontaneous movement in the form of toe-tapping or swaying, and these movements are often synchronized to the beat – a phenomenon known as entrainment. The extent that individuals entrain to a beat and to one another may predict levels of interpersonal synchrony, which may play a large role in creating behavioral changes following joint music making.

By creating a temporally irregular condition in which there was no predictable beat, I wished to manipulate synchrony while still eliciting joint movement and preserving children’s agency in the musical interaction. In doing so, I hoped to answer the question: does asynchronous joint music making produce the same changes in subsequent prosociality as more synchronous joint music making? I created two additional musical play conditions: temporally regular singing and temporally irregular – or jittered – singing (see Figure 8). Both conditions preserved the elements of musical engagement (singing, shared goal, gaze directed at a social partner) while removing the predictable temporal structure or beat for half of the participants, making synchrony virtually impossible. The children in the temporally regular condition – though still limited by their own motor capabilities – had the benefit of a beat to aid their singing coordination, and I made the assumption that the beat manipulation would produce more vocal-motor synchrony in the temporally regular condition than in the jittered condition.

The research questions guiding Experiment 2 were as follows. First, does a temporally regular joint singing interaction produce more subsequent sharing and helping than a jittered singing interaction (in which the beat is compressed and expanded by 30% and 60% at random)? Second, does a temporally regular joint singing interaction increase participant engagement (gaze directed at a social partner, singing) as compared to a jittered singing interaction? Third, does participant engagement predict sharing and helping across conditions?

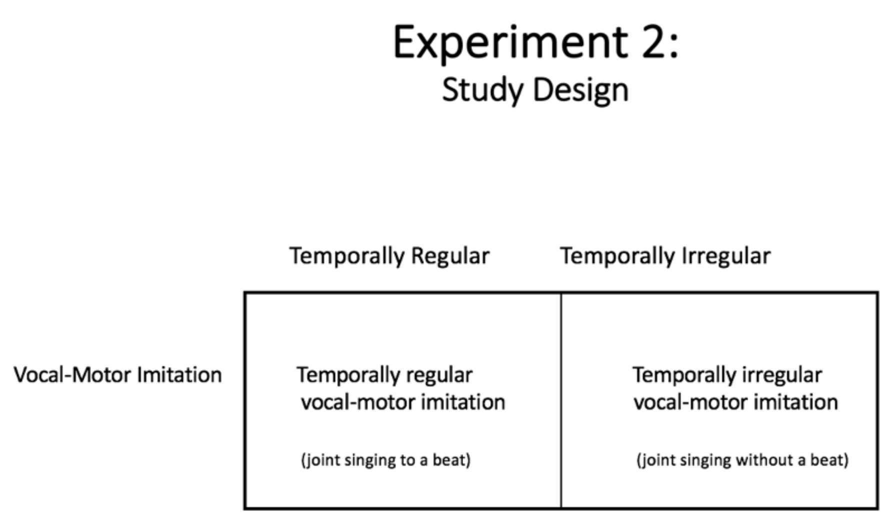

Figure 8.

In both conditions, children were asked to play a game in which they did their best to sing along with the experimenter on three unfamiliar melodies using the word "la." Melodic matching was neither expected nor measured in this context, as the melodies were unfamiliar and many children of this age do not even match single pitches reliably (Flowers & Dunne-Sousa, 1990). In the temporally regular condition, the predictable beat enabled a degree of vocal-motor synchrony since singers could predict the onsets of sung syllables, but in the jittered condition, it was impossible to synchronize since the children had no knowledge or indicators to the melodies or the deliberately awkward timing during the singing game. I chose to use unfamiliar melodies since the musical play conditions in Experiment 1 were based on an unfamiliar song, and I planned to compare the two conditions from Experiment 2 with the non-musical play control groups from Experiment 1.

I envisioned three potential outcomes of Experiment 2. First, if I observed significantly less prosocial behavior in the jittered condition as compared to the temporally regular condition, it would suggest that joint movement was not in itself sufficient to produce increases in subsequent sharing and helping and that some degree of synchrony was important. This finding would be consistent with the continuum model, in which synchrony does contribute over and above joint movement, and in which a degree of synchrony (achieved through careful vocal-motor imitation) is better than none at all (which is inevitable in the jittered condition). It could also be viewed as consistent with the threshold explanation, however, if the jittered condition was simply below threshold for producing "enough" synchrony.

Second, both conditions could be equivalent in terms of facilitating prosocial behavior, and the Experiment 2 sample as a whole could look like the musical play condition in Experiment 1. This would support the threshold explanation by showing that joint singing was sufficient to increase prosociality and participant engagement even in the absence of synchronous vocal-motor matching.

And third, it might be the case that joint singing, whether it was temporally regular or jittered, would not produce the same increases in prosocial behavior as the musical play conditions in Experiment 1. The musical play conditions in Experiment 1 involved both gross motor imitation and vocal-motor imitation, and singing did not independently predict children's helping or sharing behavior in the sample. Thus, it is possible that this different type of musical interaction – which focuses wholly on joint singing – might not produce the same prosocial behavioral effects in children. Using the threshold explanation as a framework, this outcome would suggest that vocal-motor coordination may fail to meet the threshold for synchrony when compared to the gross motor coordination elicited in Experiment 1.

As in Experiment 1, I planned to measure sharing and helping behavior subsequent to the experimental interaction, as well as children's self-reported affiliation for the research assistant. I also used behavioral coding from video to examine participants' engagement, as indicated by the proportion of time during the interaction that their gaze was directed at either the experimenter or the RA, and the proportion of time they participated by singing.

Method

Participants

Thirty-two children (14 girls, M_{age} = 4;7, *SD* = 5.03 months, range: 46-66 months) participated, with 16 children in each group (temporally regular/temporally irregular). Children were tested in local preschools as in Experiment 1, and the same recruitment methods were utilized. Diagnosed developmental delay, lack of fluency in English, and significant hearing loss were established as exclusionary criteria in advance of recruitment. According to parental report, the sample was 75% White, 11% African American, and 14 % Mixed/Other. The study was approved by the Vanderbilt Institutional Review Board, and parental consent and participant assent were obtained from all participating families.

