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DEFINING MOTHER-INFANT SYNCHRONY IN A SPEECH AND
SONG CONTEXT

by

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Submitted in Partial Fulfillment
of the requirements for the degree of
Bachelor of Arts
in
Honours Psychology

Faculty of Arts and Social Science

Huron University College

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CERTIFICATE OF EXAMINATION

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Abstract

The objective of this study was to examine the behaviours observed within mother-infant dyads during speech and song play. Previous research has suggested that caregivers convey emotional meaning through vocalizations and emanate behaviours that synchronize interactions with their infants (Dissanayake, 2000; Reyna & Pickler, 2009). Research has also suggested that infants prefer infant-directed singing over speaking and that song can be used to regulate infants' states of arousal (Nakata & Trehub, 2004). The current study was designed to extend the literature on mother-infant interactions by having mothers play with their infants while singing or speaking to them. The speech context was elicited by asking mothers to play with their infants as they normally would, while the song context was elicited by asking them to sing nursery rhymes of their choice while they played. Subsequently, a researcher entered the room to distract the mother by asking a series of questions. Both maternal and infant behaviour during speech and song were coded for frequency of occurrence; infant behaviour was further coded during the disruption. Results showed that maternal behaviour, including infant referencing, object referencing, and pausing, occurred more frequently in response to speech than to song. Infant behaviour, including positive affect, attention, and turn taking, showed no differences across the two contexts. Additionally, results showed no difference in infant behaviour during the disruption based on the prior context. The findings from the current study give insight into the types of behaviours mothers pair with vocalizations as well as the function of these behaviours.

Keywords: maternal behaviour, infancy, music, synchrony

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Introduction

A mother's bond with her baby is a distinct and unique connection that is unlike any other relationship seen in nature (Broad et al., 2006). From before the infant is born, there is a remarkable relationship that forms within the mother-infant dyad (Vittner et al., 2018). Past research on maternal-fetal relationships has highlighted that pregnant women are able to form strong mental representations of their growing babies which can foster powerful feelings of affection and attachment (DiPietro, 2010). Moreover, pregnant women have been found to alter their day-to-day diet and behaviours in order to promote the well-being of their fetuses as the environment created in utero can strongly affect fetal heart rate and motor activity (DiPietro, 2010). This demonstrates the early emergence of a distinctive relationship. After the baby is born, this bond becomes essential for physiological regulation, language acquisition, and cognitive development as the mother becomes a conduit for an atmosphere in which an infant can learn and thrive. The bond between a mother and her child may evolve and change throughout fetal development, infancy, and beyond, yet it is a constant and continuous entity. One mechanism of promoting a healthy bond throughout time is *synchrony*, the ability of mothers and babies to respond to each other (Reyna & Pickler, 2009). The concept and function of synchrony between a mother and her child can be understood in a variety of different ways, across a variety of different contexts.

Understanding Synchrony

Synchrony between a mother and an infant has been characterized as the functional ability of members of the dyad to respond and be social with one another and specifically involves matching biological rhythms, behaviours, and emotional states that bond them as one

unit (Reyna & Pickler, 2009; Leclere et al., 2014). Early on, synchrony can be characterized physiologically and may be vital for healthy organ system operation and physiological growth. Vittner et al. (2018) found that newborn infant and maternal heartbeats can be synchronized using skin-to-skin-contact, an important activity in terms of developing healthy respiratory functioning, temperature regulation, stress release, and improved motor and mental development.

Synchrony may also be rooted in mother-infant attachment. Reyna and Pickler (2009) defined mother-infant synchrony as a “rhythmic attention-withdrawal pattern that occurs as the mother regulates her level of attention in response to changes in the infant’s behaviour” (p. 470) and operationalized it as an observable pattern of harmonious, responsive behaviours that promote mutual reward. Synchrony within a dyad can, therefore, be theorized to have an association with early attachment. Early attachment in dyads is contingent on the mother anticipating the needs of her infant and differentiating among the cues the infant expresses so that infants learn that crying, sucking, and smiling gains their mother’s undivided attention (Reyna & Pickler, 2009). Mothers have been shown to be attentive and attuned to their infants’ states of arousal, subsequently altering their level of response based on the cues they receive from their infant (Trevarthen & Malloch, 2000). These findings show that synchrony, as a behavioural pattern of attention and responsiveness, may be a key factor in promoting healthy attachment in a mother-infant relationship.

Synchrony in face-to-face maternal interactions can be measured through a number of behavioural predictors or indications. Censullo et al. (1987) measured synchrony as the amount of time spent in mutual attention, the amount of positive affect, the number of vocalizations, and the presence of turn taking and maternal pauses. Positive affect (demonstrated through facial

expressions and vocalizations) is an especially salient predictor of synchrony as it indicates the responsiveness of the infant; mutual turn taking is a significant behavioural predictor of synchrony because it demonstrates cycles of reciprocal behaviour in which one member initiates and the other responds; and the presence of maternal pauses is a solid predictor of successful synchrony in that pausing after attempted engagement provides a necessary window of time for the infant to respond (Censullo et al., 1987). Importantly, synchrony has been measured as the number of successful interactions relative to the number of attempts made by each member to engage with the other (Reyna & Pickler, 2009). As the mother plays a vital role in the initiation of an interaction, as well as in the regulation of the infant's state, it may be that achieving synchrony is the basis of the caregiving interaction.

