Developmental Psychology

Developmental Trajectories and Socioemotional Correlates of Emotion Recognition in Vocal Bursts in Early Childhood

Özge Ugurlu, Anna Luerssen, Joseph Ocampo, Oliver P. John, and Özlem Ayduk

Online First Publication, September 1, 2025. https://dx.doi.org/10.1037/dev0001949

AMERICAN PSYCHOLOGICAL ASSOCIATION

Developmental Psychology

ISSN: 0012-1649

https://doi.org/10.1037/dev0001949

Developmental Trajectories and Socioemotional Correlates of Emotion Recognition in Vocal Bursts in Early Childhood

Özge Ugurlu[1], Anna Luerssen[2], Joseph Ocampo[1], Oliver P. John[1], and Özlem Ayduk[1]
[1] Department of Psychology, University of California, Berkeley
[2] Department of Psychology, Lehman College, City University of New York

Emotion recognition, one key aspect of emotion reasoning, is crucial to socioemotional development in childhood. While much developmental research has focused on facial emotion recognition, studies on the recognition of emotions conveyed through vocal bursts remain relatively scarce, despite the voice being one of the primary channels for conveying emotion. To address this gap, we investigated (a) how recognition accuracy across six well-studied emotions in vocal bursts changes between the ages of 5 and 8 ($N = 162$, 47.53% girls and 52.47% boys), (b) whether gender moderates the developmental trajectories of recognition accuracy (both overall and at the level of distinct emotions), and (c) whether recognition accuracy predicts socioemotional functioning concurrently and longitudinally. Our findings revealed that recognition accuracy was highest for happiness and lowest for fear and that accuracy improved with age for all emotions except for happiness, which was positively associated with age at a marginal level. While younger girls (compared with boys) were better at recognizing emotions, this difference disappeared by age 8. This same pattern was observed for sadness and anger at the level of distinct emotions. The capacity to recognize emotion in vocal bursts did not correlate with caregivers' perceptions of children's emotional symptoms or hyperactivity. However, it predicted a lower likelihood of conduct problems and a higher tendency toward prosocial behavior concurrently, with the latter effect staying significant longitudinally. These findings contribute to a deeper understanding of emotion recognition beyond the face and its implications for children's socioemotional adjustment.

Public Significance Statement
This study has the potential to facilitate the identification of critical periods for targeted interventions for emotional knowledge in children, informing public health initiatives aimed at promoting their well-being.

Keywords: emotion recognition, vocal bursts, developmental trajectories, socioemotional functioning, prosociality

Supplemental materials: https://doi.org/10.1037/dev0001949.supp

Emotion reasoning, a suite of abilities that involve recognizing, inferring, and predicting others' emotions (Ruba & Pollak, 2020), is vital for navigating social interactions both in childhood (Denham, 2007; Denham et al., 2003) and throughout development (Parker & Gottman, 1989). One key skill that falls under this broad construct is *emotion recognition*, the narrower capacity to decipher others' emotional cues in various expressive modalities such as the face, voice, and posture (Keltner et al., 2019). The ability to recognize emotions improves throughout infancy and early childhood (Ruba & Pollak, 2020) and is a crucial aspect of children's socioemotional development (Schultz et al., 2004). It facilitates the navigation of social situations, plays a pivotal role in interpersonal communication,

Lana Karasik served as action editor.
Özge Ugurlu https://orcid.org/0000-0002-7192-6914
Joseph Ocampo https://orcid.org/0000-0003-0187-4052
Oliver P. John https://orcid.org/0000-0003-0171-0971
Özlem Ayduk https://orcid.org/0000-0003-4779-2909
All data, research materials, and analysis code for review purposes are publicly available on the Open Science Framework at https://osf.io/qgy92/?view_only=8d69bb661904490999165453cb3f55ef. The study reported in this article was not preregistered. This study was funded by the Greater Good Science Center, University of California Berkeley (Grant 44543), and the National Science Foundation Graduate Research Fellowship Program (Grant DGE 1752814) awarded to Özge Ugurlu.

Özge Ugurlu played a lead role in conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, visualization, writing–original draft, and writing–review and editing. Anna Luerssen played a supporting role in conceptualization and writing–review and editing. Joseph Ocampo played a supporting role in formal analysis. Oliver P. John played a supporting role in methodology. Özlem Ayduk played a lead role in supervision and a supporting role in investigation and writing–review and editing.

Correspondence concerning this article should be addressed to Özge Ugurlu, Department of Psychology, University of California, Berkeley, 2121 Berkeley Way, MC 5050, Berkeley, CA 94720-5050, United States. Email: ozge.ugurlu@berkeley.edu

and enhances comprehension of others' behavior (Saarni, 1999; Scharfe, 2000). Despite its important role in day-to-day life, most empirical research on emotion recognition in childhood has focused on a single expressive modality, the face (Denham et al., 2003; Widen & Russell, 2008). However, emotions are reliably expressed across a range of modalities, including touch, posture, and voice (Keltner et al., 2019), suggesting that the current understanding of how emotion recognition develops in other modalities during childhood is relatively limited and lacks the nuance involved in real social encounters (see Ruba & Pollak, 2020). To address this gap, the present study investigated another important modality—the expression of emotion through vocal bursts (e.g., laughs, sighs). More specifically, we focused on the recognition of distinct emotions via vocal bursts, investigating (a) the developmental trajectories of this recognition among children aged 5–8 years, (b) gender differences in these trajectories, and (c) the socioemotional correlates of emotion recognition accuracy.

Emotion Recognition in Facial Cues

Most scholarship establishing the developmental trajectories and importance of emotion recognition ability centers around the face as the primary expressive modality (Hall & Matsumoto, 2004; Hampson et al., 2006; Keltner, 2019; Vassallo et al., 2009). This visual recognition commences within the first year of life (Morgan & Hayne, 2011; Oakes & Rakison, 2019), during which children begin to discriminate facial expressions based broadly on valence (i.e., positive vs. negative; Widen, 2013; Widen & Russell, 2010). By age 3, children become more able to distinguish expressions of distinct emotions (e.g., happiness, sadness, anger, fear; Székely et al., 2011), with some research suggesting that improvements continue to occur through adolescence (Batty & Taylor, 2006; Herba et al., 2006; Thomas et al., 2007). Although findings on which distinct emotions are recognized earlier versus later in development are mixed (Bruce et al., 2000), it is widely accepted that children are able to accurately recognize faces expressing happiness earlier than those depicting distinct negative emotions such as anger or disgust (Boyatzis et al., 1993; Camras & Allison, 1985; Gosselin & Larocque, 2000; Herba et al., 2008; Maassarani et al., 2014; Montirosso et al., 2010; Widen & Russell, 2003).

The role of gender in the development of children's emotion recognition ability has also been examined. In this regard, meta-analytic findings suggest a small but reliable advantage for girls in the overall ability to recognize and interpret emotions from static facial expressions (McClure, 2000). Furthermore, this effect tends to be larger in infancy but gradually disappears in later childhood as boys catch up with girls. More recent studies focusing on gender and distinct emotions have yielded results consistent with these meta-analytic findings, demonstrating an advantage for girls that has persisted through adolescence across a number of distinct emotions, including anger, disgust, and sadness (Lawrence et al., 2015; Montirosso et al., 2010). These gender differences in early emotion recognition may be due to differential socialization processes (e.g., girls are exposed to affective contexts more often; Aznar & Tenenbaum, 2015; Camras & Allison, 1985; Fivush et al., 2000; Lytton & Romney, 1991) or to maturational differences in biological mechanisms that support emotion recognition (e.g., androgens in boys delaying the maturation of temporal cortex and the amygdala; Stahl et al., 1978; also see McClure, 2000).

Given that the ability to decode others' affective states is a centerpiece of social interactions throughout the lifespan (Keltner & Haidt, 1999), it is no surprise that proficiency in facial emotion recognition during childhood is associated with better socioemotional functioning (Field et al., 1982), including higher levels of perspective taking and empathy (Carr & Lutjemeier, 2005) as well as lower levels of problematic social behaviors and hyperactivity (Chronaki et al., 2015; Izard et al., 2001). Specifically, expressions of emotions provide information about the intentions of expressors. Being able to recognize one's own and others' emotions facilitates appropriate responses, thereby helping to coordinate social interactions (Keltner & Buswell, 1997; Keltner & Kring, 1998; Schultz et al., 2004). For example, accurately perceiving someone's sadness and distress might elicit compassionate responses, which can enhance affiliative tendencies (Campos et al., 1989; Keltner & Bonanno, 1997). By contrast, challenges with emotion recognition have been linked to relationship difficulties as well as the risk for internalizing problems (Johnson et al., 2013; Joormann & Gotlib, 2010; van Os et al., 2010). Overall, the ability to recognize emotions facilitates positive relationships and underscores the importance of better understanding the predictors and consequences of these skills in children.

Emotion Recognition in Vocal Bursts

Despite the insights provided by the existing literature on the development of emotion recognition ability in children, one critique of this literature is that it focuses almost exclusively on emotion recognition in a single modality, the face. Moreover, these studies largely use static images portraying exaggerated facial expressions that are uncommon in everyday life leading to an overestimation of children's accuracy. Indeed, recognition rates get lower when children are asked to identify less intense, more subtle expressions (Montirosso et al., 2010).

