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Alignment of Knowing Versus Feeling the Emotion in Music During Middle-Childhood

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Abstract

An examination of emotion recognition and response to music can isolate perception and experience of emotion from the potentially confounding effects of other social cues (e.g., faces). Participants aged 5-6-years-old listened to clips of calm, scary, and sad music and either identified the emotional content of the music or reported on the feelings elicited by the music clip. Children correctly identified the emotions and reported feeling the emotions conveyed in music above chance. Accurately recognizing and resonating with the emotion conveyed were correlated, although the relationship varied as a function of child characteristics. Specifically, children whose parents reported them as showing more prosocial behavior had significantly greater alignment between emotion recognition and resonation. Results provide new insights into emotion perception in the absence of direct social signals and provide evidence that children's ability to perceive and resonate with the emotion conveyed through music differs depending on key socioemotional characteristics.

Keywords: emotion perception; emotion categorization; music; emotion development; prosocial behavior

Introduction

The ability to recognize and respond to emotion appropriately is key for social functioning, including for empathic responding (Decety & Jackson, 2004; Schutte et al., 2001), emotion regulation (Southam-Gerow & Kendall, 2000), and behavioral control (Tehrani-Doost et al., 2017). Knowledge about emotion processing is central to our understanding of typical development (Pollak et al., 2019) and the human mind (Dukes et al., 2021). Prior research is dominated by a focus on recognition and response to emotion signals directly conveyed by other people, including facial expressions, body postures, and vocalizations (Barrett et al., 2019). Employing signals produced by others is critical for interpreting emotion recognition in the context of social interactions. However, relying on signals directly from others introduces confounds that limit our understanding of emotion perception and response across development more generally. For example, differences in face perception may occlude or explain differences in emotion perception (Dalrymple et al., 2014; Davies et al., 2004; Webb et al., 2017; Wilson et al., 2010). In addition, individual differences in relevant socioemotional characteristics or symptoms, including social anxiety, may alter sensitivity to social information, thus affecting perception of emotion cues (Button et al., 2013). Examining emotion recognition and subjective feelings in response to emotion conveyed through *music* provides an opportunity to sidestep the limitations of relying on overt *social* signals (e.g., facial expressions or language) that would otherwise provide contextual information to guide emotion recognition or responding (Sloboda & Juslin, 2001) and may allow us to better understand the relative contributions of emotion signals outside of the context of interacting with other people. Music may be an especially compelling means for understanding emotional development in childhood, when relying on signals conveyed by other people is further complicated by the age of the expresser (Griffiths et al., 2015; Picci & Scherf, 2016).

Prior research suggests that children can accurately identify emotional content in music from age 4-years-old and that music emotion recognition improves with age (Gregory et al., 1996; Kratus, 1993; Spackman et al., 2005; Terwogt & van Grinsven, 1991). Interestingly, emotion recognition of music diverges from emotion recognition of faces in children, contingent on certain characteristics. For example, children with Autism Spectrum Disorder (ASD) have showed comparable, and even higher, accuracy in identifying emotion conveyed in music, despite showing significant differences in accurately identifying the emotion in faces (Stephenson et al., 2016). Additionally, and following the inverse pattern, children with Specific Language Impairment (SLI) are less accurate at identifying emotion in music, but do not show differences in recognizing the emotion conveyed by faces relative to typically developing children (Spackman et al., 2005). Together, there is evidence to support the idea that children are sensitive to the emotion cues present in music, that individual differences in recognizing emotion music relate meaningfully to individual differences in

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socioemotional functioning, and that a better understanding of how children process and respond to emotion in music can generate novel insights into emotional development more broadly.