Learning, Social Communication, and Synchrony

Physiological synchrony can be further understood with reference to emotional communication, the combination of sounds, gestures, and facial expressions that convey emotional intentions (Reyna & Pickler, 2009; Creighton, 2011; Dissanayake, 2000). Emotional communication requires the mother to align herself with the infant's emotional state (Creighton, 2011), which can be generated through synchrony as both members simultaneously adjust their social attention, stimulation, and acceleration of arousal to each other. These reciprocal vocal narratives may sustain a coordinated relationship over time (Trevarthen & Malloch, 2000) which may be important for infants' cognitive and language development.

Social interactions, in which continuous engagement is sustained, are dependent on active participation from both members (Leclere et al., 2014) and a mutual desire to engage in an emotionally communicative way (Trevarthen & Malloch, 2000). During infancy, participation in

these interactions is based on vocalizations. As infants express themselves through vocalizations, mothers contingently respond by imitating the pitch contour or repeating the vocalization, often with variations, such as exaggeration, or by answering with a contrasting pitch (Trevvarthen & Malloch, 2000). Caregiving behaviours exhibited by mothers may reflect the emotional intentions that they want to convey to their infants, such as lulling the infant to sleep, arousing them in play, or teaching them novel words. Emotional communication, translated through behaviour, has been considered as a flexible and dynamic pattern that changes as the infant's needs and abilities change (Dissanayake, 2000). It has been theorized that, in early stages, from birth to approximately 3 months of age, mothers tend to touch, hold, cuddle, and rock their infants as they smile and use repetitive infant-directed vocalizations to teach the baby to produce vocalizations, make eye contact, touch, and smile (Dissanayake, 2000). As the infant ages and develops, caregivers may adapt their vocalizations and movements to more animated play with exaggerated facial expressions, and vocalizations that are formed more slowly and held for longer (Dissanayake, 2000). In turn, infants may respond by producing bigger smiles, more active movements, and a larger range of sounds (Dissanayake, 2000). The intention to teach through play has been shown through exaggerated acoustic or pitch changes in infant-directed speech, which may direct the infant's attention to novel stimuli (Fernald & Mazzie, 1991). These changes in maternal behaviour showcase the role of the caregiver in encouraging and constructing infant behaviour and creating interactions from which the infant can learn and develop social abilities.

The reciprocal nature of mother-infant vocalizations and behaviours can be considered as a mutually rewarding interaction and therefore a demonstration of synchrony (Reyna & Pickler,

2009). The research literature conceptualizes the outcome of synchrony as enhancing reciprocal social interactions and emotional communication between mother and infant; therefore, perhaps the functional purpose of synchrony lies in facilitating the development of important cognitive abilities, such as language acquisition. The behaviours conveyed by mothers, whether calming or arousing, may demonstrate an intent to teach their infants. This may be shown through teaching them new words when reading, singing, or playing. Further, synchrony has been interpreted as a reflection of the innate abilities within human beings to express emotional communication and to be social with one another (Trevarthen & Malloch, 2000); therefore, synchrony can be strongly associated with mother-infant reciprocity. Specifically, it can be argued that the desire to be social with one another strengthens the attempts made by the mother to teach, and the attempts made by the infant to learn. The combination of infants' preference for their mother's voice, interpretations of their mother's behaviour, and vocalizations towards their mother, plays a role in emotional communication which contributes to learning vocalizations, phonetics, eye contact, and touch (Dissanayake, 2000; Locke, 1996). Synchrony, as a means of emotional communication, can therefore be theorized to be an important factor in teaching and learning social abilities. As well, infants' preference for their mother's voice and increased vocalization from both members play an essential role in phonetic learning because preferential responding to the mother's voice encourages continuous engagement and mutual responsiveness which promotes language development (Locke, 1996). This is considered to be a case of behavioural adjustment or entrainment of the infant and the parent (Leclere et al., 2014). As mothers and infants respond to each other, healthy attachment is maintained and strengthened, physiological entrainment is enhanced, and sustained responding may act as a catalyst for meaningful learning

to occur.

Infant-Directed Song

As synchrony is a crucial element in mother-infant interactions, it is important to understand the ways in which synchrony can be promoted within the dyad. One interesting avenue of research has focused on infant-directed song and the positive implications maternal singing may have on infant development. Song, as a functional piece of an interaction, can regulate an infant's state, sustain infant attention, and is effective in promoting emotional communication between the pair (Trehub, 2006; Trevarthen & Malloch, 2000). As one of the most universal maternal practices (Mehr et al., 2019), music may play an interesting role in the development of a synchronous interaction.

Infants have been shown to exhibit heightened engagement with song stimuli over speech stimuli and it has been posited that the regular pulse of maternal singing promotes arousal levels that sustain reciprocal engagement and enhance emotional coordination in the dyad (Nakata & Trehub, 2004). Notably, mothers are shown to modify singing in the presence of their infants (Trehub et al., 1997) and more successfully regulate the emotional state of their infants in singing contexts (Trehub, 2006). Further, the regular beat of a musical interaction compared to a speaking interaction has been suggested to generate a superior medium for emotional intentions to be communicated (Rock et al., 1999; Nakata & Trehub, 2004). The explanations for the positive implications of infant-directed singing are varied and widespread; one explanation suggests that the metrical aspects of musical rhythm enable adults and children to synchronize their behaviour with one another (Trehub, 2006) and therefore enable them to interact with each other in a more profound and meaningful way. Synchronized behaviours in this context include

bouncing, dancing, and clapping (Trehub, 2006). Consequently, it can be suggested that within a dyad, mother-infant synchrony may be more strongly represented in a singing context.

