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# Effects of Embodiment on Perceptual and Affective Responses to Infant Crying

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Table of Contents

Abstract

Three experiments were conducted to investigate how changes in bodily states might be related to perceptions of infant vocalizations. In Study 1, participants were asked to hold a pencil between their lips, mimicking a smile, while listening to infant crying. Although there were no embodied effects for perceptual ratings, results indicated that this manipulation decreased participants' self-reported, negative affect. In Study 2, participants were played both infant crying and birdsong while exposed to similar embodied manipulations, including activation of muscles related to approach and withdrawal behavior. There were no embodied effects for ratings of crying or for affect. Comparing Study 1 and 2, there was no change in affect with the addition of birdsong to infant crying. Finally, in Study 3, participants heard either infant laughter or infant crying while holding a pencil between their teeth or lips. Although the sound participants heard changed their affect ratings, there were no embodied effects on perception for laughter or crying. However, there were effects of embodiment on ratings of negative affect, for males, and in ratings of positive affect for female participants. Taken together, these results suggest that infant crying might be unique as a signal of negative affect and that its perception appears relatively impervious to manipulation via standard embodiment controls.

List of Figures

List of Tables

# Effects of Embodiment on Perceptual and Affective Responses to Infant Crying

From birth, infant crying conveys life, health, and vigor. At first, it often accompanies the onset of independent respiration and later, it can signal pain, hunger, and general distress. Interpretation and prompt responding by caregivers to cries in the first months of life has been linked to positive outcomes for the infant (Bell & Ainsworth, 1972). Although there have been debates about the nature of the early infant cry, especially whether it should be considered a discrete or graded signal, it is, at minimum, a negatively valenced stimulus, present from birth, that communicates a negative state (or emotion) of the infant to caregivers.

The present research explores the nature of caregivers' responses to infant crying. First, we review literature on the infant cry as an auditory stimulus, revisiting the historical debate about the signal value of the infant cry. Although infant cries range in timing, pitch, and duration, the signal is actively interpreted by the adult caregiver, who depends on context for formulating an appropriate response. Secondly, we consider the mechanisms for interpretation of infant crying by adult caregivers. Infant crying affects the neural, physiological, and psychological state of the adult perceiver. These changes, in turn, guide the caregiver's response to the infant cry. Third, we discuss the role of emotions and embodiment in the interpretation of infant crying. Finally, we test predictions about embodiment on adult perceptions of auditory signals both within and outside our species.

**The Cry as Discrete Signal**

Early models of infant crying focused on the exact signal value of the cry. Cries were viewed as discrete signals that conveyed a certain type of information. Wolff (1969) hypothesized that there were three major cry types: the hunger cry, the mad or angry cry, and the pain cry. These cry types differed in certain key acoustic features. The hunger cry, not necessarily attributable to hunger, was the more basic, regular, and melodious cry. The mad/angry cry was characterized by turbulence in the vocal cords, resulting from large amounts of air being forced through the vocal track. Finally, the pain cry was associated with a certain temporal pattern and less with acoustic qualities of the sound. Pain cries were marked by a more intense onset and then settled into a more rhythmic, hunger-like cry.

The idea that cries relayed discrete types of information was supported by the findings that experience seems to enhance the partitioning of cries into separate categories. When given distinct options to choose from, mothers were better at categorizing predefined cry types than fathers and women without caregiving experience (Wäsz-Hockert, Partenen, Vuorenkoski, Valanne, & Michelsson, 1964). Pediatric nurses are also able to identify distinct cry types above chance (Wäsz-Hockert, Partenen, Vuorenkoski, Michelsson, & Valanne, 1964). Therefore, it appeared as if experience acted as a mediator preceding the correct identification of a discrete cry signal and as if experience might further predict the correct caregiving response.

In this view, the cry, once identified by the receiver (either consciously or subconsciously) acted as a releaser of caregiving action. The receiver of the cry stimulus then responded with a fixed, stereotyped, motor action pattern. However, in a 1979

review paper, Murray argued that in order for the releaser model of crying to be accurate, the response had to be innate and related to some underlying, neurological motor response in the receiver. Further, the cry had to be able to take the form of a supernormal stimulus when exaggerated through summation of distinct component parts. She argued that the model fell short in both of these areas, and suggested instead that the cry acts as a *graded signal* for caregiving behavior.

**The Cry as Graded Signal**

Based on a thorough review of both empirical and theoretical work, Gustafson, Wood, and Green (2000) argued that infant crying is not a discrete stimulus that communicates a specific categorical need but rather a graded signal that indicates a certain level of distress in the infant. Unlike discrete signals which function as an "on" or "off" switch, graded signals are ones that vary with the state of the sender and affect the behavioral responses of the listener in parallel fashion. Graded signals can, therefore, be measured on one or more continuous dimensions (rather than assigned to categories, Murray, 1979).

Infant crying can be thought of as conveying the infant's level of negative arousal to the caregiver. Accurate translation of a graded signal to a response relies on the receiver's interpretation. This means that appropriate response requires some additional discernment on the part of the receiver. Rather than responding to a set number of discrete signals, the caregiver can use the context, in conjunction with the level of the signal, to determine the appropriate response. Important contextual variables for interpretation and response to infant crying include time of day, hours since last feeding/changing, and temporal pattern (in which a sudden onset usually indicates pain).

Even when the signal intensity is equivalent, infant cries may be interpreted partly by context.

For example, it has been noted that a hunger cry, if unattended, sounds like a pain cry (Wäsz-Höckert, Lind, Vuorenkoski, Partenen, & Valanne, 1968, Murray, 1979). Thus, the temporal ordering of cry sounds during longer cry bouts may facilitate identification. In a 1985 study, Zeskind et al. divided 30 second sound clips of infant crying elicited by pain and hunger into three equal segments. The segments were then played for 180 college students who had minimal caregiving experience. The "hunger" cry was perceived as increasing in urgency, arousal, and aversiveness from the first to the last 10-second segment. Alternatively, the "pain" cry followed the opposite pattern, showing increased urgency in the first two segments, but generally decreasing in the three ratings from beginning to end (for females). The authors argued that because the cry acts as a graded signal, temporal organization is taken into consideration when identifying and responding to the cry signal (Zeskind, Sale, Maio, Huntington, & Weiseman, 1985). It has been argued that graded signals are a more advanced form of animal communication (Wilson, 1975).

In sum, in comparison to discrete signals, graded signals are more variable. Whereas discrete signals incur discrete responses in a particular species, graded signals allow for variability of response depending on the strength or stimulus value of the signal. Gustafson et al. (2000) write, "…a listener's motivation to respond to the signal (in this case, crying) will vary as a function of the amount of emotion reflected in the sound itself (Bastian, 1965)." Therefore, motivation for responding is related partly to the cry stimulus, and partly to the environmental context.

## Crying and Emotional Contagion

Early crying not only signals distress in the infant but also influences the emotional state of the receiver. From a very early age, infants respond differently to their own cries versus the cries of another infant by showing more facial expressions of distress in response to the cry of another infant than to their own cry (Dondi et al., 1999). This early recognition memory and response to hearing the cries of others seems to suggest that the infants may identify with conspecific crying and take on the emotion as his or her own (Geangu, Benga, Stahl, & Striano, 2010). Later in childhood, crying triggers negative emotional reactions, measured by both expressive and physiological changes (Spinrad & Stifter, 2006; Zahn-Waxler, Friedman, & Cummings, 1983, Fabes, Eisenberg, Karbon, Bernzweig, et al., 1994; Fabes, Eisenberg, Karbon, Troyer, 1994). Arguably, however, no one is more affected by cries than infants' caregivers. Caregivers' responses to infant crying can be broken into 5 categories: behavioral, perceptual, neurobiological, physiological, and affective.

## Caregivers' Responses to Crying

**Behavioral.** Gustafson and Harris (1990) investigated the connection between infant cries and adults' behavioral responses by creating a simulated babysitting situation. When adults in the experiment heard infant crying in the presence of a baby manikin under their care, they performed a fairly limited number of caregiving behaviors. Both mothers and non-mothers picked up, held, and provided vestibular stimulation to the manikin. Most talked to it (95%), provided tactile stimulation (95%), and attempted to feed it (92%). Then they proceeded to more specific interventions, such as checking the diaper or offering a bottle or pacifier.

Whether the cry stimulus was produced by a pain or hunger, caregivers tended first to initiate behaviors that might soothe the infant's distress and then begin ministrations (e.g., feeding or diapering) that might alleviate the cause of the distress. This somewhat standard set of behaviors produced when exposed to infant crying was not related to the particular cry category (pain versus hunger) but was likely linked to the perceptions of the adult caregivers.

**Perceptual.** Perceptions of infant crying rely on the listener’s sensitivity to various acoustic features. Naturally occurring differences in acoustic aspects of the cry are related to higher ratings of infant distress and signal aversiveness. Increases in pitch, duration, dysphonation, number of wails, and period of time between wails seem to signal greater arousal, urgency, distress, and sickness (Gustafson & Green, 1989; Schuetze & Zeskind, 2001; Wood, 2009). It appears that these differences are critical for determining the gradation of distress.