In addition to signaling a recognizable emotion, music can also *evoke* powerful emotional responses—or emotional resonation—in the listener. Research in adults has shown that these evoked responses include tearfulness (Gabrielsson, 2001; Sloboda, 1991; Waterman, 1996), chills (Goldstein, 1980; Panksepp, 1995), facial electromyography responses (Khalfa et al., 2008; Lundqvist et al., 2009; Witvliet & Vrana, 2007), and changes in heart rate, blood pressure, skin conductance, or temperature (Khalfa et al., 2008; Krumhansl, 2002; Lundqvist et al., 2009; Nyklíček et al., 1997; Sammler et al., 2007). However, very little research has explored subjective emotional response to music in children. This knowledge gap is important because there is evidence to suggest that evoking an emotional reaction in a listener can directly influence that individual's emotion perception (Trilla et al. 2021). For example, listening to music has been shown to improve emotion recognition accuracy among children with ASD (Katagiri et al., 2009), particularly for certain emotions (e.g., sadness; Brown et al., 2017), and particularly when the emotion conveyed in the music is congruent with the emotion conveyed via a facial signal (Brown et al., 2017). Finally, research from adult populations presents a mixed picture in terms of the overall alignment between how people resonate with emotions in music and their ability to identify the emotional content (Campbell, 1942; Hampton, 1945; Sloboda, 1986). This lack of alignment may be due, in part, to gaps in our understanding of how people respond emotionally to music. For example, responses to music could vary based on individual differences in sensitivity to perceptual or emotional cues more broadly or because of prior exposure to music, as well as variation in the music itself, such as moment-by-moment fluctuations in pitch, key, tone, mood, or other features specific to music composition that result in changing emotional states (Hunter et al., 2008, 2010; Larsen et al., 2009; Sloboda, 2000). Therefore, while there is evidence that individuals reliably exhibit emotional responses to music, characterizing those responses, and the relationship between those responses and emotion recognition, is a more complex process. In particular, the *alignment* between recognizing the emotion conveyed versus feeling that same emotion is an important mechanism for understanding individual differences in emotional development, for which music provides a useful investigative conduit.

In the current study, we used a within-sample design to address our overarching goal of exploring alignment in recognizing and resonating with emotion in music. First, we sought to replicate prior research showing that children accurately identify emotions conveyed through novel music clips. Then, to extend previous research, our first aim was to measure children's subjective feelings in response to the clips. For our second aim, we examined the alignment between recognizing and resonating with emotions in music, and asked whether that alignment differed depending on the specific emotion conveyed. Finally, under our third aim, we explored whether the alignment between emotion recognition and resonation varied as a function of individual differences, specifically examining prosocial development as an index of socioemotional competence.

Method

Participants

Participants were 135 typically-developing children aged 5-7 (M_{age}=5.98 years, SD_{age}=0.54) recruited from the northeastern United States. Of the 135 participants in the full sample, 117 participants had data for both emotion recognition and resonance. Additionally, 27 children were excluded from analysis for incorrectly responding to two (of two) practice questions in the emotion recognition task. We did not exclude participants based on practice trials in the resonance task because we were asking for subjective responses. Therefore, the final sample was 90 children (M_{age}=5.98 years, SD_{age}=0.54; 54 Female, 35 Male; 1 Asian, 24 Black, 47 White, 13 Biracial, and 5 selected "Other").

Design and Procedure

The current task was included in a study on emotion development. Participants took part in two waves of data collection separated by approximately 6-8 weeks and recognition or resonance was measured at each visit (participants were randomly assigned to complete the recognition and resonance tasks first vs. second). For both assessment waves, the parent and child participated in a 45-minute Zoom call hosted by a trained research assistant, and questionnaire data were collected via an online survey using Qualtrics. Participants were recruited through Facebook ads with the geographic location restricted to the wider metropolitan areas of Boston and Philadelphia, flyers posted in community locations in these large cities (e.g., daycares, public playgrounds, and grocery stores), and targeted recruitment through institutionally-maintained databases of families. Interested families were directed to an online survey asking for basic demographic and contact information. Families were eligible if they had a child aged 5-6 years old, with priority given to the youngest child if more than one child per family were eligible. Families were screened with an initial phone call and children were excluded if they had previously been diagnosed with a learning or developmental disorder or were receiving treatment for a psychiatric condition.

During the Zoom visit, the research assistant explained the purpose of the study and obtained informed consent from the parent (electronic signature) and verbal assent from the child. The research assistant shared their screen with the family, which meant they could navigate the child through several behavioral tasks, including the emotional music tasks used in the current study. All Zoom visits were recorded (with parental consent) for subsequent transcription and/or coding of behavioral responses. After the child finished the tasks, the

parent was sent a link to complete the questionnaire measures online through Qualtrics. Prior to the survey, parents provided consent online (electronic signature) and then completed various questionnaires, including a questionnaire to assess prosocial behavior (see below). Study procedures were approved by the Institutional Review Board.

Music Emotion Listening Task To develop the Music Emotion Listening Task (MELT), we selected music clips that had been validated in previous research (Bigliassi et al., 2015; Eerola & Vuoskoski, 2011; Nawrot, 2003; Omar et al., 2010; Quintin et al., 2011; Robazza et al., 1994; Spackman et al., 2005; Vieillard et al., 2008). We included seven 5 s music clips for each of the emotions of calmness, sadness, and fear. Participants completed two practice trials in which they heard a music clip and selected a response. Participants could not respond until the entire 5 s clip had finished playing and could not repeat the clip. To test emotion recognition, participants heard 21 music clips, including seven calm, seven fear, and seven sad clips. Participants categorized them as "sad", "calm", or "scary" by selecting the emotion conveyed in the music using a labeled and colored pictorial scale (i.e., to reduce reliance on verbal or reading ability to convey the emotion). To test emotion resonance, participants listened to each music clip and were asked, "How does the music make you feel?", with the following response options: "calm", "scared", "sad", "happy", or "angry". For both tasks, children could also respond "I don't know" for any trial.

