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Abstract

Existing literature demonstrates that infants can discriminate between categories of infant-directed (ID) speech based on the speaker's intended message – that is, infants recognize the difference between comforting and approving ID speech, and treat different utterances from within these two categories similarly. Furthermore, the literature also demonstrates that infants understand many aspects of music and can discriminate between happy and sad music. Building on these findings, the present study investigated whether exposure to happy or sad piano music would systematically affect infants' preferences for comforting or approving ID speech. Five- to nine-month-old infants' preferences for comforting or approving ID speech were examined as a function of whether infants were exposed to sad or happy piano music. Seventeen (10 male, 7 female) full-term, healthy infants were included in the study. It was hypothesized that relative to infants exposed to happy music, infants exposed to sad music would demonstrate a stronger desire to hear comforting ID speech. The study employed an infant controlled, preferential looking procedure to test this hypothesis. The results of the study did not statistically support the researchers' hypotheses. Limitations of the present work and suggestions for future research are discussed.

Keywords: infant-directed speech, music cognition, emotion, affect

Infants' Responses to Affect in Music and Speech

The creation and enjoyment of music appears to be a universal component of human cultures (McDermott & Hauser, 2005). Usually, when a behavior is universal among all cultures it is inferred that there is something about this behavior, some quality, which is deeply ingrained and perhaps even fundamental to the human psyche. In the existing literature on the origins of music it is common to see language held up as a comparison. For example, it has been argued that unlike language, music has no clear adaptive function (Hauser & McDermott, 2003). Music has even been reduced to "auditory cheesecake," by one author who was alluding to its pleasurable qualities while dismissing it as an evolutionary byproduct of language (Pinker, 1997, p. 534). Yet it has also been contended that music can be seen as a proto-language that may have helped our pre-linguistic ancestors communicate and survive (Mithen, 2006).

The relationship between language and music does not make for an easy investigation. However, the utility of infant-directed speech (ID speech) may serve as an illuminating example of how music and speech may be related. ID speech is essentially a singsong style of speaking, characterized by exaggerated prosody and emphasized tonal shifts, which adults tend to use when trying to communicate with infants (Fernald, 1985; Moore, Spence, & Katz, 1997). Existing psychological literature demonstrates that infants can discriminate between categories of ID speech based on the speaker's intended message – that is, infants recognize the difference between comforting and approving ID speech, and treat different utterances from within these two categories similarly (Moore et al., 1997). Furthermore, the literature also demonstrates that infants understand many aspects of music and can discriminate between happy and sad music (Flom, Gentile, & Pick, 2008). It has even been shown that newborns can identify rhythm cycles and develop an expectation of the downbeat even when it is not marked by stress (Winkler, Haden, Ladinig, Sziller, & Honing, 2009). Building on these findings, the present study investigated whether exposure to happy or sad piano music would systematically affect infants' preferences for comforting or approving ID speech.

In order to shed light on what is already known about infant capabilities in regards to ID speech and music, the existing literature is reviewed here. The review begins with the role of ID speech in infant-caregiver communication and the characteristics and functions of ID speech. The literature on infant musical abilities is discussed thereafter.

Communication is an essential component of the human experience. Upon arriving in the world, a newborn brings with her the tremendous task of not only learning how to coordinate her own body but also learning how to coordinate with others, and most importantly her caretaker(s). Language, with its puzzle-like complexities and rules, will not be fully developed within the first year. But, successful infant-caretaker communication is accomplished immediately. Newborns usually come to the world bellowing for attention. What is more is that adults are equipped to respond to the cry of an infant, as studies have shown that the sound of a baby crying raises the blood pressure of adults and enacts a stress response (Parsons, Young, Parsons, Stein, & Kringelbach, 2012). As development proceeds, infants become more sophisticated in their abilities to communicate with their caretakers, as do their caretakers become more able to communicate with them. Since language is not an option, a need for a more basic system of communication presents itself. It would appear from both anecdotal experience and the psychological literature that pre-linguistic infant-adult communication takes a somewhat musical form, through the use of infant-directed (ID) speech. Even Charles Darwin, as far back as 1872, recognized the musical qualities of ID speech, referring to ID speech as "the sweet music of the species" (Darwin, 1872/1955, p. 91).