Synchrony may be especially salient in a song context. As a reciprocal and mutually rewarding occurrence, whereby emotional intentions are communicated, synchrony may find its niche in infant-directed song. Further, the proposed role that synchrony plays in learning may be especially evident in a song context. Continuous engagement and responsiveness of each member is crucial for learning and has been shown to be intensified in mother-infant song settings. Sustaining attention is critical for learning as it enables infants to focus on important messages directed towards them. In addition, infant-directed play-songs, which are highly rhythmic and arousing, have the ability to communicate information and encourage the infant to focus on the external world (Trainor, 1996; Rock et al., 1999). Play-songs are considered to be sung in a loving tone, intensify the degree to which infants prefer their mother's voice, and increase the salience of emotional coordination (Trainor, 1996). As such, it can be proposed that infant-directed singing has the potential to facilitate successful synchrony and, therefore, the potential to teach infants about themselves and about their environments.

The Present Study

The current study has been designed to examine the potential link between synchrony and song. Research on synchrony is substantial, yet there is no specific or universal scale that has been used to operationalize it. Infant-directed song has been studied in terms of acoustics, preferences, and attention, but there is little research examining the specific behaviours exhibited by mothers that are paired with infant-directed song. I will examine the typical behaviours a mother uses to engage with her infant in both a speech context and a song context.

Understanding the ways in which mothers instinctively engage infants during speech and song will add to the literature in terms of how caregivers adjust their behaviour to teach infants about the environment and about language and will expand the scope of research on synchrony.

Additionally, previous research indicates that regulating the arousal level of an infant is attributed to the mother's attempts to engage in an interaction; however, less is known about infants' attempts to engage with the mother. Studying the ways in which speech and song can mediate infants' responses to their mothers can provide insight into synchrony and the ways in which a synchronous interaction is sustained over time. To better understand this, the current study will be focused on common infant behaviours and will compare similarities and differences between speech and song contexts. These behaviours will be explored in a play episode, in which the mother is focused on engaging the infant, and a disruption episode, in which the mother is no longer solely engaged with the infant.

The current study has been designed to answer the questions: (1) what kinds of similarities and differences are observable in speech and song and how can they mediate caregiver disengagement?; and (2) what is the function of synchrony in a speech versus a song context? It is hypothesized that there will be more significant and prominent behaviours that point to synchrony in the song context and that this will lead to increased attention directed towards the mother in the disruption episode. This research will give insight into how synchrony is displayed in a typical mother-infant interaction and add to the literature on how synchrony can be defined, operationalized, and considered.

Method

Participants

The participants were 18 mother-infant dyads. Participants were recruited by telephone from a pool of potential participants, maintained by the Department of Psychology at the University of Western Ontario, all of whom had expressed interested in participating in developmental research. Infants were excluded from the study if they had any known hearing or visual deficits or if they had had more than three ear infections in the previous six months. Infants were between the ages of 7 to 9-months-old (mean age 7.8 months, age range 6.9 to 9.1 months). There were eight male and 10 female infants in the study. Mothers gave consent for themselves and their infants to participate.

Data were collected in the Department of Psychology at Huron University College, a liberal arts college affiliated with The University of Western Ontario, for a previous study examining how maternal vocal engagement affects the vocalizations of infants. Data were collected through audio and video recordings and were maintained by the Department for use in future studies. The current study is focused only on analysis of the previously collected data and was designed to answer a different set of questions.

Materials

The behavioural coding scales created for this study were developed using the behaviours and conceptualizations of mother-infant interactions described in previous literature. Synchrony has been operationalized as: (1) the amount of time both dyad members spend in mutual attention; (2) the amount of positive affect each member appears to have based on facial expression and vocalization; (3) the number of mutual turn takings; and (4) the number of

occurrences of maternal pausing to provide space for the infant to respond (Censullo et al., 1987). In this instance, each of these items was scored on a 2-point scale of either high or low synchrony based on the apparent level of observed synchrony in the interaction (Censullo et al., 1987). Literature on joint attention and coordinated play was also helpful for describing common maternal behaviours used to capture infants' attention. These behaviours included tickling, ringing toy telephones, shaking rattles or toys, making objects 'come alive', and picking up and playing with toys in which the baby showed an interest in (Bakeman & Adamson, 1984). Additionally, research by Rock et al. (1999) conceptualized inward and outward attention in infancy. This was operationalized as 'attention to self' which included behaviours such as looking at themselves or their clothing, and 'attention to caregiver' which included looking at their parent (Rock et al., 1999). The following scales were created as a subset of these behaviours and scored on frequency of occurrence, rather than on overall perceived synchrony.

Maternal Behaviour

The scale created to measure maternal behaviours was designed to describe the role of the caregiver in terms of typical types of behaviours used to engage with infants. The scale was based on the idea that, in typical play settings, attempts to capture infants' attention may look different across speech and song contexts. Maternal behaviour was coded with respect to the frequency of occurrence in three categories: (1) infant referencing; (2) object referencing; and (3) maternal pauses. If two behaviours from different categories occurred simultaneously, they were coded separately. For example, referencing the infant by name while shaking a rattle was coded once for infant referencing and once for object referencing.