In an experimental study conducted by Zeskind and his colleagues (1992), cries were artificially altered to increase or decrease the duration of expiratory sounds and pauses between cries. Cries with shorter pauses were perceived to be more arousing, informative, and aversive. This effect was further enhanced when short pauses were paired with longer expiration durations. Therefore, both naturally occurring and experimentally manipulated cry sounds affect caregivers’ interpretations of the cry stimulus.

**Neurobiological.** Little research has been conducted on the neurological responses to crying as a stimulus in humans; however, there are two findings that are significant to consider for this research. First, animal models have led researchers to

begin hypothesizing about the neurological basis of the cry circuit in humans. Although mammals produce and respond to cries, reptiles do not cry when they are young and exhibit minimal caregiving behaviors in adulthood. MacLean (1990) reported that the thalamocingulate circuit that is present in mammals but not in lizard-like reptiles may be responsible for the patterned response of mammalian parents to the cries of their young. The thalamocingulate circuit consists of the cingulate, medial thalamus, medial prefrontal cortex, and right orbitofrontal cortex. These brain areas activate when mammals are exposed to cries from their own species (Lorberbaum et al., 2002). Also, lesions to areas of this brain circuit affect the pattern of caregiving response in mammals (MacLean and Newman 1988).

In an fMRI study of first-time mothers with infants under 3.5 months of age exposure to 30 seconds of a standard infant crying prompted increased activity most notably in anterior cingulate and right medial prefrontal cortex when compared to white noise (Lorberbaum et al., 1999). All of the regions activated in this study were those known to be important for rodent maternal behavior including midbrain, hypothalamus, striatum and septal regions (Leckman, & Herman, 2002, Numan & Sheehan, 1997).

Therefore, neurobiological research supports the idea that there may exist a higher brain process that has evolved in order to recognize and respond to crying in mammals. This circuit could be the source of the behavioral variability in the maternal behaviors in response to infant crying. Further, this cortical involvement leaves room for the effect of perceptual and physiological influences for responding to infant cries. In other words, because the mammalian cry circuit involves cortical control, it can be influenced by both perceptual and physiological influences at both the conscious and subconscious level.

Secondly, fMRI data suggest that there is a neural basis for approach behavior in response to infant crying. Lorberbaum and collegues (2002) argue that the same areas associated with the cry circuit in adult mammals are also related to approach behaviors. Areas in the midbrain, basal forebrain, and basal ganglia as well as the cingulate/prefrontal cortex are activated in response to crying. This is consistent with the notion that crying infants might activate mesolimbic, mesocortical, and nigrostriatal dopaminergic pathways involved in approach and seeking behavior (Mirenowicz and Schultz 1996; Numan and Nagle 1983). This gives neurological support to the idea that behavioral responses to infant crying can be related to physical changes that occur within the body.

**Physiological.** A number of studies have examined physiological responses to infant cries in humans. One particularly interesting study focused on mothers' let down responses in response to their newborn's cry. In the first experimental report of this phenomenon, researchers presented 40 first-time mothers with a 7-minute segment of crying. Mothers who were lactating experienced an increase in the temperature of their breasts, which lead to a subsequent release of milk (Vuorenkoski, Wäsz-Höckert, Koivisto, & Lind, 1969).

Universally, infant crying incites arousal and anxiety (Tyson & Sobschak, 1994). This perceptual assessment is undoubtedly the result of an appraisal of distinct physiological changes that occur in the autonomic nervous system of the receiver. Both parents and non-parents show increases in blood pressure, heart rate, and skin conductance while listening to the crying of human infants when compared to conditions of silence, or the crying of juvenile cats, orangutans, and aversive mechanical sounds

(Boukydis & Burgess, 1982; Murray, 1985). Further, as aforementioned, certain acoustic features affect perception of distress and arousal. This is mirrored in physiological arousal as well. High or variable pitched cries produce greater autonomic arousal when measured by heart rate and skin conductance (Boukydis 1985; Crowe & Zeskind 1992; Frodi 1985; Frodi & Lamb 1980; Zeskind 1987).

It has been suggested that it is this specific biological arousal that leads to the abuse of infants. Some studies have shown that abusers, or those determined to be likely to abuse, exhibit higher autonomic responses to high-pitched cries (Crowe & Zeskind 1992; Frodi 1985; Frodi & Lamb 1980; Zeskind 1987). Zeskind (1987) argued that heart acceleration reflects aversiveness. This leads to a situation in which the receiver tries to eliminate the aversive, physiologically arousing stimulus instead of responding with caregiving behavior.

**Mood and Self-Reported Affect.** Limited research has addressed the link between affect of the listener and perceptions of infant crying. One study used a caregiving simulation to make the link between crying and self-reported negative affect (Bruning & McMahon, 2009). Eighty, nulliparous women were left with an infant manikin that cried at variable intervals. Negative affect and anxiety on the part of the caregiver were related to the amount of time that the manikin spent crying. This seems to suggest that crying directly influences negative affect. In this particular study the origin of this mood change was not addressed.

Thus, caregivers' responses to infant crying can be evaluated at many levels – perceptual, behavioral, physiological, neurobiological, and affective. It is important to note that very few studies collect more than one type of data in evaluating caregivers'

responses to infant crying. The present research was designed, in part, to explore the relation between perceptual and affective responses to crying. We therefore provide next a brief review of relevant theories of emotional responses.

**Emotion Theory**

James (1884) proposed that emotions were not merely identified or known outright, but were based on the interpretation of our own bodily signals, including behavioral, physiological, and neurological changes. In other words, our behavioral (re)actions and physiological reverberations are the emotion. Devoid of this feedback, there is no purely cognitive basis for emotions in response to a valenced stimulus. This theory is well known as the James-Lange theory of emotions. Because James believed that the basis of an emotion was the bodily changes that occurred in response to an emotional stimulus, he was, in effect, claiming that emotions are embodiments. The associations between bodily changes and valenced stimuli happen naturally and without much conscious awareness.

As aforementioned, emotional contagion may play a vital role in caregiver's response to infant cries. In this process, emotions are literally passed from the sender to the receiver. Merely watching another person in pain or in good humor incites feelings of congruent emotions in the receiver. It has been suggested that mimicry is the basis for this contagion. When exposed to another person experiencing an emotion, humans tend to mimic the expression of the sender. According to theories of embodied cognition, these bodily responses should facilitate cognitive processing of emotional stimuli (Havas, Glenberg, & Rinck, 2007; Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009).

In one demonstration of this effect, Wallbott (1991) had participants categorize the emotional facial expressions displayed in photographs. As participants categorized the photographed expressions, their own faces were unwittingly videotaped. Results showed that the participants tended to mimic the facial expressions as they categorized them. When they categorized happy faces, for example, they smiled themselves. Furthermore, participants' accuracy in classifying the facial expressions was positively correlated with the extent of mimicry. The more participants mimicked the faces, the better they were at discerning what expression the face was displaying. Therefore, facial mimicry has been implicated as an embodiment that affects emotions and emotional perceptions.

Both experiencing the emotion yourself and viewing another person experiencing the emotion become linked to changes in our own bodies. One of the most basic embodiments involves moving toward, or withdrawing from, stimuli in our environment. Thus, the embodied state of approach becomes linked to positively valenced properties of our environment, while withdrawal becomes linked to negative stimuli. For example, in his 1884 paper "What is an emotion?" James writes "In depression the flexors tend to prevail; in elation or belligerent excitement the extensors take the lead."

Once this association has formed, it affects the way we perceive and interact with the world. For example, Chen and Bargh (1999) had participants indicate the valence of presented words (e.g., *love*, *hate*) either by pulling a lever toward them or by pushing it away. Participants responded faster to positive words when pulling the lever toward them and to negative words when pushing it away, indicating that categorization of the words' valence is facilitated by a congruent bodily state. Similar findings have been

reported by Neumann and Strack (2000); Förster and Strack (1997, 1998); Cacioppo, Priester, and Berntson (1993); and Alexopoulos and Ric (2007). These findings suggest that the meaning of emotional words is at least partially grounded in the motor states involved in the approach versus avoidance responses to the words' referents (Niedenthal, 2007).

Cacioppo et al. (1993) explored the perception of neutral visual stimuli when motor activity was consistent with either approach or withdrawal behavior. Participants were asked to push upward on a table from underneath (an action typically associated with approach, reflective of positive attitudes) or to push downward on the tabletop (an action typically associated with avoidance, reflective of negative attitudes) while they were exposed to novel Chinese ideographs. They found, consistent with an embodied view of emotional appraisal, that participants rated the ideographs more positively when executing approach behaviors and less positive when they were performing avoidance behaviors. (We use this manipulation in Study 2 below.)

This association also appears to be relevant not only for ambiguous symbols and valenced words, but also when recalling information about people. Förster and Strack (1997, 1998) asked participants in their study to generate the names of famous people and classify the people according to whether they liked, disliked, or were neutral about them. During the name generation task, participants either pulled up on the table in front of them from underneath its bottom surface (an approach behavior, as described earlier) or pushed down on its top surface (an avoidance behavior). Participants who performed the approach behavior during name generation retrieved more names of people they liked. Conversely, participants who performed the avoidance action retrieved more names of

people they disliked. Thus, participants' motor behavior influenced retrieval from long-term memory of valence-congruent items. It appears, therefore, that the association of approach toward pleasant goals/stimuli and withdrawal from negative goals/stimuli is relevant for interpretation of many emotion-related stimuli.