Prosocial Behavior Prosocial behavior was measured using the Prosocial Behavior subscale of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Questions comprising the subscale are: considerate of other people's feelings, shares readily with other children, helpful if someone is hurt, kind to younger children, and often volunteers to help others. The questions are scored as 0 = Not True, 1 = Somewhat True, 2 = Certainly True, therefore scores can range from 0 to 10. Parents of the child participants completed the questionnaire at each visit, and responses were moderately correlated ($r(87) = .62$, $p < .001$, 95% CI [.47, .73]). An average of the two scores was used in the analysis ($M = 8.53$, $SD = 1.51$, *range* = 4-10).

Analytic Strategy

First, we assessed overall accuracy across the whole task, as well as accuracy for each emotion. We compared averaged accuracy against chance (i.e., .25 because there were four response options including "I don't know") using a t-test. We used a one-way ANOVA (with emotion type as a repeated measure) to test for accuracy differences by emotion, employing Bonferroni-corrected *post hoc* tests for pairwise comparisons. We used the same analytic approach for assessing emotional resonance for the music clips (Aim 1), but the dependent variable was emotion "match" (i.e., whether participant responses about how the clips made them feel matched the intended emotion of the music clip). Because there were six possible response options, we compared average accuracy against chance as .17. The one-way ANOVA (with Bonferroni-corrected *post hoc* tests) was the same as described for accuracy.

To assess alignment (Aim 2) we ran a linear mixed effects model with match regressed on emotion recognition accuracy, emotion type (fear was set as the referent), and their interaction. We included a by-participant random intercept. Finally, to investigate whether alignment varied as a function of prosocial behavior, we regressed match on emotion recognition accuracy, emotion type (fear was set as the referent), prosocial behavior, and all interactions. Again, we included a by-participant random intercept. We also controlled for participant age and gender in both models. Data and the analysis script are available at https://osf.io/qncka/.

Results

Children Accurately Identify Emotion Conveyed in Music

Children accurately recognized the emotion conveyed in music above chance (mean proportion correct = .56, $t(89) = 18.99$, $p_{adj} < .001$, 95% CI = [0.53, 0.59], $d = 4.03$). Accuracy was also above chance when examining each emotion individually (Figure 1). However, children were less accurate in categorizing sad compared to calm or scary music clips (omnibus: $F(2, 178) = 24.06$, $p < .001$, $eta^2g = 0.12$; see Table 1 for pairwise comparisons). Importantly, accuracy did not differ based on the order of doing the tasks (i.e., whether the child completed the recognition task during their first or second online visit, $p = .63$). Accuracy also did not vary as a function of participant gender ($p = .23$), though emotion recognition improved with age ($b = .07$, $F(1, 85) = 5.96$, p = .02).

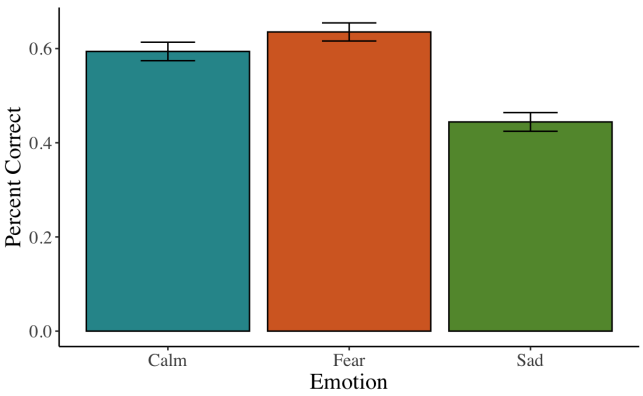

Figure 1: Emotion recognition accuracy by emotion type.

