The Impact of Infant Crying and Soothability on Cognition in Mothers and Other Adults

by

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Abstract

Perception of infant crying has been linked to the brain regions that are activated with stress and conflict monitoring, such as the anterior cingulate and amygdala. Whether the stress of cry perception affects cognitive processes is heretofore unknown. This research combines an experimental paradigm of an unsoothable infant cry task (Donovan, Leavitt, & Taylor, 2005) with a series of Rejection Stroop tasks (Dandeneau & Baldwin, 2004) with the expectation that perception of infant distress would deplete neural resources underlying the regulation of attention. Two studies were conducted on non-parent young adults and two studies were conducted on mothers of infants. Results indicated that the cry task causes negative affect and cognitive interference in non-parent young adults to a greater extent than does a musical stimulus, and that mothers of infants experience negative affect and cognitive interference comparable to the non-parent young adults.
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1 Introduction

Most mothers have experienced the frustration and despair of being unable to soothe their crying infant at one time or another. Inconsolable crying has been linked with feelings of anger, guilt, and despair, and even significantly increases the risk of infant abuse (Long & Johnson, 2001). According to attachment theorists, infant crying is a signaling device that functions to maintain the infant’s proximity to the mother. A reciprocal relationship exists between the mother and infant involving the infant’s production of cues such as cries (e.g. Gustafson et al., 2000), the mothers’ auditory, physiological (Crowe & Zeskind, 1992), and neurological (Lorberbaum et al., 2002) perception of the cries, the mothers’ behavioural reactions to cries (Wade, Black, & Ward-Smith, 2005), and the infant’s production of further cues to tell the mother whether its needs have been met (e.g. Jahromi & Sifter, 2007). One area of this reciprocal relationship that has not been investigated is the impact of the mother’s interpretation of the cry on her feelings and behaviour toward her crying infant. We don’t know why mothers respond the way they do to their infants’ signals. One way to approach this fundamental issue is to examine the impact of the perception of infant crying on affect and cognition in parents and in non-parents (see Figure 1).

1.1 Cry Perception

Human infant crying provides an early, salient, powerful, and functional cue for parents. Using an ethological perspective, Ainsworth and Bowlby (1979) hypothesized that infant crying is an attachment behaviour that evolved as a protective function by bringing caregivers into close proximity with the infant thus providing safety against dangers and eliciting care. These authors argued that infants remain innately programmed to cry when out of contact with caregivers or when distressed, and that infant behaviours are adapted to attract the attention of a caregiver who is also innately programmed to be appropriately nurturing and responsive to infant crying. Optimally, an infant’s cries will elicit nurturing and protective responses from people in the infant’s environment (Lester, 1985). Thus the infant cry serves as a “releaser” of caregiving behaviour. Accordingly, the cry and the perception of the cry co-evolved to ensure that caregivers would protect offspring. Thus for our purposes, we will consider infant crying to be an attachment-related (or relationship-specific) stressor for mothers of infants.
Several studies have demonstrated that infant crying elicits negative affect in mothers resulting in the mothers’ wanting or attempting to quiet the infant immediately (Bisping, Steingrueber, Oltmann, & Wenk, 1990; Crowe & Zeskind, 1992; Frodi, Lamb, Leavitt, & Donovan, 1978; Frodi et al., 1978; Wade, Black, & Ward-Smith, 2005). Infant cries also elicit significant physiological reactions in mothers, such as cardiac acceleration, increased skin conductance, and increased cortisol levels. Bleichfeld and Moely (1984) measured heart rate in response to recorded infant cries and found that greater childcare experience was associated with greater heart rate acceleration. In contrast, inexperienced adults showed heart rate decelerations. Interestingly, heart rate accelerations are generally interpreted as preparatory responses to stimuli and elevated arousal, interest, and motivation (Leavitt & Donovan, 1979); whereas heart rate decelerations have been associated with focused attention or orienting behaviour (Wisenfeld & Klorman, 1978). In addition to heart rate, Stallings, Fleming, Corter, Worthman, & Steiner (2001) measured cortisol in response to recorded pain and hunger cries. They found that mothers with higher circulating levels of cortisol and higher baseline heart rates prior to hearing the infant cries tended to respond with greater sympathy to the cries. Taken together, these findings suggest an experiential effect of caregiving on affect, autonomic, and hormonal responses to cry perception (Chodera et al., 1991; Corter & Fleming, 1995; Fleming & Corter, 1995). These studies suggest that autonomic arousal, including activation of the HPA axis, is easily evoked by perception of infant cries only in mothers or caregivers with experience. The hypothesized adaptive purpose of the physiological reactivity is to motivate the mother to approach the infant in order to terminate the cry, whether to relieve the infant of distress or to simply reduce the unpleasant accompanying maternal reactions (Frodi, Lamb, Leavitt, & Donovan, 1978; Murray, 1979). Thus infant crying can be seen as a relationship-specific “stressor” for mothers.

Brain imaging studies provide another important window into understanding the potential impact of cry perception on affect and cognition in mothers. Newman (2007) reported in his review of maternal perception of infant cries that the amygdala, medial preoptic area, and cingulate gyrus were associated with cry responding. However, how these specific areas are connected and under what conditions they become active is unclear. In a recent fMRI experiment, Lorberbaum et al. (2002) discovered that in new mothers, the anterior cingulate, thalamus, mesial prefrontal cortex, and right orbitofrontal cortex were more active when listening to an infant cry than during a control sound. All these regions were also uniquely activated by the cry (cry minus control).
except for the anterior cingulate, which may be due to the fact that the anterior cingulate has a role in cognitive attention and both sounds demanded attention.

As reviewed above an important body of work has examined the impact of cry perception on affect, physiology, and, more recently, brain activity in parents and non-parents. However, as far as we know, no study has examined the impact of cry perception on cognition. Given our assumption that cry perception evolved as an intrinsic component of the attachment system, we also assume that the potential links between cry perception and cognition can be appreciated through the conceptual lens of attachment theory.