Infant referencing behaviours included touching the baby, looking at the baby, talking about the baby, asking the baby a question, bouncing the baby, and moving the baby to the rhythm. The touching and looking categories included reference to any part of the infant's body, they were not exclusive to the infant's face. Each behaviour was coded for frequency of occurrence and summed as the total score of infant referencing.

Object referencing behaviours included touching, pointing, picking up, referring to, gesturing to, or making an object 'come alive'. Each of these behaviours was coded for frequency and summed as the total score of object referencing. For clarity, touching an object was considered as reaching out and feeling the object, while picking up an object was considered as lifting it and holding it. Referring to an object was considered as talking about or referencing the object in a vocalization (speech or song), for example, "this is a very cute bear". If the mother, for instance, asked, "do you want to play with this bear?", frequency would be counted for both infant referencing (asking the baby a question) and object referencing (referring to an object).

Maternal pauses were measured as the presence of a pause for two or more seconds following an attempt to engage. For example, asking the infant if they wanted to play with a toy truck and then pausing in anticipation of a smile or vocalization in agreement. Each occurrence of maternal pausing was coded and summed as the total maternal pauses score.

Infant Behaviour in Speech and Song

The measurement of infant behaviour was designed to describe the responsiveness of the infant with regard to the attempts made by the mother to initiate an interaction. Behaviour was coded only if it was in response to an attempt made by the mother to engage the baby. Infant

behaviour in the speech and song episodes was coded across three categories: (1) positive affect; (2) attention; and (3) turn taking.

Positive affect included the number of times the infant responded to the mother's attempt to engage by means of a vocalization (laugh or coo) or a positive facial expression (smile). Occurrences of each of these behaviours were summed for a total score of positive affect.

Attention was based on previous research demonstrating that eye gaze is a significant measure of engagement (Bakeman & Adamson, 1984). Attention was coded as the frequency of mutual eye gaze on each other, and the frequency of mutual eye gaze focused on an object. Mutual eye gaze on each other could arise, for example, from the mother pushing a toy truck and then looking at the baby and the baby making eye contact with her. Mutual eye gaze on an object included behaviours such as the mother pushing a toy truck, followed by the mother and the baby both looking at the toy truck. These frequencies added together created a total score of attention.

Turn taking was coded as the frequency of occurrence of infants responding to their mothers with their own attempt to engage. For example, the mother bouncing the baby to the rhythm and the infant responding by clapping his or her hands.

Infant Behaviour During the Disruption

The scale measuring infant behaviour in the disruption episode was designed to examine how infants react to their mothers being distracted. It was predicted that this would vary depending on the environment that was initially created prior to the disengagement. Infant behaviour was coded across three categories: (1) attention towards the mother; (2) attention towards the environment; and (3) attention towards the self.

Attention towards the mother included the baby touching the mother, the baby looking at

the mother, the baby vocalizing towards the mother, and the baby crying for attention. Attention towards the environment included touching, pointing, picking up, looking at, and playing with objects or toys in the environment. Attention towards the self included infants touching their own faces, rocking themselves, and sitting calmly by themselves.

Reliability

Reliability data for each of the three scales were taken from a “semi-blind second” coder who coded a random sub-sample of the participant sample. Six participant pairs were coded by both the researcher and another student. High inter-coder reliability was found (83.4% agreement between two independent raters on a random sample of six episodes). The remaining 12 participant pairs were coded independently by the researcher.

Procedure

Original Video Recording Procedure

Participants were asked to make a one-time visit to the Infant and Child Lab at Huron University College. Participants were first asked to complete a questionnaire pertaining to the current health of their infant, the number of ear infections their infant has had, and any history of hearing loss in their family. The questionnaire took approximately 5 minutes to complete. Participants were then asked to sit with their infant in a quiet laboratory room. The laboratory was set up with a children’s Playmat® and a box of toys including toy trucks, plastic rings, and stuffed animals. Audio and video recording of the entire session was mandatory for participation. Footage was recorded on two cameras with synchronized video and sound recordings. One camera was angled towards the infant and the other camera towards the mother. Mother-infant dyads were randomly assigned to one of two experimental groups: (1) speech first; or (2) song

first.

Mothers in the ‘speech first’ group were asked to play with their child as they normally would at home until the researcher came into the room. After approximately 5 minutes of play, the researcher came in to complete a ‘disruption episode’. This episode consisted of the researcher sitting in the room and asking generic questions, such as, “what do you do for work?”, “did you have a good weekend?”, “do you have plans for the rest of the day?”, and “do you have any other children?”. The disruption episode lasted approximately 3 minutes. At this point, the mothers were asked to sing any nursery rhymes or songs that their baby might like, and the researcher left the room. The musical episode of the visit lasted approximately 5 minutes.

In the ‘song first’ group, the episodes were reversed so that mothers were asked to sing with their infants before the researcher disrupted them and play as they normally would after the researcher left. The testing portion of the visit lasted approximately 20 minutes.

The Present Study

In the present study, the episode following the disruption was omitted and the recorded data were treated as a between-subjects design in which half of the participants were in the speech group and half of the participants were in the song group.