Because the exaggerated prosody and emphasized tonal shifts that characterize ID speech are similar to those found in music, this style of speaking is sometimes called musical speech (Fernald, 1989; Sakkalou & Gattis, 2012; Trainor, Austin, & Desjardins, 2000). ID speech tends to be more rhythmic than adult-directed (AD) speech, has more exaggerated pitch contours, a larger pitch range, and is generally higher in pitch than AD speech (Ferguson, 1964; Katz, Cohen, & Moore, 1996; Stern, Spieker, & MacKain, 1982). There are many reasons why this type of speech facilitates adult-infant communication. Compared to AD speech, infants prefer ID speech (Cooper & Aslin, 1990; Fernald, 1985; Pegg, Werker, & McLeod, 1992), ID speech fosters infants' attention better than AD speech (Werker & McLeod, 1989), and ID speech has been shown to be more arousing to infants than AD speech (Kaplan, Goldstein, Huckeby, & Owren, 1995). For all of these reasons, ID speech is useful. However, perhaps the most important function of ID speech is that it allows caretakers to communicate emotional information to infants, which helps to foster the important emotional bond between them (Trainor et al., 2000). For example, it has been shown that infants can make distinctions between different types of ID speech based on the meaning intended (e.g., comforting utterances vs. approving utterances) by the adult speaker (Moore et al., 1997).

Beyond speech, empirical investigations have provided evidence that infants can recognize and respond to aspects of music that are not directly connected to language, such as tempo, melody, pitch, beat, and musical phrase structure (Schellenberg & Trehub, 1996; Trehub, Schellenberg, & Kamenetsky, 1999; Trehub, Thorpe, & Morrongiello, 1987; Winkler et al., 2009). Additionally, infants demonstrate a preference for consonant over dissonant patterns in music (Masataka, 2006; Trainor, Tsang, & Cheung, 2002). The musical abilities of infants are quite remarkable; however, it is still unclear whether infants can discern and be affected by the discrete emotional messages present in music. It is clear from the literature that adults associate faster tempos and major modes with happiness, and slower tempos and minor modes with sadness (Balkwill & Thompson, 1999). If infants are indeed able to perceive the affect intended in music, similar results would be expected.

Perhaps one of the best ways to consider the value of music in the communication of affect is to examine the way that mothers sing to their babies. Rock, Trainor, and Addison (1999) recorded mothers singing a song of their choosing in one of two styles: play song or lullaby. In order to validate the recorded songs, the experimenters asked adults whether each song was a play song or a lullaby and adults identified the songs correctly with 100 percent accuracy. The authors then took the recorded audio clips of the play songs and lullabies and played them to infants while the infants' expressions were videotaped. Adults who watched the videotapes without sound performed at above chance when guessing the type of song the infant in the video was hearing. The results of this study lend support to the idea that singing (and therefore, music) is an effective way to communicate with prelinguistic infants.

More recently, research reported by Falk (2011) lent support to the idea that there is a connection between information transmitted by the global contours of ID speech and those of improvised maternal singing in play and soothing contexts. In the study, the researchers asked French-, German-, and Russian-speaking parents to play, speak, sing, and interact freely with their infants while researchers recorded their interactions with a microphone. From these recordings, the researchers assessed whether there was a relationship between the intonation and contour of parents' ID songs and ID speech within play and soothing contexts and whether this relationship was evident across the three different languages. The results of the study showed that there were intonational and melodic similarities between the songs and ID speech used in play contexts in all three languages. However, in soothing contexts, the contour types of parents' ID speech and songs were only partially congruent and cross-linguistic differences were evidenced. Despite mixed evidence in soothing contexts, this research showed that ID speech and song are indeed related in play contexts. This relation may warrant a view that ID speech may serve as a scaffold to support infants through the transition of communication through song to communication through language.