1.2 Attachment and Cognition

Mikulincer and Shaver (2003) propose a framework explaining how the domains of attachment influence cognitive processing. Attachment-related feelings, thoughts, memories, and action patterns are organized like associative neural networks in the brain and are linked to perception of threats with excitatory circuits. The first step of attachment system activation is monitoring and appraising possibly threatening cues, a task likely associated with the anterior cingulate cortex. Once a threat is subjectively appraised, the system is activated both preconsciously and consciously. During preconscious activation, the mental pathways to memories and images of one’s earliest relationship (either of positive-accepting or negative-rejecting interactions) are accessed, a task likely associated with the amygdala. Conscious activation involves thoughts of seeking proximity to an attachment figure; in adults, merely thinking of the attachment figure and of his or her qualities (of caring, empathy, capability, etc.) is often enough to make one feel comforted and secure. If one can call up soothing thoughts of the attachment figure successfully, the system is deactivated. If unsuccessful, secondary strategies come into play to help one cope with feelings of rejection, as described by Main (1990): deactivation (retreating from attachment figures – an avoidance response) and hyperactivation (ambivalent proximity-seeking – an anxiety response).

A fundamental assumption of attachment theory is that an individual’s attachment model determines not only how he or she responds to threats but also how he or she responds as a caregiver. In the case of cry perception, the crying may activate the attachment system in the adult listener, especially when the listener is a parent. This initial response may involve the
motivation of approaching rather than withdrawing. However, the subsequent appraisal processes that activate either positive-accepting or negative-rejecting memories of the attachment history will depend on individual differences and may thus determine the subsequent responses elicited by the cry.

1.3 Cry Perception and Conflict Monitoring

The Stroop colour-naming task (quickly naming the colour in which a word is printed, which requires ignoring or suppressing the meaning of the word) is perhaps one of the most reliable ways to study preconscious cognitive processes (Stroop, 1935). Attentional tasks of this nature involve “attention for action,” a cognitive modality that selects which stimuli will control an individual’s actions at any given moment. This is associated with the activation of the anterior cingulate cortex, which is important for resolving cognitive conflict (i.e. the conflict involving deciding which stimulus to pay attention and respond to; Smith & Jonides, 1999).

Preferential processing of negative, threatening emotional information tends to interfere with performance on Stroop tasks. While this can be adaptive through facilitating rapid processing of threats, it also depletes the cognitive resources available for more voluntary control of attention performance (Bishop, Duncan, Brett, & Lawrence, 2004; Desimone & Duncan, 1995; Kieras et al., 2000; Miller & Cohen, 2001). Because conflict monitoring (as measured by the Stroop task) and the reaction of mothers to infant cries are both associated with the anterior cingulate, we thought it was reasonable to envision that repeated cry perception would diminish performance on the Stroop task.

1.4 The Current Research

The current research is modeled on the assumption that the infant’s attachment signals (i.e. crying) elicit care by physiologically arousing the mother; her arousal mediates her response. Her perception of the infant’s signals is filtered through her attachment schema, which contain cognitive and affective biases stored in associative neural networks and activate associated behavioural patterns. Some of these behaviour patterns are thought to be universal and others based on individual differences.
Our experiment exposed mothers and non-mothers to two computer simulations of an infant’s cries, one that was easily “soothed” by the pressing of buttons and one that was not; this was the cry responding task. We included both soothable and unsoothable trials so that we could study the impact of the subjects’ perceptions of efficacy on their affective and cognitive responses. Immediately after each of these cry responding tasks, participants completed a Stroop (1935) task to evaluate differences in conflict monitoring. This task contained a set of attachment-related items developed by Dandeneau and Baldwin (2004) called the Rejection Stroop. This attachment-related Stroop is used in place of a standard Stroop because the infant cry is considered to be an attachment-related stressor for our purposes. Additionally, participants completed scales of affect and rated the sound of the infant cries in order to determine the emotional impact of the cry responding task on participants.

2 Study 1: Non-Parent Undergraduates

In this study we examined 1) the affective responses to the cry stimuli in non-parents, and 2) their performance on a new version of a Stroop task. Through testing non-parent undergraduate participants, a population that has not been studied with respect to infant cry reactions, Study 1 investigated the possibility that there is a universal human reaction to the sound of infant crying. It has been largely assumed in research that only mothers or parents will respond to infant cues,
but we argue that all humans, as social primates, are primed to pay attention to and react to infant cues. As discussed above, Bleichfield and Moely (1984) observed that participants inexperienced in infant care respond to infant cries with heart rate decelerations, indicating an attentive or orienting response; thus we expected our non-parent participants to demonstrate a similar response to the infant cry. In addition, the anterior cingulate has been linked to the perception of infant distress (Lorberbaum et al., 2002) and to the regulation of attention during conflict monitoring tasks (Smith & Jonides, 1999); thus we expected our participants’ response to infant distress to interfere with their ability to regulate attention during a conflict-monitoring task (i.e. the Stroop task). More specifically, we expected that the perception of infant distress would deplete neural resources underlying the regulation of attention.

2.1 Methods

2.1.1 Participants

One hundred and one undergraduates were recruited from the UTSC participant pool, as approved by the University of Toronto Research Ethics Board (reference #22346). Nine participants were excluded for not completing the study (n=8), or for being parents (n=1). Demographic information for the remaining 92 participants is as follows: 64 participants were female; the ages of the participants ranged from 18 to 25 years with a mean of 20.03 years (65.9% of participants being 20 years or younger); 82 participants were single, 6 were married or cohabitating, and 3 declined to indicate marital status; 63 participants reported a language other than English as their native language; 67 participants reported being born in a country other than Canada; and distribution of participants’ religions was None (n=31), Hindu (n=16), Protestant (n=15), Muslim (n=14), Other (n=8), Jewish (n=4), Buddhist (n=3). Participants’ experience with infants was assessed through combining several demographic items such as “how many diapers have you changed in your life”; participants ranged from low (n=64), medium (n=19), to high (n=9) in baby experience. Bivariate correlation revealed that none of these demographic variables had any association with Stroop task performance, or with the affect measures.