Materials

In both conditions, children were introduced to a puppet as in Experiment 1. After being invited to hold and interact with the puppet if they chose, the puppet was put away and not used again. I included the interaction with the puppet – which was necessary to the framing of Experiment 1 but not Experiment 2 – due to planned comparisons across experiments and the possibility that omitting it would give children less time to warm up to both the experimenter and RA, perhaps producing unanticipated changes in prosocial behavioral measures.

The song stimuli were created as part of a larger set of stimuli consisting of three well-known children's songs: "Mary Had a Little Lamb," "Are You Sleeping," and

“Twinkle Twinkle Little Star.” I created four recorded piano versions of each song to be used as an in-ear reference to guide singing with participants: familiar/temporally regular, unfamiliar/temporally regular, familiar/jittered, and unfamiliar/jittered (See Appendix E for stimuli used in the current experiment). Unfamiliar versions were created by playing each melody backwards. Songs were selected based on their frequent appearance on lists of well-known American children’s songs and the absence of dotted notes that would complicate the unfamiliar versions. Each song was recorded being played on a piano along with a metronome set to 120 beats per measure (bpm). Temporally regular versions were not digitally altered.

To create the jittered versions, I used Adobe Audition to create .5-second segments coinciding with a single quarter note. I then generated random orders (using the function Randbetween in Microsoft Excel) of five possible segment treatments: segment left at 100%, segment compressed by 30%, segment expanded by 30%, segment compressed by 60%, and segment expanded by 60%. If Excel generated consecutive repeated numbers, I manually changed the repeated number to avoid perceptually eliciting a new, steady tempo. To verify that the jittered stimuli were perceptually more difficult to sing with, I asked six adults to rate the difficulty of singing with each of the twelve song stimuli, and jittered songs were rated significantly more difficult to sing with than temporally regular stimuli, t (35) = -5.66, $p < .01$. For Experiment 2, only unfamiliar stimuli were used (jittered and temporally regular) since Experiment 1 utilized an unfamiliar song as well and I did not wish to introduce familiarity as a variable. A Macbook Pro with earbuds was used to reference the piano stimuli during the musical interaction.

Procedure

Pre-testing procedures for obtaining consent and assent were identical to Experiment 1. Other procedures were also the same as Experiment 1 until immediately after the puppet was introduced. To summarize, after obtaining child assent, the experimenter introduced the pictorial likert scale, familiarized the participant with how to use it, and then asked several questions (pre-interaction mood measure, single-item self-report measure of shyness, and a single-item self-report measure of musical engagement). As in Experiment 1, these single-item measures served as an ice-breaker and will not be reported further. The RA was then asked to join the child and experimenter, sitting directly across from the child. The experimenter then introduced the puppet and allowed both the child and RA to hold it if desired.

Experimental interaction. The experimenter asked the child and the RA if they would like to play a singing game using the syllable *la*. The instructions were as follows: "We're going to play a game where we do our best to sing together using the syllable *la* – using the word *la*. It might get tricky. Are you ready? Remember, our job is to do our best to sing together using the word *la*. Here we go!" Three melodies were used with each participant, all of which were either jittered or temporally regular. Before the second and third melody, the experimenter said "Great job, guys!" and repeated the instruction: "Remember, our job is to do our best to sing together using the word *la*. It might get tricky! Here we go!" In cases where children were inclined to look at the laptop before the game began, the experimenter explained, "This computer is just here to help me sing, but you don't need to look at it. Remember, our job is to do our best to sing together." The game was complete after the third melody.

Sticker sharing task & helping task. Both tasks were identical to Experiment 1 and consistently occurred in the same order for all participants (sharing followed by helping). When the coloring was complete, the RA left the room, saying "Thanks for playing with me!"

Post- interaction measures. As in Experiment 1, the participant was asked to answer three questions about his or her feelings of affiliation for the RA. The content comprehension measure used in Experiment 1 was not applicable to Experiment 2.

Measures

Measures were identical to those taken in Experiment 1, with the exception of content comprehension (which was not applicable since the joint singing task used the syllable "la"). Behavioral coding from video was used to quantify participant engagement during the experimental interaction itself. Using interval coding in 5-second bins, I examined the proportion of time participants directed their gaze to either the experimenter or the RA and the proportion of time during the experimental interaction that participants sang.

Results

I examined the effect of temporal regularity in a joint singing interaction on children's subsequent sharing and helping using Fisher's Exact Test of Association. This test is recommended over the Chi-Square Test for use with small samples. I also looked at correlations between behavioral measures of engagement (singing and gaze) and helping and sharing.

Effect of Temporal Regularity on Prosocial Behavior

Sharing. A Fisher's Exact test (1-sided) was conducted between temporal condition and spontaneous sharing. The test showed a non-significant association between temporal condition and spontaneous sharing, $p = .113$. Spontaneous sharing occurred rarely in the sample, with only 3/32 (9.37%) children sharing before they were asked directly; all spontaneously sharing children were in the temporally regular condition.

Next, I conducted a Fisher's Exact test (1-sided) between temporal condition and overall sharing. The association was not statistically significant, $p = .143$. The trend was in the expected direction, however, with 68.8% of children sharing within the temporally regular condition (11/16), while only 43.8% shared in the jittered condition (7/16).

Helping. A Fisher's Exact test (1-sided) for association was conducted between temporal condition and spontaneous helping. The association was not statistically significant, $p = .078$. Interestingly, the trend was not in the expected direction; 68.8% of children in the jittered condition helping before being asked (11/16), while only 37.5% of children in the temporally regular condition did so (6/16).

Affiliation for research assistant. An independent sample t test showed that there was no statistically significant difference in children's self-reported affiliation for the RA between the temporally regular and jittered group, $t(29) = -.520$, $p = .607$. Both groups of children reported liking the RA equally well.