**Facial Feedback**

Could it be that the mere act of expressing an emotion (in any way) facilitates the emotional experience? Darwin (1872) was the first to suggest that this was in fact the case. He believed that the degree of emotion expression, referring in this case to a smile, is directly proportionate to the experience of the expression itself. Therefore, he predicted that a greater smile would lead to a greater feeling of happiness.

Various studies have shown that emotional experience can be manipulated in this way (McCaul, Holmes, & Solomon, 1982; Laird, 1974). Simply asking someone to smile makes the person feels happier. However, fewer studies have demonstrated that the purely physiological aspects of emotions are in fact associated with the experience of the emotion. A possible role for "offline" appraisal of emotions was first explored by Strack, Martin, and Stepper in 1988. They were able to show that the perceived funniness of a cartoon was subject to covert manipulation of feedback from facial muscles. Under the guise of identifying optimal pen positions for disabled writers, they asked participants to hold a pen in their mouth in two different ways. They first asked participants to hold a pen between their teeth, which facilitated a smile, and then asked participants to hold the pen between their lips, which inhibits smiling. They were then asked to judge how funny they perceived a set of cartoons. Participants who were unwittingly smiling rated the

cartoons as funnier than participants who were forced to frown. (This type of manipulation is used in Study 1 and 3 below.)

Because crying is an emotionally valenced signal, it is logical to conclude that responses to it might be affected by the types of physical manipulations outlined above. Our guiding hypothesis in all three studies reported below was that changing the bodily feedback of receivers, in turn, would have a measurable effect on their perceptual and affective responses to infant crying. Additionally, because gender appeared relevant to cry perception in the previous literature, we were interested in further exploring the effect of caregiver's gender on perceptual and affective responses to infant crying in this research.

However, it is important to note that none of the studies reported above have dealt with emotional signals presented ***auditorily***. Previous research on embodiment has examined manipulations of facial musculature, approach/withdrawal (pulling and pushing) and covert mimicry in combination with visual stimuli (e.g., schematic faces) or semantic categories (e.g., words such as 'love' and 'hate'). In general, research on the expression of emotions has been dominated by the visual modality (see review by Green, Whitney, & Gustafson, 2010). It is somewhat surprising that research on infant crying has not generally been placed in the broader context of perception of emotional expressions.

## Study 1

In Study 1, we investigated the effects of facial feedback from the zygomaticus major muscle on: 1. self-reported negative affect; and on 2. perceptions of infant crying. The zygomaticus major is the muscle that allows for facial expression of the mouth.

When flexed, it raises the corners of the mouth creating a smile. We manipulated the zygomaticus major by asking the participants to hold a pencil between their teeth, which has been shown to alter subjective perceptions in studies using valenced, visual stimuli (Strack, Martin, and Stepper, 1988).

Based on the aforementioned findings from covert facial mimicry in the visual expression of emotion (Oberman, Winkielman, & Ramachandran, 2007), we also included a condition in which participants were asked to silently repeat or "mimic" the cry sounds. We predicted that participants who were covertly smiling would rate the cries as less sad, distressed, and upset than those who were mimicking the cry sounds silently to themselves or who were in a control condition. Because the embodied feedback simulated expression of positive emotions, we also predicted that the participants would report feeling less negative affect.

# Method

## Participants

Participants were college students in the New England area ($M_{age}$ = 19.01, $SD_{age}$ = 1.21) who participated in this experiment as part of a course requirement. There were a total of 95 participants (41 male, 51 female, 3 choosing not to report) participating in one of three experimental conditions, described below.

## Cry Stimuli

All cries were selected from previous recordings available in the Infancy Laboratory at the University of Connecticut. Cries used in this study were recorded from both boys and girls at 14.3 (*SD* = .48) days after birth. All infants were full term and developing normally. Crying was recorded in infants' homes with high-quality audio and

video equipment. Recording began when infants wakened spontaneously and began fussing or crying. A Sennheiser ME80 microphone was positioned approximately 15 cm above the infant's mouth and was recorded on a professional quality audiocassette recorder.

**Materials**

The Positive and Negative Affect Schedule (PANAS) developed by Watson, Clark, and Tellegen (1988) was administered to gauge the participants' mood. The PANAS is a short, 20 item self-report measure of both positive and negative affect. Ten positive and ten negative adjectives are rated on 5-point scales. Each 10-item grouping is then aggregated to create two scales, labeled positive and negative affect. High positive affect is characterized by high energy, full concentration, and pleasurable engagement with the environment, while high negative affect is characterized by distress and unpleasurable engagement. Low measures of both positive and negative affect reflect a lack of this self-reported engagement. The PANAS has been shown to be a reliable and valid scale across time and for different populations (Crawford & Henry, 2004).

**Design and Procedure**

Participants listened to 13, 10-second sound clips of newborn crying. After *each* cry segment, the participants were asked to rate the sound on three 7-point scales pertaining to the infant vocalization: "How (sad, distressed, and upset) does the infant sound?" Each participant then completed the PANAS mood questionnaire to determine positive and negative affect.

Participants in the *Control* condition were given instructions to rate each cry using the three aforementioned scales. Participants in the *Pencil* condition were asked to hold a

pencil between their teeth while making the ratings of the cries. Finally, those in the *Mimic* condition were asked to silently mimic the sounds as they were listening to the cries.

**Scoring**

Participant's ratings of the 13 cries were averaged to create a mean score of how sad, distressed, and upset each participant judged the thirteen cries.

## Results

**Negative and Positive Affect**

A 3 (*Condition*) x 2 (*Gender*) ANOVA was performed for self-reported *Negative Affect* scores. This analysis revealed a main effect of *Condition*, $F(2, 86) = 4.34$, $p = 0.016$, $\eta_p^2 = 0.092$. Post hoc testing using Tukey's HSD indicated that participants who held a pencil in their mouth reported feeling *less* negative than participants in the control condition, $p = 0.023$ (Table 1). There were no other significant main effects or interactions.

A 3 (*Condition*) x 2 (*Gender*) ANOVA was performed for self-reported *Positive Affect*. This analysis revealed no main effects of *Condition* or *Gender*, and no significant interaction.

Self-reported *Negative Affect* was not correlated with participants' ratings of infants as *Sad*, $r(93) = -0.07$, $p = 0.478$, *Distressed*, $r(93) = -0.04$, $p = 0.702$, or *Upset*, $r(93) = -0.13$, $p = 0.214$.

*Positive Affect* was not correlated with participants' ratings of infants as *Sad*, $r(91) = 0.02$, $p = 0.831$, *Distressed*, $r(91) = -0.08$, $p = 0.444$, or *Upset*, $r(91) = 0.03$, $p = 0.785$.

*Positive Affect* was not correlated with *Negative Affect*, $r(91) = -0.148$, $p = 0.158$.

**Cry Ratings**

A 3 (*Condition*) x 2 (*Gender*) analysis of variance was conducted on each participant's average rating of the cries as *Sad, Distressed,* and *Upset*. There were no main effects or interactions of *Condition* and *Gender* in any of the analyses (see Table 2 for means and standard deviations).

A second analysis of the ratings used each individual cry as levels of a repeated factor in a 13 (*Cry Stimulus*) x 3 (*Condition*) x 2 (*Gender*) mixed design ANOVA. (As there were significant violations of the assumption of sphericity for all three ratings, degrees of freedom were corrected using the Greenhouse-Geisser procedure.)

For ratings of *Sadness*, there was a main effect of *Cry Stimulus Rating*, $F(8.09, 687.43) = 25.38$, $p < 0.001$, $\eta_p^2 = 0.230$. The 13 individual cries varied significantly in how *Sad* they were perceived by the participants. For *Distress*, there was a significant main effect of *Cry Stimulus Rating*, $F(7.76, 659.97) = 57.32$, $p < 0.001$, $\eta_p^2 = 0.403$, and a *Cry Stimulus* x *Gender* interaction, $F(7.76, 659.97) = 2.04$, $p = 0.042$, $\eta_p^2 = 0.023$, with females rating cry stimulus #7 as less distressed than males, $F(1,85) = 8.31$, $p = 0.005$, (see Figure 1). For the ratings of *Upset*, there was, again, a main effect of *Cry Stimulus*, $F(8.50, 722.32) = 62.47$, $p < 0.001$, $\eta_p^2 = 0.424$, and a main effect of *Gender*, $F(1, 85) = 4.06$, $p = 0.047$, $\eta_p^2 = 0.046$. Females perceived the infants as more upset than the males ($M_{Males} = 4.39$; $M_{Females} = 4.63$). There were no other main effects or interactions.