2.1.2 Procedure

All participants were recruited for a study that ostensibly investigated their ability to learn to respond to a caregiving situation. After signing the consent form, participants were then oriented
to the Rejection Stroop task, a variant of the Stroop color-naming task (1935) that requires participants to respond to the colour in which a target word is printed while simultaneously ignoring the content of the word. Our Rejection Stroop task, presented with E-Prime software (Psychology Software Tools, 1996), contained a set of attachment-related items developed by Dandeneau and Baldwin (2004), which consists of 6 targets from each of three categories: acceptance (words such as “wanted” and “liked”), rejection (words such as “rejected” and “ignored”), and neutral (words such as “chair” and “because”). There are no differences in word length between the types of words. In our analyses, the three categories of words are referred to as “stimuli valence.” Each word appeared 4 times to participants in each of 4 colours, for a total of 72 targets appearing in random order. Participants were told that this task measured how quickly they could process information. Participants responded to Stroop items by striking a coloured key on a keyboard, and reaction time was measured in milliseconds. We also measured participants’ memory of the words presented in the colour-naming task by later asking them how many words from the task they recalled after the being distracted by a connect-the-dots task. Participants completed this same Stroop task three times over the course of the experiment, the first being referred to as the “Baseline” task, and subsequent tasks referred to as “Time 1” and “Time 2.”

After completing the Baseline Stroop task, participants were oriented to the Cry Responding task, which we adapted from an infant temperament manipulation created by Donovan, Leavitt, and Taylor (2005). In this task participants were exposed to several trials of a recorded infant cry (a “colic” cry recorded from a 4-month-old healthy infant) presented on E-Prime software. Participants were told that there was a correct combination of 3 keys on the keyboard that would end the crying, and that the purpose of the task was to determine how quickly they would be able to figure out the correct response each time; the situation was likened to a real-life situation in which “your baby is crying, and you must try different things to stop him or her from crying, but the same thing does not always work.” However, the “soothability” of the computerized infant was predetermined by the researchers; some of the crying blocks were “easily soothed,” ending after 45 seconds (regardless of participants’ key pressing) and displaying the message “soothed successfully!” printed in yellow, while some cry blocks were “unsoothable,” ending after 90 seconds and displaying the message “not soothed successfully!” in red. Participants completed this Cry Responding task twice over the course of the experiment, once receiving 5 “soothable”
trials (which we shall call the “Soothable condition”) and once receiving 4 “unsoothable” trials (which we shall call the “Unsoothable condition”). The order in which participants received the two trials was counterbalanced, which created two groups based on whether participants received the soothable condition first (STF; n=47) or the soothable condition last (STL; n=45).

Immediately after the first Cry Responding task, participants completed two affect measures: the Cry Characteristic Scale (CCS; Zeskind & Lester, 1978), which quantifies participants’ perceptions of the infant cry with items such as “distressing – not distressing;” and the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1998), which quantifies participants’ emotional state with items such as “excited” and “upset.” After completing these measures, participants then completed their second Stroop task. Following this Stroop task, participants were given the Trail Making task (Reitan, 1955), a connect-the-dots task used as a distracter for our purposes, and then were given a free recall task, in which they were asked to write down as many words from the Stroop task as they could remember in one minute. After this recall task, participants then began their second Cry Responding task, which was followed by the same sequence of events: the CCS and PANAS, the final Stroop task, the Trail Making and recall tasks.

Participants then completed three questionnaires, The Experiences in Close Relationships Scale–Revised (ECR-R; Fraley, Waller, & Brennan, 2000), a measure of attachment security that yields subscales of Anxiety and Avoidance and also sorts participants into one of four adult attachment styles (secure, fearful, preoccupied, avoidant); the Rejection Sensitivity scale (RS; Downey & Feldman, 1996), a measure of trait-like expectations of rejection; and a demographics questionnaire. Finally, the deception used in this experiment was explained to participants, who were thanked for their time.

2.2 Results

2.2.1 Affect Measures

A repeated measures ANOVA was conducted on the means of CCS at Time 1 and Time 2 with order (soothable trials first [STF] vs. soothable trials last [STL]) as the between subjects factor and time as the repeated factor. The ANOVA revealed a significant main effect of order, $F(1,90)=12.10, p=.001$, which indicated that subjects in the STF group perceived both cry tasks
on average more negatively than subjects in the STL group. However, this main effect of order was qualified by a significant time x order interaction effect, $F(1,90)=51.29$, $p=.001$. Planned contrasts indicated that there was no effect of order on cry perception when subjects first hear the crying (i.e., all the subjects perceive the crying similarly at Time 1) but that cry perception at Time 2 is significantly affected by order. Specifically, the STF group perceived the infant cry at Time 2 more negatively than the STL group, $p=.001$.

A repeated ANOVA was performed on PANAS at Time 1 and Time 2 with order (STF or STL) as the between subjects factor and time and the two subscales of the PANAS (positive or negative valence) as the repeated factors. The ANOVA yielded a significant 3-way interaction effect of order x time x valence, $F(1,90)=86.45$, $p=.001$. Similar to the CCS results above, the STF group perceived the infant cry at Time 2 as significantly more negative, $F(1,48)=12.97$, $p=.001$, and less positive, $F(1, 48)=4.86$, $p=.032$, than the STL group. In other words, participants in the STL group had less negative emotion and more positive emotion after the second infant cry task than the STF group. Again, participants change their feelings in relation to the cry at Time 2 depending on the order of when they were exposed to the soothable cry.