The speech, song, and disruption episodes were all coded in 3-minute segments. In the disruption episode, the 3-minute segment began after the first question was asked. In the speech group, the coding segment was determined as 3 minutes before the disruption began. In the song group, the coding segment started as soon as the first song began and lasted for 3 minutes.

Results

Of the 18 participants, data from 16 were included in analysis. One participant was

excluded due to incomplete video footage, and one participant was excluded because there was another person present in the room, posing as a distraction from the interaction. Data from eight participants were included in the speech context and data from eight participants were included in the song context. With the intent to eliminate an order effect of coding, the chronological order of participants was shuffled, and each video set was randomly selected for coding analysis. Coding was recorded in a Microsoft Excel file where the frequency of each behaviour was counted. The footage was time stamped for interesting or rare behaviour.

Maternal Behaviour

A one-way multivariate analysis of variance on maternal behaviour, measuring infant referencing, object referencing, and pausing, revealed a statistically significant difference in frequencies of behaviours based on a speech or song context, $F(3, 12) = 6.82, p < .006$; Wilk's $\Lambda = 0.370$, partial $\eta^2 = .63$. The results indicated a significant effect for musical context with mean scores for each category showing significantly higher frequencies in the speech context compared to the song context as can be seen in Table 1. Musical context had a statistically significant effect on infant referencing ($F(1, 14) = 4.89; p < .044$; partial $\eta^2 = .26$), object referencing ($F(1, 14) = 13.85; p < .002$; partial $\eta^2 = .50$) and maternal pausing ($F(1, 14) = 11.16; p < .005$; partial $\eta^2 = .44$).

Infant Behaviour in Speech and Song

A one-way multivariate analysis of variance showed that there was no significant difference in infant behaviour, including the dependent variables of positive affect, attention, and turn taking, based on the speech or song context, $F(3, 12) = 1.35, p > .305$; Wilk's $\Lambda = 0.748$, partial $\eta^2 = .25$. Table 1 shows the descriptive statistics.

Table 1. *Descriptive Statistics of Coded Behaviours Across the Speech and Song Groups*

Musical Condition	Speech			Song		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Maternal Behaviour*						
Infant Referencing*	8	27.75	6.67	8	20.38	6.67
Object Referencing*	8	15.75	4.59	8	7.00	4.81
Maternal Pauses*	8	12.13	4.79	8	4.88	3.83
Infant Behaviour in Speech/Song						
Positive Affect	8	8.25	5.01	8	10.00	8.35
Attention	8	10.63	3.67	8	7.88	3.09
Turn Taking	8	3.75	1.98	8	2.88	1.89
Infant Behaviour During the Disruption						
Attn. Towards Mother	8	8.50	6.65	8	8.25	4.27
Attn. Towards Enviro.	8	10.25	5.73	8	10.38	7.54
Attn. Towards Self	8	3.00	3.16	8	4.75	2.31

Note. * Significant results. N = 16 (n=8 for each condition). Infant participants were, on average, 7.8 months old, and participant age did not differ by condition.

Infant Behaviour During the Disruption

A one-way multivariate analysis of variance did not show a statistically significant difference in infant behaviour during the disruption episode, coded as: (1) frequency of attention towards the mother; (2) attention towards the environment; and (3) attention towards the self, based on a previous speech or song context, $F(3, 12) = .47, p > .708$; Wilk's $\Lambda = 0.895$, partial $\eta^2 = .11$. The descriptive statistics may be found in Table 1.

Discussion

The results of the present study show that mothers use different types of behaviour to engage their infants when asked to speak or sing to them during play interactions. The main purpose of the present investigation was to explore the typical behaviours that are observed in interactions between mothers and 6 to 9-month-old infants, specifically when speech and song are involved. This was accomplished by recreating a typical play setting and measuring the frequency of occurrence of specific behaviours across both members of the dyad.

Maternal Behaviour

Maternal behaviour across speech and song showed significant differences with regard to object referencing, infant referencing, and maternal pauses. Previous literature has suggested that mothers initiate interactions in which they want to convey emotional messages to their infants, and that they alter their behaviours based on cues from their infants (Reyna & Pickler, 2009; Trevarthen & Malloch, 2000; Dissanayake, 2000). It has also been suggested that maternal sensitivity to infant arousal states can promote synchrony (Reyna & Pickler, 2009) and that song contexts can more successfully communicate intentions (Nakata & Trehub, 2004; Trehub, 2006). Therefore, it was hypothesized that there would be a higher occurrence of behaviours pointing to synchrony in a song context rather than a speech context, shown through object referencing, infant referencing, and maternal pausing. The results show that mothers significantly alter their behaviour depending on the context they are in; however, the results opposed the hypothesis as the mothers showed higher frequency counts in the speech context across all three categories.

Object Referencing

Results showing higher frequency of object referencing in speech are not entirely

surprising. Past research has supported the idea that mothers are eager to promote joint attention through object referencing and object play (Bakeman & Adamson, 1984) and, specifically, objects increasingly become the focus of parent-infant interactions as the infant ages from 6 to 9-months-old (Feldman, 2007). Further, it has been considered that parenting in Western cultures tends to provide more object presentation than non-Western cultures and focuses frequently on the infant's interest in toy manipulation (Feldman, 2007). This was certainly observed in the present study as the mothers frequently referenced the new toys or novel objects in the environment. Common occurrences included asking, "Do you like this new toy truck/stuffed animal?" and commenting, "All you want to do is explore" or "You're only interested in the camera equipment". It was also commonly observed that mothers played with multiple toys and switched tactics throughout the speech episode. In this experiment it was observed that song was more static with regard to object play.