Emotions are expressed through multiple modalities including body posture, gestures, words, and pitch (de Gelder & Vroomen, 2000; Hampson et al., 2006; Keltner et al., 2019; Vassallo et al., 2009), and each of these modalities inherently constrains the type and the amount of information conveyed. One such modality is vocalization. Emotional vocal cues include inflections in speech, known as emotional prosody (e.g., rhythm, stress, and intonation), and purely nonverbal emotional vocalizations, such as sighs, laughter, screams, or cries, often called vocal bursts (Cordaro et al., 2016; Cowen et al., 2019; Scherer & Wallbott, 1994; Trinh et al., 2022). Vocal bursts are described as the auditory equivalent of facial expressions (Grandjean, 2021) and are also rich sources of emotion signaling (Keltner & Haidt, 2001). Like facial expressions, they provide insights into the internal state of others even though they do not rely on words (Kraus, 2017). Thus, they are essential to social interactions and influence the hearer's reactions to their environment. For example, toddlers are less likely to play with a toy when their parents vocalize yuck—a burst expressing disgust (Hertenstein & Campos, 2004). Studies have found that individuals can reliably discern emotions through vocalizations across cultures both in adults (Cordaro et al., 2016; Sauter et al., 2010; Simon-Thomas et al., 2009) and children (Chronaki et al., 2018), even when the person producing the vocal burst cannot be seen. Therefore, vocal bursts may carry unique and important information about other people's emotional states that are missed when research focuses solely on the face.

Like facial emotion recognition, infants can discriminate across different emotional vocal bursts soon after birth (Grossmann, 2010; Soderstrom et al., 2017; Wu et al., 2017). Recognition accuracy in this modality develops with age, with greater gains in early childhood, followed by slower improvement and an eventual plateau. Some research indicates that children reach adult-level competency around age 15 (Grosbras et al., 2018), while other studies suggest this plateau occurs earlier, possibly by age 9 (Tonks et al., 2007). Some studies also suggest that developmental trajectories vary across distinct emotions (Matsumoto & Kishimoto, 1983). For example, Sauter et al. (2013) found that recognition of surprise conveyed through vocal bursts improved from ages 5 to 10, whereas no such improvement was found for the other distinct emotions assessed, including anger, disgust, fear, sadness, achievement, amusement, contentment, and relief. Similar to facial recognition, girls tend to be more accurate in identifying emotional nuances conveyed through vocal bursts during childhood (Allgood & Heaton, 2015; Chronaki et al., 2015; Grosbras et al., 2018). However, minimal research has evaluated gender differences in emotion recognition for distinct emotions in this modality during early childhood.

The potential implications of emotion recognition in vocal cues for socioemotional outcomes have been addressed by limited research focusing primarily on emotional prosody. Specifically, preschoolers' ability to recognize emotional prosody has been associated with increased peer-rated popularity and decreased emotional and behavioral problems (Nowicki & Mitchell, 1998), as well as lower levels of hyperactivity and conduct problems (Chronaki et al., 2015). Similarly, school-age children's ability to recognize emotional prosody has been linked to enhanced social competence, peer-rated popularity (Leppänen & Hietanen, 2001), and reduced emotional and behavioral difficulties (Nowicki et al., 2019). However, a study specifically focusing on emotional vocal bursts showed no significant associations between recognition accuracy and socioemotional functioning in 6- to 8-year-old children (Neves et al., 2021). The scarcity of research on this topic, combined with the limited scope and inconsistencies across findings, collectively underscores the need for further examination of whether recognition accuracy in the vocal modality relates to important outcomes in childhood.

The Current Research

The present study aimed to address several of the knowledge gaps described in the preceding sections. First, given that most emotion recognition tasks for children rely heavily on visual stimuli, it is important to examine the recognition of emotions expressed through other modalities (see Ruba & Pollak, 2020, for review). This includes vocal bursts, which also convey important information about the internal states of others (Kraus, 2017). Second, while children's ability to recognize emotions in vocal bursts improves with age (Herba & Phillips, 2004; Sauter et al., 2013), there is a lack of well-powered research on the developmental trajectories of distinct emotions and how these trajectories may vary by gender. Third, there is limited research on how a child's ability to reliably recognize vocal bursts might relate to their socioemotional functioning. Beyond broadening our understanding of emotion recognition in childhood, addressing these gaps could inform whether the ability to recognize emotions in vocal bursts is associated with the development of socioemotional functioning later in life, thus offering insights for both early assessments and interventions.

To address these gaps, a modestly large sample of children aged 5–8 years completed a computer task in which they heard a series of vocal bursts emitted by different voices and were asked to identify the emotion conveyed (Sauter et al., 2013). The task included well-studied distinct emotions (Ekman & Friesen, 1976), including happiness, anger, fear, surprise, disgust, and sadness. Additionally, caregivers completed a well-validated and widely used questionnaire (Strengths and Difficulties; Goodman, 2001) assessing their child's socioemotional functioning in various domains, including emotional symptoms, conduct problems, hyperactivity/inattention, and prosocial behavior both at the time of the laboratory assessment (Time 1) and again approximately 3 years later (Time 2).

We evaluated the role of age and gender (along with their interaction) in predicting overall recognition accuracy (collapsed across emotions) and recognition accuracy separately for each of the six distinct emotions. We hypothesized that children's overall recognition accuracy would increase with age (Hypothesis 1) and that girls would recognize emotions more reliably than boys (Hypothesis 2). While we expected recognition to improve with age across distinct emotions, we did not have specific hypotheses about which distinct emotions might show the greatest versus the smallest improvements with age or for which emotions there would additionally be interactions with gender.

In a final set of analyses, we assessed whether the ability to recognize emotions in vocal bursts is associated with functioning in the aforementioned socioemotional domains: emotional symptoms, peer relationships, conduct problems, prosocial behavior, and hyperactivity/inattention. Based on the prior literature establishing a connection between other forms of emotion recognition (e.g., facial cues, emotional prosody) and socioemotional functioning, we generally expected a positive association (Hypothesis 3). That said, of the latter domains, we expected the weakest association with hyperactivity/inattention given that it is not directly related to social communication and understanding.

Method

Participants

The initial sample at Time 1 consisted of 171 children aged 5–8 years, recruited from nearby elementary schools, museums, or family events (M = 6.86, SD = 1.11, range = 5–8.92). The determination of the lower and the upper age bounds was guided by several factors. The lower bound was set at the typical age of school entry (age 5). We reasoned that the onset of schooling is a pivotal juncture in a child's life, potentially impacting their emotional capacity, socialization processes, and socioemotional development. The results reported here are part of a broader caregiver–child study investigating the links between self-control, emotion recognition and regulation, as well as family dynamics (also see Luerssen et al., 2024). Delay of gratification was used as a measure of self-control in the broader study. As children near the end of elementary school, performance on the delay of gratification task starts to show a large ceiling effect (Ayduk et al., 2000; Luerssen et al., 2015; Rodriguez et al., 1989); as such, the upper age limit was set at 8 years.

Children visited our laboratory with one accompanying caregiver (81.01% mothers, 18.35% fathers, 0.63% other), who participated in the study. The first five children were pilot subjects and were, therefore, removed from the sample on an a priori basis. Additionally, four participants were excluded because they were either not in the right age range ($n = 3$) or not typically developing ($n = 1$). After these exclusions, 162 children remained in the final sample. As reported by caregivers, 47.53% of the children were girls, and 52.47% were boys (see Table 1 for the full list of demographics). Age and gender (boy = −1; girl = 1) were not correlated in this sample, $r(160) = .02$, $p = .79$.

Given that the broader child–caregiver study was targeting multiple constructs (see the Supplemental Materials for a full list of measures), we did not have an a priori effect size for conducting power analysis to determine sample size. Our stopping rule was

Table 1

Participants' Demographics at T1 and T2

T1 (N = 162)	n (%)	T2 (N = 98)	n (%)
Child variable			
Age at T1		Age at T2	
5 (23 boys, 21 girls)	44 (27.2)	5 (14 boys, 12 girls)	26 (26.5)
6 (22 boys, 20 girls)	42 (25.9)	6 (15 boys, 13 girls)	28 (28.6)
7 (20 boys, 21 girls)	41 (25.3)	7 (11 boys, 12 girls)	23 (23.5)
8 (20 boys, 15 girls)	35 (21.6)	8 (11 boys, 10 girls)	21 (21.4)
Gender		Gender	
Girl	77 (47.5)	Girl	47 (48.0)
Boy	85 (52.5)	Boy	51 (52.0)
Race		Race	
Asian American	20 (12.3)	Asian American	9 (9.2)
Black/African American	6 (3.7)	Black/African American	4 (4.1)
Native Hawaiian or Pacific Islander	1 (0.6)	Native Hawaiian or Pacific Islander	0 (0)
White	76 (46.9)	White	48 (49.0)
Other	10 (6.2)	Other	5 (5.1)
Multiracial	42 (25.9)	Multiracial	29 (29.6)
Missing	7 (4.3)	Missing	3 (3.1)
Ethnicity		Ethnicity	
Hispanic/Latinx	25 (15.4)	Hispanic/Latinx	12 (12.2)
Other	128 (79.0)	Other	82 (83.7)
Missing	9 (5.6)	Missing	4 (4.1)
Caregiver variable			
Age		Age	
M (SD)	40.1 (4.73)	M (SD)	40.2 (4.62)
Gender		Gender	
Woman	122 (75.3)	Woman	73 (74.5)
Man	30 (18.5)	Man	17 (17.3)
Other	1 (0.6)	Other	1 (1.0)
Missing	9 (5.6)	Missing	7 (7.1)
Race		Race	
Asian American	42 (25.9)	Asian American	24 (24.5)
Black/African American	9 (5.6)	Black/African American	6 (6.1)
Native Hawaiian or Pacific Islander	1 (0.6)	Native Hawaiian or Pacific Islander	0 (0)
White	62 (38.3)	White	43 (43.9)
Other	10 (6.2)	Other	5 (5.1)
Multiracial	21 (13.0)	Multiracial	12 (12.2)
Missing	17 (10.5)	Missing	8 (8.2)
Highest degree earned		Highest degree earned	
High school diploma or equivalent	10 (6.2)	High school diploma or equivalent	4 (4.1)
Associate degree (junior college)	12 (7.4)	Associate degree (junior college)	2 (2.0)
Bachelor's degree	64 (39.5)	Bachelor's degree	42 (42.9)
Master's degree	44 (27.2)	Master's degree	27 (27.6)
Doctorate	16 (9.9)	Doctorate	13 (13.3)
Professional (MD, JD, DDS, etc.)	10 (6.2)	Professional (MD, JD, DDS, etc.)	7 (7.1)
Missing	6 (3.7)	Missing	3 (3.1)
Household income		Household income	
$5,000 through $11,999	2 (1.2)	$5,000 through $11,999	1 (1.0)
$12,000 through $24,999	1 (0.6)	$12,000 through $24,999	0 (0)
$25,000 through $34,999	5 (3.1)	$25,000 through $34,999	1 (1.0)
$35,000 through $49,999	6 (3.7)	$35,000 through $49,999	2 (2.0)
$50,000 through $74,999	14 (8.6)	$50,000 through $74,999	8 (8.2)
$75,000 through $99,999	16 (9.9)	$75,000 through $99,999	6 (6.1)
$100,000 and greater	99 (61.1)	$100,000 and greater	68 (69.4)
Missing	19 (11.7)	Missing	12 (12.2)