Effect of Temporal Regularity on Engagement

Gaze. An independent sample *t* test showed that there was no statistically significant difference in gaze directed at a social partner between the temporally regular and jittered group, $t(30) = -.229$, $p = .827$. Children in both groups were looking at the faces of one of the experimenters for over 90% of the coded intervals in the interaction (μ_{jitter}=.949, $\mu_{temporally\ regular}$=.937).

Singing. A *t* test also showed no difference in singing participation between the groups, $t(30) = -.639$, $p = .528$, with both groups singing for more than 60% of the coded intervals (μ_{jitter}=.623, $\mu_{temporally\ regular}$=.708).

Gaze and singing as predictors of prosocial behavior. Spearman Rank Order Correlations were used to examine the relation between participant engagement (gaze and singing) and measures of sharing and helping due to the ordinal nature of the coded prosocial behavioral measures. Gaze was not significantly associated with either helping (r_s =.098, p =.596) or sharing (r_s =.002, p =.989) in a two-tailed test. However, the proportion of time during the experimental interaction during which children were looking at the face of one of the experimenters was uniformly high across both conditions (M_{gaze} = .943, SD = .161). Singing participation was significantly associated with sharing (r_s =.375, p =.034) but not helping (r_s =.241, p =.183).

Discussion

The results of Experiment 2 provided no evidence that the temporal regularity of a joint singing interaction influences children's engagement in the musical interaction or their subsequent prosocial behavior. Children's sharing and helping, as well as the degree to which they directed their gaze at social partners and the proportion of time they participated by singing, did not differ based on whether the singing interaction was temporally regular or jittered. Interestingly, however, singing was significantly associated with sharing across conditions. Children who sang a higher percentage of the time shared with less prompting that children who sang less. Singing did not predict helping behavior.

These findings show that facilitating vocal-motor coordination in a joint singing interaction by using a predictable pulse or beat did not influence children's sharing or helping. Why might this be? One possibility is that the beat did not make a difference in children's ability to coordinate their voices with another person because it was challenging for them in both conditions. In other words, even under the most temporally regular conditions, many children coordinated the rhythmic features of their singing poorly, so the manipulation of musical beat may not have resulted in the desired difference between the two groups. A 2006 cross-sectional study of children and adults engaged in a continuation tapping task showed high error variability in 4- and 5-year old children at 120 bpm (the tempo of the joint singing stimuli), and although the current experiment required children to entrain to a social partner rather than an isolated auditory stimulus, they may not have been able to execute well enough in the temporally regular condition to create a noticeable difference between groups (McAuley et. al., 2006).

Piloting with adults in a within-subjects design showed that undergraduates reliably rated jittered stimuli as more difficult to sing with than temporally regular stimuli, but the experimental design did not assume that children could make that explicit judgment. Rather, in the context of a singing game, I predicted that the difficulty of coordinating one's voice with others in the absence of a beat would show itself in less attention, less singing, and perhaps less sharing and helping. The fact that none of these measures differed between groups raises the possibility that children may not "feel" the difference between singing to a predictable beat and singing to an unpredictable, jittered timeline, particularly when the melody is unfamiliar. It could be that results would differ if a familiar melody provided an element of predictability in the form of melodic expectancy. Perhaps in using the unfamiliar melody, I inadvertently made both conditions too challenging for children, and the challenge of the novel singing game may have obscured the difference between temporally regular and jittered conditions across participants.

A second possibility, however, is that the manipulation did achieve differences in children's vocal-motor synchrony, but that motor imitation remained necessary and salient in both conditions. In observing children during data collection for both experiments, I was struck by the degree to which motor synchrony is tied to motor imitation or mimicry, a non-beat-based form of social and motor interaction that has been shown to increase prosocial behavior in children and adults (Carpenter, Uebel, & Tomasello, 2013; see Chartrand & van Baaren, 2009 for a review of findings with adults). Motor Imitation is not always involved in joint music making, particularly when the music is familiar and/or the musicians more skilled, but in this experimental setting with this age group, motor imitation is necessary for children to achieve any synchrony at all with the experimenter and the RA. Children in both conditions in Experiment 2 were likely relying on motor imitation to participate in the singing game, and there's no reason to suspect that the degree of motor imitation differed between conditions even though the results of that effort may have differed.

Although the two experimentally manipulated conditions did not produce measurably different sharing or helping behavior, singing participation did significantly correlate with sharing across conditions. In attempting to reconcile this finding with Experiment 1, in which joint movement was more predictive than synchrony, it is worthwhile to consider what singing represents in the current experiment, which is non-synchronized joint vocal-motor movement. Within the sample of 32 children who participated, the extent to which they engaged in joint vocal-motor movement predicted their sharing. The design of the experiment was such that even in the temporally regular condition, the unfamiliar melody meant that children were engaging in motor imitation to achieve any degree of synchrony. In the jittered condition, synchrony was impossible to achieve. Therefore, we see that a type of joint movement – with or without synchrony – is predictive of sharing in this context. As this association is correlational, however, it is less conclusive than an experimental manipulation of singing would be. We cannot determine whether singing causes an increase in sharing, or whether there is a third variable contributing to both sharing and singing behavior. For example, it could be that children who are more compliant in general or more sensitive to the implicit desires of the experimenters are more likely to sing and share.

However, singing did not predict helping, which seems to provide evidence against a third variable explanation accounting for the correlation between singing and sharing. If individual differences in children's temperament or desire to please adults are responsible for the association between sharing and singing, why wouldn't this characteristic also result in increased helping? Just as in Experiment 1, we see different patterns of children's behavior with respect to sharing and helping. But contrary to Experiment 1, here we see that sharing correlates significantly with an element of joint music making while helping does not.