### 2.2.2 The Stroop Tasks

Analysis of the Stroop task reaction times (RT) focuses on three possible sources that were thought to contribute to variation in RT on the Stroop task: 1) valence of stimuli (acceptance, rejection, and neutral word targets) 2) time, (testing at Baseline, Time 1, and Time 2); and finally, order (STF and SFL). Accordingly, a repeated ANOVA with time and valence as the within subjects factors and order as the between subjects factor was conducted on RT. There was a significant main effect of valence, $F(1, 168)=7.93$, $p=.001$, indicating that “acceptance” targets ($M=823.59\text{ms}$) were associated with significantly slower RTs than neutral targets ($M=807.31\text{ms}$, $p=.002$), and that there was a trend for “rejection” targets ($M=814.55$) to be slower than the RTs of neutral targets ($p=.065$). In addition, there was a main effect of time, $F(1, 170)=42.69$, $p=.000$, indicating RTs sped up from Baseline ($M=796.69\text{ms}$) to Time 1 ($M=766.34\text{ms}$, $p=.023$) and slowed down from both previous time points at Time 2 ($M=883.57\text{ms}$, $p=.000$). Finally, there was a significant valence x time interaction effect, $F(2, 271)=36.15$, $p=.000$ (see Figure 2). Pairwise comparisons indicated significant differences at Time 2, such that “acceptance” targets
were associated with slower RTs than “rejection” and neutral targets ($p=.000$). No other effects were observed.

![Figure 2. Study 1 valence x time interaction, indicating a significantly slower RT at Time 2 for acceptance items.](image)

### 2.3 Discussion

The results of Study 1 suggest that as predicted, exposure to infant crying interferes with attention regulation in non-parent undergraduates, though the pattern of this interference is not as expected. The anticipated intrinsic difference between stimuli types was found, but the way in which stimuli type interacted with the feedback order and especially with time were more surprising. Because the feedback order was randomly assigned, it was assumed that reaction times would change only with condition and not over time. However, the sequential order of the Stroop tasks has a larger effect. The pattern of slight speeding up from Baseline to Time 1 is possibly due to practice effects (Elliott & Cowan, 2001). However, the extreme slowing that is evident at Time 2 is novel. This could be interpreted as the cry task having an additive effect, in which the more crying one is exposed to, the more it interferes with attention performance. The fact that “acceptance” words were associated with the slowest responding supports this idea, as
“acceptance” words are the most incongruent with the negative experience of repeated crying episodes. This notion is supported by research on emotional Stroop tasks, which contends that higher state anxiety increases cognitive interference for emotional items (Dresler, Meriau, Heekeren & van der Meer, 2009). “Rejection” words causing the second-highest amount of interference is similarly supported, as emotional words tend to elicit more interference than neutral words (Williams et al., 1997).

The affect findings suggest that the subjective response of participants to the first episode of infant crying is the same regardless of whether they were exposed to soothable trials first or last. This means that merely hearing the infant cry affects all participants similarly even without the added component of soothability. The fact that there is a change in the affect measures after the second cry task suggests that the experimental manipulation of soothability (i.e., being told that you are effectively soothing the infant) is causing differences in the way participants feel about the cry, but only in comparison to the first condition they were exposed to.

3 Study 2: Matched Undergraduates

In this study a control group was added to ensure that cognitive reactivity observed in Study 1 is in fact due to the infant crying stimulus, and not merely a reaction to noise or a general slowing due to fatigue. The control group was exposed to a musical stimulus, which like the infant cry, is complex, rhythmic, and emotion-evoking. The infant cry is expected to produce greater interference on attention then the control stimulus, as the crying should activate the cingulate, the region of the brain that is used for the Stroop task. Music, conversely, is expected to activate temporal lobe regions of the brain such as bilateral anterior portions of bilateral temporal lobes, superior temporal regions, and parahippocampal gyri, which are not involved in Stroop task performance (Satoh, Takeda, Nagata, Shimosegawa, & Kuzuhara, 2006). In addition, we wanted to control for potential confounds that might have contributed to the effects of the cry task on the Stroop RT such as age, gender, language, and baby experience.
3.1 Participants and Methods

Twenty-six non-parent undergraduates were recruited from the UTSC participant pool to participate in the control group. The procedure used is the same as described in Study 1, but instead of responding to recorded infant cries, participants were instead exposed to the rock song “Kashmir” by Led Zeppelin (Page, Plant, & Bonham, 1975). This song is approximately 8 minutes in length, which is the approximate length of the all of the cry trials heard by the experimental group in Study 1. During the song participants did not press any keys nor were they given any feedback. Another difference is that when completing the CCS, participants were asked to think of the quality of the song (rather than the quality of the infant cry).

We then used the data of this control group of undergraduates and the previously collected data of the experimental group of undergraduates from Study 1 to compile a set of 40 matched subjects. All of these participants were ranked by the following variables: age, baby experience (as calculated through several questions on time spent doing infant-care activities), gender, first language, whether Canadian-born, and religion. The 20 best-matched pairs of participants were selected for use in further analysis. Of these, 25 are female; ages range from 18-24 ($M=20.15$, $SD=1.76$); 25 reported being born outside of Canada; 27 reported a first language other than English; the distribution of participants’ religion is Hindu (n=12), none (n=11), Catholic (n=8), Muslim (n=4), and other (n=5).

3.2 Results

3.2.1 Affect Measures

A repeated measures ANOVA was performed to investigate the influence of “group” (whether heard the song or heard the infant cries) on the means of the CCS at Time 1 and Time 2. As expected, group had a significant main effect on how the stimulus (cry or song) was rated for both Time 1 ($F[1, 38]=22.15, p=.000$) and Time 2 ($F[1, 38]=15.37, p=.000$). Participants in the control group rated the song as significantly more positive than participants in the experimental group rated the infant cry.

A repeated ANOVA was performed investigating the influence of group on the means of the PANAS subscales at Time 1 and Time 2. Significant differences were only observed for the
negative subscale of the PANAS, at Time 1 ($F(1, 38)=4.73, p=.036$) and at Time 2 ($F(1, 38)=4.82, p=.034$). As expected, participants in the control group experienced less negative emotion after hearing the song than those in the experimental group did after hearing the infant cry.