As might be expected from the pattern of results above, the ratings of cries as *Sad, Distressed,* and *Upset* were correlated within and across participants. Computing correlations between these ratings for each of the 95 participants showed that the median

correlation between *Sad* and *Upset* was 0.27 (range 0.11 - 0.58), between *Distressed* and *Upset* was 0.20 (range 0.02 – 0.40), and between *Sad* and *Distressed* was 0.06 (range -0.12 – 0.23). These correlations are similar to previous perceptual studies of cry sounds demonstrating that such ratings are often moderately intercorrelated (Gustafson & Green, 1989).

**Discussion**

As predicted, manipulation of the facial muscles via the pencil manipulation had an effect on the participant's negative mood scores. Participants holding the pencil between their teeth rated their mood as less negative than participants in the control condition, in which facial muscles were not manipulated. This finding suggests that facial manipulations play a part in self-reported affect ratings in response to a negative auditory stimulus, infant crying. However, for the sample as a whole, there was no correlation between this negative change score and perceptions of infant cries as sad or distressed.

Unlike findings from the Strack et al. (1988) study, manipulating the activation of the zygomaticus major muscle in the cheek does not appear to affect *perceptions* of these auditory, emotional stimuli. Here, facial feedback from the zygomaticus major muscle did not affect the participants' judgments of the cries as less sad, distressed, and upset, whereas similar manipulations do appear to affect perceptions of visual expressions of emotion (e.g., faces). Exploration of a positive vocal stimulus, laughter, was performed in Study 3 in order to determine whether the lack of effect of facial feedback is specific to cry sounds or might include positive vocal signals as well.

Secondary findings from Study 1 indicated a gender difference between males and females on ratings of infant cries as more or less upset. Males in the study rated the cries as less upset than the females. This finding is similar to previous reports of gender differences in cry perception (Frodi, Lamb, Leavitt, & Donovan, 1978).

## Study 2

In Study 2, we investigated another common embodiment manipulation, namely, simulated approach and withdrawal behaviors. As aforementioned, it has been argued that extensor muscles are associated with attaining positive goals and flexors relate to retreat from negative stimulation.

As in Study 1, we also manipulated the ability to mimic facial and vocal expression of emotions by covertly blocking mimicry. We manipulated the participants' ability to mimic the infant sounds by blocking the facial and vocal feedback of the participants while they were completing the rating task as described below.

Finally, we added birdsong as a second auditory stimulus. This second stimulus was added to minimize carry-over effects from one cry to the next, thus conceivably increasing the variability of the cry ratings. Also, because birdsong is considered generally positive in valence, we expected that it might enhance the negativity of the cry sounds and thus influence perception and perhaps self-reported affect.

We predicted that participants in the *Approach* condition would rate the cries as more sad, distressed, and upset than participants in the *Control* condition. Similarly, we predicted that participants in the *Withdrawal* condition would rate the cries as less sad, distressed, and upset than participants in the control condition. We added two other conditions similar to the 'mimic' condition in study 1, called the *drink* and *candy*

conditions, designed to interfere with covert vocal activity that participants might be engaging in when listening to cries or birdsong. We predicted that participants would rate these two conditions as less sad, distressed, and upset than participants in the control condition.

## Method

### Participants

Participants were college students in the New England area ($M_{age}$ = 19.14, $SD_{age}$ = 2.59) who received course credit for participation in the experiment. There were 116 participants total (48 male, 66 female) divided into 5 conditions (Control = 45, Drink = 15, Candy = 15, Withdrawal = 21, Approach = 20), described below.

### Design and Procedure

The same 13 cries from Study 1 were used as stimuli. After *each* cry segment, the participants were asked to rate the sound on three 7-point scales pertaining to the infant vocalization: "How (sad, distressed, and upset) does the infant sound?" After each cry, participants also heard a time-matched sound segment of birdsong for contrast. They were asked to rate each birdsong on the same three scales used for the cry ratings. Participants were divided into five conditions. Those in the *Control* condition were given instructions to rate each cry using the three aforementioned scales. Participants in the *Drink* condition were asked to take a small sip of water at the beginning of the study and after the fifth cry rating. Participants in the *Candy* condition were asked to hold a piece of hard candy in their mouth while they were listening to the cries. Participants in the *Approach* Condition were asked to place their hands on the underside of the table in front of them and gently press up while listening to the sound segments. Finally, those in the

*Withdrawal* condition were asked to place their hands on the top of the table and press downward while listening to the cries. Each participant then completed the PANAS mood questionnaire to determine positive and negative affect.

**Scoring**

As before, participant's ratings of the infant crying were averaged to create a mean score of how sad, distressed, and upset he/she judged the sounds. The composites of "Negative Affect" and "Positive Affect" were calculated from the PANAS questionnaire. Both Positive and Negative Affect scores ranged from 5 (Low positive/negative affect) to 50 (High positive/negative affect).

## Results

**Negative and Positive Affect**

A 5 (*Condition*) x 2 (*Gender*) analysis of variance indicated that there were no significant main effects or interactions for self-reported *Negative Affect* (see Table 3 for means).

A 5 (*Condition*) x 2 (*Gender*) analysis of variance indicated that there were no significant main effects or interactions for self-reported *Positive Affect*.

Self-reported *Negative Affect* was correlated with participants' ratings of infants as *Sad*, $r(113) = 0.24$, $p = 0.009$, *Distressed*, $r(113) = 0.25$, $p = 0.007$, and *Upset*, $r(113) = 0.21$, $p = 0.025$. *Positive Affect* was not correlated with the cry ratings of *Sad*, $r(114) = 0.16$, $p = 0.082$, *Distressed*, $r(114) = 0.15$, $p = 0.108$, or *Upset*, $r(114) = 0.09$, $p = 0.360$. Negative affect was not correlated with positive affect, $r(113) = 0.03$, $p = 0.720$.

**Cry Ratings**

Three separate 5 (*Condition*) x 2 (*Gender*) ANOVAs were calculated for participants' ratings of infant cries as more or less *Sad*, *Distressed, and Upset* (see Table 4 for means). For the ratings of *Sad* and *Upset*, there were no main effects of *Condition* or *Gender* and no interactions. For *Distress*, there was a main effect of *Gender*, $F(1, 104) = 4.00$, $p = 0.048$, $\eta_p^2 = 0.037$. Similar to Study 1, females perceived the cries as more distressed than the males did. There was no main effect of *Condition* and no interaction.

**Cry vs. Birdsong**

Using affect scores from Study 1 and Study 2, a 2 (Study 1/Study 2) x 2 (Gender) ANOVA indicated no significant main effects or interaction for participant's *Negative Affect* or *Positive Affect.* Affect scores were not significantly changed by the addition of birdsong to the cry stimuli.

A mixed-design ANOVA with *Sound Type* (Cries vs. Birdsong) as a within-subjects factor and *Condition* (5) and *Gender* (2) as between-subjects factors revealed a main effect of *Sound Type* for *Sadness*, $F(1, 104) = 354.91$, $p < 0.001$, $\eta_p^2 = 0.773$, *Distress*, $F(1, 104) = 132.92$, $p < 0.001$, $\eta_p^2 = 0.561$, and *Upset*, $F(1, 104) = 292.85$, $p < 0.001$, $\eta_p^2 = 0.738$. Cries were rated as more *Sad* ($M_{cry} = 3.87$ vs. $M_{bird} = 1.79$), *Distressed* ($M_{cry} = 4.42$ vs. $M_{bird} = 2.77$), and *Upset* ($M_{cry} = 4.39$ vs. $M_{bird} = 2.20$) than birdsong. No other main effects or interactions were found.

## Discussion

Contrary to our predictions, activating the flexor and extensor muscles of the arm was unrelated to judgments of infant crying. Similarly, blocking the effects of mimicking the vocalizations of infant crying had no significant effect on the perceptions of the cry sounds. Although effects of these manipulations have been found previously for both

unfamiliar figures and for familiar words, no previous studies have used this manipulation with auditory stimuli. It is unclear whether the perception of auditory stimuli more generally is unaffected by embodiment, or whether it is the perception of infants' cries specifically that is difficult to alter.

Similar to Study 1, there was a main effect of gender for ratings of infant cries as more or less distressed. The males in this study perceived the cries as slightly less distressed than did the females.

When comparing PANAS Scores from Study 1 and Study 2, the addition of birdsong, although generally considered a positive stimulus, did not change the participants' mood ratings. Participants in the *Control* conditions in Study 1 and Study 2 showed similar levels of both positive and negative affect. It seems likely that that this signal from another species may not transmit any particular emotion to humans, at least as gauged by self-reported measures of affect. These findings support the idea that crying is a powerful signal of negative emotion in humans, whose effect on perception and mood is difficult to disrupt. We will explore this idea further in Study 3 by contrasting cry sound with human infant laughter, which is a positive stimulus that communicates feelings of pleasure within our species.

**Study 3**

Both discrete and dimensionalist accounts of emotion agree that emotional expressions and affect exist in a valenced, positive to negative fashion. Correct identification of the valence of the expression has been linked to higher IQ and positive social outcomes. For example, the inability to read emotional cues has been linked to disordered outcomes and pathological states including autism (Clark, Winkielman, &

McIntosh, 2008). Research has also linked accurate recognition of the valence of briefly presented facial expressions to self-reported emotional empathy (Martin, Berry, Dobranski, & Horne, 1996). Other research has linked recognition of briefly presented facial expressions to emotional intelligence (Austin, 2004; Petrides & Furnham, 2003).

