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When soothing succeeds: Simulating a risk for repeated shaking in abusive head trauma in infants[☆]

Mandy Chen^a, Ronald G. Barr^a, Erica Miller^b, Nichole Fairbrother^{c,*}, Alissa Antle^d, Rollin Brant^e

^a Department of Pediatrics, University of British Columbia, 4480 Oak Street, F507, Vancouver, British Columbia, V6H3V4, Canada

^b Faculty of Health Sciences, Simon Fraser University, Children's Health Policy Centre, 2439–515 West Hastings Street, Vancouver, British Columbia, V6B 5K3, Canada

^c Department of Psychiatry, University of British Columbia, Room 002, Pearkes Building, Queen Alexandra Centre for Children's Health, 2400 Arbutus Road, Victoria, British Columbia, V8N 1V7, Canada

^d School of Interactive Art & Technology, Simon Fraser University, #250 13450 102nd Avenue (Podium 2–2832), Surrey, British Columbia, Canada

^e Department of Statistics, University of British Columbia, 4480 Oak Street, F508, Vancouver, British Columbia, V6H3V4, Canada

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ABSTRACT

Purpose: To investigate the observation that perpetrators of abusive head trauma engage in repeated shakings because shaking “works” to quiet the infant.

Methods: Sixty first-time parent couples individually cared for a programmable model infant in two consecutive 7-min trials. After six minutes of consolable followed by inconsolable crying, parents selected one of three soothing techniques. For trial one, parents were randomized to a “Successful” or “Failed” Soothing Condition. Whether the soothing technique was repeated after trial two was determined by the study investigators. Parents rated their frustration after each trial.

Results: As hypothesized, parents were more likely to repeat a soothing technique that “worked” in trial one. Compared to fathers, mothers reported more frustration when soothing failed.

Conclusions: That caregivers were more likely to repeat a successful soothing technique converges with perpetrator confessions that crying cessation after shaking may be a reason why shaking is used repeatedly in response to crying.

1. Introduction

Abusive head trauma (AHT) in infancy is a serious form of intentional inflicted injury that can occur with violent shaking of an infant, with or without contact with a hard surface. It may cause severe long-term neurological damage (Keenan et al., 2003; Piteau, Ward, Barrowman, & Plint, 2012), has a 19–38% mortality rate (Fujiwara, Barr, Brant, Rajabali, & Pike, 2012; Keenan, Runyan, & Nocera, 2006; King, MacKay, & Sirnick, 2003) and incurs a substantial financial cost (Friedman, Reed, Sharplin, & Kelly, 2012; Peterson et al., 2014).

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* Corresponding author.

E-mail addresses: mandy.psyc@gmail.com (M. Chen), rbarr@cw.bc.ca (R.G. Barr), Erica_bhcp@sfu.ca (E. Miller), nicholef@uvic.ca (N. Fairbrother), aantle@sfu.ca (A. Antle), rollin@stat.ubc.ca (R. Brant).

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Because of legal implications, confessions and witnessed accounts are infrequently obtained. Etiological investigation is understandably constrained by ethical considerations. Nevertheless, studies have elucidated some risk factors, including economic hardship (Berger et al., 2011; Huang et al., 2011; Wood et al., 2012), being a male caregiver (Esernio-Jenssen, Tai, & Kodsí, 2011; Flaherty 2006; King et al., 2003; Klevens and Leeb 2010; Scribano, Makoroff, Feldman, & Berger, 2013), and being a male infant (Berger et al., 2011; Esernio-Jenssen et al., 2011; Keenan et al., 2003; Scribano et al., 2013). The close correspondence between the age-specific incidence curve of hospitalized AHT cases and the normal crying curve implies that crying is an important trigger to infant shaking (Barr 2012; Deyo, Skybo, & Carroll, 2008; Dias et al., 2005; Runyan et al., 2009; Showers 1992; Talvik, Alexander, & Talvik, 2008). Prolonged unsoothable crying bouts are particularly frustrating to caregivers (Fujiwara, Barr, Brant, & Barr, 2011; Radesky et al., 2013). Perpetrator confessions support these findings. Adamsbaum, Grabar, Mejean and Rey-Salmon (2010) reviewed perpetrator confessions in 29 AHT cases. In 55%, the confessions described 2–30 occurrences of repeated violent shaking; in 62.5%, the effectiveness of shaking at stopping crying was a reason for repeated shaking.