CHAPTER IV

COMPARISON OF EXPERIMENTS ONE AND TWO

Given that there were no group differences between jittered and temporally regular joint singing conditions, I wished to compare the prosocial behavior and participant engagement of children in the joint singing groups with children in the Experiment 1 non-musical play groups (prosocial/non-musical play and neutral/non-musical play) and musical play groups (prosocial/musical play and neutral/musical play).

Prior to Experiment 2, I envisioned three potential patterns of results. The first was that the two joint singing conditions would differ such that temporally regular singing produced more helping, sharing, and participant engagement than jittered singing. Results did not support this possibility; no differences emerged between groups in Experiment 2. Assuming no differences were found, I did not know whether joint singing would look more like musical play and produce increases in sharing, helping, and engagement, or if it would produce subsequent behavior and engagement at levels more similar to the non-musical play conditions. A comparison of sharing and helping patterns across Experiments 1 and 2 makes it possible to determine which of these possibilities is supported by the data.

I also planned to look at correlations between coded behaviors and prosocial behaviors across the entire sample. Since manipulating the experimental interaction produced somewhat inconsistent results with regard to the two prosocial behaviors of interest (sharing and helping), I wished to look at the complete sample to see which factors of that interaction were significantly correlated with sharing and helping. I also wanted to know if sharing and helping were significantly correlated across the sample.

Effect of Condition on Prosocial Behavior

A chi square test for association was conducted between condition and spontaneous helping (including non-musical play, musical play, and joint singing). All expected cell frequencies were greater than five. The association was not statistically significant, $\chi^2(1) = 3.970$, $p = .137$. A chi square test for association was conducted between condition and overall sharing (including non-musical play, musical play, and joint singing). As was the case with helping, the association was not statistically significant, $\chi^2(1) = 5.060$, $p = .080$. However, visual inspection of the frequency distributions of overall sharing and helping codes shows that the musical play condition did induce more overall sharing and spontaneous helping than non-musical play or joint singing, although the difference did not reach statistical significance when all three conditions were included (see Figures 9 and 10).

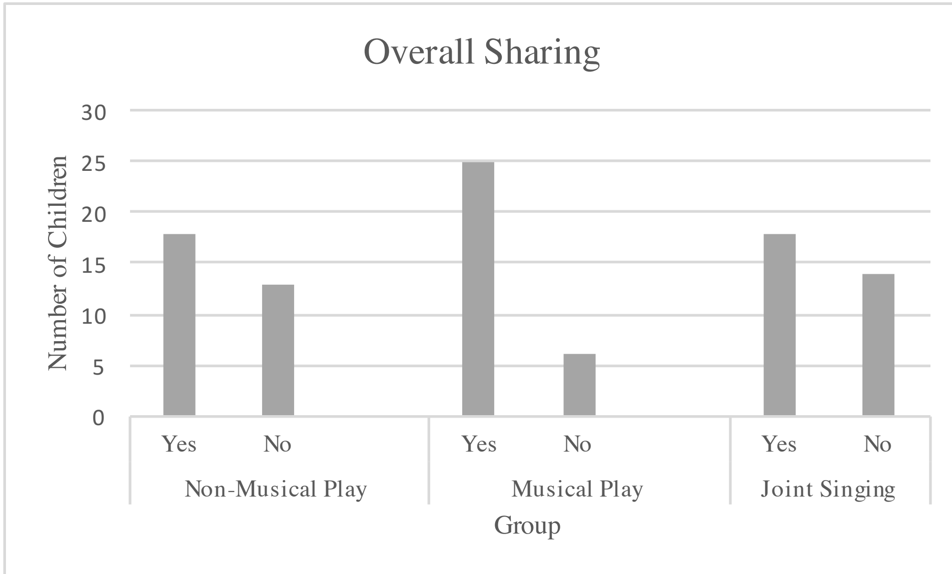

Figure 9. Overall sharing across three conditions in Experiments 1 and 2.

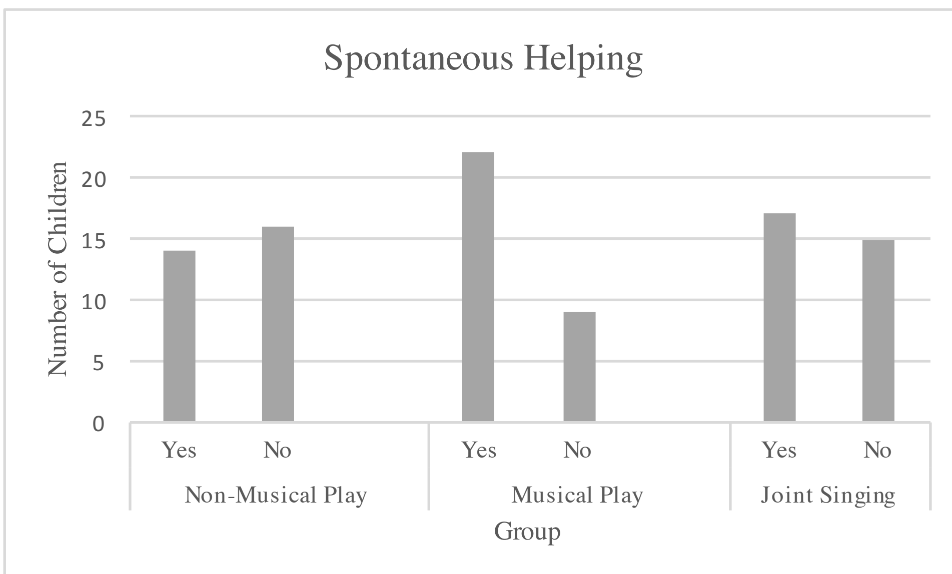

Figure 10. Spontaneous helping across three conditions in Experiments 1 and 2.

Effect of Condition on Social Engagement

A one-way ANOVA was conducted to determine if gaze and singing participation varied by group where the groups were non-musical play (*n* = 31), joint musical play (*n* = 29), and joint singing (*n* = 32). A statistically significant difference in gaze was found between groups, $F(2,89)=4.277$, $p = .017$. Post-hoc Bonferroni comparisons showed that the mean increase from non-musical play to joint singing (.125, 95% CI [.106, .241]) was significant ($p = .027$), but no other pair of means was significantly different (See Figure 11).