### 3.2.2 The Stroop Tasks

A repeated measure ANOVA was conducted on RT with valence and time as the repeated within subjects factors and group (cry vs. song) as the between subjects factor. There was a significant main effect of time, $F(1, 64)=19.72, p=.000$, indicating that as in Study 1, RTs sped up from Baseline to Time 1 ($p=.001$) and slowed down from both previous time points at Time 2 ($p=.000$). There was a significant time x group interaction effect, $F(1, 64)=3.35, p=.049$ (see Figure 3). Planned contrasts revealed significant differences at Time 2, such that the cry group was associated with a greater slowing than the song group ($p=.041$). Finally, as in Study 1, there was a significant valence x time interaction effect, $F(3, 132)=5.88, p=.000$. Planned contrasts indicated significant differences at Time 2, such that “acceptance” targets were associated with slower RTs than “rejection” and neutral targets ($p=.000$) and “rejection” targets were associated with slower RTs than neutral targets ($p=.002$). No other effects were observed.
3.3 Discussion

The slowed reaction time being associated with the infant cry group and not with the song group suggests that as expected, the infant cry leads to greater cognitive interference than this musical stimulus. The affect findings suggest that as expected, the infant cry is a more aversive stimulus than the song, which may underlie the associated reaction time discrepancy between the two stimuli. However, the song is simply less negative than the crying and not more positive, suggesting that the song still acts as a negative stimulus, which accounts for the slowed RT to “acceptance” targets found in the song group. The fact that both groups were associated with a general pattern of slowing at Time 2, and that both were associated with slowed reaction time to “acceptance” words begs the question as to whether the song group would show the same effects as the cry group if the particular song used were more aversive. An ideal direction for future research is thus to investigate whether level of aversiveness or selective activation of brain regions underlies performance differences on the Stroop task using EEG or PET technology.

4 Study 3: Mothers of Infants

In this study we examined the cognitive and affective responses to the cry responding task in mothers of infants, and compared these responses to those of the non-parent undergraduates in Study 1. As discussed above, greater childcare experience is associated with greater autonomic reactivity to infant cry stimuli (Bleichfeld & Moely, 1984); additionally, infant cry stimuli is considered an attachment signal for mothers of infants more so than to non-parents (Bowlby, 1979). Thus it follows that mothers of infants will exhibit the expected deficit in attention regulation following exposure to the infant responding task, as well as the expected negative emotional reaction to the infant cries. Additionally, we anticipate participants in this study to differ in their responses based on the sootheability conditions, as the conditions mimic the experience of these participants more so than those in Study 1. Finally, it is reasonable to expect these mothers of infants to be more reactive to the infant crying than the undergraduates
in Study 1, showing greater negative emotion on the affect scales and greater cognitive interference on the Stroop task.

4.1 Methods

4.1.1 Participants

Forty-five mothers of infants were recruited through parent-baby events and through a purchased list of subscribers to a parent’s magazine. Five participants were excluded for not completing the study. Demographic information for the remaining 40 participants is now described: ages of participants ranged from 23 to 39 years with a mean of 33.05 years (57.5% of participants being 33 years or older); 33 participants were married or cohabitating, 4 were single, and 3 declined to indicate marital status; the distribution of participants’ highest education level is some high school (n=1), completion of high school (n=1), some post-secondary training (n=4), completion of post-secondary training (n=22), some graduate training (n=1), completion of graduate training (n=7) and 4 declined to indicate education level; and the distribution of participants’ religion is Catholic (n=8), Protestant (n=8), Buddhist (n=6), Muslim (n=4), Other (n=5), Hindu (n=4) and 5 declined to indicate religion. Participants’ experience with infants prior to the birth of their most recent infants was assessed through combining several demographic items such as “how many diapers have you changed in your life excluding the last year;” participants ranged from low (n=7), medium (n=15), and high (n=11) Baby Experience, with 7 declining to answer. The age of the infants at the time of the mothers’ participation ranged from 4 to 12 months with a mean of 8.43 months, and 22 of these infants were female. 18 participants were primiparous, 11 had one other child, 7 had two or more other children, and 4 declined to indicate their number of children. Bivariate correlation revealed that none of these demographic variables had any association with Stroop task performance.

4.1.2 Methods

The procedure used for the mothers of infants was the same as that used in Study 1 with several adjustments. Participants came to the lab with their infants, and the infants were entertained by a research assistant while their mothers completed the experimental procedure in a separate room. Participants donated three saliva samples at different stages of the experiment, which involved placing two swabs in their mouths for one minute. The swabs were placed in plastic tubes and
frozen by the researcher for later analysis at an outside facility. Saliva was collected at the beginning of the experiment, again 20 minutes after the commencement of the first Cry Responding task, and again 10 minutes after the second sample was collected. Participants completed the final three questionnaires of the experiment, the ECR-R, RS, and demographics, while sitting in a playroom with their infants and while being videotaped as part of a Divided Attention task. This is a task in which participants are asked to attend to their infants while simultaneously conducting some other activity in order to measure how sensitively they respond to their infants while their attention is divided.

4.2 Results

4.2.1 Affect Measures

A repeated measures ANOVA was conducted on the means of CCS at Time 1 and Time 2 with order (soothable trials first [STF; n=21] vs. soothable trials last [STL; n=19]) as the between subjects factor and time as the repeated factor. Replicating the results found with the undergraduates in Study 1, the ANOVA revealed a significant main effect of order, \(F(1,38)=4.47, p=.043\), which indicated that subjects in the STF group perceived both cry tasks on average more negatively than subjects in the STL group. A significant time x group interaction effect, \(F(1,38)=34.20, p<.000\) was found, which planned contrasts indicated that while all the subjects perceive the crying similarly at Time 1, cry perception at Time 2 is rated more negatively in the STF group as compared to the STL group, \(p=.001\), just as is the case in Study 1.