However, little is known about positive and negative emotional expression outside the visual domain. There are no studies to date that have used only auditory stimuli in order to investigate perceptions of positive and negative valence in infant sounds. Therefore, the first aim of this study was to investigate basic ratings of infant laughter and crying on two subjective continua. We predicted that valenced vocal stimuli can exist on a continuum from positive to negative, and that participants would be able to rate valence from sound alone.

Laughter informs a social partner of recognition and reinforces his/her behaviors (Porteous, 1988). Just as the pitch, duration, and variability of cry can predict mother-infant interaction (Lester, 1984), so the characteristics of laughter most likely contribute to early attachment behavior (Stern, 1985). Studying both infant laughter and crying in tandem allows for direct comparison of the two signals, which tell us more than analyzing each individual signal alone (Provine, 2004).

We were also interested in knowing the effect of valenced auditory stimuli (in this case cry and laugh) on ratings of approach. Much of the embodied cognition literature dealing with approach and withdrawal behaviors suggests that humans approach positive stimuli and withdraw from negative stimulation. However, the infant cry is a unique stimulus because it is both negative and predicts approach toward the stimuli for members of the same species. Because both laughter and crying have been linked to

approach behavior in adults, we were interested in first demonstrating that self-report data could corroborate this link.

A second aim of Study 3 was to investigate the emotional impact of valenced sounds on the participants' self-reported *negative* and *positive* affect. As in the Bruning & McMahon (2009) study, we predicted that sound type would influence self-reported Negative Affect. We predicted that crying would increase the listener's Negative Affect and laughter would decrease Negative Affect.

Finally, in Study 3, we investigated the effect of embodied manipulations on both infant crying and laughter. We gauged participants' ratings and self-reported approach behaviors to these two sound signals under the influence of embodied feedback. We predicted similar results to Study 1, namely, crying would be perceived more negatively by females.

## Method

### Participants

Participants were college students in the New England area ($M_{age}$ = 18.92, $SD_{age}$ = 1.00) who received course credit for participation in the experiment. There were 160 participants total (44 male, 116 female) divided into 4 conditions, described below.

### Design and Procedure

Eleven of the 13 cries from Study 1 and 2 were used as stimuli. Each cry was edited to create a 3-second segment with at least 2 expirations. In addition, ten, time matched segments of infant laugher were added for contrast. Half of the participants heard crying and half heard laughing. After each sound segment, the participants were asked to rate the sound on two, 9-point, bipolar scales: "How (Happy-Sad and Content-

Upset) does the infant sound?" Participants were also asked to rate their "Likelihood to Approach" the infant they heard on a separate 9-point scale.

Each participant was assigned to one condition and listened to either crying or laughing. Participants in the *Control* condition were given instructions to rate each sound using the three aforementioned scales. The remaining three conditions involved manipulations of facial musculature. Participants in the *Frown* condition, held the pencil between their lips to inhibit the zygomaticus major from contracting, those in the *Teeth* and *Lips* conditions held the pencil to facilitate zygomaticus major contraction (see Figure 2).

Participants in Study 3 completed the PANAS mood questionnaire twice, once before hearing either crying or laughter and once afterward.

## Scoring

Participant's ratings of the infant crying or laughing were averaged to create a mean score of how sad and upset he/she judged the sounds. Likelihood to approach the infant was also averaged across trials.

# Results

## Negative and Positive Affect [1]

To examine change in affect, a mixed-design ANOVA with Negative Mood Change (pretest, posttest) as a within-subjects factor and *Condition* (4) x *Sound Type* (2) x *Gender* (2) as between subject factors was performed. There was a significant *Gender*

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[1] One participant from the "Frown" condition was dropped from the following test of affect for being 3 SD above the mean in both positive and negative affect at Pretest.

x *Sound Type* x *Negative Mood Change* interaction, $F(1, 143) = 7.57$, $p = 0.007$ $\eta_p^2 = 0.050$. There was no difference either for males or females, in either the cry or laugh condition, at negative affect at pretest (Figure 3). Males, however, showed a significant decrease in negative affect when listening to laughs, $t(26) = 2.36$, $p = 0.026$, and a significant increase in negative affect when listening to cries, $t(15) = 2.26$, $p = 0.039$. Females showed only a significant decrease in negative affect when listening to laughter, $t(52) = 3.98$, $p < 0.001$. Two of the lower order interactions were also significant, namely, between *Sound Type* and *Negative Mood Change* and between *Gender* and *Negative Mood Change.* These interactions are not interpreted because they occurred in the context of a 3-way interaction.

A mixed-design ANOVA with *Positive Mood Change* (pretest, posttest) as a within-subjects factor and *Condition* (4), *Sound Type* (2), and *Gender* (2) as between subject factors also revealed a significant 3-way interaction, but here it was for *Positive Mood Change* x *Condition* x *Gender* interaction, $F(3, 142) = 2.77$, $p = 0.044$, $\eta_p^2 = 0.055$ (see Figure 4). There was no significant difference in Positive Affect Scores for the different conditions at pretest for males, $F(3, 39) = 0.64$, $p = 0.595$ or females, $F(3, 111) = 2.192$, $p = 0.093$. For males, the change in Positive Affect Scores was significant for participants in the control condition $t(9) = 3.14$, $p = 0.012$, but not for the Frown, $t(8) = 0.82$, $p = 0.435$, Lips, $t(6) = -0.47$, $p = 0.652$, or Teeth, $t(16) = -0.13$, $p = 0.899$, conditions. For females, the change in Positive Affect Scores was significant for participants in the teeth condition $t(22) = 2.63$, $p = 0.015$, but not for the Control, $t(28) = 1.41$, $p = 0.171$, Frown, $t(29) = 0.98$, $p = 0.336$, or Lips, $t(32) = 1.78$, $p = 0.085$, conditions. There were no other significant interactions, although there were main effect

of *Positive Mood Change*, $F(1, 142) = 8.80$, $p = 0.004$, $\eta_p^2 = 0.058$, and *Gender,* $F(1, 142) = 6.92$, $p = 0.009$, $\eta_p^2 = 0.046$, again not interpreted as a result of the presence of a higher order interaction.

Thus, the effects of embodiment in this study were moderated by other variables. Somewhat paradoxically, positive affect decreased when female participants were holding a pencil between their teeth and listening to either cries or laughs. For males, the effect of any of the embodiment manipulations appeared to be to prevent a decrease in positive affect over the course of the study.

The correlation between positive and negative affect was not significant at pretest, $r(157) = -0.05$, $p = 0.518$, or posttest, $r(157) = -0.10$, $p = 0.235$. However, there were significant correlations of Negative Affect scores at pretest and posttest, $r(158) = 0.77$, $p < 0.001$. Similarly, there were significant correlations of Positive Affect scores at pretest and posttest, $r(157) = 0.76$, $p < 0.001$.

**Cry Ratings**

A 4 (*Condition*) x 2 (*Sound Type*) x 2 (*Gender*) ANOVA indicated an effect of *Sound Type* on participants' ratings of infants as *Content*, $F(1, 144) = 21.32$, $p < 0.001$, $\eta_p^2 = 0.129$. Cries were perceived as less Content that laughter. Ratings of *Contentment* were not affected by *Gender* or *Condition*. There were no significant interactions.

A 4 (*Condition*) x 2 (*Sound Type*) x 2 (*Gender*) ANOVA indicated an effect of *Sound Type* on participants' ratings of infants as *Happy*, $F(1, 144) = 32.82$, $p < 0.001$, $\eta_p^2 = 0.186$. Participants perceived cries as less happy than laughter. Ratings of *Happiness* were not affected by *Gender* or *Condition*. There were no significant interactions.

A 4 (*Condition*) x 2 (*Sound Type*) x 2 (*Gender*) ANOVA showed a significant *Condition* x *Sound Type* interaction for *Approach*, $F(3,144) = 2.81$, $p = 0.042$, $\eta_p^2 = 0.055$. Participants only differed from one another in approach ratings when not receiving any facial feedback (see Figure 5). That is, participants in the control condition were more likely to approach crying infants than laughing infants. Any of the embodiment manipulations reduced this effect. There were no other significant main effects or interactions.

**Discussion**

As predicted, sound type (crying or laughter) affected participants' perceptions. Participants were able to judge the positive and negative valence of the stimuli from the sound alone, rating cries as less happy and less content than laughter.

Consistent with Study 1 and Study 2, males reported a significant change in Negative Affect when listening to cries; where as this change was not significant for females. Laughter, on the other hand, decreased Negative Affect in both males and females.

There were no effects of manipulating the zygomaticus major muscle on participants' perceptions of laughter and crying as content or happy. It appears that this manipulation was not strong enough to affect the perceptions of such robust stimuli. It is also possible that that previous findings on embodied perception and cognition may not be generalizable to communicative signals in the auditory domain.

However, there was an effect of the embodied manipulations for ratings of approach. While participants in the conditions involving facial manipulation were equally likely to approach both sound types, participants in the control condition reported

a greater likelihood of approaching crying in comparison to laughter. This suggests that, although crying is negative in valence, participants were more likely to say they would approach crying than laughter, but only when their facial musculature was not manipulated.