Note. T = time.

therefore guided by the availability of our resources for the study and the sample sizes published in developmental journals (including *Developmental Psychology*; Ball et al., 2017; Bayet et al., 2018; Simmering & Wood, 2017). Around the time we started data collection (2018), typical sample sizes ranged anywhere from 77 to 208 participants (Bayet et al., 2018; Xiao et al., 2017). Using this as a rule of thumb, we aimed to recruit 20 boys and 20 girls for each age group. This approach ensured equal gender representation within each age category, resulting in a total sample size of 160. We initially oversampled in anticipation of attrition. Data collection for Time 1 occurred between January 2018 and January 2020 (just before the declaration of the global pandemic), forcing us to cease the data collection before we were able to reach our targeted sample size for girls at age 8.

Procedure

All procedures were approved by the institutional review board. The laboratory session lasted approximately 60–90 min, and children were compensated with a small toy for their participation. Upon arrival in the laboratory, an experimenter obtained consent and parental permission from the accompanying caregiver and informed assent from the child. Children were then taken to a separate procedure room and completed a series of questionnaires and behavioral measures, including the recognition of emotions in the vocal burst task. Meanwhile, caregivers stayed with a second experimenter in the control room and completed the caregiver survey. Measures relevant to the current assessment are described below with all additional measures outlined in the Supplemental Materials.

Approximately 2.5–3 years later (M = 2.9 years, SD = .37), all caregivers who participated in the initial laboratory session were sent personalized links to a second survey via Qualtrics as part of a larger follow-up study (Time 2). Of the 162 caregivers included in the final analysis at Time 1, a total of 98 completed the Time 2 survey. The attrition rate was 39.5%, likely because the follow-up took place in the middle of the COVID-19 pandemic.

Nevertheless, the Time 2 sample was not significantly different from the Time 1 sample in terms of caregivers' age, $M_{diff} = 0.49$, $t(124.6) = 0.61$, $p = .53$; gender, $\chi^2(2) = 0.78$, $p = .68$; or race/ethnicity, $\chi^2(6) = 4.51$, $p = .60$. Similarly, there were no differences in child participants' age at Time 1, $M_{diff} = 0.02$, $t(205) = 0.11$, $p = .91$; gender, $\chi^2(1) = 0.05$, $p = .81$; race, $\chi^2(5) = 5.60$, $p = .34$; or performance on the vocal burst recognition task, $M_{diff} = -0.03$, $t(134.77) = -1.43$, $p = .15$. However, the Time 2 sample was significantly higher in income than the Time 1 sample, $M_{diff} = 0.64$, $t(91.50) = 2.63$, $p = .01$.

Measures and Materials

Emotion Recognition From the Vocal Burst Task

Children completed a forced-choice categorization task consisting of 24 emotional sounds presented on an IBM tablet (Sauter, 2007; Sauter et al., 2010). Child participants were instructed to select the emoji that best corresponded to the emotion conveyed in the vocal bursts. The stimuli were a shortened subset of affective, nonverbal vocalizations validated with both adult and child encoders, including laughs, sighs, and grunts (Sauter et al., 2010, 2013). Four vocalizations (two boys, two girls) were presented for each of the following distinct emotions: anger (irrgghh), surprise (woo), happy (laugh), sad (whine), fear (scream), and disgust (eww).

The task followed a previously validated procedure (Sauter et al., 2013). For each burst, children were shown four emojis as response options chosen from a larger pool of six, each corresponding to one of the distinct emotions listed above. Prior to starting the task, the experimenter trained children on all six emojis to ensure they knew which emotion each emoji represented. Of the four emojis presented as response options, one matched the category of the vocal burst presented. The remaining three emoji options were randomized and counterbalanced to ensure that all emotions had equal representation.

Children's response to each vocal burst was coded as correct (1) or incorrect (0). Recognition accuracy was computed as the percent of correct answers. If a child did not respond to at least 50% of trials, their data were not included in the analysis ($n = 2$). Otherwise, trials that were skipped (1.6% of all trials) were treated as incorrect. We removed one observation as an outlier because it was more than 3.5 SD above the mean.

Socioemotional Functioning at Times 1 and 2

To assess children's socioemotional functioning both at Times 1 and 2, caregivers completed the Strengths and Difficulties Questionnaire (Goodman, 2001). The original measure includes five subscales, each consisting of five items that assess (a) emotional symptoms (e.g., "has many fears, easily scared"), (b) conduct problems (e.g., "often fights with other children"), (c) hyperactivity/inattention (e.g., "restless, overactive"), (d) peer problems (e.g., "has been picked on or bullied by other children"), and (e) prosocial behavior (e.g., "shares readily with other children"). Caregivers rated their agreement with each item on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*). As part of our team's effort to reduce the length of the caregiver survey, we omitted one item from the emotional symptoms subscale (often complains of headaches) given that we deemed its relevance to the respective subscale ambiguous. Caregivers' ratings were averaged to create a summary score for each subscale. The peer problems subscale, consisting of four items, had low reliability at Time 1 ($\alpha = .29$) and at Time 2 ($\alpha = .50$); therefore, it was dropped from our analyses.

Transparency and Openness

All statistical analyses were performed using RStudio (R Core Team, 2021) in the R programming environment. We reported how we determined our sample size, all data exclusions, and all measures used in the study. We also followed Journal Article Reporting Standards (Appelbaum et al., 2018). All data, research materials, and analysis code for review purposes are publicly available on the Open Science Framework at https://osf.io/qgy92/?view_only=8d69bb661904490999165453cb3f55ef. The study reported in this article was not preregistered.

Data Analytic Plan

Descriptive statistics for all the variables are displayed in Table 2, and their intercorrelations are displayed in Supplemental Tables S2 and S3. We first compared the recognition accuracy of

Table 2
Descriptive Statistics

Variable	Time 1 *M*	Time 1 *SD*	Time 1 α	Time 2 *M*	Time 2 *SD*	Time 2 α
Emotion accuracy	0.82	0.11				
Emotional symptoms	2.18	0.88	.71	2.35	0.88	.79
Conduct problems	1.74	0.65	.70	1.70	0.57	.76
Hyperactivity	2.74	0.86	.76	2.58	0.77	.78
Prosocial behavior	4.09	0.69	.82	4.03	0.62	.80

Note. Emotion accuracy scores ranged from 0 to 1, while socioemotional scores ranged from 1 to 5. α represents estimates of reliability.

emotions conveyed through vocal bursts across distinct emotions and then examined how overall recognition accuracy and recognition accuracy for distinct emotions changed with age. This was followed by an analysis of the interaction between age and gender on overall recognition accuracy and recognition accuracy for distinct emotions. Finally, we explored the relationships between recognition accuracy and the various domains of socioemotional functioning.

Results

Recognition Accuracy

Overall recognition accuracy (percentage of correct responses collapsed across distinct emotions) in the sample was 82.3%, which is significantly above chance (see Table 3). Accuracy rates for all six distinct emotions were also above chance (>25% correct for all emotions), with children showing the highest accuracy for happiness, followed by anger and disgust, and then by surprise and sadness. Accuracy was the lowest for fear (see Figure 1).

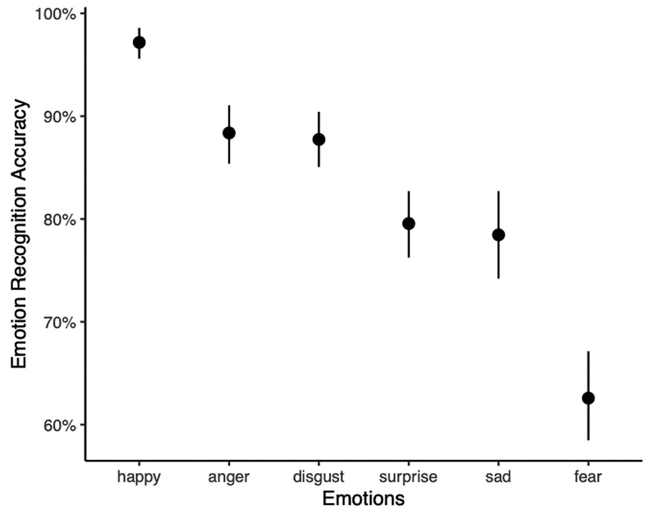
Holm *p* value pairwise comparisons showed that accuracy for happiness (highest) and fear (lowest) were significantly different than accuracy for all other emotions. Anger and disgust did not differ significantly from one another nor did surprise and sadness.

Table 3
Recognition Accuracy Against Chance

Emotion	Accuracy by emotion: % correct	*t*	*p*
Total	82.3	64.87	<.001
Happy	97.2_a	93.47	<.001
Anger	88.4_b	43.95	<.001
Disgust	87.7_b	43.99	<.001
Surprise	79.6_c	32.16	<.001
Sad	78.5_c	25.77	<.001
Fear	62.6_d	17.77	<.001

Note. Percentage correct was tested against chance (25%). Different subscripts for distinct emotions indicate that accuracy rates are significantly different from each other at Holm-adjusted $p < .05$.

