Emotion

1528-3542/12/$12.00 DOI: 10.1037/a0028705

BRIEF REPORT

Interpreting Infant Vocal Distress: The Ameliorative Effect of Musical Training in Depression

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An infant's cry is one of the most emotionally salient sounds in our environment. Depression is known to disrupt a mother's ability to respond to her infant, but it is not well-understood why such difficulties arise. One reason might be that depression disrupts the perceptual abilities necessary to interpret infant's affective cues. Given that musicians are known to have enhanced auditory perception, we assessed whether depression and previous musical training can impact on the ability to interpret distress in infant cries, as manipulated by changes in pitch. Depressed participants with musical training demonstrated better discriminative acuity of distress in infant cry bursts compared to those without. Non-depressed participants, with and without musical training, had levels comparable to musicians with depression. We suggest that previous musical training may act as a protective factor that maintains auditory perceptual abilities in the context of depression. These findings have potential implications for the development of novel training interventions to maintain sensitivity to infant vocal cues in individuals with postnatal depression.

Keywords: infants, crying, depression, musicians

Crying is a universal form of human emotional expression, especially ubiquitous early in life. The ability to emit distress cries is present at birth and other vocalizations, such as laughing and babbling, are gradually added to the infant's vocal repertoire. These affective vocalizations are the infant's primary means of capturing a caregiver's attention from a distance. Hearing a distress cry allows the listener to form a general picture of the infant's affective and physiological state, which a brief glance can help to refine.

A plethora of recent studies have examined how adults respond to infant faces (Lobmaier, Bolte, Mast, & Dobel, 2010; Parsons, Young, Kumari, Stein, & Kringelbach, 2011; Parsons, Young, Parsons, et al., 2011; Sprengelmeyer et al., 2009). Adults have been shown to be remarkably attuned to infant facial configuration, and emerging evidence suggests that the specialized processing of infant faces may be supported by affective neural circuits (Kringelbach et al., 2008; Parsons, Young, Murray, Stein, & Kringelbach, 2010). Recent evidence suggests that adult sensitivity to infant facial expressions might be altered in depression (Arteche et al., 2011; Stein et al., 2008).

Relatively less is known about how adults perceive and interpret infant vocal cues. Mothers are known to be highly sensitive to acoustical parameters within infant vocalizations and can imitate their infants' sounds with a high degree of accuracy and actively do so in interactions with young infants (Papoušek & Papoušek, 1989). These early interactions are characteristically musical (Malloch & Trevarthen, 2008), with mother and infant sharing melodic and rhythmical vocalizations.

A growing body of work has demonstrated that mothers with postnatal depression have difficulties responding promptly and appropriately to their infants (Field, 1995; Murray, Halligan, & Cooper, 2010). These difficulties have been associated with attachment problems (van Ijzendoorn, Schuengel, & Bakermans-Kranenburg, 1999) and adverse child developmental outcomes (Murray, Fiori-Cowley, Hooper, & Cooper, 1996), but the causal pathway linking depression with parental responsiveness is not well understood. Responsive caregiving is dependent upon adequate perception and interpretation of affective infant cues in the visual and auditory domains.

Emerging evidence suggests that depression can lead to specific difficulties in responding to infant vocalizations. Mothers with

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This research was supported by a Medical Research Council Studentship to Katherine S. Young, funding from the Wellcome Trust, United Kingdom (Grant 090139), and the TrygFonden Charitable Foundation.

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depression rate infant cries as less likely to elicit caregiving responses (Schuetze & Zeskind, 2001) and may be less sensitive to pitch in infant cries than healthy mothers (Donovan, Leavitt, & Walsh, 1998). More broadly, adults with depression have more difficulty identifying emotion in the prosody of adult speech than healthy individuals (Péron et al., 2011), consistent with the notion that emotional processing is disrupted in depression (Disner, Beevers, Haigh, & Beck, 2011). Disrupted perceptual processing of emotional stimuli may impact on an adults' ability to interact sensitively with their infant. Disrupted mother–infant interactions have been shown to compromise the quality of early care (Stanley, Murray, & Stein, 2004) and may in turn affect infant attachment and the risk for adverse child outcomes.