In an attempt to address the question of whether infants are able to perceive emotion in music, Nawrot (2003) exposed infants to a happy or sad piece of music and observed their looking times at videos of either a sad or happy human face. She hypothesized that if the infants understood the emotional message of the music being played, they would look at the facial expression that corresponded with the emotion portrayed in the music (i.e., happy music would make the infant look mostly at the happy facial expression). However, infants only evidenced the hypothesized looking behavior for happy faces, which provides at best only murky support for the hypothesis that infants can discriminate the emotions conveyed by music. It is likely that infants were demonstrating no more than a preference for happy faces in general and that the significant looking correspondence between happy music and the happy face was an artifact of the study design.

An earlier study by Soken and Pick (1999) replicated the preference for happy faces shown in Nawrot's (2003) work. In the study, the researchers presented infants with a preferential looking procedure in which infants could choose between looking at one of two emotional faces while hearing vocal expressions that affectively matched only one of the two faces. The emotional contrasts displayed in the faces were happy/interested, happy/sad, happy/angry, interested/sad, interested/angry, and sad/angry. Infants demonstrated longer looking times at the displays concordant with the emotional valence of heard vocalizations in all conditions except for the happy/sad and interested/sad conditions. Similar to the result reported by Nawrot (2003), infants preferred to look at the happy or interested faces in these conditions, despite whether the voice was concordant or discordant. Both Nawrot (2003) and Soken and Pick (1999) argued that infants were able to discriminate between the affects presented. The fact that infants demonstrated such a strong preference for happy faces, despite the lack of concordance with the audio stimulus, demonstrates discrimination *per se*, even if this result did not support the researchers' hypotheses.

Flom and colleagues (2008) offered strong support to the hypothesis that infants are able to perceive and distinguish between emotions in music. The authors showed that 9-month-old infants can successfully discriminate between happy and sad musical excerpts. In Experiment 1, the authors of the study presented 3-, 5-, 7-, and 9-month-old infants with three musical excerpts – which were previously rated happy or sad by adults and preschoolers – utilizing an infant-controlled habituation procedure. After habituating the infants to the first group of happy or sad musical excerpts, infants were presented with new musical excerpts from either the same or different affect group. The authors found that 9-month-olds successfully discriminated between affect groups in music but 3-month-olds did not. Interestingly, the 5- and 7-month-olds only successfully discriminated between affect groups when habituated to sad excerpts. In their discussion, the authors offered the possible explanation that this asymmetry could be due to happy music being more arousing and therefore more likely to renew infants' attention after habituation. The authors additionally mentioned that 5- and 7-month-olds could differ from 9-month-olds in their level of reactivity. However, Flom and Pick (2012), using the same method as Flom and colleagues (2008) used in their Experiment 1, found that 5- and 7-month-old infants could indeed discriminate symmetrically between sad and happy musical excerpts, provided that habituation was defined as a 70% decrement in looking, rather than the usual 50%. This finding is important because it shows that even though younger infants require more time to habituate, they, too, are able to discriminate between the different affective qualities in music.

In Flom and colleagues' (2008) second experiment, 5-, 7-, and 9-month-olds were habituated to either three happy or three sad musical excerpts and then presented with two novel excerpts from the same affect group to which they were habituated. The authors found that the infants did not discriminate between these novel, yet affectively similar excerpts and those to which they had been habituated. Thus, Flom and colleagues (2008) offered strong evidence for true discrimination between happy and sad music because the authors demonstrated that infants could discriminate between happy and sad categories while failing to dishabituate to novel excerpts within sad and happy categories.

The literature demonstrates that infants (1) have the ability to process many aspects of music, (2) use musical cues present in ID speech, lullabies, and play songs to interpret the emotional intent of the speaker, and (3) can discriminate between affectively happy and sad musical excerpts and facial expressions. Although infants are able to pick up on differential cues regarding the emotional content present in musical compositions (Flom et al., 2008; Flom & Pick, 2012), the evidence for whether infants are able to feel emotional messages conveyed in music is still unclear. There is a strong debate among researchers in the field of music cognition regarding whether music elicits emotions within the listener or if it only represents emotions which are identifiable but not actually conjured up in the listener (Tan, Pfordresher, & Harré, 2010). Those who believe that music fails to actually elicit emotions are in the *cognitivist* camp of the debate, while those who believe that music indeed does elicit emotions in the listener find themselves on the *emotivist* side (Tan et al., 2010). If infants are not emotionally affected by the music they hear, there would not seem to be much of an impetus for them to desire comfort or approval as a result of exposure to the music. For a strong preference to be demonstrated, it would appear necessary for the infant to actually feel the emotion from within.