Figure 1
Recognition Accuracy Across Distinct Emotions



Note. Recognition accuracy is operationalized as the percentage of trials correct for each distinct emotion. Figure included 95% confidence intervals.

Recognition Accuracy Across Age

We first regressed overall recognition accuracy on age (in months). Then, we repeated this analysis separately for each distinct emotion. Age had a significant positive effect on all accuracy indices aside from happiness, which was positively associated with age at a marginal level (see Table 4 and Figure 2).

Visual inspection of these trajectories suggested that there might be a nonlinear association between age and recognition accuracy for some emotions (e.g., disgust, sadness), which we explored in two ways. First, we tested the significance of the change in accuracy from ages 5 to 6. This did not reveal a consistent pattern across emotions, with growth significant for disgust, β = .56, 95% CI [0.14, 0.99], $t(155) = 2.63$, $p = .009$, and sadness, β = .48, 95% CI [0.06, 0.89], $t(155) = 2.28$, $p = .024$, but not for happy, surprise, anger, or fear: $|t|\text{s} < 1.78$. Second, we fit a curvilinear effect of age in the regression analyses reported above. The quadratic term was not statistically significant for any of the emotions, $|t|\text{s} < 0.97$. Taken together, these analyses indicated that the effect of age on recognition accuracy was best captured by the linear term.

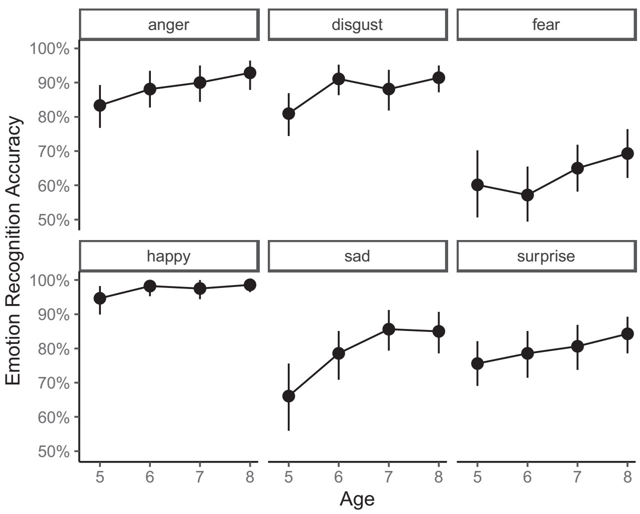
Table 4
Age Regressed on Recognition Accuracy

Emotion	*B* [95% CI]	Std. β [std. 95% CI]	*t*	*df*	*p*
Overall	0.03 [0.02, 0.05]	0.34 [0.19, 0.49]	4.50	157	<.001
Anger	0.03 [0.00, 0.05]	0.16 [0.00, 0.31]	1.99	157	.048
Disgust	0.03 [0.01, 0.06]	0.20 [0.04, 0.35]	2.51	157	.013
Fear	0.04 [0.01, 0.08]	0.18 [0.03, 0.34]	2.31	157	.022
Happy	0.01 [−0.00, 0.03]	0.15 [−0.01, 0.30]	1.86	157	.065
Sad	0.06 [0.02, 0.10]	0.25 [0.10, 0.40]	3.23	157	.001
Surprise	0.03 [0.00, 0.06]	0.16 [0.00, 0.31]	2.02	157	.045

Note. Age was scored in months. CI = confidence interval; Std. = standardized.

Figure 2

Age Regressed on Recognition Accuracy for Each Distinct Emotion



Age × Gender Interactions in Recognition Accuracy

To examine whether gender moderated the effect of age, we regressed overall recognition accuracy on age (months; group mean centered), gender (boy = −1; girl = 1), and the interaction between age and gender. There was a main effect of age, $\beta = .34$, $t(155) = 4.66$, 95% CI [0.19, 0.48], $p < .001$, and a main effect of gender, $\beta = .23$, $t(155) = 3.28$, 95% CI [0.09, 0.38], $p = .001$. However, these main effects were qualified by a significant Age × Gender interaction, $\beta = -.19$, $t(155) = -2.61$, 95% CI [−0.33, −0.05], $p = .010$.

As illustrated in Figure 3, simple slopes analysis (Aiken et al., 1991) showed that for boys, recognition accuracy improved significantly from ages 5 to 8, $\beta = .52$, $t(155) = 5.25$, $p < .001$. By contrast, for girls, recognition accuracy did not change across the same developmental period, $\beta = .15$, $t(155) = 1.42$, $p = .158$. Furthermore, at age 5, girls were better at recognizing emotions than boys, $\beta = 1.10$, $t(155) = 3.88$, $p = .001$, but this difference was no longer significant at age 8, $\beta = .08$, $t(155) = 0.41$, $p = .686$.

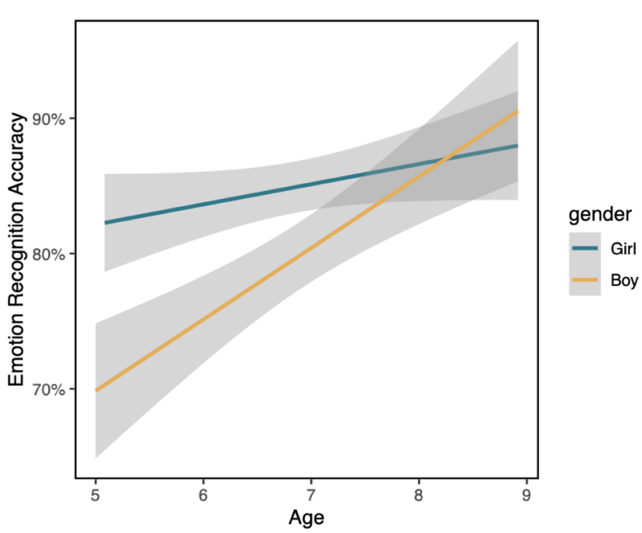
Using the same approach outlined above, next we examined Age × Gender interactions in predicting recognition accuracy at the level of distinct emotions. The interaction term was only significant for sadness, $\beta = -0.17$, $t(155) = -2.26$, $p = .025$, and anger, $\beta = -0.16$, $t(155) = -2.06$, $p = .041$ ($p > .099$ for all other emotions; see Figure 4). Simple slopes analysis showed that for boys, recognition accuracy for sadness improved significantly, $\beta = .42$, $t(155) = 4.00$, $p < .001$. By contrast, for girls, recognition accuracy for sadness did not change across the same developmental period, $\beta = .08$, $t(155) = 0.70$, $p = .484$. In terms of anger, boys' recognition accuracy again improved significantly, $\beta = .31$, $t(155) = 2.93$, $p = .004$, but girls' did not, $\beta = -0.01$, $t(155) = -0.05$, $p = .963$. Full results for all distinct emotions can be found in Supplemental Table S1.

Recognition Accuracy Predicting Socioemotional Functioning

In our final analyses, we explored the association between emotion recognition accuracy in vocal bursts and children's socioemotional functioning as reported by their caregivers. We predicted ratings on each socioemotional subscale (emotional symptoms, conduct problems, hyperactivity/inattention, prosocial behavior) from overall recognition accuracy, as we did not have specific hypotheses about recognition ability at the level of distinct emotions and aimed to avoid inflating Type 1 error due to multiple comparisons when predicting five socioemotional domains at the distinct emotion level (see Supplemental Table S4 for this analysis).

Figure 3

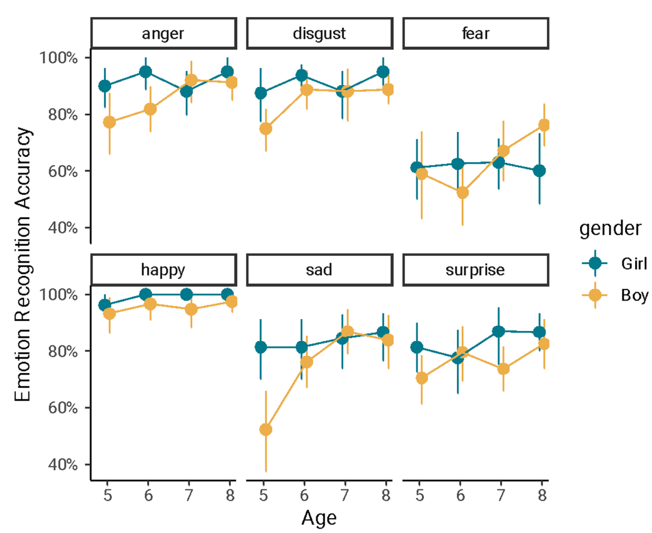
Age × Gender Interaction in Overall Recognition Accuracy



Note. See the online article for the color version of this figure.

Figure 4

Age × Gender Interactions in Recognition Accuracy Across Distinct Emotions



Note. Girls and boys are plotted at the same age, but for better visual presentation, their means and confidence intervals are slightly offset on the *x*-axis. See the online article for the color version of this figure.

Table 5
Recognition Accuracy Predicting Socioemotional Functioning at Time 1

	Socioemotional functioning at Time 1			
	Emotional symptom	Conduct problem	Hyperactivity	Prosociality
Predictor	β (std. *SE*)	β (std. *SE*)	β (std. *SE*)	β (std. *SE*)
Step 1				
Recognition accuracy	−0.01 (.08)	−0.20 (.08)*	−0.11 (.08)	0.28 (.08)**
Step 2				
Recognition accuracy	−0.09 (.09)	−0.17 (.09)†	−0.09 (.09)	0.25 (.08)**
Gender	0.06 (.08)	−0.14 (.08)	−0.18 (.08)*	0.22 (.08)**
Age	0.20 (.09)*	−0.01 (.09)	0.04 (.09)	−0.06 (.08)

Note. Separate regressions were run for emotion accuracy as a predictor; for gender, boy = −1, girl = 1. Std. = standardized; *SE* = standard error.
* $p < .05$. ** $p < .01$. † $p < .10$.