Although not tested on speech and song, previous research by Rock et al. (1999) suggested that the arousing nature of play-songs offer more opportunity to interact with the external world and to engage with objects in the environment than lullabies do. These findings led to the expectation that the song setting would generate higher occurrences of object referencing than the speech setting. In the current study, the arousing song setting showed less object referencing than would the speech setting, indicating that speech may have had more opportunity, than did song, to reference the environment. Just as play-songs are shown to be more externally focused than lullabies, perhaps infant-directed speech, in this case, was more externally arousing than play-songs. Trainor (1996) argued that mothers modify both speech and song patterns when addressing infants, but that the exaggerated pitch fluctuations found in

infant-directed speech, which may allow for sustained attention (Trehub, 2006), may not be possible in infant-directed song, because song is constrained within musical structure. Although not directly related to object referencing, it may be suggested that the play-songs in this case were constrained within the lyrical and rhythmic parameters set out in the specific song, thereby limiting the number of times mothers were able to vocally reference objects or toys. It may be the case that speech offers more of an opportunity to talk about the characteristics of the toys and objects, for example, “this toy truck is so fast” or “this bear is so soft”. Song, on the other hand, may therefore be more constrained to touching or gesturing to the objects without referencing them in vocalizations. Song offers an opportunity to adapt and change the lyrics to incorporate external referencing; however, this may be less easy than referring to objects in speech. This may have accounted for the higher frequency of object referencing in the speech context. However, more research evidence is required regarding the potential constraints in song settings.

Infant Referencing

Interestingly, infant referencing was also more prominent in the speech setting. Infant referencing behaviours included touching the baby, looking at the baby, talking about the baby, asking the baby a question, bouncing the baby, and moving the baby to the rhythm. It was anticipated, specifically, that frequency of looking at the infant would be higher in the song setting because the amount of time spent looking at one another has been shown to be a significant measure of synchrony (Censullo et al., 1987). However, evidence to support this expectation was not found in the current study. This finding may also provide evidence for the hypothesis that speech offers increased opportunities to attempt engagement than song does.

Although mothers demonstrated less frequent infant referencing in the song setting, it

was often observed that certain behaviours were engaged in for longer in durations. For example, it was repeatedly noted that infants stood facing their mothers while she held their hands and looked directly at their faces. The mother would hold her gaze for an extended period of time without introducing toys or objects into the interaction. In this case, frequency counts may have been a less-sensitive measure for the ‘looking at’ and ‘touching’ infant categories of maternal behaviour. This may have accounted for the lower frequency count of infant referencing in the song context; a measure of duration might have been a more salient measure of infant referencing in this case.

Paralleled with object referencing, it may be theorized that the musical constraints of song pose an issue for vocal infant referencing. For example, in one commonly used play-song *Pat-A-Cake Pat-A-Cake*, there is an opportunity to reference the child in the lyric “put it in the oven for (baby’s name) and me”. This opportunity only arises once before the lyrics and beat continue. It was noted that other common nursery rhymes in the song episodes included *Five Little Monkeys Jumping on the Bed*, *Old MacDonald Had A Farm*, and *The Itsy-Bitsy Spider*, all of which offer little to no opportunity for infant referencing in vocalizations. However, this only applies to the vocalization aspect of infant referencing. Previous literature has stated that songs are more arousing and active than speech, in the sense that music is often paired with touching, clapping, bouncing, and laughing (de l’Etoile, 2006; Trainor, 1996). This indicates that perhaps there was another issue with the operationalization of infant referencing. It should be noted that touch and gaze can be measured durationally and that a summed score in this category may not have been the best approach for generating relevant data. In this coding scheme, some categories may have been more conducive to speech (talking about the baby and asking the baby a

question), while some may have been more conducive to song (bouncing the baby and moving the baby to the rhythm). Although it was predicted that the frequency counts from these specific categories would ultimately equal one another, this may not have been the case; the behavioural scales may need further refinement.

Maternal Pauses

Pausing was operationalized as the presence of the mother ceasing stimulation for at least 2 seconds following an attempt to engage, offering a time period for the infant to respond to the attempt. Maternal pauses are noteworthy because they indicate a mother's sensitivity and ability to adjust her arousal levels to those of her infant (Censullo et al., 1987), an important reciprocal aspect of synchrony. Pausing also offers a chance for the infants to demonstrate their level of responsiveness in the interaction. Maternal pauses were shown to be higher in the speech context compared to song context. This further supports the hypotheses above, suggesting that there may be less constraint in infant-directed speech. Perhaps speaking gave the mothers more of an opportunity to pause in their vocalizations than singing did because they were not focused on continuing the lyrics or rhythm of the song.

The Function of Maternal Behaviour

It is important to note that the results of the current study are somewhat congruent with previous research suggesting that caregivers' behaviour may reflect the intentions they have for the interaction (Fernald & Mazzie, 1991). Emotional communication has been suggested to be initiated by the caregiver and is thought to convey information to the infant (Dissanayake, 2000). It is evident from past and present research that maternal behaviour plays an essential role in initiating a sustained interaction within the dyad. Although the findings show the opposite of

what was expected, they offer insight into the intentions mothers may have when initiating an interaction. The current findings further support the idea that caregivers, and the environments they create, may involve the intention to teach infants about themselves and about their environments.