Table 1: Pairwise comparisons between emotion types for recognition and resonance.

	t (89)	p_{adj}
Recognition		
Calm vs. Fear	-1.38	0.51
Calm vs. Sad	5.06	<.001
Fear vs. Sad	6.77	<.001
Resonance		
Calm vs. Fear	-2.82	0.02
Calm vs. Sad	-0.07	1
Fear vs. Sad	3.09	0.008

Music Evokes Intended Feelings

In terms of resonating with the music conveyed, children's responses were above chance in terms of match with the intended emotion (mean proportion correct = .41, $t(89)$ = 12.54, p_{adj} < .001, 95% CI = [0.38, 0.45], d = 3.03). Correct resonation with the emotion was also above chance when each emotion was evaluated individually (Figure 2). Further, children were more likely to report feeling scared in response to fear clips compared to feeling calm or sad in response to calm or sad clips, respectively (omnibus: $F(1.83, 162.64)$ = 4.95, p = .01, eta^2_g = 0.03; see Table 1 for pairwise comparisons). As before, the "match" between the emotion conveyed in the music did not differ based on the order in which children completed the tasks (p = .09). Match also did not differ based on participant gender (p = .37) or age (p = .39). In sum, the music clips evoked the intended emotions in children, with the highest resonance match for fear music.

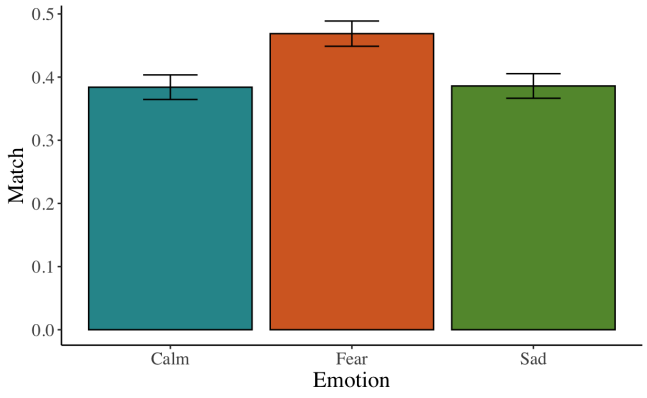

Figure 2: Resonance match by emotion type.

Recognition and Resonance Align

Children with better recognition of emotion were also more accurate in resonating with the emotion conveyed in the music clip (b = 0.34, X^2 = 31.62, p < .001; Figure 3). This relationship did not differ by type of emotion (i.e., the interaction between emotion recognition accuracy and emotion type for resonance match was not significant (X^2 = 0.48, p = .78; see Table 2 for correlations by emotion type). Together, findings revealed a moderate association between emotion knowledge and reporting of a subjective feeling in response to emotional music, which was consistent for calm, fearful, and sad clips.

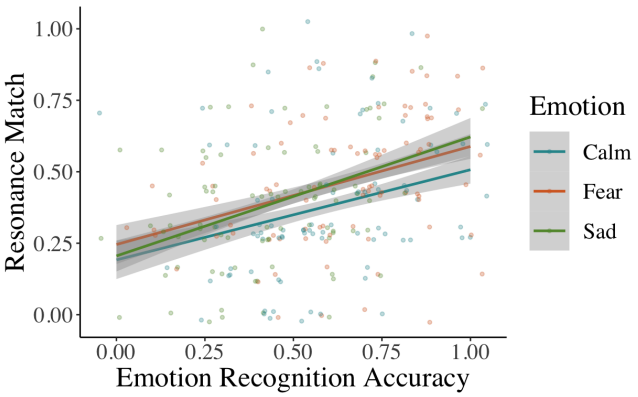

Figure 3: Alignment between recognition and resonance by emotion.

Table 2: Correlations between recognition and resonance for each emotion type.

	r	p
Calm	0.27	0.01
Fear	0.38	<.001
Sad	0.37	<.001

Alignment of Recognition and Resonance Varies as a Function of Prosocial Behavior

Parent report of child prosocial behavior moderated the relationship between recognition and resonance. Specifically, children who were higher on prosocial behavior exhibited a stronger relationship between recognition and resonance with emotion in music (b = 0.16, $F(1, 80)$ = 4.95, p = .03; Figure 4). The three-way interaction between recognition, prosocial behavior, and emotion type was not significant (X^2 = 1.98, p = .61). That is, children with higher prosocial behavior showed similarly greater alignment between recognition and resonation across for calm, fear, and sad music clips.

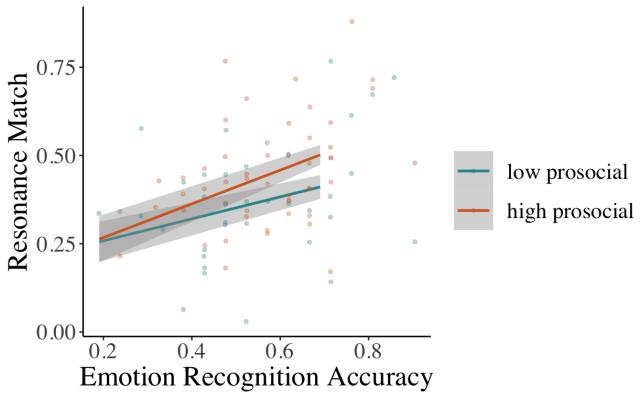

Figure 4: Emotion recognition and resonance are more strongly aligned among children showing higher prosocial behavior. Prosocial scores are depicted with a median split for illustration purposes, but were analyzed continuously.