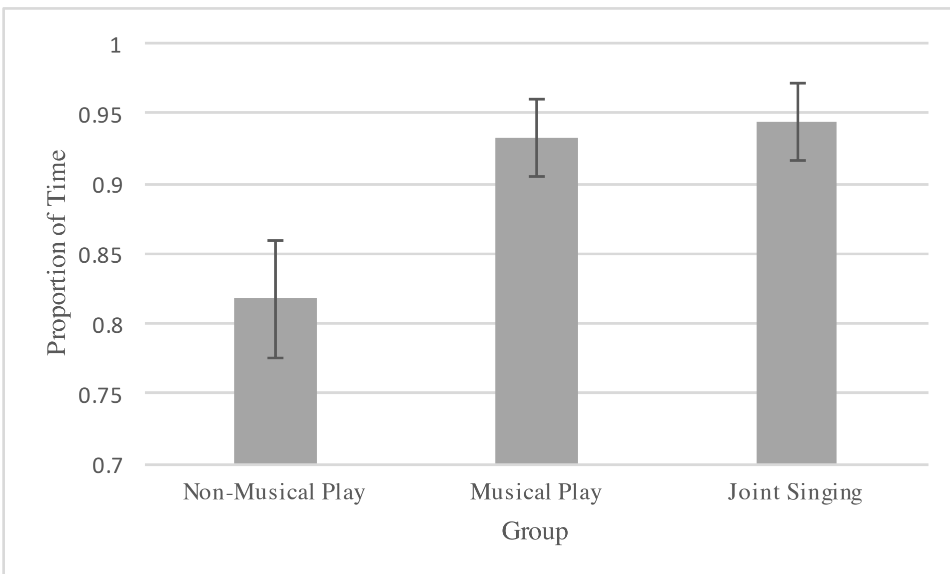

Figure 11. Gaze at a social partner. Error bars represent standard error of the mean.

One-way ANOVA was also used to examine the effect of group on singing participation. A statistically significant difference in singing was found between groups, $F(2,89)=42.060$, $p < .01$. Post-hoc Bonferroni comparisons showed that the mean increase from non-musical play to musical play (.504, 95% CI [.315, .692]) was significant ($p < .01$), as was the mean increase from non-musical play to joint singing

(.666, 95% CI [.482, .850]; $p < .01$) but no other means were significantly different (See Figure 12). In all conditions, singing participation and gaze were measured from the time when the puppet was put away to the time when the experimenter asked if the child would like to play with stickers, exclusive of time spent giving instructions.

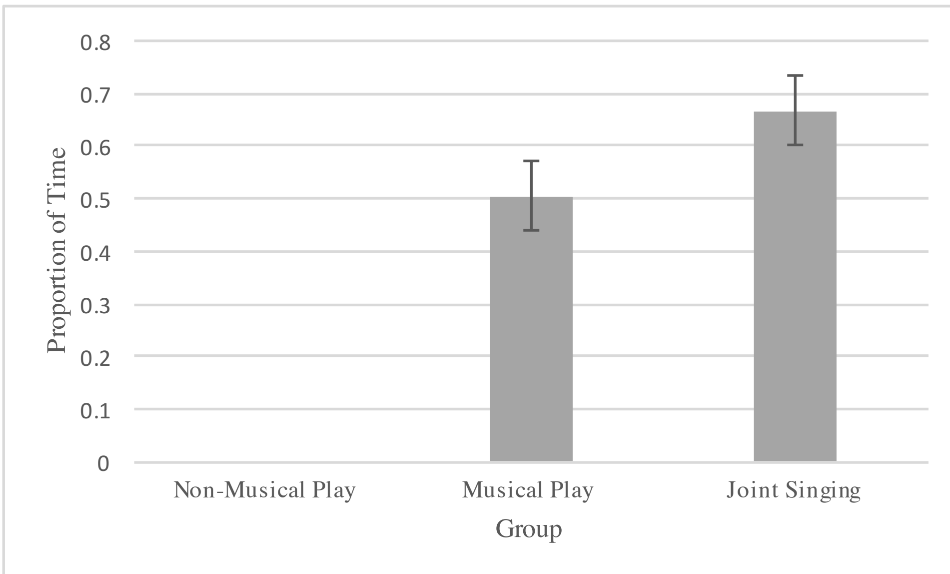

Figure 12. Singing participation. Error bars represent standard error of the mean.

Correlations Across Full Sample

Table 1 displays the correlations within the entire sample (n = 92), including Experiments 1 and 2, giving us a broader picture of predictors of both sharing and helping behavior following a brief musical or non-musical interaction with two previously unknown adults. Age was not significantly correlated with any other measured variables. Notably, sharing and helping were not significantly correlated, and the factors which correlated with each prosocial behavior differed.

Table 1: Correlations for entire sample including Experiments 1 and 2.

Variable	1	2	3	4	5	6
1. Age (months)	—	.111†	-.032†	-.074	-.068	-.008
2. Sharing code		—	.165†	.276† **	-.133†	.129†
3. Helping code			—	.584†**	.202†*	.231†*
4. Affiliation for research assistant				—	.275**	.512**
5. Gaze at social partners					—	.365**
6. Singing participation						—

Note:

*** Correlation is significant at the .01 level (one-tailed)*

** Correlation is significant at the .05 level (two-tailed)*

† *Correlation reported is a Spearman's rank order correlation coefficient rather than a Pearson correlation*

Predictors of Sharing

For sharing, affiliation for the RA was the only significant association, and it is possible that causality for this association could go either direction. Participants who report liking the RA may be more likely to share, but it is also plausible that after having the positive experience of sharing with someone, children are more likely to report liking that person. Alternatively, some unmeasured facet of temperament could explain children's tendency to share more readily and report liking the RA. Importantly with regard to the discussion of how music making could impact prosocial behavior, neither singing nor gaze at social partners predicted sharing behavior across the whole sample.