In an effort to add to the existing literature, the present study investigated whether exposure to happy or sad piano music would systematically affect infants' preferences for comforting or approving ID speech. In the current study, all infants were exposed to a one-minute composite of musical excerpts – developed and validated by Vieillard et al. (2008) – from one of two affective categories: happy or sad. Immediately after hearing the musical excerpts, infants were given the opportunity to choose to hear either comforting or approving filtered ID speech by looking at one of two screens. Infants' reactions were measured to explore if their behavior varied as a function of whether they had previously heard happy or sad music. It was hypothesized that infants exposed to sad music would demonstrate a stronger preference for the comforting ID speech than would infants exposed to happy music. If infants' emotions are indeed stirred by the sad music, it would make sense from an emotion regulation standpoint that they would desire comfort over approval (Kopp, 1989). Because it was expected that happy music would not generate any state of discomfort or need, it was hypothesized that infants exposed to happy music would not demonstrate a preference between the auditory stimuli provided.

Method

Participants

Twenty-five full-term, healthy infants (15 males, 10 females) were recruited for the study. However, data from eight infants were excluded from analyses due to fretting or technical malfunction. Analyses were conducted on those 17 infants (10 males, 7 females) who provided useable data. Infants included in the study ranged in age from 5 months, 9 days to 9 months, 18 days (*M* = 200 days, *SD* = 32 days). All infants were from primarily English-speaking homes. Infants' parents self-reported their racial/ethnic backgrounds. The 34 parents self-identified as 50% White, 41% Latino or Hispanic, 8% Asian, .05% Pacific Islander, and .05% Native American.

Materials

Brief interview. Before beginning participation in the study, caretakers were asked to complete a brief questionnaire regarding their infant's medical history and home environment. The questionnaire asked caretakers to describe their infant's health, any delivery problems, how well the infant slept the night before the study, when their infant was last fed, information regarding their infant's prior experience with music, and whether there were any musicians in the family.

Equipment. An IBM PC-clone computer was used to present the auditory and visual stimuli for this study. The computer used two monitors and two stereo speakers (left and right) to present auditory and visual stimuli to participating infants. Self-designed software randomly assigned infants to happy music exposure and sad music exposure groups, presented them with computer-selected auditory and visual stimuli, and recorded looking times as expressed on an experimenter-controlled joystick.

Music samples. The music samples used for this study consisted of musical excerpts developed and validated by Vieillard et al. (2008). Infants were presented with four or five 10- to 15-second music excerpts from one of two affective categories: happy or sad. Specifically, infants in the happy music condition heard excerpts g02, g04, g05, g11, and g14, whereas infants in the sad music condition heard excerpts t01, t03, t09, and t11. Excerpts were chosen based on the validating procedures conducted by Vieillard et al. (2008), which showed the selected excerpts to be most quickly identified and most accurately labeled by adult participants.

Speech samples. Speech samples for the present study were recorded during natural, mother-infant interactions. Prior to the current study, one group of 30 adults was presented with a set of 31 comforting speech samples and another group of 30 adults was presented with 31 approving speech samples. The group presented with the comforting speech samples was asked to rate each sample based on whether it provided a good example of a mother trying to comfort her infant; the group presented with the approving speech samples was asked to rate each sample based on whether it was a good example of a mother trying to communicate approval to her infant. The raters were all given the following scale on which to rate each clip: 1: *extremely bad example*; 2: *bad example*; 3: *neutral*; 4: *good example*; 5: *extremely good example*. Of the 31 approving samples and 31 comforting samples, the 14 samples from each category that received the highest scores were selected for inclusion in the present study. All speech samples were then processed using a low-pass audio filter with a 650Hz cut-off, which removed the phonetic distinctions of the speech, leaving only the tonality and prosody of the speech samples.