Results at Time 1 showed that recognition accuracy positively predicted child prosociality, $\beta = .28$, $t(151) = 3.60$, $p < .001$, and negatively predicted conduct problems, $\beta = -.20$, $t(151) = -2.56$, $p < .01$. Associations with the other subscales were nonsignificant ($|t|$s < 1.36). A second step in the regression controlled for the child's age and gender. The effect of recognition accuracy on prosociality remained significant, $\beta = .25$, $t(149) = 3.02$, $p < .001$, while the effect on conduct problems became marginal, $\beta = -.17$, $t(149) = -1.95$, $p = .05$. Once again, no other effects were significant ($|t|$s < 1.02; see Table 5).

For Time 2 outcomes, recognition accuracy (from Time 1) positively and prospectively predicted child prosociality, $\beta = .19$, $t(94) = 1.91$, $p = .05$, and negatively predicted hyperactivity, $\beta = -.21$, $t(94) = -2.11$, $p = .03$. Associations with emotional symptoms and conduct problems were not significant ($|t|$s < 0.38). A second step in the regression controlled for the child's age, gender, and time lag between Time 1 and Time 2 assessments (see Table 6).[1]

These analyses showed that the effect for prosociality, $\beta = .26$, $t(91) = 2.33$, $p = .02$, and hyperactivity, $\beta = -.24$, $t(94) = -2.06$, $p = .04$, remained significant. Associations with emotional symptoms and conduct problems were not significant ($|t|$s < 0.98). As a third step, we controlled for Time 1 assessments of each subdomain of socioemotional functioning. When accounting for socioemotional functioning at Time 1, our results showed that the effects of prosociality, $\beta = .17$, $t(88) = 1.76$, $p = .08$, and hyperactivity, $\beta = -.17$, $t(88) = -1.86$, $p = .06$, became marginal (see Table 6). Associations with emotional symptoms and conduct problems were not significant ($|t|$s < 0.24).

Discussion

The ability to recognize expressions of emotion, an aspect of emotion reasoning (Ruba & Pollak, 2020), is one linchpin of effective social interactions (Denham, 2007; Denham et al., 2003; Keltner & Haidt, 1999; Keltner & Kring, 1998; van Kleef & Côté, 2022) and is predictive of socioemotional functioning in childhood (Parker & Gottman, 1989). Although extensive research has explored changes in emotion recognition over the course of development in boys and girls (Kok et al., 2014; Williams et al., 2009), the majority of this research has primarily focused on facial cues (Denham et al., 2003; Widen & Russell, 2008). This raises the question of when children are able to recognize emotions in other modalities, such as those conveyed via vocal bursts, and whether this ability is also connected to socioemotional functioning (for review, Kilford et al., 2016). To address this gap, we assessed (a) the developmental trajectories of the ability to recognize emotions in vocal bursts (overall and by distinct emotion) among children aged 5–8 years, (b) the role of gender in moderating these developmental trajectories, and (c) the socioemotional correlates of this emotion recognition ability.

Our results showed that all of the distinct emotions were recognized above the chance level in this age range. These findings align with prior research on emotion recognition from vocal cues (Cordaro et al., 2016; Sauter et al., 2013; Simon-Thomas et al., 2009). Happiness was the most accurately recognized emotion. This is also consistent with prior research, which has shown that happiness in facial expressions tends to be recognized earlier in development than distinct negative emotions (Boyatzis et al., 1993; Camras & Allison, 1985; Gosselin & Larocque, 2000; Herba et al., 2008; Maassarani et al., 2014; Montirosso et al., 2010; Widen & Russell, 2003). After happiness, recognition accuracy was the highest for anger and disgust, which were recognized equally well. Accuracy for surprise and sadness came next. Finally, among the well-studied emotions in this study, fear was the least well recognized. One possible explanation for this finding is that the relatively privileged children in our sample may have had more limited exposure to emotive screams in everyday life, at least in comparison to other emotion vocalizations such as ewws and laughs. The finding that recognition accuracy was lower for fear aligns with some studies on facial cues (Boyatzis et al., 1993; Camras & Allison, 1985; Gosselin & Larocque, 2000), but not others (Maassarani et al., 2014; Montirosso et al., 2010). Given these mixed findings, more research is needed to determine whether this effect is indeed unique to the emotion conveyed in the vocal domain.

Next, we investigated the developmental trajectories of emotion recognition in vocal bursts. Consistent with previous findings (Chronaki et al., 2015; Grosbras et al., 2018; Sauter et al., 2013) and our hypotheses (Hypothesis 1), we found that recognition

[1] We opted to control for the latter because the lag between Time 1 and Time 2 assessments varied substantially (range = 2.4–4.05 years), potentially impacting the child's age and subsequently the key outcomes we measured.

Table 6
Recognition Accuracy Predicting Socioemotional Functioning at Time 2

	Socioemotional functioning at T2			
	Emotional symptom	Conduct problem	Hyperactivity	Prosociality
Predictor	β (std. *SE*)	β (std. *SE*)	β (std. *SE*)	β (std. *SE*)
Step 1				
Recognition accuracy (T1)	0.04 (.10)	0.00 (.10)	−0.21 (.10)*	0.19 (.10)*
Step 2				
Recognition accuracy (T1)	−0.00 (.12)	−0.11 (.11)	−0.24 (.11)*	0.26 (.11)*
Age (T1)	0.15 (.11)	0.21 (.11)†	0.13 (.11)	−0.18 (.11)
Gender	−0.09 (.11)	0.07 (.11)	−0.09 (.11)	0.06 (.10)
Time lag between T1 and T2 assessments	−0.06 (.11)	−0.21 (.10)†	0.00 (.10)	0.24 (.10)*
Step 3				
Recognition accuracy (T1)	0.02 (.10)	0.02 (.10)	−0.17 (.09)†	0.17 (.10)†
Age (T1)	0.06 (.10)	0.19 (.10)*	0.05 (.09)	−0.21 (.09)*
Gender	−0.05 (.09)	0.12 (.09)	0.02 (.09)	−0.07 (.09)
Time lag between T1 and T2 assessments	0.11 (.10)	−0.17 (.09)	0.03 (.08)	0.18 (.09)
Socioemotional functioning (T1)	0.53 (.10)**	0.54 (.09)**	0.62 (.08)**	0.56 (.09)**

Note. Separate regressions were run for recognition accuracy as a predictor; for gender boy = −1, girl = 1. Std = standardized; *SE* = standard error; T = time.
* $p < .05$. ** $p < .01$. † $p < .10$.

accuracy improved overall between the ages of 5 and 8 and for all distinct emotions except happiness. Recognition for happiness was trending in the expected direction but remained marginal, likely due to a ceiling effect. A more granular analysis revealed that the largest improvement in accuracy tended to occur between the ages of 5 and 6 and then slowed thereafter. This might be related to the onset of schooling, including more exposure to others' emotions or even lessons about emotion in the kindergarten curriculum. Consequently, ages 5–6 might be a pivotal period for caregivers and educators to directly engage children in discussions about emotions, using playbooks or games as tools. Unfortunately, our data do not provide a timeframe to pinpoint when the development of emotion recognition in vocal bursts starts to plateau or reach adult-level proficiency. We did find that among our oldest participants, accuracy was relatively high for happiness, anger, and disgust (around 85%–95%), indicating that children might be nearly proficient at recognizing these emotions by age 8. By contrast, accuracy for surprise, sadness, and particularly fear remained lower (around 60%–80%), suggesting the possibility of more protracted development. Future (particularly longitudinal) research should include an older sample to more fully explore this question.

Next, we investigated the moderating role of gender in recognition accuracy. Consistent with some research on vocal bursts (Allgood & Heaton, 2015; Chronaki et al., 2015; Grosbras et al., 2018), we hypothesized that girls would be more accurate than boys overall (Hypothesis 2), which was supported albeit in a nuanced way. That is, although girls were better than boys at recognizing emotions in vocal bursts at the age of 5 (consistent with Hypothesis 2), this difference disappeared by age 8. Moreover, for girls, accuracy did not change significantly across this developmental period, suggesting that this skill may be honed early on. By contrast, boys showed marked improvement across this developmental period and finally caught up with their female peers. This same pattern was observed for sadness and anger at the level of distinct emotions. These findings are consistent with a small body of research demonstrating that girls tend to be more proficient than boys at recognizing both sadness (Mancini et al., 2018) and anger (Lawrence et al., 2015; Montirosso et al., 2010) in facial expressions. Taken together, the overall gender effects reported in our study are consistent with the continuing presence of gender norms surrounding the experience and understanding of emotions. This aligns with findings from the meta-analysis by McClure (2000), which showed that girls develop emotion recognition abilities earlier than boys. In line with socialization processes, caregivers may provide more emotion-related feedback to girls at early ages (Aznar & Tenenbaum, 2015; Fivush et al., 2000), fostering an environment where they have greater exposure to emotional cues and thus more opportunities to practice interpreting them. This exposure may facilitate the recognition of emotional expressions, as individuals tend to more accurately recognize emotions they frequently encounter in social interactions due to familiarity (Calvo et al., 2014). Additionally, the early maturation of facial expression processing networks in girls, combined with the suppressive effect of androgens on amygdala function in boys, may help explain these early disparities (McClure, 2000).

Finally, we examined the socioemotional correlates of recognition of vocal bursts cross-sectionally and longitudinally and generally expected positive associations (Hypothesis 3). Our results from cross-sectional analyses suggested that the capacity to recognize emotions in vocal bursts did not correlate with caregivers' perceptions of children's emotional symptoms (e.g., often worried, depressed, nervous, having fears) or hyperactivity. However, those children who were better at recognizing emotions in vocal bursts were less susceptible to conduct problems (e.g., fighting with other children, lying, cheating, losing temper) and more likely to exhibit prosocial behavior (e.g., considering others' feelings, assisting those experiencing distress, consistently displaying kindness), with the latter effect staying significant even when controlling for age and gender.