Predictors of Helping

Affiliation for the RA, gaze, and singing participation all emerged as predictors of helping behavior subsequent to the experimental interaction. Recall that a comparison of gaze and singing participation across the three manipulated conditions showed that both musical conditions (musical play and joint singing) resulted in significantly more gaze at social partners and singing participation than non-musical play, but that only non-musical play resulted in increased spontaneous helping and overall sharing. The implications for future work are discussed below.

Discussion

Contrary to my hypothesis, neither the temporally regular nor jittered joint singing conditions increased children's sharing and helping relative to the non-musical play group in Experiment 1. Why would this be? Using the threshold explanation as a framework, this outcome could suggest that vocal-motor coordination – with or without a beat – may fail to meet the threshold for synchrony when compared to the gross motor coordination elicited in Experiment 1. It could be that coordinated singing, even done well, is less perceptually salient to children than the visually salient gross motor movement utilized in the musical play conditions. Another way to put this is that singing may be too subtle a movement to “work” for coordinating kids’ movement and giving them the perception of blurred boundaries between self and other.

Alternatively, it could be that this particular singing task was too hard, and that children were simply worse at coordinating their singing than they were at coordinating sways and shaker movements in the musical play conditions. One could test this hypothesis by running conditions in which kids were able to be successful in coordinating their singing, perhaps by singing an overlearned, familiar song like “Happy Birthday” or “Twinkle Twinkle Little Star.” If better coordinated singing produced increased prosocial behavior, that would suggest that the experimental interaction was simply too hard for children to execute. Even in the temporally regular condition, they were often hesitant and quiet in their singing, although many freely sang a song of their choice with me at the end of the experiment.

Another possibility is that singing does “work” to increase prosociality, but not on a single trial of a particular behavior like sharing or helping. The only published study to specifically examine singing (exclusive of other movement synchrony) as it relates to prosociality in children was done with primary school-aged children engaged in a thirty-minute group singing activity (Good & Russo, 2016). Although the children in the group singing group did show more cooperative behavior than children in a cooperative art group or a competitive games group, the effect emerged only after multiple trials. The current experiment consisted of a single helping trial and a single sharing trial. An adaptation using the preschool version of the Prisoner’s Dilemma would be ideal for creating a behavioral task with multiple trials.

A final possibility is that the game set-up was stress-inducing or otherwise worked at cross purposes to the behavioral measures. In order to encourage children to sing, I introduced the task as a game in Experiment 2. In terms of encouraging participation, it was a success. Children in the musical play conditions in Experiment 1 sang approximately 50% percent of the time they were encouraged to sing, while children in Experiment 2 sang approximately 67% percent of the time. However, the difficulty of the task (particularly in the jittered condition) coupled with the fact that many children appeared so unsure and sang with such hesitation may suggest that they felt pressure to do well at the game.

Since two of the above explanations posit that the joint singing game may have been difficult for children, it could be that at least with this particular singing task, children need more time with the task to get past that difficulty in order to see any prosocial benefits of coordinated singing or even uncoordinated singing. I designed the conditions based on the assumption that joint movement would occur in both conditions, and that the temporally regular condition would produce more synchrony than the jittered condition. While this was true, the overall level of synchrony was still very low, and many children knew it, with over a third (9/24 who gave a response) reporting that the singing game was hard or very hard (equally distributed between jittered and temporally regular groups). If half of the participants thought the game was hard, they may have been focused on that in some unforeseen way that differed from the experience of the children in Experiment 1.

CHAPTER V

GENERAL DISCUSSION

The current study shows that joint musical play increased preschoolers' spontaneous helping and overall sharing relative to non-musical play, while joint singing did not. Verbal content did not influence children's helping and sharing in the context of this experimental paradigm. Behavioral coding suggests that within the context of musical play – the only experimental condition that resulted in increased prosociality – gaze and joint movement were predictive of helping, while synchrony was not. Neither gaze nor joint movement was predictive of sharing, however. Across the whole sample, singing and gaze predicted helping, while neither predicted sharing. This study is the first to examine this effect as it applies to children's behavior toward a novel adult rather than an age-matched peer.

One theme which emerges from these data is that sharing and helping seem to represent distinct types of prosocial behavior and cannot be considered jointly. Children's sharing and helping behavior were not significantly correlated, and different predictors were associated with each. The effect of joint musical play on spontaneous helping was hypothesized based on past research, and the data supported that hypothesis. For sharing, an effect only emerged in delayed sharing, which was not as predicted. Thus, helping may be a more reliable behavior for future studies of the behavioral effects of coordinated musical movement in preschoolers.

Regarding the role of joint movement and movement synchrony in eliciting prosocial behavior in preschoolers, the data from the current study suggest that the degree to which movement is synchronized with another individual matters less than the presence of joint movement itself. Musical engagement which involves gross motor movement is most definitely a vehicle for promoting joint movement, and this type of musical engagement did increase sharing and helping. The results of Experiment 2 were surprising in that joint singing – with or without a beat – did not create the same prosocial gains as musical play. As a statistical predictor, however, singing did significantly predict one of the prosocial behaviors within the joint singing sample (sharing). To the extent that joint singing is a special case of joint movement, Experiment 2 provides additional evidence that joint movement could be driving the effect rather than synchrony. I have presented two frameworks for considering the relation between joint movement and prosocial behavior in preschoolers, and while I submit that the current data fit the threshold explanation better, my hope is that both frameworks may generate future testable hypotheses.