A repeated ANOVA was performed on the PANAS at Time 1 and Time 2 with order (STF or STL) as the between subjects factor and time and the two subscales of the PANAS (positive or negative valence) as the repeated factors. The ANOVA yielded a significant 3-way interaction effect of order x time x valence, \(F(1, 38)=78.13, p=.001\). Similar to the results of Study 1, participants in the STL group had less negative emotion and more positive emotion after the second infant cry task than the STF group. Again, participants change their feelings in relation to the cry at Time 2 depending on the order of when they were exposed to the soothable cry.
4.2.2 The Stroop Tasks

A repeated ANOVA with time and valence as the within subjects factors and order as the between subjects factor was conducted on RT. There was a significant main effect of valence, $F(2, 76)=5.96, p=.004$, indicating that “acceptance” targets ($M=914.54$ms) were associated with significantly slower RTs than neutral targets ($M=895.69$ms, $p=.007$), and that there was a trend for “rejection” targets ($M=899.22$) to be slower than the RTs of neutral targets ($p=.061$). In addition, there was a main effect of time, $F(1, 56)=59.27, p=.000$, indicating RTs sped up from Baseline ($M=894.35$ms) to Time 1 ($M=837.58$ms, $p=.000$) and slowed down from both previous time points at Time 2 ($M=977.51$ms, $p=.000$). Finally, there was a significant valence x time interaction effect, $F(3, 142)=3.61, p=.009$ (see Figure 4). Planned comparisons indicated significant differences at Time 2, such that “acceptance” targets were associated with slower RTs than “rejection” and neutral targets, $p=.001$. No other effects were observed.

![Figure 4. Study 3 valence x time interaction indicating significantly slower RT at Time 2 for acceptance items.](image-url)
4.2.3 Comparison of Mothers of Infants to Non-Parent Undergraduates

A one-way ANOVA revealed that mothers of infants and undergraduates differed significantly on the demographic variables of age \((p=.000)\), gender \((p=.000)\), education \((p=.000)\), marital status \((p=.001)\), religion \((p=.006)\), and baby experience excluding the last year \((p=.000)\). Mothers were all female, and tended to be older, more educated, married or common-law, and to have more experience with infants (prior to the birth of their youngest infant) than undergraduates. However only two of these variables significantly influenced RT and the affect scales, those being age and level of education.

In terms of affect, a repeated ANOVA was performed on the PANAS at Time 1 and Time 2 with type of participant (undergraduate vs. mother) and order (STF or STL) as the between subjects factor and time and the two subscales of the PANAS (positive or negative valence) as the repeated factors. There was a significant valence x type interaction effect, \(F(1, 122)=5.63, p=.019\). Planned contrasts revealed that participants in Study 3 tend to experience less positive affect \((M=1.80)\) than participants in Study 1 \((M=2.19)\) and more negative affect \((M=3.2)\) than participants in Study 1 \((M=2.45)\). No significant differences were noted for the CCS.

In terms of reaction time, a repeated ANCOVA was conducted on RT with valence and time as the repeated within subjects factors and type of participant (undergraduate vs. mother) and order (STF vs. STL) as the between subjects factor and age as a covariate. Although there appears to be a pattern in which mothers are generally slower than undergraduates, there were no significant differences in their responding to the stimuli or to time.

4.3 Discussion

The results of Study 3 suggest that as predicted, exposure to infant crying interferes with attention regulation in mothers of infants, though the degree of the interference is not as expected. Because of the greater salience of the infant cry responding task to mothers, we anticipated that the pattern of responding in this study would diverge from that found in Study 1, with mothers of infants in the current study being influenced by and responding differentially to the soothability conditions of the cry responding task; this prediction was not supported. Additionally, it was expected that participants in the current study would show greater cognitive interference in response to the cry task than participants in Study 1; instead the results of the two
studies are essentially identical. Finally, we predicted that the infant cry would have a greater emotional impact on mothers in relation to undergraduates, and this expectation was partially supported.

The affect findings suggest that the pattern of responding to the cry task is comparable in both Study 1 and Study 3, such that the first infant cry is experienced similarly by all participants regardless of the soothability condition while ratings of the second infant cry diverge according to the condition participants were exposed to first. It is surprising that participants in both studies show this same pattern as it seemed likely that mothers of infants would be more reactive to the conditions. However, the fact that mothers experience globally more negative and less positive emotion than the undergraduates suggests that the cry stimulus itself is in fact the effective and salient stressor for mothers in this context that it was expected to be. The fact that affect scores did not diverge between the two types of participants suggests that the task itself elicits universal feelings of failure or efficacy rather than a relationship-specific challenge.

The reaction time findings again suggest a comparable pattern found in both Study 1 and Study 3, including no differences between order of conditions, a general slowing at Time 2, and differential responding to the stimuli valence such that “acceptance” items are responded to most slowly at Time 2. The fact that RT results for all studies conducted thus far change only at Time 2 as do the affect results suggest, as was proposed following Study 1, that the additive effect of the infant crying has a greater influence over attention than the failure-success manipulation. The general slowing observed in Studies 1 and 3 at Time 2 suggest that the additive infant crying does in fact interfere with attentional resources (however, as suggested following Study 1, there may be other reasons for this slowing which will be addressed in a subsequent study). The fact that “acceptance” words are associated with the slowest RTs for all studies conducted thus far suggests that the negativity of the repeated stimuli also has some influence over attentional resources. It is still surprising, however, that mothers exhibit the same cognitive interference as the undergraduates despite the fact that they are more adversely influenced by the cries; perhaps the stimulus is not salient enough to cause a divergence. A direction for future research would be to use the cry of an infant closer in age to the mother’s own, or to use the cry of the mother’s own infant.
5 Study 4: Mothers of Infants using Altered Procedures

In this study, a second control group was added to ensure that the pattern of slowed reaction time at Time 2 found in Study 1 and Study 3 is in fact due to cognitive interference from the infant cry, and not due to intentional slowing or to distraction and fatigue. It is possible that participants intentionally slow their responses to the second Stroop task in order to avoid errors or to improve performance on the recall task; participants be attempting to enhance their performance during the final Stroop thereby increasing feelings of self-efficacy in order to compensate for negative feelings elicited by the repeated exposure to infant crying or by feelings of failure elicited by the unsoothable cry task condition. This possibility seems likely as participants in Study 2, who are not exposed to the infant cry or to the feelings of failure, do not exhibit the same slowing effect as those in Studies 1 and 3. It is also possible that performance is diminishing due to fatigue or distraction. To investigate these possibilities, an additional group of mothers of infants were tested with some changes to the procedure (explained below), whose results were compared to those of participants in Study 3.