Emotion recognition ability at Time 1 also predicted less hyperactivity and more prosociality at Time 2, though these relationships became statistically marginal when Time 1 levels and other relevant covariates were also included as predictors. We note, however, that the effect sizes for emotion recognition at Time 2 were similar with (.17) and without covariates (.19) in the model. Therefore, we believe that the reduction in statistical significance may in part be due to low power (i.e., losing degrees of freedom).

Taken together, our results were broadly consistent with Hypothesis 3. They also aligned well with previous research demonstrating that reliable emotion recognition promotes appropriate social responses, underscoring the robust association between emotion recognition in vocal bursts and prosociality. For instance, individuals, including children, adept at discerning emotions from affective cues in others are more likely to recognize sadness in a peer, understand their needs, and respond with comforting behaviors (Eisenberg & Fabes, 1995; Izard, 2002). Therefore, reliable emotion recognition facilitates the appropriate utilization of emotions, fostering prosocial behaviors such as sharing and helping, all aimed at benefiting others (de Waal, 2008; Dovidio, 2001; Izard et al., 2000; Penner et al., 2005). Relatedly, these findings support previous evidence showing that the ability to recognize emotions in others strongly correlates with the capacity for empathy (Mayer et al., 1990), which in turn plays a crucial affiliative role in social interactions, aiding in the formation and maintenance of healthy relationships (Anderson & Keltner, 2002; Ringwald & Wright, 2021).

Limitations and Future Directions

Although the current research enriches our understanding of emotion recognition in childhood, there are several limitations. First, although our stimuli derive from well-studied emotions (Ekman, 1992), recent research suggests that people experience and express a much broader range of emotions (Cordaro et al., 2016; Cowen et al., 2019). Therefore, future research should explore when, how, and by whom other distinct emotions are recognized in vocal bursts. Second, although contextual information is instrumental in identifying emotions in natural settings (Barrett et al., 2011), our stimuli were presented in isolation. On the other hand, identifying emotions in vocal bursts without broader context might be a more challenging task for young children and may thus be more diagnostic of their skills and more predictive of socioemotional outcomes. Nevertheless, future research should compare and contrast emotion recognition accuracy in vocal bursts presented with contextual information versus without it.

The demographic characteristics, specifically parental education (>40% held graduate degrees) and household income (>60% reported annual incomes exceeding $100,000), of our sample warrant caution when considering the generalizability of our results to less educated and less wealthy populations. Because socioeconomic status shapes children's developmental trajectories quite powerfully (Neuman & Moland, 2019; Reiss, 2013), the question of whether we would see stronger or weaker relationships between recognition ability in vocal bursts and socioemotional functioning necessitates attention in future research. Age-related changes seen in vocal emotion recognition ability may also be different depending on family socioeconomic status as prolonged exposure to poverty, and therefore chaos in the household, might delay the development of children's emotion recognition abilities (Raver et al., 2015). On the other hand, households with lower socioeconomic status may place greater emphasis on social connectedness (Kraus et al., 2009, 2012) and might therefore expose children to richer affective experiences, facilitating the development of emotion recognition. Future research should examine these possibilities and assess the generalizability of the findings presented here in a more socioeconomically diverse sample.

Finally, our data do not directly compare emotion recognition accuracy in faces versus voices to determine whether one is a stronger predictor of socioemotional competencies than the other. Future studies should directly compare these modalities in young children and evaluate their relative associations with children's socioemotional outcomes.

Conclusion

These limitations aside, the current research contributes to the broader emotion reasoning literature by examining the developmental trajectories, gender interactions, and socioemotional correlates of an understudied aspect of emotion recognition in vocal bursts. The insights gained from this research have the potential to facilitate the identification of critical periods for targeted interventions, educational strategies, and caregiver practices aimed at fostering emotional literacy and socioemotional competence in children.

References

Aiken, L. S., West, S. G., & Reno, R. R. (1991). *Multiple regression: Testing and interpreting interactions*. Sage Publications.

Allgood, R., & Heaton, P. (2015). Developmental change and cross-domain links in vocal and musical emotion recognition performance in childhood. *British Journal of Developmental Psychology*, *33*(3), 398–403. https://doi.org/10.1111/bjdp.12097

Anderson, C., & Keltner, D. (2002). The role of empathy in the formation and maintenance of social bonds. *Behavioral and Brain Sciences*, *25*(1), 21–22. https://doi.org/10.1017/S0140525X02230010

Appelbaum, M., Cooper, H., Kline, R. B., Mayo-Wilson, E., Nezu, A. M., & Rao, S. M. (2018). Journal article reporting standards for quantitative research in psychology: The APA Publications and Communications Board task force report. *American Psychologist*, *73*(1), 3–25. https://doi.org/10.1037/amp0000191

Ayduk, O., Mendoza-Denton, R., Mischel, W., Downey, G., Peake, P. K., & Rodriguez, M. (2000). Regulating the interpersonal self: Strategic self-regulation for coping with rejection sensitivity. *Journal of Personality and Social Psychology*, *79*(5), 776–792. https://doi.org/10.1037/0022-3514.79.5.776

Aznar, A., & Tenenbaum, H. R. (2015). Gender and age differences in parent–child emotion talk. *British Journal of Developmental Psychology*, *33*(1), 148–155. https://doi.org/10.1111/bjdp.12069

Ball, C. L., Smetana, J. G., Sturge-Apple, M. L., Suor, J. H., & Skibo, M. A. (2017). Moral development in context: Associations of neighborhood and maternal discipline with preschoolers' moral judgments. *Developmental Psychology*, *53*(10), 1881–1894. https://doi.org/10.1037/dev0000378

Barrett, L. F., Mesquita, B., & Gendron, M. (2011). Context in emotion perception. *Current Directions in Psychological Science*, *20*(5), 286–290. https://doi.org/10.1177/0963721411422522

Batty, M., & Taylor, M. J. (2006). The development of emotional face processing during childhood. *Developmental Science*, *9*(2), 207–220. https://doi.org/10.1111/j.1467-7687.2006.00480.x

Bayet, L., Behrendt, H. F., Cataldo, J. K., Westerlund, A., & Nelson, C. A. (2018). Recognition of facial emotions of varying intensities by three-year-olds. *Developmental Psychology*, *54*(12), 2240–2247. https://doi.org/10.1037/dev0000588

Boyatzis, C. J., Chazan, E., & Ting, C. Z. (1993). Preschool children's decoding of facial emotions. *The Journal of Genetic Psychology*, *154*(3), 375–382. https://doi.org/10.1080/00221325.1993.10532190

Bruce, V., Campbell, R. N., Doherty-Sneddon, G., Langton, S., McAuley, S., & Wright, R. (2000). Testing face processing skills in children. *British Journal of Developmental Psychology*, *18*(3), 319–333. https://doi.org/10.1348/026151000165715

Calvo, M. G., Gutiérrez-García, A., Fernández-Martín, A., & Nummenmaa, L. (2014). Recognition of facial expressions of emotion is related to their frequency in everyday life. *Journal of Nonverbal Behavior*, *38*(4), 549–567. https://doi.org/10.1007/s10919-014-0191-3

Campos, J. J., Campos, R. G., & Barrett, K. C. (1989). Emergent themes in the study of emotional development and emotion regulation. *Developmental Psychology*, *25*(3), 394–402. https://doi.org/10.1037/0012-1649.25.3.394

Camras, L. A., & Allison, K. (1985). Children's understanding of emotional facial expressions and verbal labels. *Journal of Nonverbal Behavior*, *9*(2), 84–94. https://doi.org/10.1007/BF00987140

Carr, M. B., & Lutjemeier, J. A. (2005). The relation of facial affect recognition and empathy to delinquency in youth offenders. *Adolescence*, *40*(159), 601–619.

Chronaki, G., Hadwin, J. A., Garner, M., Maurage, P., & Sonuga-Barke, E. J. (2015). The development of emotion recognition from facial expressions and non-linguistic vocalizations during childhood. *British Journal of Developmental Psychology*, *33*(2), 218–236. https://doi.org/10.1111/bjdp.12075

Chronaki, G., Wigelsworth, M., Pell, M. D., & Kotz, S. A. (2018). The development of cross-cultural recognition of vocal emotion during childhood and adolescence. *Scientific Reports*, *8*(1), Article 8659. https://doi.org/10.1038/s41598-018-26889-1

Cordaro, D. T., Keltner, D., Tshering, S., Wangchuk, D., & Flynn, L. M. (2016). The voice conveys emotion in ten globalized cultures and one remote village in Bhutan. *Emotion*, *16*(1), 117–128. https://doi.org/10.1037/emo0000100

Cowen, A. S., Elfenbein, H. A., Laukka, P., & Keltner, D. (2019). Mapping 24 emotions conveyed by brief human vocalization. *American Psychologist*, *74*(6), 698–712. https://doi.org/10.1037/amp0000399

de Gelder, B., & Vroomen, J. (2000). The perception of emotions by ear and by eye. *Cognition and Emotion*, *14*(3), 289–311. https://doi.org/10.1080/026999300378824

de Waal, F. B. (2008). Putting the altruism back into altruism: The evolution of empathy. *Annual Review of Psychology*, *59*(1), 279–300. https://doi.org/10.1146/annurev.psych.59.103006.093625

Denham, S. A. (2007). Dealing with feelings: How children negotiate the worlds of emotions and social relationships. *Cogniţie Creier Comportament*, *11*(1), 1–48.