Discussion

In the current study, we provide further evidence that children as young as 5 years old can accurately recognize emotions conveyed in music clips. Consistent with prior studies, children correctly identified calm, fear, and sad music from brief and novel cues (Gregory et al., 1996; Kratus, 1993; Spackman et al., 2005; Terwogt & van Grinsven, 1991). The findings add to a body of support indicating music as a useful means for assessing emotion recognition.

In addition to exploring emotion recognition, we used a within-subjects design to explore how children reported *feeling* in response to the emotional music – focusing on the extent to which they resonated with the emotion intended to be conveyed by each clip. Children generally reported resonating with the emotion conveyed by the music clips. Therefore, not only do children demonstrate knowledge about the emotionality of the music but the emotionality of the music appeared to activate concomitant feelings, which were recognizable to children. Notably, though above chance given the number of response options, mean resonance match was fairly low (<50%). While this is lower than previous research—which typically show above 50% performance—prior studies have used fewer response options (Gregory et al., 1996; Kratus, 1993) or included older children (Spackman et al., 2005). Therefore, we need more research to be able to better directly compare resonance across development in middle childhood.

Next, we found significant alignment between recognition of emotion in music and resonance with those emotions, with consistent effects across calm, fear, and sad music. These finding increase the appeal of using music to assess emotional development, particularly because emotional experience has been shown to support emotion recognition (Brown et al., 2017; Katagiri et al., 2009). Beyond recognition, there is more recent research conducted with adults that is consistent with the idea that emotional experience in response to music can increase prosocial behavior and compassion (McDonald et al., 2022). We add to this literature the finding that *alignment* between emotion recognition and resonance is stronger for children whose parents rated them as frequently showing prosocial behavior. The significance of this finding is that the coherence between emotion recognition and response is particularly strong among children with higher prosocial behavior. That is, children who are better at connecting an externally-cued emotion (i.e., in this case, via music) with an internally-experienced emotion (i.e., resonance with music) may be better at responding to the needs and emotions of others, as exemplified through our prosocial behavior measure (e.g., considerate of other people's feelings and helpful if someone is hurt). This interpretation is consistent with prior evidence showing that joint music making (Kirschner & Tomasello, 2010) and rhythmic synchrony (Mogan et al., 2017) are also associated with prosocial behavior in childhood. However, our correlational design means we cannot infer causality, with the inverse relationship just as plausible (i.e., children with a greater propensity for prosocial behavior may be better at connecting emotion recognition and feeling). Nevertheless, the pattern of results highlights the importance of future research to investigate whether alignment in music recognition and response and prosocial behavior share an underpinning characteristic and/or whether there is a causal link (and in which direction).

There were a number of strengths to our study, including use of a new music task, that we leveraged a within-subjects design, and that we tested a racially/ethnically diverse sample within a narrow age range. Nevertheless, our findings should be considered in the context of several limitations, which can also be useful for guiding the directions of future inquiry. First, some of the task features could have influenced the strength of the results, including the greater number of response options for the resonance versus recognition task and the use of a pictorial rating scale. Despite these limitations, participants were still above chance at reporting the feeling reflected in the music clip, and, even though there were overall lower rates of resonance, resonance and recognition were correlated. Second, we relied on parent report of prosocial behavior. Although we leveraged a widely-used, established, and previously validated questionnaire, future research could be strengthened by including more objective or behavioral measures of prosocial behavior in children. Third, while we argue in favor of the benefits of examining emotional development using music in part because it avoids reliance on direct social cues, it is important to acknowledge that most music is created by people and emotion perception in music could be considered interpersonal (Gabrielsson & Juslin, 1996). However, emotion as conveyed via music still sidesteps the reliance on perception of physical social cues (e.g., the face).

In sum, our study highlights the potential utility of using music clips more widely to explore individual differences in emotion recognition and resonance. Results provide new insights into emotional development and provide evidence that children's ability to perceive and resonate with the

emotion conveyed through music is different for children depending on key socioemotional characteristics. In particular, children who showed a stronger connection between emotion understanding and feeling were reported by their parents to exhibit more real-world prosocial responding, including recognizing and responding appropriately to the feelings and needs and others. From a translational perspective, interventions to improve positive socioemotional development could include components that leverage emotional music clips.

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