Not all mothers with depression have difficulties interacting with their infants (Nylen, Moran, Franklin, & O'Hara, 2006). Identification of protective factors that account for the individuals who, despite being exposed to some of the same risk factors, continue to make healthy behavioral adaptations is of great importance clinical and theoretical importance (Salekin & Lochman, 2008; Sohr-Preston & Scaramella, 2006). One factor that may be protective in relation to sensitivity to infant vocal cues is musical training. Music and human vocalizations are experientially distinct but have many shared features at the acoustic and perceptual levels. Individuals with musical training have been shown to be better than nonmusicians both at detecting pitch changes in complex tones (Micheyl, Delhommeau, Perrot, & Oxenham, 2006) and identifying emotion in speech prosody (Lima and Castro, 2011; Thompson, Schellenberg, & Husain, 2004), but see Trimmer and Cuddy, 2008 for conflicting evidence). The advantages associated with musical training are presumably a consequence of high-levels of attention and guided exposure to subtle acoustical cues. It remains to be seen whether the proposed advantages associated with musical training could extend to interpreting infant affective vocalizations. Furthermore, no studies to date have addressed whether musicians with affective disorders such as depression retain their auditory processing advantages (if such advantages exist at all).

In this study, we bring together two diverse, highly topical fields: adults' understanding of infant communication and the purported benefits of musical training. We investigated individuals' discriminative acuity of infant cries and whether this ability is altered in the context of depression and previous musical training.

Infant cries are characterized by a number of key parameters, with pitch frequently identified as an important and robust communicative marker of distress (Soltis, 2004; Zeskind & Marshall, 1988). Temporal characteristics, such as duration of cry bursts and pauses, have also been linked to the perception of distress in infant cries (Protopapas & Eimas, 1997), although this effect seems less robust than that for pitch (e.g., Dessureau, Kurowski, & Thompson, 1998). The fundamental frequency of healthy infant cries (a physical correlate of pitch) typically falls in the range of 200–600 Hz (Soltis, 2004). We systematically altered the pitch of varying infant cry bursts in small step sizes and asked participants to identify which "sounded more distressed," to obtain a sensitive measure of perceptual discrimination. We expected that participants with clinical depression would be less able to discriminate distress compared with healthy participants. In addition, we expected that participants with some musical training (more than 4 years) would be more able to discriminate distress in infant vocalizations than those with minimal training.

Method

Fifty-seven adults, aged between 18 and 54 years ($M = 27.16$, $SD = 8.31$), participated in this study: 15 healthy musicians, 13 musicians with depression, 15 healthy nonmusicians, and 14 nonmusicians with depression. Five participants had children, all of whom were aged more than 18 months at the time of testing. Current depressive symptoms were assessed using the Edinburgh Postnatal Depression Scale (EPDS), which has been validated for use in adults outside the postnatal period (Cox, Chapman, Murray, & Jones, 1996). Symptoms of anxiety were assessed using the Generalized Anxiety Disorder Questionnaire (GAD-Q). Primary diagnosis of depression was confirmed using the Structured Clinical Interview for *DSM–IV* (SCID). "Musicians" were defined as individuals who reported receiving 4 or more years of formal musical training. "Nonmusicians" were those who had less than 4 years musical training (see Table 1 for demographic characteristics).

Stimuli

Fifteen digital recordings of infant cry bursts from a database of 87 infant vocalizations were used in this study. Audio recordings in this database were collected from nine infants filmed in their own homes during a play and feeding session with a caregiver. The infants were full-term, healthy, and aged between 6 and 8 months ($M = 6.7$ months, $SD = 0.9$). Stimuli were independently rated by 80 participants on three dimensions: infant distress, infant mood, and participant's mood after listening to the clip. These ratings were used to identify 15 cry vocalizations: those rated as most distressed (on a scale of 1–7: $M = 5.3$, $SD = 1.5$), with lowest