In terms of the postulated link between synchrony and learning, it can be argued that speech contexts, which may provide more opportunity for external referencing, are more conducive to cognitive teaching and learning than are musical contexts. It was originally thought that song would enhance the responsiveness of the infant and therefore be a salient conductor of cognitive development, but the results suggest otherwise. However, it should not be concluded that song does not offer any learning opportunities. Past research has suggested that emotional communication can be enhanced through music (Trainor, 1996) and, also, that infant-directed speech is underlaid with an emotional expressiveness that is attractive to infants (Singh et al., 2002). Perhaps it is the case that the emotionality in song serves a different function than the emotional communication in speech. Infant-directed singing has specifically been considered as a regulatory agent to soothe or arouse infants (Trainor, 1996) and a mechanism to enhance social communication (Gerry et al., 2012). Song, creating an active and reciprocal environment, may promote social and communicative learning (Gerry et al., 2012) while speech, using external referencing, may promote cognitive associations between words and objects. In this case, perhaps the function of synchrony in infant-directed song has more to do with social development, whereas the function of synchrony in infant-directed speech has more to do with cognitive development. Arousing song contexts may increase an infant's ability to respond to others, interpret their behaviours, and build relationships, whereas speech may be more salient

for developing memory consolidation, information processing, and language acquisition. Certainly, infant referencing aspects of speech may be important in terms of adjusting the infant's attention towards what is of interest. The increased opportunity to ask the infant direct questions, using their name, and the heightened fluctuation of pitch and vocal acoustics in speech as compared to song (Bergeson & Trehub, 2002, as cited in Nakata & Trehub, 2004) may have allowed for increased cognitive learning opportunities. The object referencing aspect may particularly differentiate the two contexts, as object presentation is essential for drawing attention to new words and phrases, as well as drawing connections between words and objects. It has been found that infants' ability to switch their gaze between their mother and an object is positively correlated with learning word-object relationships (Matatyaho, as cited in Leclere et al., 2014). As well, maternal pausing can be theorized to increase the salience of cognitive learning as it gives the infant a chance to respond to an attempt to communicate made by the mother, with a vocalization or indication of language development.

It appears that the frequency of maternal behaviour occurs at a higher level in speech contexts, however, this does not diminish the idea that synchrony can occur in a song setting. It may be the case that synchrony in speech and song appear in substantially different ways and messages from each context may simply be conveying different intentions to infants. It should not be assumed that synchrony is decreased in a musical interaction but rather that synchrony is presented in a different and unique way. Future research is needed to solidify the operationalization of synchrony in each setting.

Infant Behaviour in Speech and Song

In contrast to the findings associated with maternal behaviours, infant behaviours showed

no change across the speech and song contexts. It was hypothesized that there would be more behaviours pointing to synchrony in a song context than a speech context, shown through positive affect, attention, and turn taking. In the current coding scheme this was based on the level of perceived engagement in response to the mother so that only behaviours that were in response to the mother's attempts were coded. The aim of studying infant behaviour was to show whether there was a difference in responsiveness across play settings using speech or song as previous literature has suggested that song can promote arousal and sustain attention (Tsang et al., 2017; Nakata & Trehub, 2004). Contrary to previous findings, the present experiment did not show increased attention or responsiveness in the song context.

The results of this analysis reveal interesting insights into the way in which infants receive information from their caregiver. Previous research literature has found that infants can discriminate between speech and song and preferentially respond to infant-directed speech over infant-directed song (Tsang et al., 2017; Nakata & Trehub, 2004). The findings in the present study indicate that infants did not show a preference for either means of communication directed towards them; however, it is likely that the behavioural scale used to measure responsiveness was not sensitive to the nature of the interaction. It may be suggested that the findings imply that infants are not partial to the specific vocalizations made by their mother; however, it should be noted instead that perhaps maternal vocalization was not the most significant indicator of interactional synchrony. This finding may also indicate that information received by infants is based on additional subtle cues from the mother, such as body language, expressional cues, demeanor, or excitement levels, rather than vocalizations. Future research is needed to further explore this theory.

The results of the ‘attention’ category, as one measure of synchrony, were quite surprising. Based on previous research findings showing that song contexts can more easily capture and sustain infants’ attention (Trehub, 2006; Trevarthen & Malloch, 2000), it was predicted that infant attention would be significantly higher in the song context. Perhaps, in this case, singing did not pique infants’ attention because the novel environment was more stimulating than the mother’s vocalizations. It may also be the case that infant responsiveness, contingent on maternal behaviour, was not as encouraged in the song setting. It was noted from the footage that the mothers in the speech context were eager to reference the novel toys in the laboratory and speech allowed for more independent exploratory behaviour, such as picking up and touching new toys. In contrast, mothers in the song setting initiated more stationary and uniform behaviour, such as facing and maintaining eye contact with their infant. This may have had an effect on the infant’s interest in the dyadic interaction.