Visual stimulus. The visual stimulus used for the study consisted of an image of three dynamic black and white random checkerboards (Karmel, 1969) presented over a mid-gray background. The white squares turned black (and vice versa) in a random fashion repeatedly, so as to make the checkerboards dynamic and interesting to infants. These checkerboards were interesting enough to infants to initially attract their attention, but not to sustain it in the absence of any auditory stimulation. The stimulus was presented on two computer monitors simultaneously. Although two monitors were used to display the visual stimulus for the study, they always displayed the same image. The only difference between the monitors was the category of ID speech associated with each monitor (see the Procedure section, below).

Laboratory layout. In the testing room, a chair was located 4.5 feet in front of two computer screens, which were mounted on a wall. Behind the wall, a researcher stood and peered through a hole (3 cm diameter), located above and centered between the computer screens. When the researcher observed the infant looking at one of the two screens, the researcher pressed a joystick to the left or right, which signaled the computer to play the appropriate ID speech sounds (comforting or approving) through the stereo speakers located to the left and right of the screens and to record the amount of time the joystick was pressed (and therefore the amount of time the infant spent looking at a given screen and hearing a particular kind of ID speech). Additionally, video cameras recorded infants' looking behavior, to guard against the loss of data, in case something unexpected happened.

The laboratory environment was designed to give infants control over the stimulus they heard. Thus, the screens were utilized only to provide infants with the choice to hear one of three options at a time. Looking toward one screen consistently caused comforting ID speech to be played through the speakers, looking toward the other screen consistently caused approving ID speech to be played through the speakers, and looking away consistently produced silence. The screens served only one function: to provide infants with an environment in which they could choose to hear the auditory stimulus they preferred.

Procedure

Guardians of newborns were contacted by mail and those who were interested in participating in the study had the option to send a postcard back to the laboratory to provide more thorough contact information. Once this information had been received, the researcher called potential participants to describe the current study and invite them to the lab and schedule them to participate. Once in the laboratory, a caretaker was present with the infant at all times.

After completing a brief interview form and reading and signing an informed consent form, the caretaker and infant were brought into the testing room and were asked to sit (with the infant on the caretaker's lap) in front of the computer screens. The caretaker was asked to wear noise-dampening headphones playing simultaneously occurring ID utterances, spoken by many different mothers, so as to "blind" the participating caretaker to the stimuli the infant was hearing. The experimenter, too, wore a pair of the same headphones – playing the same simultaneously presented ID utterances – to ensure that the experimenter was unable to influence the infant's behaviors or the data collection process.

The current study used a mixed 2 (music: happy or sad) x 2 (screen: comforting or approving) design in which the music condition was a between-subjects variable and the screen condition was a within-subjects variable. Before each testing session commenced, the computer randomly assigned infants to a music exposure condition (sad or happy); participants were exposed to only one type of music. In addition, the computer randomly selected which category of ID speech would be associated with the left versus the right screen, and these screen assignments remained constant throughout the entirety of the study.

Infants' participation in the experiment can be described as a movement through three phases: an orienting phase, a music exposure phase, and a testing phase.

The sole purpose of the orienting phase was to train the infant to associate the left or right screen with the category of ID speech produced when the infant looked at that screen (which varied from infant to infant; for some infants, comforting ID speech was associated with the right screen, while for others it was associated with the left). To this end, infants were required to look at both the left and right screens for a minimum of 3 consecutive seconds two different times (i.e., they were required to spend no less than 6 seconds looking at each of the two screens). Furthermore, infants were required to look away from both screens in order to hear at least 1 second of silence two different times. This was required so that infants would learn that their looking behavior toward the screens caused the speech to be produced, and furthermore, that looking away would cause the speech to stop. Once these criteria were met, the infant was considered to have had enough experience with the sound/screen correspondences and the orienting phase terminated.

Directly after the termination of the orienting phase, the musical exposure phase began. In this phase, infants heard one minute of happy or sad music. Immediately after the music stopped playing, the musical exposure phase ended and the testing phase began.

In the testing phase, infants' looking times at the screens were recorded during a 30 second window of screen looking time (across both screens, not including time spent looking away from the screens). In order to guard against an infant getting "stuck" looking at one screen without experiencing the other, the computer required infants to look at both left and right screens for a cumulative 2 seconds each before allowing the study to conclude. If an infant failed to meet criterion for the first test trial, a new 30-second test trial began. All but three infants required only one test trial to complete the study, and all of the infants who completed the study did so with a maximum of two test trials. Data from the first successful test trial were compared to reveal any preferences for the comforting or approving ID speech that were a function of prior musical exposure.