Table 1
Demographic Characteristics of Groups

Measure	Healthy nonmusicians	Healthy musicians	Nonmusicians with depression	Musicians with depression
Number of subjects[a]	15 (9)	15 (9)	14 (5)	13 (5)
Age[b]	31.00 (12.40)	25.07 (3.26)	27.79 (8.51)	24.46 (4.45)
EPDS score[b]	3.00 (2.51)	3.27 (1.98)	19.00 (2.83)	19.00 (2.58)
GAD-Q score[b]	1.29 (1.60)	1.49 (1.67)	9.52 (1.49)	9.11 (2.21)
Years musical training[b]	.33 (0.90)	8.87 (3.58)	0.00 (0.00)	8.15 (3.53)

Note. EPDS = Edinburgh Postnatal Depression Scale; GAD-Q = Generalized Anxiety Disorder Questionnaire.
[a] Values in parentheses are male subjects. [b] Values are means with standard deviations in parentheses.

infant mood (on a scale of 1–9: $M = 2.6$, $SD = 1.3$), and lowest participant mood (on a scale of 1–9: $M = 2.9$, $SD = 1.4$). These stimuli were free from background noise, matched for peak and average root-mean-square intensity, clipped to 1500 ms, and had 150-ms linear rise and fall times.

We digitally altered individual cry clips to increase and decrease overall pitch by 0.25, 0.5, one and two semitones, using Adobe Audition software (CS5.5 v4.0). This corresponded to changes in fundamental frequency of approximately 5–10, 12–17, 25–30, and 50–60 Hz, respectively (see Table 2 for mean fundamental frequencies of original and manipulated cry clips). Clips of the same cry burst at different pitches were presented in pairs that differed by 0.5 semitones (−0.25 vs. +0.25), one semitone (−0.5 vs. +0.5), two semitones (−1 vs. +1), and four semitones (−2 vs. +2).

Procedure

We used a two-alternative forced choice task. Participants listened to two clips successively and were asked to choose which cry burst "sounded more distressed." Each pitch difference (0.5, one, two, or four semitones) was presented for each of the 15 vocalizations, resulting in a total of 60 trials. Sounds were presented using Presentation software (Version 14.4 Neurobehavioral Systems, Inc., www.neurobs.com; 24-bit Realtek High Definition Audio sound card) through Sony in-ear earphones (MDR-EX77LP). To facilitate ease of responding, sounds were presented alongside an image of an unfamiliar fractal (a fragmented geometric shape) in one of two locations. Participant responses and response latencies were recorded. Accuracy was defined as the number of trials in which participants identified the higher-pitched clip as "more distressed." The order of whether the correct clip was presented first or second was randomized, and the order of trials was pseudorandomized across participants by creating two versions of the task with different orders of trials.

Results

Figure 1 presents the percentage of correct trials at the four levels of pitch difference for each group. In general, higher pitched cry bursts were chosen as sounding "more distressed" (percentage of correct trials, $M = 62.87$, $SD = 18.86$). Overall, participants' scores were significantly different from chance, $t(56) = 8.82$, $p < .001$, $r = .76$, and each groups' score was also significantly above chance ($p < .01$). At the smallest pitch difference (0.5 semitones), all participants scores were not significantly different from chance, $t(56) = -.11$, $p = .91$, $r = .01$. Group scores increased to differing extents as the pitch difference increased, though no group were at ceiling at any level.