In this study, the embodied manipulation was also related to the participants' change in positive affect. This relationship was moderated by gender, such that males decreased in positive affect only when there was no manipulation (i.e., in the Control condition) whereas females decreased in negative affect only in the manipulation designed to mimic a smile.

## General Discussion

### Crying as a Signal

All three studies in this report support the idea that infant crying is a robust stimulus employed for communication in humans. The nature of the sound alone causes receivers to infer a negative state in the signaler. In accordance with the graded signal theory of infant crying, adults were able to use this auditory signal in order to rate the infant cries on continuous scales reflecting negative emotions (e.g., sadness and distress). The participants were also able to systematically rate some of the cries as more negative than others. Even without context or facial information, the audio signal alone was enough to create a gradation of signal intensity.

The infant cry is a unique sound. Results from Study 2 indicated that adults perceive infant crying as communicating increased levels of sadness, distress, and upset when compared to birdsong. Similarly, Study 3 showed that adult caregivers rate infant crying as more sad and upset, while rating laughter as more happy and content. While

these two findings may seem at first to be less than remarkable, it is notable that the participants reported a distinct pattern of approach behavior for laughter and crying in Study 3. In the control condition, participants reported an increased likelihood of approaching infant crying, a negatively valenced stimulus, over infant laughter. Study 3 showed that although crying is a negative and aversive stimulus, which would usually incite withdrawal in the receiver, there is self-reported approach behavior. This paradoxical quality may be unique to the cry stimulus.

Another interesting quality of the cry stimulus is that the signal value appears to be moderated by the gender of the participants. Results from Study 1 and 2 suggested that males perceive infant crying as less perceptually intense than females do. Although the signal value was perceived as less intense, males reported an increased level of self-reported negative affect when listening to the cries in comparisons to females. Therefore, it appears that while the females perceive a more intense signal from the infants, their own internalization of the emotion may not be affected in the same manner as males. Some type of physiological measure would be important to collect in order to corroborate this finding based on self-report.

**Crying's Effects on Affect**

Crying communicates negative affect of the infant to the adult. This signal is perceived as more negative than at least some of the signals from other species. Study 1 and 2 together demonstrated that birdsong, a robust signal from another species, does not influence the ratings of positive or negative affect in human participants when they listen to infant crying. When birdsong was added along with infant crying in Study 2,

participants did not report detectable changes in mood. It could be that birdsong does not engender an affective response in humans.

Both powerful signals within our own species, laughter and crying influence negative affect differently. Study 3 demonstrated that a reduction in negative affect occurs in both male and female participants when they listen to laughter. This study is the first to suggest that the auditory signal of infant laughter changes the affect of the listener. For males only, listening to crying was associated with an increase in negative affect. Again, auditorily presented emotional signals, both positive and negative, appear to engender an affect state in the listener.

Thus, Study 3 suggests that the mood of the male participants was more affected than that of the women when listening to infant crying. Although women perceived the cries as more negative in content, this perception did not appear to influence their own emotional reaction. This pattern of results suggests that there may be an appropriate balance that caregivers must reach in which the cries are perceived as negative, but this negative affect is not internalized.

**Crying and Embodiment**

The PANAS mood questionnaire was sensitive enough in Study 1 to pick up on the change in negative affect due to manipulation of facial muscles associated with smiling. This does seem to confirm, as cited in Strack et al. (1988) that perceptions of our own emotions are directly related to the positions of our body, specifically covert contractions of muscles within the face. Participants might use this implicit knowledge about the state of their body when making judgments about their own affect. However, we were unable to detect a change in participants' negative affect in Study 3 rated to

embodiment manipulations. Also, in both Study 1 and Study 3, we were unable to relate changes in facial muscles to perceptions of emotions conveyed in sounds.

There are several possible explanations for the inconsistent findings in regard to our embodiment manipulations. First, our dependent measures might not have been sensitive enough to pick up on the embodied effects. The PANAS is a rather gross measurement scale for mood change. It takes into consideration both high and low arousal as well as positive and negative valence. However, it was created to measure changes over longer time periods, and here it was administered only once or twice in each study. Because it is a self-report questionnaire, it also relies on the participant's ability to explicitly judge his or her own internal state. Therefore, it may not be as precise when detecting the smaller changes in mood that might be picked up by physiological measures of arousal.

Similarly, the Likert-type rating scales used in these studies may not have been sensitive enough to detect change due to embodiment. Although the rating scales were continuous, which allowed for comparison between our cry stimuli, the entire cry segment was taken into account when participants made their ratings of the cry. In order to gather a more precise measurement of the perceptions of individual sounds, a more fine-grained measurement of perception should be used. For example, instead of taking one measurement of each cry stimulus, participants could be asked to use a sliding scale in order to judge the level of distress of the infant moment by moment.

Second, there was not a lot of variability in the stimulus. The cry stimuli used in this study was taken when infants were presumably hungry. The auditory signals used were robust exemplars of infant crying. There were no whines, fusses, or whimpers

included in the sound stimuli. Negative, vocal affect might be more subject to embodiment manipulations if the stimuli were more varied.

Third, the results may indicate a unique property of the sound alone. Once the sound is identified as an infant cry, the determined signal value takes precedence over any manipulation of our bodies. For that reason, a better way to investigate the effects of embodiment on perceptions of infant crying might be through using a reaction time test. It may be that robust human signals like laughter and crying are more quickly identified when the matching facial constructions are manipulated. Embodied cognition may still play a part in the ability to identify the value of the signal, but once identified, and the category label applied, response to the category takes precedence over additional bodily feedback. More accurate measurements of embodied effects should be studied at the precise moment that the decision is being made.

**Conclusion**

Infant crying is a robust signal that may not be perceived and processed like other valenced stimuli. Because it was not easily affected by the typical manipulations used to study embodied cognition, it might have a special signal value for humans. It is perceptually detectable from the sound alone, and it affects the emotional state of receivers. Further, men and women react differently to crying--males report lower perceptions of distress, but higher mood ratings. Women, on the other hand, demonstrate the opposite pattern. Infant crying is paradoxical because unlike most stimuli that are negative in valence, humans report an increased likelihood to approach and help when they hear this signal.

The present studies focused on perceptual and affective responses to infant crying, but previous studies have examined behavioral, physiological, and neurobiological responses to crying. It would be desirable to relate the changes in affect observed here to physiological measures of arousal and/or attention. If such a multivariate approach could be employed on a small timescale, and with clearly defined gradations of negativity in the cry stimulus, it might be possible to determine what makes infant crying a unique signal of negative emotions in humans.

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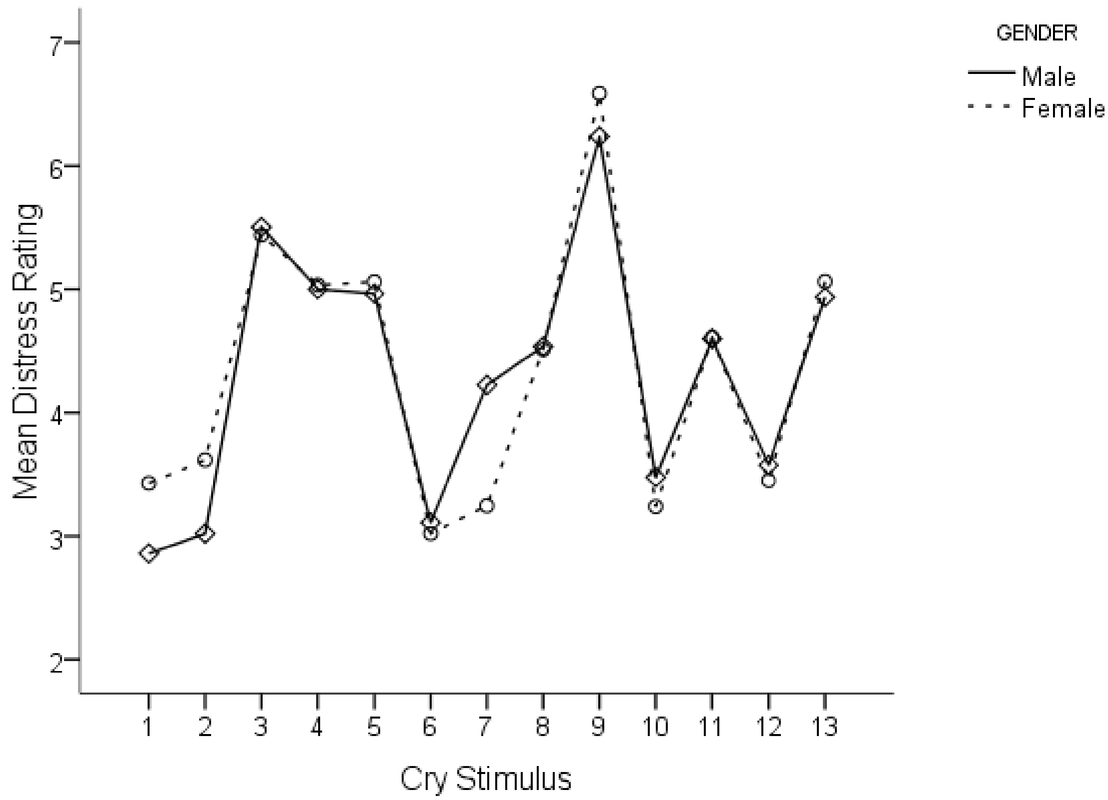


*Figure 1.* Mean distress rating (out of 7) for males and females for the 13 cry stimuli.