Results

Analyses focused on the amount of time infants spent looking at the approving or comforting screen during the first successful test trial. There were two hypotheses for the current study: (1) Infants exposed to sad music would look significantly longer at the screen offering comforting utterances than at the screen offering approving utterances and (2) infants exposed to happy music would demonstrate no preference. Three *t*-tests, comparing the means of difference scores, were conducted to examine whether the data supported these hypotheses.

Difference scores were computed by subtracting the time infants spent looking at the approving (A) screen from the time they spent looking at the comforting (C) screen (C – A = diff score). Because the test trial consisted of only 30 seconds of screen-looking time (as opposed to total test time, which would include time spent looking away from the screens) difference scores indicated preference. Positive scores indicated a preference for comforting ID speech, whereas negative scores indicated a preference for approving ID speech. For example, if an infant spent 5 seconds looking at the approving screen and 25 seconds looking at the comforting screen (25 – 5), her difference score was 20, indicating a strong preference for comfort. On the other hand, if an infant spent 25 seconds looking at the approving screen and 5 seconds looking at the comforting screen (5 – 25), her difference score was -20, indicating a strong preference for approval.

To evaluate the hypothesis that infants exposed to sad music would look longer at the comforting screen than would those infants exposed to happy music, an independent samples *t*-test was conducted using the difference scores to compare the average preferences of the group exposed to happy music (M = 3.23, SD = 8.53) and the group exposed to sad music (M = -1.62, SD = 14.04). The test was not significant, $t(15) = 0.87$, $p = .40$ and thus did not support the original hypothesis. Additionally, the mean values reported above were opposite in direction to values that would support the original hypothesis. The 95% confidence interval ranged from -7.00 to 16.69. The eta square index indicated that 4.8% of the variance in the difference scores was accounted for by the music to which infants were exposed. Because sample sizes were low in this study, Levene's test for equality of variances was run and almost reached significance, $p = .06$, indicating that the variances of each group's scores were almost significantly different.

In addition, two one-sample *t*-tests were conducted to compare the preferences in each music exposure group to chance. The difference scores within each condition were compared to the value of zero, because a difference score of zero would indicate that the infant spent an equal amount of time looking at both screens and did not have a preference for either type of ID speech. The sample mean difference score for infants exposed to sad music, -1.62 ($SD = 14.04$), was not significantly different from 0, $t(7) = -0.33$, $p = .38$. The 95% confidence interval ranged from -13.35 to 10.12. The eta square index indicated that 1.5% of the variance in screen-preference was accounted for by exposure to the sad music. These results do not support the hypothesis that infants exposed to sad music would demonstrate a looking preference for the screen associated with comforting utterances.

Likewise, the sample mean difference score for infants exposed to happy music, 3.23 ($SD = 8.53$), was not significantly different from 0, $t(8) = 1.14$ $p = .29$. The 95% confidence interval ranged from -3.33 to 9.79. The eta square index indicated that 14% of the variance in screen-preference was accounted for by exposure to the happy music. These results are consistent with the hypothesis that infants exposed to happy music would not prefer one type of speech over the other.

Discussion

Because the existing literature had demonstrated that 6-month-old infants can categorize comforting and approving ID speech (Moore et al., 1997) and that 5- to 9-month-old infants can discriminate between happy and sad music (Flom et al., 2008), the present study investigated whether exposure to happy or sad music would systematically affect infants' preferences for comforting or approving ID speech. It was hypothesized that infants exposed to sad music would demonstrate a stronger preference for comforting utterances, whereas infants exposed to happy music would not demonstrate any preference. The results of this study failed to show any significant speech preference for either group.