Increasing Gaze at Social Partners Through Music Making

Also of note is that gaze at a social partner increased in both musical play and joint singing conditions as compared to non-musical play. For preschool-age children engaging in music making with friends and adults, musical interaction may be a vehicle for promoting gaze directed at social partners, which could act as a mediator for helping and perhaps other prosocial behaviors. It is also valuable on its own merit; every teacher or parent who has ever tried to engage with a child who does not want to engage for any number of reasons might benefit from the knowledge that when you sing and move together with a child, he or she may look at you more than if you engage in non-musical play. This could have implications for using music more intentionally to get the attention of typically developing children, which was the population of interest in the current study. Children who are shy or slow to warm up to adults might particularly benefit from caregivers using musical play to get and keep their attention. Additionally, this knowledge could also inform research on musical engagement in children with Autism Spectrum Disorder. The National Autism Center recently classified music-based treatment programs as "emerging," meaning that there is some support for their efficacy but that more work is needed (National Autism Center, 2015). Facilitating social interaction in children with autism using active musical engagement is a growing area of research (Skaggs, Lense, & Clayton, 2017), and the current study suggests that increasing gaze at social partners through music making could be a focus.

Value of Mutual Social Entrainment

The differences observed in children's prosocial behavior subsequent to musical play involving gross motor movement versus joint singing alone are also notable. As discussed previously, the threshold model gives us one framework to consider these differences. Perhaps vocal-motor synchrony is not perceptually salient in the same way that body movement is, and it is thus sub-threshold in terms of fostering increased prosociality. Another difference between the synchrony fostered by the two types of conditions, however, is that the musical play conditions elicited what Jessica Phillips-Silver and colleagues call mutual social entrainment (Phillips-Silver, Aktipis, & Bryant,

2010) while the joint singing condition utilized the less specific category of social entrainment. While social entrainment is defined as a special type of motor coordination where the rhythmic signal originates from another person, mutual social entrainment allows for two individuals to use each other's rhythmic output responsively as they coordinate their movements. In other words, by opting for the experimental control afforded by the in-ear rhythmic template in the joint singing conditions, I lost the flexibility to responsively engage in mutual social entrainment. It's possible that mutual social entrainment could be a powerful tool for coordinating movement over and above social entrainment, especially with children whose ability to entrain to an isochronous beat is still developing into the preschool years and has been shown to benefit from a social context (Kirschner & Tomasello, 2009).

Limitations of the Current Study

It is well known that the expectations of an experimenter can exert subtle but meaningful pressures on participants and thereby influence their behavior, even when interaction is highly scripted as was the case in the current study. A 2016 meta-analysis on motor-sensory interpersonal synchrony (which includes synchronization of motor movements and synchronization of sensory stimulation) and prosocial behavior focused on the possibility that the prosocial effects of synchrony may be partially or wholly due to a methodological artifact: experimenter effects (Rennung & Göritz, 2016). The authors concluded that while results from 48 experiments indicate a highly significant effect of synchrony on prosocial *attitudes* regardless of whether or not the experimenter was blind to hypothesis and condition, *behavioral* effects of synchrony all but disappear in a subset of nine studies in which the experimenter was blind to hypothesis and condition. This highlights an important limitation of the current study, in which both the experimenter and the RA were aware of the experimental condition of each participant. However, the fact that behavioral results did not directly support the hypotheses of the author in either experiment suggests that experimenter effects were not responsible for group level differences.

Another limitation of the current study is that the primary statistical analysis used to detect associations between type of interaction and prosocial behavior, Fisher's Exact Test of association between categorical variables, does not offer information about the size of the effect. Thus, we can determine that there is very likely an association between musical play and spontaneous helping, for example, but we cannot quantify the size of that association with the current tests.

Long-Term Benefits of Musical Engagement for Prosociality

When considering the effect of such a brief musical play interaction on children's subsequent sharing and helping, it's reasonable to wonder if regular musical interaction over a long period of time would be likely to have a cumulatively positive effect on children's prosocial skills. In fact, a 2016 study found that among third and fourth graders who participated in weekly group music lessons over ten months, those with poor prosocial skills before the lessons began did show larger increases in prosocial behavior and sympathy than students who did not participate (Schellenberg, Corrigall, Dys, & Malti, 2015). The authors argue that their results are consistent with the view that music may be an adaptive behavior due to its emphasis on cooperation and social cohesion.

Children in group music lessons may develop cooperative habits with peers, and these habits could extend beyond the music classroom. Since the non-participating group did not have a parallel activity, however, we cannot conclude that group music lessons would foster more prosociality than other shared activities with cooperative peer interaction (e.g. team athletics, drama lessons). In fact, despite this finding, one could argue that even if joint singing and movement in the context of musical play foster social bonding among participants, there is no reason to expect that feeling of closeness and its attending behavioral changes to generalize or extend beyond a particular time and place. Although a 2016 study of adults showed some generalization of increased prosociality to out-group members following collective synchronized movement (Reddish, Tong, Jong, Lanman, & Whitehouse, 2016), an investigation into generalization of prosocial increases in infants failed to find evidence of such generalization (Cirelli, et al., 2016). Cirelli and colleagues showed that increased infant helpfulness following synchronized movement did not extend to a neutral observer.

Even if social bonding induced by musical play does not generalize beyond a particular context, however, certain elements of group music classes (e.g. listening, turn-taking, pursuit of shared goals) may afford children positive experience with peer interaction that does generalize. Rabinowitch and colleagues recently demonstrated increases in 8- to 11-year-old children's emotional empathy after long-term participation in musical group interaction, and they focused on musical games that emphasized imitation and entrainment (Rabinowitch, Cross, & Burnard, 2013). More research is needed to connect brief experimental paradigms for examining the effect of music making on prosociality with longitudinal studies of group music making in children.

Conclusion

The current study provides further evidence that joint musical play in preschoolers – inclusive of joint singing and percussive gross motor movement to a regular beat – does influence children's subsequent prosocial behaviors and their engagement in the interaction. It also suggests key areas for future research. Primary among them are further examinations of joint singing in which children engage with familiar songs, tests of the generalizability of this effect over time and to other individuals, and longitudinal studies investigating the cumulative social effects of children's participation in musical play.