A 4 (pitch difference) × 4 (group) repeated-measures ANOVA was carried out to investigate differences between participant groups. Pitch difference (0.5, 1, 2 or 4 semitones) was the within-subjects factor, and "group" (healthy nonmusicians, healthy musicians, nonmusicians with depression or musicians with depression) was the between-subjects factor. There were significant main effects of pitch difference, $F(3, 159) = 33.60$, $p < .001$, $n_p^2 = .39$, and group, $F(3, 53) = 4.45$, $p < .01$, $n_p^2 = .20$, and a significant interaction between these two factors, $F(9, 159) = 1.96$, $p = .48$, $n_p^2 = .10$. As the difference in pitch increased, the mean percentage of correct trials increased (see Figure 1). Post hoc Bonferroni pairwise comparisons demonstrated significant differences between the scores of nonmusicians with depression and healthy musicians ($p = .04$, $r = .27$) as well as between nonmusicians with depression and musicians with depression ($p = .024$, $r = .30$). The mean score of nonmusicians with depression ($M = 56.59$, $SD = 7.87$) was lower than the mean score of healthy musicians ($M = 67.22$, $SD = 11.56$) and musicians with depression ($M = 68.33$, $SD = 12.59$). Healthy nonmusicians' scores ($M = 59.72$, $SD = 7.88$) were not significantly different from any other group. There was a significant positive correlation of average score with years of musical training, $\tau = .53$, $p < .001$, and no significant relationship between task score and EPDS score, $\tau = -.02$, $p = .42$, or between task score and GAD-Q score, $\tau = -.03$, $p = .37$.

There were no differences in overall performance between men and women, $t(55) = -.007$, $p = .99$, $r = .001$. Five participants in this study were parents; a sensitivity analysis was carried out, removing these participants and the same pattern of results was observed.

A repeated-measures ANOVA was conducted with an additional group of eight nonmusicians and 11 musicians for whom EPDS, GAD-Q, and SCID data were not available, but who were presumed to be healthy. The analysis found the same significant main effects of pitch, $F(3, 216) = 46.74$, $p < .001$, $n_p^2 = .39$, and group, $F(3, 72) = 6.98$, $p < .001$, $n_p^2 = .23$, and a significant interaction between pitch and group, $F(9, 216) = 2.26$, $p = .020$, $n_p^2 = .09$.

General task performance was also assessed using response latencies which were found to be similar across groups (healthy nonmusicians $M = 1.02$, $SD = .45$; healthy musicians $M = .72$, $SD = .30$; nonmusicians with depression, $M = .65$, $SD = .32$; musicians with depression, $M = .83$, $SD = .38$). A one-way ANOVA of log-transformed median response latencies demonstrated no significant differences across groups, $F(3, 56) = 2.76$, $p > .05$, $n_p^2 = .14$.

Table 2
Mean Fundamental Frequencies of Original and Manipulated Stimuli

	Fundamental frequency (Hz)
Clip type	
−2 semitones	424.20 (68.56)
−1 semitone	449.33 (75.09)
−0.5 semitones	459.37 (74.22)
−0.25 semitones	469.42 (76.22)
Original clip	475.88 (78.62)
+0.25 semitones	484.50 (79.95)
+0.5 semitones	489.52 (81.68)
+1 semitones	505.31 (82.85)
+2 semitones	532.59 (91.89)

Note. Values are means with standard deviations in parentheses.

Discussion

In a group of individuals with depression, those with musical training demonstrated enhanced discriminative acuity of distress in infant cry bursts compared to those with no musical training. This