Although no significant difference was found between groups in speech preference, there were limitations to the present study that may explain the lack of significant findings. The most obvious and noteworthy limitation of the present study is its low sample size. With only nine infants in the happy music condition and eight in the sad music condition, the ability to discover a significant effect was severely hampered. Furthermore, Levene's test for equality of variances was marginally significant, $p = .06$, which showed that the variances between conditions were fairly unequal, a problem that might have been remedied had the sample been bigger. If the sample had been larger, other interesting analyses would have been possible as well, such as investigating whether being related to musicians might have affected infants' reactions to the music (i.e., strength of speech preference). Seven infants in the present study were related to one or more musicians. Additionally, with a bigger sample it would have been possible to examine how age may have been related to performance in the study.

Large age differences between participants were a second major limitation of the present study. Due to having a limited time-frame in which to collect data and a limited pool of possible participants, the ages of infants included in the study spanned a range of 4 months and 10 days, which is very large for an infant study. Because development occurs so dramatically and rapidly within the first year of life, a 9-month-old infant's cognitive abilities are drastically different from those of a 5-month-old. Thus, the large variation in age in the current study may have clouded any effect that could have existed for infants in a more specific age range. For example, Flom and colleagues' (2008) Experiment 1 found that only 9-month-olds regained attention to sad music after being habituated to happy music, while 5- and 7-month-olds did not. Had data from each of the three age groups (5-, 7-, and 9-months) been analyzed as one group, the significant effect of 9-month-olds' renewed attention would have been obscured by the insignificant data from the 5- and 7-month-olds. The low number of participants in the current study required that analyses include all participants, regardless of age, in one group, possibly creating this sort of problem.

In addition, although it has been demonstrated that infants can categorize comforting and approving ID speech (Moore et al., 1997) and that they can discriminate between happy and sad music (Flom et al., 2008), it may be the case that both comforting and approving ID speech are, in effect, comforting to infants due to the positive emotional valence of each speech type (Moore et al., 1997). If infants derived similar comfort from both types of speech, then the dependent variable used in the current study was inapt. However, choosing contrasting speech types is a difficult task, as infants tend to show a strong preference for positive stimuli (Nawrot, 2003; Soken & Pick, 1999). For example, if infants were provided with a choice between disapproving speech and approving speech, they would likely prefer approving speech regardless of whether they heard happy or sad music, solely because of the reinforcing, positive nature of approving speech. Perhaps it would have been more effective in the current study to offer a choice between speech of a questioning nature and speech of a comforting nature after exposure to the music, because questioning speech may have a more or less neutral affective valence. Moving forward, if infants are offered a choice between speech categories that are more affectively different than those offered in the current study, a more dramatic difference in looking behavior based on prior musical exposure may evidence itself.

It could have also been the case that the orienting phase failed to provide infants with enough of a clear representation of how the laboratory situation functioned. In the current study, infants were presented with both screens at the same time. For some infants, this presentation worked well, but many infants scanned back and forth between the screens so rapidly that they did not always hear complete utterances. Therefore, the orienting phase may have failed to present more active infants with a clear enough understanding of the difference between the categories of speech because they did not look long enough to hear complete utterances. Thus, it might have been better to present one screen and its corresponding stimulus at a time. For example, if the right screen went black while the left screen was displaying the flashing checker boxes and the speech associated with the left screen was playing simultaneously (and vice-versa), infants may have had an easier time learning which speech category to associate with each screen.

Perhaps utilizing a head-turn preference procedure (Kemler Nelson et al.,1995; Werker, Polka, & Pegg, 1997) instead of the screen-looking paradigm currently employed would have simplified the association procedure. It could have been the case that the dynamic, checkerboard displays on the screens were distracting to infants, and a simple head-turn procedure would have made the association between looking behavior and speech easier for infants. Additionally, because turning one's head requires more effort than moving one's eyes, infants in a head-turn paradigm may be less likely to switch too rapidly to hear complete utterances and might thereby stand a better chance of learning to associate each ID speech type with its respective side.

Due to the major limitations of a large age range, small sample size, unclear orienting phase, and too much similarity between categories of ID speech stimuli, the present research should be understood as a pilot study for a possible future study. It is recommended that questioning ID speech be used in place of the approving speech used in this study. Additionally, to simplify the formation of associations between looking behavior and speech and to avoid rapid switching between speech stimuli during the orientation phase, it is recommended that a head-turn procedure be employed instead of the current screen-looking design.

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