5.1 Methods

5.1.1 Participants

Thirty mothers of infants were recruited through parent-baby events and through a purchased list of subscribers to a parent’s magazine. Eight participants were excluded for not completing the study; no differences were observed between participants who completed the study and those who did not. Demographic information for the remaining 22 participants is now described: ages of participants ranged from 27 to 41 years with a mean of 32 years (58.3% of participants being 33 years or older), and 3 declined to indicate age; 16 participants were married or cohabitating, 3 were single; the distribution of participants’ highest education level is some high school (n=1), completion of high school (n=1), some post-secondary training (n=4), completion of post-secondary training (n=11), some graduate training (n=1), completion of graduate training (n=3); and the distribution of participants’ religion is Protestant (n=6), Catholic (n=5), Muslim (n=4), Hindu (n=3), Buddhist (n=3), Other (n=1). Participants’ experience with infants prior to the birth of their most recent infant ranged from low (n=8), medium (n=6), and high (n=3) Baby
Experience, with 2 declining to answer. The age of the infants at the time of the mothers’ participation ranged from 4 to 12 months with a mean of 8.4 months, and 13 of these infants were female. 10 participants were primiparous, 6 had one other child, 2 had two or more other children, and 4 declined to indicate their number of children. Bivariate correlation revealed that none of these demographic variables had any association with Stroop task performance.

5.1.2 Procedures

The procedure used for this group of mothers of infants was the same as that used in Study 3 with one major adjustment. Participants in Study 3 completed the first crying task, then completed the CCS and PANAS questionnaires before going on to the Time 1 Stroop task, then completed the Trail Making task and recall task following the Time 1 Stroop. The order of tasks in the current study progresses instead from the first cry responding task directly to the Time 1 Stroop, directly to the second cry responding task. After the final cry task, participants then complete one CCS (with instructions to think about all of the crying they have heard over the course of the experiment) and PANAS (with instructions to think about how they feel in this moment), and one Trail Making and recall task after the final Stroop task. All other aspects of participation remained the same. Removal of these 4 tasks was expected to diminish the effects of fatigue through shortening the length of participation required; removal of the first recall task was expected to diminish intentional slowing that may be done in order to improve performance on the second recall task.

5.2 Results

5.2.1 Affect Measures

A univariate ANOVA was conducted on the mean of the CCS with order (soothable trials first [STF; n=9] vs. soothable trials last [STL; n=13]) as the between subjects factor, which did not yield significant results, $F(1, 26)=.122, p=.730$. This indicates that there is no difference in how participants perceived the cumulative infant crying based on order of tasks. Likewise, a multivariate ANOVA conducted on the means of the PANAS subscales with order as a between subjects factor did not yield significant results ($F(1, 26)=2.03, p=.166$ and $F(1, 26)=1.36, p=.254$ respectively). Again this indicates that the cumulative infant cry tasks are not associated with any
difference between participants in the STF and STL condition in state emotion following the final cry task.

5.2.2 The Stroop Tasks

A repeated ANOVA with time and valence as the within subjects factors and order as the between subjects factor was conducted on RT. There was a significant main effect of valence, $F(1, 29)=5.96, p=.022$, indicating that “acceptance” targets ($M=831.38\text{ms}$) were associated with significantly slower RTs than rejection targets ($M=812.48\text{ms}, p=.000$). In addition, there was a main effect of time, $F(1, 30)=7.60, p=.004$, indicating that RTs sped up from Baseline ($M=853.73\text{ms}$) to Time 1 ($M=800.24\text{ms}, p=.000$), but unlike in all previous studies, did not slow down at Time 2 ($M=807.84\text{ms}$). Finally, there was a significant valence x time interaction effect, $F(3, 79)=8.28, p=.000$. Planned comparisons indicated significant differences at Time 2, such that “acceptance” targets were associated with slower RTs than “rejection” and neutral targets, $p=.000$. No other effects were observed.

5.2.3 Comparison of the Two Groups of Mothers

A one-way ANOVA revealed that mothers of infants from Study 3 and Study 4 did not differ significantly according to age, education, marital status, religion, baby experience, the age of their infants, and the number of children they had. No significant differences between the two studies in relation to the two affect measures were observed.

A repeated measure ANOVA was conducted on RT with valence and time as the repeated within subjects factors and study (Study 3 or Study 4) and condition (STF or STL) as the between subjects factor. As found in the previous studies, significant main effects of valence ($F(2, 116)=8.81, p=.000$) and time ($F(1, 87)=27.28, p=.000$) were revealed, indicating that “acceptance” targets were associated with significantly slower RTs than rejection targets, and that RTs sped up from Baseline to Time 1 and slowed down at Time 2. There was also the same significant time x valence effect, $F(3, 223)=8.28, p=.000$, indicating that “acceptance” targets were associated with slower RTs at Time 2.

There was a significant time x study interaction effect, $F(1, 87)=26.41, p=.000$ (see Figure 5). Planned contrasts indicated significant differences at Time 2, such that participants in Study 3
had significantly slower RTs ($M=977.52$ms) than participants in Study 4 ($M=807.84$, $p=0.000$). This, in addition to the main effect of time for Study 4, suggests that participants from Study 4 have a different pattern of responding than participants from the previous studies. Two higher-order significant interactions, those of valence x condition x study, $F(2, 116)=3.38, p=0.037$, and time x valence x group, $F(3, 223)=2.78, p=0.029$, were found, and investigated by re-running the same analysis using study as a split file. The significant time x valence interactions effect for both Study 3 ($F(3, 142)=3.62, p=0.009$) and Study 4 ($F(3, 79)=8.28, p=0.000$), were revealed by planned contrasts to follow the familiar pattern of “acceptance” targets being associated with slower RTs than “rejection” and neutral targets, as expected.