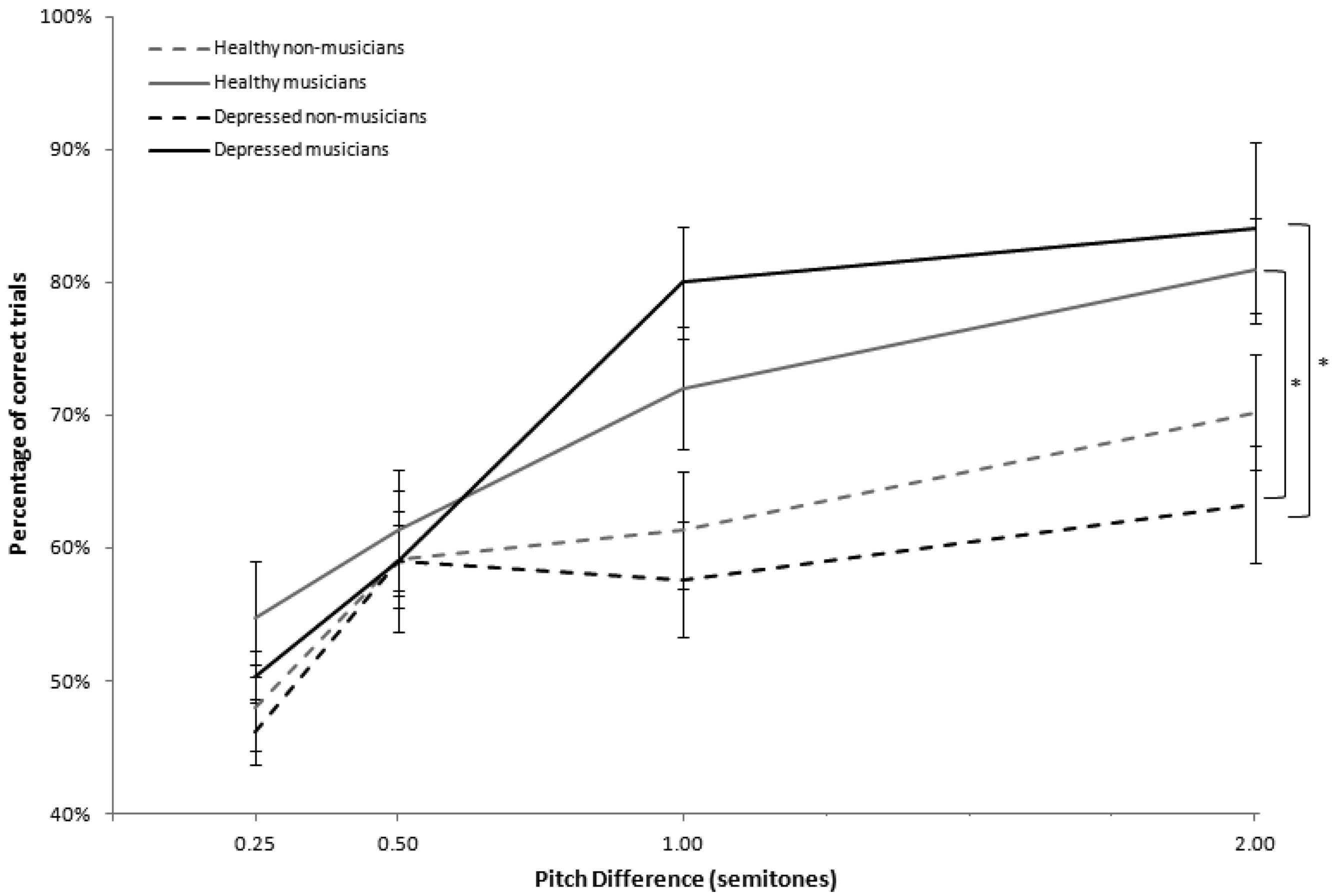

Figure 1. Percentage of correct trials for each group at each level of pitch difference. This figure presents the relationship between actual difference in pitch and perceived distress. The scores of nonmusicians with depression were significantly lower than both groups of musicians at two and four semitones. Error bars represent mean ± standard error. * $p < .001$.

association was not demonstrated in healthy individuals with differing levels of musical training; all healthy participants had levels of discriminative acuity comparable to that of the musicians with depression. We suggest that previous musical training may help to maintain discriminative acuity of distress (as signaled by pitch) in infant cry bursts in the context of depression. This novel finding has potential implications for the study of factors that may protect against disruptions to caregiving behavior associated with depression.

Consistent with previous studies (Schuetze & Zeskind, 2001), we demonstrated that pitch is reliably perceived as an indicator of distress in infant cries. However, unlike Donovan and colleagues (1998), we did not find that depression alone predicted discriminative acuity of pitch/distress in infant cries. In the current study, only individuals with depression and no musical training demonstrated lowered discriminative acuity compared with healthy musicians. Neither depression nor lack of musical training alone resulted in differences in discriminative acuity.