Denham, S. A., Blair, K. A., DeMulder, E., Levitas, J., Sawyer, K., Auerbach-Major, S., & Queenan, P. (2003). Preschool emotional competence: Pathway to social competence? *Child Development*, *74*(1), 238–256. https://doi.org/10.1111/1467-8624.00533

Dovidio, J. F. (2001). On the nature of contemporary prejudice: The third wave. *Journal of Social Issues*, *57*(4), 829–849. https://doi.org/10.1111/0022-4537.00244

Eisenberg, N., & Fabes, R. A. (1995). The relation of young children's vicarious emotional responding to social competence, regulation, and emotionality. *Cognition and Emotion*, *9*(2–3), 203–228. https://doi.org/10.1080/02699939508409009

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, *6*(3–4), 169–200. https://doi.org/10.1080/02699939208411068

Ekman, P., & Friesen, W. V. (1976). Measuring facial movement. *Environmental Psychology and Nonverbal Behavior*, *1*(1), 56–75. https://doi.org/10.1007/BF01115465

Field, T. M., Woodson, R., Greenberg, R., & Cohen, D. (1982). Discrimination and imitation of facial expression by neonates. *Science*, *218*(4568), 179–181. https://doi.org/10.1126/science.7123230

Fivush, R., Brotman, M., Buckner, J., & Goodman, S. (2000). Gender differences in parent–child emotion narratives. *Sex Roles*, *42*(3–4), 233–253. https://doi.org/10.1023/A:1007091207068

Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child & Adolescent Psychiatry*, *40*(11), 1337–1345. https://doi.org/10.1097/00004583-200111000-00015

Gosselin, P., & Larocque, C. (2000). Facial morphology and children's categorization of facial expressions of emotions: A comparison between Asian and Caucasian faces. *The Journal of Genetic Psychology*, *161*(3), 346–358. https://doi.org/10.1080/00221320009596717

Grandjean, D. (2021). Brain networks of emotional prosody processing. *Emotion Review*, *13*(1), 34–43. https://doi.org/10.1177/1754073919898522

Grosbras, M. H., Ross, P. D., & Belin, P. (2018). Categorical emotion recognition from voice improves during childhood and adolescence. *Scientific Reports*, *8*(1), Article 14791. https://doi.org/10.1038/s41598-018-32868-3

Grossmann, T. (2010). The development of emotion perception in face and voice during infancy. *Restorative Neurology and Neuroscience*, *28*(2), 219–236. https://doi.org/10.3233/RNN-2010-0499

Hall, J. A., & Matsumoto, D. (2004). Gender differences in judgments of multiple emotions from facial expressions. *Emotion*, *4*(2), 201–206. https://doi.org/10.1037/1528-3542.4.2.201

Hampson, S. E., Goldberg, L. R., Vogt, T. M., & Dubanoski, J. P. (2006). Forty years on: Teachers' assessments of children's personality traits predict self-reported health behaviors and outcomes at midlife. *Health Psychology*, *25*(1), 57–64. https://doi.org/10.1037/0278-6133.25.1.57

Herba, C. M., & Phillips, M. (2004). Annotation: Development of facial expression recognition from childhood to adolescence: Behavioural and neurological perspectives. *Journal of Child Psychology and Psychiatry*, *45*(7), 1185–1198. https://doi.org/10.1111/j.1469-7610.2004.00316.x

Herba, C. M., Benson, P., Landau, S., Russell, T., Goodwin, C., Lemche, E., Santosh, P., & Phillips, M. (2008). Impact of familiarity upon children's developing facial expression recognition. *Journal of Child Psychology and Psychiatry*, *49*(2), 201–210. https://doi.org/10.1111/j.1469-7610.2007.01835.x

Herba, C. M., Landau, S., Russell, T., Ecker, C., & Phillips, M. L. (2006). The development of emotion-processing in children: Effects of age, emotion, and intensity. *Journal of Child Psychology and Psychiatry*, *47*(11), 1098–1106. https://doi.org/10.1111/j.1469-7610.2006.01652.x

Hertenstein, M. J., & Campos, J. J. (2004). The retention effects of an adult's emotional displays on infant behavior. *Child Development*, *75*(2), 595–613. https://doi.org/10.1111/j.1467-8624.2004.00695.x

Izard, C. E., Fine, S., Schultz, D., Mostow, A., Ackerman, B., & Youngstrom, E. (2001). Emotion knowledge as a predictor of social behavior and academic competence in children at risk. *Psychological Science*, *12*(1), 18–23. https://doi.org/10.1111/1467-9280.00304

Izard, C. E. (2002). Translating emotion theory and research into preventive interventions. *Psychological Bulletin*, *128*(5), 796–824. https://doi.org/10.1037/0033-2909.128.5.796

Izard, C. E., Ackerman, B. P., Schoff, K. M., & Fine, S. E. (2000). Self-organization of discrete emotions, emotion patterns, and emotion-cognition relations. In M. D. Lewis & I. Granic (Eds.), *Emotion, development, and self-organization: Dynamic systems approaches to emotional development* (pp. 15–36). Cambridge University Press. https://doi.org/10.1017/CBO9780511527883.003

Johnson, S. L., Carver, C. S., Mulé, S., & Joormann, J. (2013). Impulsivity and risk for mania: Towards greater specificity. *Psychology and Psychotherapy: Theory, Research and Practice*, *86*(4), 401–412. https://doi.org/10.1111/j.2044-8341.2012.02078.x

Joormann, J., & Gotlib, I. H. (2010). Emotion regulation in depression: Relation to cognitive inhibition. *Cognition and Emotion*, *24*(2), 281–298. https://doi.org/10.1080/02699930903407948

Keltner, D. (2019). Toward a consensual taxonomy of emotions. *Cognition and Emotion*, *33*(1), 14–19. https://doi.org/10.1080/02699931.2019.1574397

Keltner, D., & Bonanno, G. A. (1997). A study of laughter and dissociation: Distinct correlates of laughter and smiling during bereavement. *Journal of Personality and Social Psychology*, *73*(4), 687–702. https://doi.org/10.1037/0022-3514.73.4.687

Keltner, D., & Buswell, B. N. (1997). Embarrassment: Its distinct form and appeasement functions. *Psychological Bulletin*, *122*(3), 250–270. https://doi.org/10.1037/0033-2909.122.3.250

Keltner, D., & Haidt, J. (1999). Social functions of emotions at four levels of analysis. *Cognition and Emotion*, *13*(5), 505–521. https://doi.org/10.1080/026999399379168

Keltner, D., & Haidt, J. (2001). Social functions of emotions. In T. J. Mayne & G. A. Bonanno (Eds.), *Emotions: Current issues and future directions* (pp. 192–213). Guilford Press.

Keltner, D., & Kring, A. M. (1998). Emotion, social function, and psychopathology. *Review of General Psychology*, *2*(3), 320–342. https://doi.org/10.1037/1089-2680.2.3.320

Keltner, D., Sauter, D., Tracy, J., & Cowen, A. (2019). Emotional expression: Advances in basic emotion theory. *Journal of Nonverbal Behavior*, *43*(2), 133–160. https://doi.org/10.1007/s10919-019-00293-3

Kilford, E. J., Garrett, E., & Blakemore, S. J. (2016). The development of social cognition in adolescence: An integrated perspective. *Neuroscience and Biobehavioral Reviews*, *70*, 106–120. https://doi.org/10.1016/j.neubiorev.2016.08.016

Kok, T. B., Post, W. J., Tucha, O., de Bont, E. S., Kamps, W. A., & Kingma, A. (2014). Social competence in children with brain disorders: A meta-analytic review. *Neuropsychology Review*, *24*(2), 219–235. https://doi.org/10.1007/s11065-014-9256-7

Kraus, M. W. (2017). Voice-only communication enhances empathic accuracy. *American Psychologist*, *72*(7), 644–654. https://doi.org/10.1037/amp0000147

Kraus, M. W., Piff, P. K., & Keltner, D. (2009). Social class, sense of control, and social explanation. *Journal of Personality and Social Psychology*, *97*(6), 992–1004. https://doi.org/10.1037/a0016357

Kraus, M. W., Piff, P. K., Mendoza-Denton, R., Rheinschmidt, M. L., & Keltner, D. (2012). Social class, solipsism, and contextualism: How the rich are different from the poor. *Psychological Review*, *119*(3), 546–572. https://doi.org/10.1037/a0028756

Lawrence, K., Campbell, R., & Skuse, D. (2015). Age, gender, and puberty influence the development of facial emotion recognition. *Frontiers in Psychology*, *6*, Article 761. https://doi.org/10.3389/fpsyg.2015.00761

Leppänen, J. M., & Hietanen, J. K. (2001). Emotion recognition and social adjustment in school-aged girls and boys. *Scandinavian Journal of Psychology*, *42*(5), 429–435. https://doi.org/10.1111/1467-9450.00255

Luerssen, A., Gyurak, A., Ayduk, O., Wendelken, C., & Bunge, S. A. (2015). Delay of gratification in childhood linked to cortical interactions with the nucleus accumbens. *Social Cognitive and Affective Neuroscience*, *10*(12), 1769–1776. https://doi.org/10.1093/scan/nsv068

Luerssen, A., Ugurlu, O., Mauss, I., & Ayduk, Ö. (2024). Child inhibited temperament and caregiver distraction encouragement jointly predict children's delay of gratification competencies. *Scientific Reports*, *14*(1), Article 1798. https://doi.org/10.1038/s41598-024-52288-w

Lytton, H., & Romney, D. M. (1991). Parents' differential socialization of boys and girls: A meta-analysis. *Psychological Bulletin*, *109*(2), 267–296. https://doi.org/10.1037/0033-2909.109.2.267

Maassarani, R., Gosselin, P., Montembeault, P., & Gagnon, M. (2014). French-speaking children's freely produced labels for facial expressions. *Frontiers in Psychology*, *5*, Article 555. https://doi.org/10.3389/fpsyg.2014.00555

Mancini, G., Agnoli, S., Baldaro, B., Bitti, P. E. R., & Surcinelli, P. (2018). Facial expressions of emotions: Recognition accuracy and affective reactions during late childhood. In A. Rokach (Ed.), *Emotions and their influence on our personal, interpersonal and social experiences* (pp. 21–39). Routledge. https://doi.org/10.4324/9781315100319-3

Matsumoto, D., & Kishimoto, H. (1983). Developmental characteristics in judgments of emotion from nonverbal vocal cues. *International Journal of Intercultural Relations*, *7*(4), 415–424. https://doi.org/10.1016/0147-1767(83)90047-0