Figure 5. Study 4 time x study interaction indicating significantly slower RT at Time 2 for Study 3 only.

5.3 Discussion

The results of Study 4 suggest that while the pattern of responding mimics those found in earlier studies, there is a difference in responding at Time 2 that can be explained by the altered procedures. Reaction time results suggest that, as is evident in studies 1 and 3, “acceptance” words are associated with the slowest RTs at Time 2, even in the absence of the general slowing
effect that is observed in all previous studies. This is expected as the infant crying stimulus was not altered in this study. The unchanging nature of this finding lends support to the idea that “acceptance” words show the greatest interference effects as a result of being the most incongruent with the cry stimuli.

Results of the current study indicate that while there is a speeding up of RT from baseline to Time 1, which is evident in previous studies, there is no pattern of slowing during Time 2. The fact that the pattern of RT results in this study diverges from that of all other studies conducted thus far, including Study 2 which used a control stimulus, lends quite powerful support to the idea that participants may be intentionally slowing their responses at Time 2.

The fact that no differences were observed in the affect ratings is expected as differences observed in previous studies between affect ratings were based on order of conditions, while the current study used only one of each affect rating. The lack of differences observed between Study 3 and the current study is also expected, as the infant cry task was not altered in the current study.

6 General Discussion

The primary goal of this research was to determine whether infant crying interferes with attentional processing. The first three studies suggest that it does, at least over time, based on the slowing of RT at Time 2 that is associated with the infant crying but not with a rock song. Study 4, however, suggests that the cognitive interference is actually intentional slowing in order to improve recall performance at Time 2. This is evidenced by the fact that participants who heard a song rather than a cry in Study 2, and completed two recall tasks, exhibited a significant slowing at Time 2 relative to baseline. Inspection of the recall scores, however, (which have yet to be analyzed) indicates that there is no difference in recall performance over time. That is, even though participants may be making a conscious effort to remember the Stroop task items during Time 2, their performance does not improve. Likewise, inspection of error rates in the Stroop task (which have yet to be analyzed) also indicates no change over time. Additionally, recall and error rates indicate no difference between recall and error rates of Study 4 in comparison to the previous studies. Thus it is reasonable to conclude that attentional resources are in fact being depleted by our cry task manipulations such that even deliberate attempts to improve
performance are not successful. This also suggests that because recall rates are affected, the infant crying may be interfering with working memory as well. Future study may investigate this possibility through manipulating participants’ motivation during the Stroop and recall tasks.

It is interesting that all four studies evidenced the same slowed RT to “acceptance” targets, especially at Time 2. This effect is not accounted for by word length differences or other semantic differences between the valences of words used in the Stroop task. The fact that participants exposed to the rock song rather than the infant crying display this same pattern argues against our expectation that the infant cry would act as an attachment-specific stressor. According to Mikulincer, Birnbaum, Woddis, and Nachmias (2000), priming with an attachment-related stressor is associated with increased processing of attachment-related stimuli. As the song was not expected to be an attachment-related stressor (nor does it contain any content related to social relationships), it is more likely that the slowing effect is explained by “acceptance” words being most incongruent with the negative stimuli of the infant crying (as well as the less-negative stimulus of the rock song). Thus, our contention of the infant cries acting as a releaser of attachment thoughts and behaviours for mothers of infants is not supported.

A secondary goal of this research was to determine the utility of the cry responding task. The crying was expected to be perceived as an aversive stimulus for all participants; the “unsoothable” condition was intended to cause greater stress than the “soothable” condition, as well as elicit feelings of failure; the task was expected to cause greater distress in mothers of infants than non-parents; and the task was intended to mimic a real-life attachment challenge. Evidence partially supports some of these predictions. Participants in Studies 1 and 3 did express negative emotion in response to the task, and this emotion changed based on which soothability condition participants were exposed to first. That is, the cry task was associated with only negative (never positive) affect ratings, and these ratings did become more negative after the unsoothable cry task in comparison to the soothable cry task for the Soothable Task First (STF) condition. Additionally, mothers of infants did express more negative emotion than undergraduates in response to the infant cry.
The remaining predictions regarding the cry responding task are not supported. The unsoothable trials did not appear to elicit feelings of failure but rather feelings of “hostility,” as suggested by examination of individual items of the PANAS (which are not analyzed here). The same individual items did suggest that the soothable trials were associated with feelings of “pride,” but only for participants in the STF condition, and only for undergraduates. This suggests that the cry responding task has the potential to have the expected effect, but modifications are likely required. A possible confound in the design of this task lies in the deception, as many participants claimed to have “figured out” that the length of the cries was pre-determined. An ideal direction for future study is to investigate ways to make the task more convincing without sacrificing experimental control, such as making use of different cry sounds, and randomizing the length of the cries within pre-determined limits.

The results of these studies taken together suggest that in its current form, the infant responding task does interfere with attentional resources but to a lesser extent than expected. Future studies to investigate the cognitive influences of infant crying on mothers and non-parents would do well to include autonomic measures of stress, such as cortisol levels and cardiac impedance, to determine the degree of stress that is being caused by the infant cry with greater accuracy than self-report scales (this data is collected for Studies 3 and 4 but not yet analyzed). It would also be prudent to investigate the cognitive interference using EEG studies, which could determine the regions of the brain activated by the different tasks. Finally, to better investigate whether the infant crying acts as an attachment signal for mothers, a different set of stimuli that are specifically relevant to mother-infant interactions should be developed for use in the Stroop task.
References