The potential for this line of work to inform parents, teachers, and therapists, as well as creators of children's media content, is vast. Although singing, music, and movement are currently used in early childhood education programs across the United States, research is just beginning to provide empirical support for how and why use of music might benefit children's developing social skills and the broader social culture of the classroom. In considering a definition of musical meaning that is robust in both interdisciplinary and cross-cultural settings, Ian Cross and Elizabeth Tolbert write that "ethnomusicological research indicates that music might be better conceived as a mode of interaction rather than as the object of auditory perception" (2009, p. 43). Thus conceived, music may prove to be an effective and enjoyable vehicle for fostering community and meaningful social interaction among young children, peers, and care-givers.

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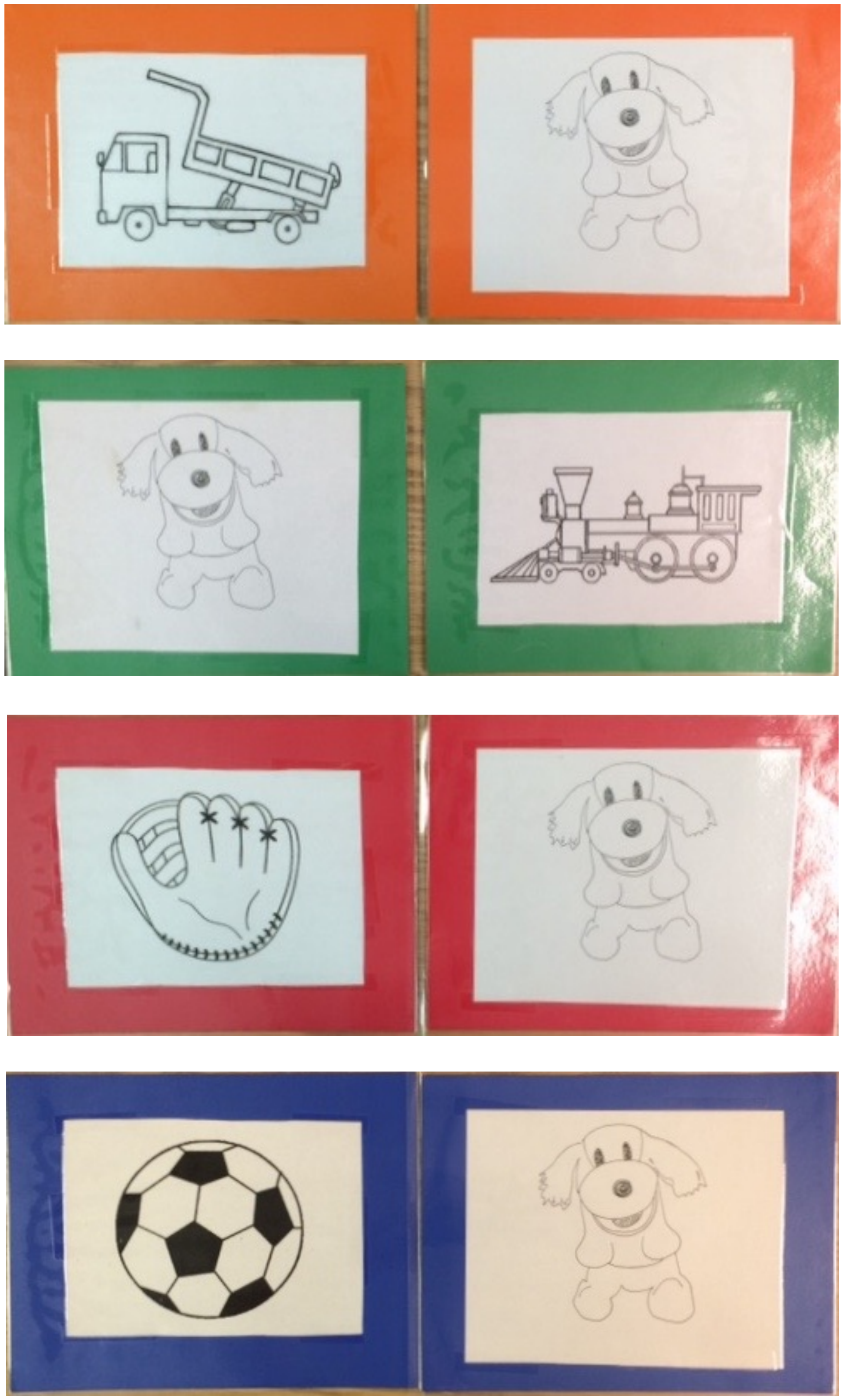
Appendix A

Appendix B



Appendix C

Coding Criteria for Sharing

4=child shares with no prompting.

3=child shares after one prompt. ("RA1 says after 10 seconds, "I wish I had more stickers. I love stickers," while looking sadly at the stickers.)

2=child shares after two prompts, the second being a direct request. (RA1 says after 20 seconds, "Will you share your stickers with me?")

1=child indicates willingness to share in response to the second prompt (verbally or using gesture or nodding) but does not actually initiate sharing any stickers within ten seconds of his/her response

0=child does not indicate willingness to share even after both prompts, and does not share any stickers

Appendix D

Coding Criteria for Helping

4=child helps with no prompting (either immediately after the spill or within ten seconds).

3=child helps after one prompt. ("RA1 says after ten seconds, "It's going to take forever to pick up all these pencils.")

2=child helps after two prompts, the second being a direct request. (RA1 says after 20 seconds, "Will you help me pick them up?")

1=child indicates willingness to help in response to the second prompt (verbally or using gesture or nodding) but does not actually get up to help within ten seconds of his/her response.

0=child does not help even after both prompts and does not indicate willingness to help.

Note: **Helping is defined as getting up, picking up at least one pencil, and either giving it to RA or putting it in the cup.**

Appendix E

"Twinkle, Twinkle Little Star" (backward)

"Mary Had a Little Lamb" (backward)

"Are You Sleeping" (backward)