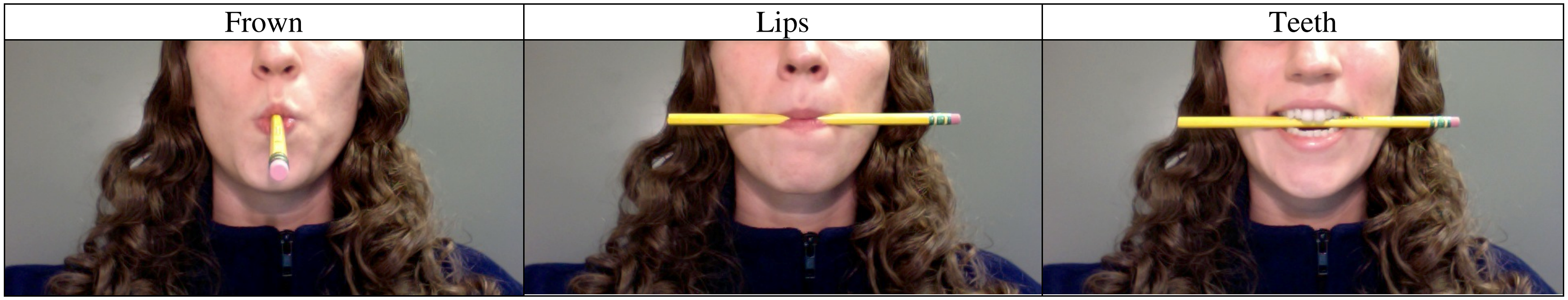


*Figure 2*. Experimental conditions in Study 3.

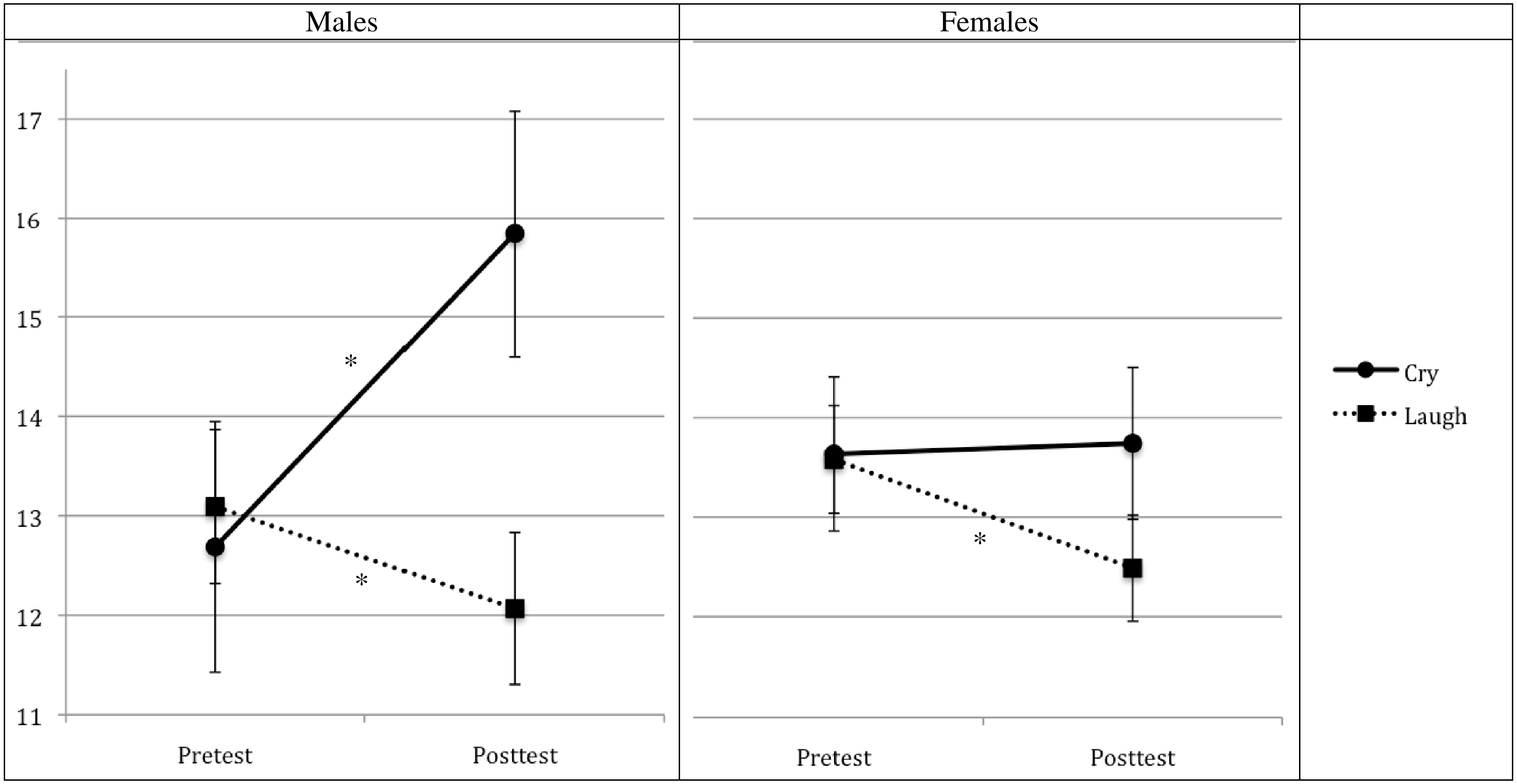


*Figure 3.* Males' and Females' mean Negative Affect Rating (out of 50) at pretest and posttest for laughter and crying. Significant change scores denoted with an asterisk (*). Error bars represent 1 SEM.

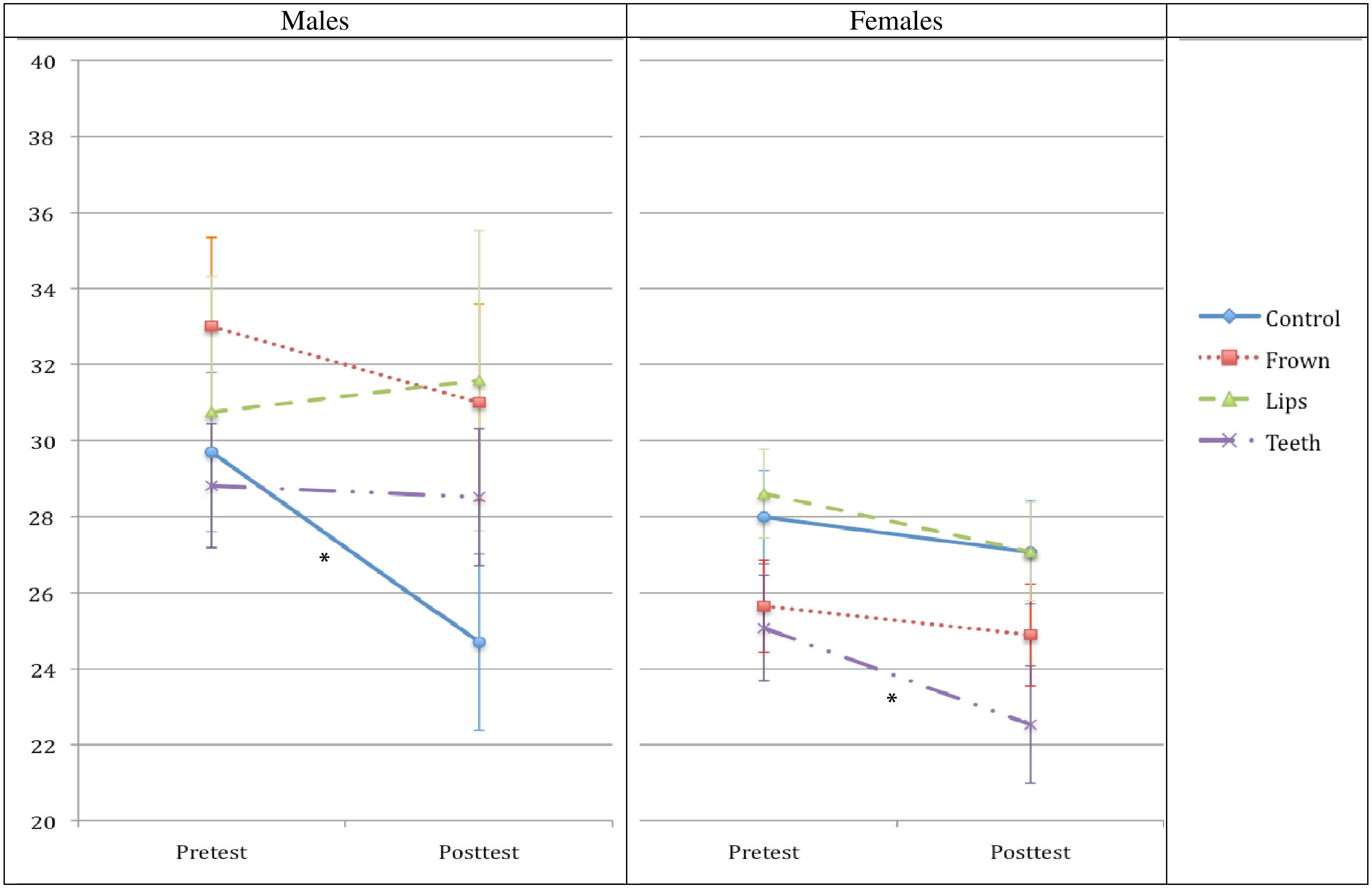


*Figure 4.* Males' and Females' mean Positive Affect Rating (out of 50) at pretest and posttest for each condition. Significant change scores denoted with an asterisk (*). Error bars represent 1 SEM.