Notably, this effect was apparent using only a moderate definition of musicianship. Previous studies investigating the enhanced perceptual abilities of musicians have used much stricter criteria such as "at least 10 years, starting before age 5, with at least 4 hr practice each week for the last 10 years" (Musacchia, Sams, Skoe, & Kraus, 2007). The cutoff used in this study was chosen to reflect a more common level of musical training in the general population. Our findings in relatively inexperienced musicians suggest that even some level of musical training can help to maintain discriminative acuity for acoustic features of infant vocalizations in individuals with depression.

Alternative explanations for these results is that participants with depression were less able to interpret high-pitched cries as reflecting distress or to label emotional cues appropriately. Interpretation biases are a common feature of depression, but in general, individuals with depression tend to rate emotional stimuli more negatively than healthy individuals do (e.g., Punkanen, Eerola, & Erkkila, 2011; Stein et al., 2010). Therefore, it seems improbable that negative interpretation bias disrupts the ability to label high-pitched cries as sounding distressed. The design of the task meant that participants were not explicitly asked to label a cry as distressed, but instead to choose which of two cries sounded more distressed. It seems unlikely that the results observed are related purely to an inability to label emotional cues appropriately. A further possible explanation of our results is that poorer accuracy on the discriminative acuity task was related to diminished overall performance in individuals with depression. Given that there were no differences on response latencies between groups of participants, this interpretation seems less plausible.

The findings from this study raise two important questions. First, does this pattern of results translate into behavioral differences in mother–infant interactions? Depression has been shown to disrupt maternal responses to infant vocal cues, but it is not known whether previous musical training may mitigate this disruption. Future studies assessing whether there is an association between musical training and sensitivity to vocal cues in actual mother–infant interactions are important to clarify this issue.

Second, is it possible to train individuals with depression to interpret infant vocal cues more effectively? Simple interventions targeting phonological perception and awareness in children with dyslexia have been shown to be highly effective in improving related language skills (e.g., Bradley & Bryant, 1983). Similar training focused on perception and awareness of acoustic features of vocalizations could improve a parent's ability to interpret their infant's vocal cues. The strength of this type of intervention is that it could be carried out during pregnancy, before parents have any experience of interacting with their infant. Recent studies have demonstrated that it is possible to improve individuals' performance on pitch discrimination tasks following 30-min training sessions (Amitay, Irwin, & Moore, 2006). However, whether this improvement can generalize to other settings remains under debate (Wright & Zhang, 2009) and may not afford the same long-term advantages as more sustained exposure to musical training.

This study examines discriminative abilities of individuals to auditory infant cues only. It remains to be seen whether similar findings would be observed in "cross-modal" settings, combining cues from faces, voices, and gestures. The findings of this study were derived from a group of individuals with depression, not specifically occurring in the postnatal period. It may be the case that increased exposure to infant vocalizations improves an individual's performance on this task. It would be important to examine similar questions in a group of individuals with postnatal depression. Similarly, it would be of great interest to investigate how this perceptual discrimination relates to specific caregiving behavior, such as imitation of vocal cues, and to attachment status in individuals with and without depression and musical training.

References

Amitay, S., Irwin, A., & Moore, D. R. (2006). Discrimination learning induced by training with identical stimuli. *Nature Neuroscience, 9,* 1446–1448. doi:10.1038/nn1787

Arteche, A., Joormann, J., Harvey, A., Craske, M., Gotlib, I. H., Lehtonen, A., . . . Stein, A. (2011). The effects of postnatal maternal depression and anxiety on the processing of infant faces. *Journal of Affective Disorders, 133,* 197–203. doi:10.1016/j.jad.2011.04.015

Bradley, L., & Bryant, P. E. (1983). Categorizing sounds and learning to read—A causal connection. *Nature, 301,* 419–421. doi:10.1038/301419a0

Cox, J. L., Chapman, G., Murray, D., & Jones, P. (1996). Validation of the Edinburgh postnatal depression scale (EPDS) in non-postnatal women. *Journal of Affective Disorders, 39,* 185–189. doi:10.1016/0165–0327(96)00008–0

Dessureau, B. K., Kurowski, C. O., & Thompson, N. S. (1998). A reassessment of the role of pitch and duration in adults' responses to infant crying. *Infant Behavior & Development, 21,* 367–371. doi:10.1016/S0163-6383(98)90013-3