Mayer, J. D., DiPaolo, M., & Salovey, P. (1990). Perceiving affective content in ambiguous visual stimuli: A component of emotional intelligence. *Journal of Personality Assessment*, *54*(3–4), 772–781. https://doi.org/10.1080/00223891.1990.9674037

McClure, E. B. (2000). A meta-analytic review of sex differences in facial expression processing and their development in infants, children, and adolescents. *Psychological Bulletin*, *126*(3), 424–453. https://doi.org/10.1037/0033-2909.126.3.424

Montirosso, R., Peverelli, M., Frigerio, E., Crespi, M., & Borgatti, R. (2010). The development of dynamic facial expression recognition at different intensities in 4- to 18-year-olds. *Social Development*, *19*(1), 71–92. https://doi.org/10.1111/j.1467-9507.2008.00527.x

Morgan, K., & Hayne, H. (2011). Age-related changes in visual recognition memory during infancy and early childhood. *Developmental Psychobiology*, *53*(2), 157–165. https://doi.org/10.1002/dev.20503

Neuman, S. B., & Moland, N. (2019). Book deserts: The consequences of income segregation on children's access to print. *Urban Education*, *54*(1), 126–147. https://doi.org/10.1177/0042085916654525

Neves, L., Martins, M., Correia, A. I., Castro, S. L., & Lima, C. F. (2021). Associations between vocal emotion recognition and socio-emotional adjustment in children. *Royal Society Open Science*, *8*(11), Article 211412. https://doi.org/10.1098/rsos.211412

Nowicki, S., Bliwise, N., & Joinson, C. (2019). The association of children's locus of control orientation and emotion recognition abilities at 8 years of age and teachers' ratings of their personal and social difficulties at 10 years. *Journal of Nonverbal Behavior*, *43*(3), 381–396. https://doi.org/10.1007/s10919-019-00304-3

Nowicki, S., Jr., & Mitchell, J. (1998). Accuracy in identifying affect in child and adult faces and voices and social competence in preschool children. *Genetic, Social, and General Psychology Monographs*, *124*(1), 39–59.

Oakes, L. M., & Rakison, D. H. (2019). *Developmental cascades: Building the infant mind*. Oxford University Press. https://doi.org/10.1093/oso/9780195391893.001.0001

Parker, J. G., & Gottman, J. M. (1989). Social and emotional development in a relational context: Friendship interaction from early childhood to adolescence. In T. J. Berndt & G. W. Ladd (Eds.), *Peer relationships in child development* (pp. 95–131). Wiley.

Penner, L. A., Dovidio, J. F., Piliavin, J. A., & Schroeder, D. A. (2005). Prosocial behavior: Multilevel perspectives. *Annual Review of Psychology*, *56*(1), 365–392. https://doi.org/10.1146/annurev.psych.56.091103.070141

R Core Team. (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Raver, C. C., Blair, C., Garrett-Peters, P., & the Family Life Project Key Investigators. (2015). Poverty, household chaos, and interparental aggression predict children's ability to recognize and modulate negative emotions. *Development and Psychopathology*, *27*(3), 695–708. https://doi.org/10.1017/S0954579414000935

Reiss, F. (2013). Socioeconomic inequalities and mental health problems in children and adolescents: A systematic review. *Social Science & Medicine*, *90*, 24–31. https://doi.org/10.1016/j.socscimed.2013.04.026

Ringwald, W. R., & Wright, A. G. C. (2021). The affiliative role of empathy in everyday interpersonal interactions. *European Journal of Personality*, *35*(2), 197–211. https://doi.org/10.1002/per.2286

Rodriguez, M. L., Mischel, W., & Shoda, Y. (1989). Cognitive person variables in the delay of gratification of older children at risk. *Journal of*

Personality and Social Psychology, *57*(2), 358–367. https://doi.org/10.1037/0022-3514.57.2.358

Ruba, A. L., & Pollak, S. D. (2020). The development of emotion reasoning in infancy and early childhood. *Annual Review of Developmental Psychology*, *2*(1), 503–531. https://doi.org/10.1146/annurev-devpsych-060320-102556

Saarni, C. (1999). *The development of emotional competence*. Guilford Press.

Sauter, D. A. (2007). *An investigation into vocal expressions of emotions: The roles of valence, culture, and acoustic factors*. University of London, University College London.

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2010). Cross-cultural recognition of basic emotions through nonverbal emotional vocalizations. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(6), 2408–2412. https://doi.org/10.1073/pnas.0908239106

Sauter, D. A., Panattoni, C., & Happé, F. (2013). Children's recognition of emotions from vocal cues. *British Journal of Developmental Psychology*, *31*(1), 97–113. https://doi.org/10.1111/j.2044-835X.2012.02081.x

Scharfe, E. (2000). Development of emotional expression, understanding, and regulation in infants and young children. In R. Bar-On & J. D. A. Parker (Eds.), *The handbook of emotional intelligence: Theory, development, assessment, and application at home, school, and in the workplace* (pp. 244–262). Jossey-Bass/Wiley.

Scherer, K. R., & Wallbott, H. G. (1994). Evidence for universality and cultural variation of differential emotion response patterning. *Journal of Personality and Social Psychology*, *66*(2), 310–328. https://doi.org/10.1037/0022-3514.66.2.310

Schultz, D., Izard, C. E., & Bear, G. (2004). Children's emotion processing: Relations to emotionality and aggression. *Development and Psychopathology*, *16*(2), 371–387. https://doi.org/10.1017/S0954579404044566

Simmering, V. R., & Wood, C. M. (2017). The development of real-time stability supports visual working memory performance: Young children's feature binding can be improved through perceptual structure. *Developmental Psychology*, *53*(8), 1474–1493. https://doi.org/10.1037/dev0000358

Simon-Thomas, E. R., Keltner, D. J., Sauter, D., Sinicropi-Yao, L., & Abramson, A. (2009). The voice conveys specific emotions: Evidence from vocal burst displays. *Emotion*, *9*(6), 838–846. https://doi.org/10.1037/a0017810

Soderstrom, M., Reimchen, M., Sauter, D., & Morgan, J. L. (2017). Do infants discriminate non-linguistic vocal expressions of positive emotions? *Cognition and Emotion*, *31*(2), 298–311. https://doi.org/10.1080/02699931.2015.1108904

Stahl, P., Gotz, F., Poppe, I., Amendt, P., & Domer, G. (1978). Pre- and early postnatal testosterone levels in rat and human. In G. Dorner & M. Kawakatni (Eds.), *Hormones and brain development* (pp. 99–109). Elsevier/North-Holland.

Székely, E., Tiemeier, H., Arends, L. R., Jaddoe, V. W., Hofman, A., Verhulst, F. C., & Herba, C. M. (2011). Recognition of facial expressions of emotions by 3-year-olds. *Emotion*, *11*(2), 425–435. https://doi.org/10.1037/a0022587

Thomas, L. A., De Bellis, M. D., Graham, R., & LaBar, K. S. (2007). Development of emotional facial recognition in late childhood and adolescence. *Developmental Science*, *10*(5), 547–558. https://doi.org/10.1111/j.1467-7687.2007.00614.x

Tonks, J., Williams, W. H., Frampton, I., Yates, P., & Slater, A. (2007). Assessing emotion recognition in 9–15-years olds: Preliminary analysis of abilities in reading emotion from faces, voices and eyes. *Brain Injury*, *21*(6), 623–629. https://doi.org/10.1080/02699050701426865

Trinh, D. L., Vo, M. C., Kim, S. H., Yang, H. J., & Lee, G. S. (2022). Self-relation attention and temporal awareness for emotion recognition via vocal burst. *Sensors*, *23*(1), Article 200. https://doi.org/10.3390/s23010200

van Kleef, G. A., & Côté, S. (2022). The social effects of emotions. *Annual Review of Psychology*, *73*(1), 629–658. https://doi.org/10.1146/annurev-psych-020821-010855

van Os, J., Kenis, G., & Rutten, B. P. (2010). The environment and schizophrenia. *Nature*, *468*(7321), 203–212. https://doi.org/10.1038/nature09563

Vassallo, S., Smart, D., & Price-Robertson, R. (2009). The roles that parents play in the lives of their young adult children. *Family Matters*, *82*, 8–14.

Widen, S. C. (2013). Children's interpretation of facial expressions: The long path from valence-based to specific discrete categories. *Emotion Review*, *5*(1), 72–77. https://doi.org/10.1177/1754073912451492

Widen, S. C., & Russell, J. A. (2003). A closer look at preschoolers' freely produced labels for facial expressions. *Developmental Psychology*, *39*(1), 114–128. https://doi.org/10.1037/0012-1649.39.1.114

Widen, S. C., & Russell, J. A. (2008). Young children's understanding of other's emotions. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 348–363). Guilford Press.

Widen, S. C., & Russell, J. A. (2010). Differentiation in preschooler's categories of emotion. *Emotion*, *10*(5), 651–661. https://doi.org/10.1037/a0019005

Williams, L. M., Mathersul, D., Palmer, D. M., Gur, R. C., Gur, R. E., & Gordon, E. (2009). Explicit identification and implicit recognition of facial emotions: I. Age effects in males and females across 10 decades. *Journal of Clinical and Experimental Neuropsychology*, *31*(3), 257–277. https://doi.org/10.1080/13803390802255635

Wu, Y., Muentener, P., & Schulz, L. E. (2017). One- to four-year-olds connect diverse positive emotional vocalizations to their probable causes. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(45), 11896–11901. https://doi.org/10.1073/pnas.1707715114

Xiao, N. G., Quinn, P. C., Ge, L., & Lee, K. (2017). Facial movements facilitate part-based, not holistic, processing in children, adolescents, and adults. *Developmental Psychology*, *53*(9), 1765–1776. https://doi.org/10.1037/dev0000360

Received June 18, 2024
Revision received October 23, 2024
Accepted January 15, 2025 ■