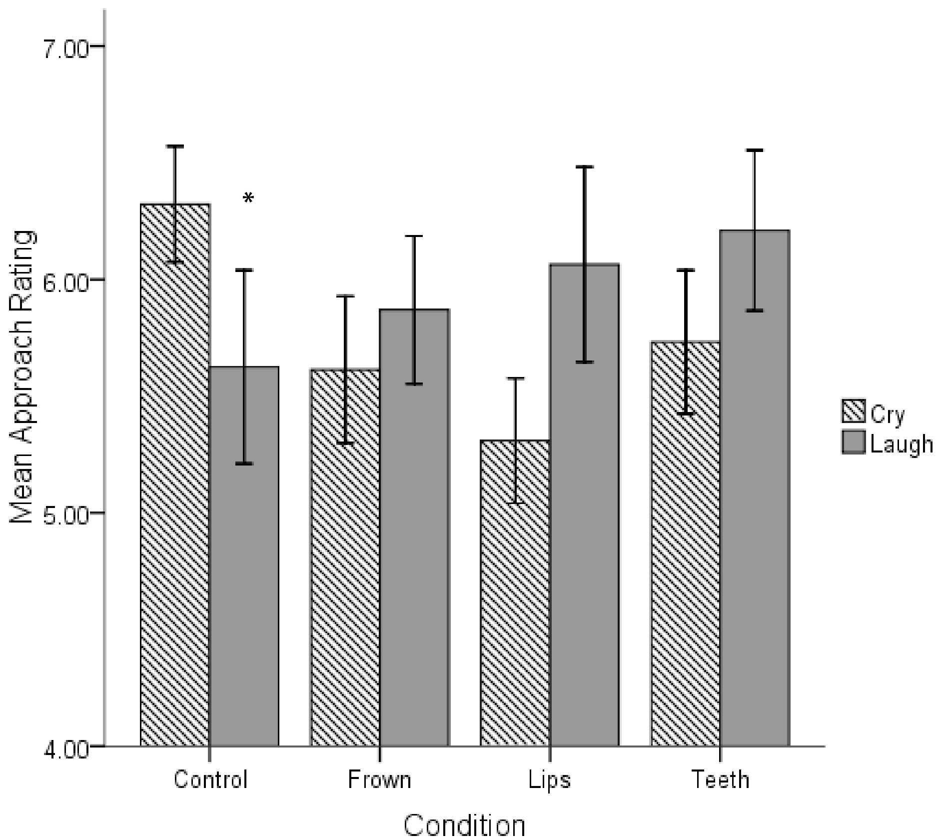


*Figure 5.* Mean approach rating (out of 9) for each sound type by condition. Significant change scores denoted with asterisk (*). Error bars represent 1 SEM.

Table 1

*Means (Standard Deviation) for Positive Affect and Negative Affect by Condition*

| | PA | | | | | | NA | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Control | | Mimic | | Pen | | Control | | Mimic | | Pen | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Males | 25.91 | (6.32) | 23.69 | (5.84) | 22.59 | (6.78) | 18.00 | (5.12) | 14.46 | (5.19) | 13.88 | (3.26) |
| Females | 22.58 | (6.77) | 24.50 | (6.04) | 25.36 | (7.04) | 15.75 | (4.79) | 15.25 | (3.80) | 13.33 | (3.74) |
| Overall | 23.61 | (6.67) | 23.97 | (5.74) | 23.84 | (6.93) | 16.50 [a] | (4.87) | 14.84 | (4.30) | 13.63 [a] | (3.44) |

[a] superscripts indicate a significant mean difference as measured by Tukey's HSD.

Table 2

*Means (Standard Deviation) for Ratings by Condition*

| | Sad | | | | | |
|---|---|---|---|---|---|---|
| | Control | | Mimic | | Pen | |
| | Mean | SD | Mean | SD | Mean | SD |
| Males | 3.95 | (0.69) | 4.08 | (0.62) | 4.16 | (0.50) |
| Females | 4.02 | (0.62) | 4.12 | (0.78) | 4.18 | (0.75) |
| Overall | 4.00 | (0.64) | 4.10 | (0.70) | 4.17 | (0.62) |
| | Distressed | | | | | |
| | Control | | Mimic | | Pen | |
| | Mean | SD | Mean | SD | Mean | SD |
| Males | 4.41 | (0.52) | 4.04 | (0.59) | 4.48 | (0.42) |
| Females | 4.38 | (0.41) | 4.31 | (0.72) | 4.29 | (0.72) |
| Overall | 4.39 | (0.44) | 4.19 | (0.67) | 4.40 | (0.58) |
| | Upset | | | | | |
| | Control | | Mimic | | Pen | |
| | Mean | SD | Mean | SD | Mean | SD |
| Males | 4.14 | (0.61) | 4.35 | (0.45) | 4.67 | (0.57) |
| Females | 4.49 | (0.34) | 4.77 | (0.71) | 4.55 | (0.72) |
| Overall | 4.37 | (0.48) | 4.58 | (0.64) | 4.61 | (0.64) |

Note. Ratings were based on a 7-point Likert scale.

Table 3

*Means (Standard Deviation) for Affect by Condition*

| | Negative Affect | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Control | | Drink | | Candy | | Withdrawal | | Approach | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Males | 13.39 | (2.77) | 11.50 | (2.14) | 13.50 | (2.65) | 14.89 | (4.65) | 18.67 | (8.67) |
| Females | 15.52 | (5.36) | 16.86 | (7.20) | 16.40 | (5.36) | 16.75 | (3.47) | 15.91 | (8.50) |
| Overall | 14.63 | (4.55) | 14.00 | (5.67) | 15.57 | (4.83) | 15.95 | (4.02) | 17.15 | (8.47) |
| | Positive Affect | | | | | | | | | |
| | Control | | Drink | | Candy | | Withdrawal | | Approach | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Males | 22.39 | (5.59) | 22.13 | (6.83) | 23.00 | (8.83) | 18.78 | (7.19) | 23.44 | (3.43) |
| Females | 20.12 | (6.51) | 23.29 | (6.73) | 23.36 | (5.70) | 23.42 | (9.08) | 24.73 | (7.46) |
| Overall | 21.07 | (6.17) | 22.67 | (6.56) | 23.27 | (6.32) | 21.43 | (8.46) | 24.15 | (5.89) |

Note. Ratings were based on a 50-point scale.

Table 4

*Means (Standard Deviation) for Ratings by Condition*

| | Control | | Drink | | Candy | | Withdrawal | | Approach | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| | Sad | | | | | | | | | |
| Males | 3.62 | (0.93) | 3.73 | (1.37) | 3.85 | (0.48) | 3.92 | (0.64) | 3.96 | (1.04) |
| Females | 4.08 | (1.04) | 3.70 | (0.92) | 4.34 | (0.67) | 3.94 | (0.95) | 3.57 | (0.93) |
| Overall | 3.89 | (1.01) | 3.72 | (1.14) | 4.21 | (0.65) | 3.93 | (0.81) | 3.75 | (0.98) |
| | Distressed | | | | | | | | | |
| Males | 4.11 | (0.86) | 3.96 | (1.18) | 4.50 | (0.83) | 4.22 | (0.65) | 4.42 | (0.74) |
| Females | 4.70 | (1.00) | 4.10 | (0.69) | 4.86 | (0.69) | 4.68 | (0.91) | 4.66 | (0.55) |
| Overall | 4.45 | (0.98) | 4.03 | (0.95) | 4.76 | (0.71) | 4.48 | (0.82) | 4.55 | (0.64) |
| | Upset | | | | | | | | | |
| Males | 4.30 | (0.76) | 4.06 | (1.67) | 4.02 | (1.04) | 4.34 | (1.10) | 4.33 | (0.59) |
| Females | 4.40 | (1.30) | 4.35 | (0.79) | 5.29 | (0.60) | 4.52 | (1.03) | 4.31 | (0.84) |
| Overall | 4.36 | (1.10) | 4.19 | (1.30) | 4.95 | (0.91) | 4.44 | (1.03) | 4.32 | (0.72) |