Disner, S. G., Beevers, C. G., Haigh, E. A., & Beck, A. T. (2011). Neural mechanisms of the cognitive model of depression. *Nature Reviews Neuroscience, 12,* 467–477. doi:10.1038/nrn3027

Donovan, W. L., Leavitt, L. A., & Walsh, R. O. (1998). Conflict and depression predict maternal sensitivity to infant cries. *Infant Behavior & Development, 21,* 505–517. doi:10.1016/S0163-6383(98)90023-6

Field, T. (1995). Infants of depressed mothers. *Infant Behavior & Development, 18,* 1–13. doi:10.1016/0163-6383(95)90003-9

Kringelbach, M. L., Lehtonen, A., Squire, S., Harvey, A. G., Craske, M. G., Holliday, I. E., . . . Stein, A. S. (2008). A specific and rapid neural signature for parental instinct. *PLoS One, 3,* e1664.

Lima, C. F., & Castro, S. L. (2011). Speaking to the trained ear: Musical expertise enhances the recognition of emotions in speech prosody. *Emotion, 11,* 1021–1031. doi:10.1037/a0024521

Lobmaier, J. S., Bolte, J., Mast, F. W., & Dobel, C. (2010). Configural and featural processing in humans with congenital prosopagnosia. *Advances in Cognitive Psychology, 6,* 23–34. doi:10.2478/v10053-008-0074-4

Malloch, S., & Trevarthen, C. (Eds.). (2008). *Communicative musicality: Exploring the basis of human companionship.* Oxford, UK: Oxford University Press.

Micheyl, C., Delhommeau, K., Perrot, X., & Oxenham, A. J. (2006). Influence of musical and psychoacoustical training on pitch discrimination. *Hearing Research, 219,* 36–47. doi:10.1016/j.heares.2006.05.004

Murray, L., Fiori-Cowley, A., Hooper, R., & Cooper, P. (1996). The impact of postnatal depression and associated adversity on early mother-infant interactions and later infant outcome. *Child Development, 67,* 2512–2526. doi:10.2307/1131637

Murray, L., Halligan, S. L., & Cooper, P. J. (2010). Effects of postnatal depression on mother-infant interactions, and child development. In T. Wachs & G. Bremner (Eds.), *Handbook of Infant Development* (pp. 192–220). Hoboken, NJ: Wiley-Blackwell. doi:10.1002/9781444327588.ch8

Musacchia, G., Sams, M., Skoe, E., & Kraus, N. (2007). Musicians have enhanced subcortical auditory and audiovisual processing of speech and music. *Proceedings of the National Academy of Sciences of the United States of America, 104,* 15894–15898. doi:10.1073/pnas.0701498104

Nylen, K. J., Moran, T. E., Franklin, C. L., & O'Hara, M. W. (2006). Maternal depression: A review of relevant treatment approaches for mothers and infants. *Infant Mental Health Journal, 27,* 327–343. doi:10.1002/imhj.20095

Papoušek, M., & Papoušek, H. (1989). Forms and functions of vocal matching in interactions between mothers and their precanonical infants. *First Language, 9,* 137–157. doi:10.1177/014272378900900603

Parsons, C. E., Young, K. S., Kumari, N., Stein, A., & Kringelbach, M. L. (2011). The motivational salience of infant faces is similar for men and women. *PLoS One, 6,* e20632. doi:10.1371/journal.pone.0020632

Parsons, C. E., Young, K. S., Murray, L., Stein, A., & Kringelbach, M. L. (2010). The functional neuroanatomy of the evolving parent-infant relationship. *Progress in Neurobiology, 91,* 220–241. doi:10.1016/j.pneurobio.2010.03.001

Parsons, C. E., Young, K. S., Parsons, E., Dean, A., Murray, L., Goodacre, T., . . . Kringelbach, M. L. (2011). The effect of cleft lip on adults' responses to faces: Cross-species findings. *PLoS One, 6,* e25897. doi:10.1371/journal.pone.0025897