The findings of the present study, connected with the findings of previous studies, may support the concept that synchrony can be displayed and cultivated in both speech and song settings. If infants find song settings to be more pleasurable than speech settings (Tsang et al., 2017; Nakata & Trehub, 2004) and song can promote synchrony (Trehub, 2006), perhaps synchrony serves a different function in each setting. As noted above, it may be the case that speech offers an environment whereby an infant can learn cognitive skills, while song fosters the development of social skills. Both contexts require a synchronous interaction; however, perhaps synchrony is required for different reasons. Based on observable differences in the maternal behaviour categories, it appears that each setting may need to be measured using its own set of behaviours. In order to understand the functional differences between synchronous interactions

in speech and song and differences between infant responsiveness, future research is needed.

Infant Behaviour During the Disruption

Finally, there were no significant differences in infant behaviours during the disruption episode based on being previously sung to or previously spoken to. It was hypothesized that elevated synchrony in the song setting would lead to increased attention directed towards the mother in the disruption episode. The findings did not support this hypothesis, nor did they show a significant difference in attention towards the environment or attention towards the self. Behavioural coding of the disruption episode specifically was designed to answer whether or not the infant tried to initiate an interaction while the mother was distracted and whether or not synchrony would have an effect on self-regulation behaviour. It was previously thought that increased attention towards the mother would indicate that the infant was seeking to re-engage or re-establish a synchronous interaction. Although this scale did not bring about significant results, these are interesting findings that give insight into mother-infant synchrony.

The results of this study entertain the idea that synchrony is not something that is sustained over time. These findings imply that the function of synchrony may simply lie in the intentions set out by the person initiating the interaction. Infants may not be partial to the mechanism with which information is communicated and further, the type of interaction may not have lasting effects. If infant-directed song is, in fact, preferred over infant-directed speech, it appears that this preference has no bearing on subsequent changes in the interaction.

Furthermore, previous research has stated that synchrony is associated with early attachment (Reyna & Pickler, 2009). It was posited in the introduction that synchrony may be a key factor in promoting healthy attachment. However, the lack of interest in re-engaging with the

mother during the disruption demonstrates that synchrony, whether previously cultivated or not, does not determine the way in which subsequent attachment-related interactions play out.

Synchrony may present itself only in the ongoing interaction; however, when the infant is put in a situation in which the interaction is disrupted, perhaps attachment style becomes the prominent driver of behaviour. Studying attachment behaviour in this setting may have been a more notable indicator of difference.

Limitations and Future Directions

One of the most significant limitations of this study was the sample size and the amount of recorded data that was used for analysis. The coded segments of the data were only a sample of the entire recorded footage that was available for analysis. In this study, 9 minutes of footage per participant was used, and the second episode of play was omitted from coding. Using this small subset of data from 16 participants was not sufficient to draw concrete conclusions about the way in which synchrony can be defined. It may be of interest to use a within-subjects design to test these effects in the future. Sample size in this study was important because, based on anecdotal observations, there appeared to be wide variance in the dispositions of both the mothers and the infants. It seemed apparent during the disruption episode that maternal participants had varying personalities and dispositions: some of the mothers eagerly engaged with the researcher and were open about their jobs, spouses, and children, while others were quite reserved and did not seem willing to engage with these questions. Further, there was large variance amongst the infants in terms of temperament. Some infants were fussier than others, perhaps due to maintenance schedules, and it was apparent that some infants were substantially more vocal, more playful, and had more positive affect than others. These findings add to the

literature; however, more coded footage or a larger sample size would be useful in future studies.

Additionally, the camera angles were somewhat of a limitation. Throughout the videos, the mothers were frequently picking up their children and moving them back into the frame. This may have had an effect on the frequency count of ‘touching the baby’, depending on how often this occurred. In order to rectify this limitation, camera angles should be adjusted to extend the frame or additional cameras should be set up. The camera equipment also offered a new and novel environment for the child which often caused distraction from the mother’s attempts and may have had an effect on the infant scores of ‘attention towards the environment’ in the disruption episode. Importantly, future research coders should omit frequency counts not related to the independent variables or adjust the behavioural scales to code for ambiguous behaviours.

This study was also limited to data that were collected for the purpose of a previous study; the measures of behavioural coding were designed to answer questions that were constructed around existing data. The speech and song contexts were consistent across participants, and the environments were likely analogous to typical interactions a dyad might have at home; however, future studies may consider more specific methodology to test synchrony. The current coding scheme should be referenced as it can be adjusted and altered to answer future research questions. Additionally, it may be of value to have multiple coders from which an average score on each scale is attained, rather than relying on one or two sets of researcher judgements.

Finally, it is worthy of note that, based on anecdotal evidence, observable differences between the ways in which mothers interacted with female or male infants were not apparent in the footage. Research in parenting, however, has found that parents often encourage gender

stereotyping in play and social upbringing (Lytton & Romney, 1991). This may be an interesting avenue for future research.

Conclusion

The present study offers significant insight into the ways in which mothers typically engage their infants in speech and song settings. It is evident that the caregiver plays an essential role in initiating the dyadic interaction and facilitating social communication between the pair. The specific infant referencing, object referencing, and pausing behaviours of mothers offer insight into the ways in which caregivers can promote language acquisition and the ways in which they already do so. Future research is needed to further understand the ways in which synchrony can be analyzed and operationalized differently across speech and song as well as the specific processes and interactions that may strengthen infant development over time.

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