Péron, J., El Tamer, S., Grandjean, D., Leray, E., Travers, D., Drapier, D., . . . Millet, B. (2011). Major depressive disorder skews the recognition of emotional prosody. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 35,* 987–996. doi:10.1016/j.pnpbp.2011.01.019

Protopapas, A., & Eimas, P. D. (1997). Perceptual differences in infant cries revealed by modifications of acoustic features. *Journal of the Acoustical Society of America, 102,* 3723–3734. doi:10.1121/1.420403

Punkanen, M., Eerola, T., & Erkkila, J. (2011). Biased emotional recognition in depression: Perception of emotions in music by depressed patients. *Journal of Affective Disorders, 130,* 118–126. doi:10.1016/j.jad.2010.10.034

Salekin, R. T., & Lochman, J. E. (2008). Child and adolescent psychopathy: The search for protective factors. *Criminal Justice and Behavior, 35,* 159–172. doi:10.1177/0093854807311330

Schuetze, P., & Zeskind, P. S. (2001). Relations between women's depressive symptoms and perceptions of infant distress signals varying in pitch. *Infancy, 2,* 483–499. doi:10.1207/S15327078IN0204_06

Sohr-Preston, S. L., & Scaramella, L. V. (2006). Implications of timing of maternal depressive symptoms for early cognitive and language development. *Clinical Child and Family Psychology Review, 9,* 65–83. doi:10.1007/s10567-006-0004-2

Soltis, J. (2004). The signal functions of early infant crying. *The Behavior & Brain Sciences, 27,* 443–458.

Sprengelmeyer, R., Perrett, D. I., Fagan, E. C., Cornwell, R. E., Lobmaier, J. S., Sprengelmeyer, A., . . . Young, A. W. (2009). The cutest little baby face: A hormonal link to sensitivity to cuteness in infant faces. *Psychological Science, 20,* 149–154. doi:10.1111/j.1467-9280.2009.02272.x

Stanley, C., Murray, L., & Stein, A. (2004). The effect of postnatal depression on mother-infant interaction, infant response to the Still-face perturbation, and performance on an Instrumental Learning task. *Development and Psychopathology, 16,* 1–18. doi:10.1017/S0954579404044384

Stein, A., Arteche, A., Lehtonen, A., Craske, M., Harvey, A., Counsell, N., & Murray, L. (2010). Interpretation of infant facial expression in the context of maternal postnatal depression. *Infant Behavior & Development, 33,* 273–278. doi:10.1016/j.infbeh.2010.03.002

Stein, A., Malmberg, L. E., Sylva, K., Barnes, J., Leach, P., & Team, F. C. C. C. (2008). The influence of maternal depression, caregiving, and socioeconomic status in the post-natal year on children's language development. *Child: Care, Health and Development, 34,* 603–612. doi:10.1111/j.1365-2214.2008.00837.x

Thompson, W. F., Schellenberg, E. G., & Husain, G. (2004). Decoding speech prosody: Do music lessons help? *Emotion, 4,* 46–64. doi:10.1037/1528-3542.4.1.46

Trimmer, C. G., & Cuddy, L. L. (2008). Emotional intelligence, not music training, predicts recognition of emotional speech prosody. *Emotion, 8,* 838–849. doi:10.1037/a0014080

van Ijzendoorn, M. H., Schuengel, C., & Bakermans-Kranenburg, M. J. (1999). Disorganized attachment in early childhood: Meta-analysis of precursors, concomitants, and sequelae. *Development and Psychopathology, 11,* 225–249. doi:10.1017/S0954579499002035

Wright, B. A., & Zhang, Y. (2009). A review of the generalization of auditory learning. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364,* 301–311. doi:10.1098/rstb.2008.0262

Zeskind, P. S., & Marshall, T. R. (1988). The relation between variations in pitch and maternal perception of infant crying. *Child Development, 59,* 193–196.

Received November 12, 2011
Revision received April 24, 2012
Accepted April 24, 2012 ■