Adamsbaum et al.'s (2010) study highlights a particularly dangerous but well recognized clinical feature of AHT; namely, that if a crying infant is shaken with sufficient force, the baby calms down and stops crying, likely due to induction of a mild concussion. The cessation of crying functions as *positive* feedback because the infant responds as the caregiver wanted. If the caregiver had slapped or hit the infant, the opposite, undesirable outcome – including *increased* crying – would occur. Furthermore, shaking usually leaves no visible mark and no sting on the caregiver's hand. Paradoxically, this positive feedback may lead to *repeated* shaking because it “works” without negative consequences for the perpetrator. Although well-recognized among child abuse physicians, this positive feedback cycle has never been systematically studied.

A programmable model infant was used to empirically investigate this potential risk factor for the *reoccurrence* of shaking: namely, that infants quiet after being shaken the first time. However, due to potential distress parents might experience when asked to vigorously shake a life-like model infant, the underlying behavioral principle was tested instead; namely, the hypothesis that if a soothing technique succeeded rather than failed at soothing a crying model infant, parents would be more likely to repeat the same soothing technique (i.e., there would be fewer behavioral switches from one soothing technique to another). Second, whether caregivers would report different levels of frustration depending on whether they successfully soothed the infant was also explored. It was hypothesized that successful compared with failed soothing would result in less post-soothing frustration in the caregiver. Third, possible mother vs. father or male vs. female infant differences in the likelihood of soothing technique switches and post-soothing frustration were explored.

2. Method

2.1. Participants

Mothers were recruited prepartum from the British Columbia Women's Hospital Prenatal Ultrasound Clinic or postpartum from maternity wards, postnatal fitness classes, and community center flyers. Inclusion criteria included parents being primiparous and fluent in English. Appointments were scheduled when the infant was between 2 and 4 months of age. Mothers and fathers participated as couples, but individually provided consent.

Three hundred and forty-two couples were registered, of whom 83 were subsequently visited (Fig. 1: participant flow chart). There were seven non-completing couples: five with one parent (three due to technical error, one declined participation, and one had language difficulty) and two with both parents (due to equipment malfunction) not completing. The final sample of 120 parents (60 couples) were individually randomized into four experimental conditions. No group differences were found on any demographic variables (Table 1).

2.2. Model infant

The model infant used in the research was the RealCareII+[®] doll (Reality Works [Minnesota, USA]), originally designed for teen pregnancy prevention (Realityworks Inc., 2010). The commercial model can generate 15 versions of 24-h crying experiences, weighs approximately seven pounds, and has male anatomy but gender-neutral facial features. Gender was manipulated by using a blue (“Ethan”) or a pink (“Emily”) sleeper.

The model infant was customized to run two schedules. In both, the model infant cried for three minutes during which he/she would calm to gentle rocking, and remain quiet for 15 s before crying resumed. This period of “consolable crying” served to increase the “reality feel” of the infant. The model infant then became unresponsive to caregiver movement, crying inconsolably for two minutes and 45 s regardless of rocking. At the sound of a tone five minutes and 45 s from the start, parents were asked to perform one of three soothing options (i.e., placement in a bouncy chair, playing music, or pushing in a stroller). Twenty-five seconds later, the model infant calmed to silence (“Successful” Soothing Condition) or escalated its crying (“Failed” Soothing Condition). To signal the end of a trial, a chime emanated from the model infant after 10 s. The total trial duration was six minutes and 20 s. Each parent experienced two consecutive soothing trials.

Procedure

Ethics approval was obtained from the University of British Columbia's Behavioural Research Ethics Board. Data was collected between September 2012 and September 2013. Of the 60 couples, six completed the study in our hospital laboratory and 54 in their

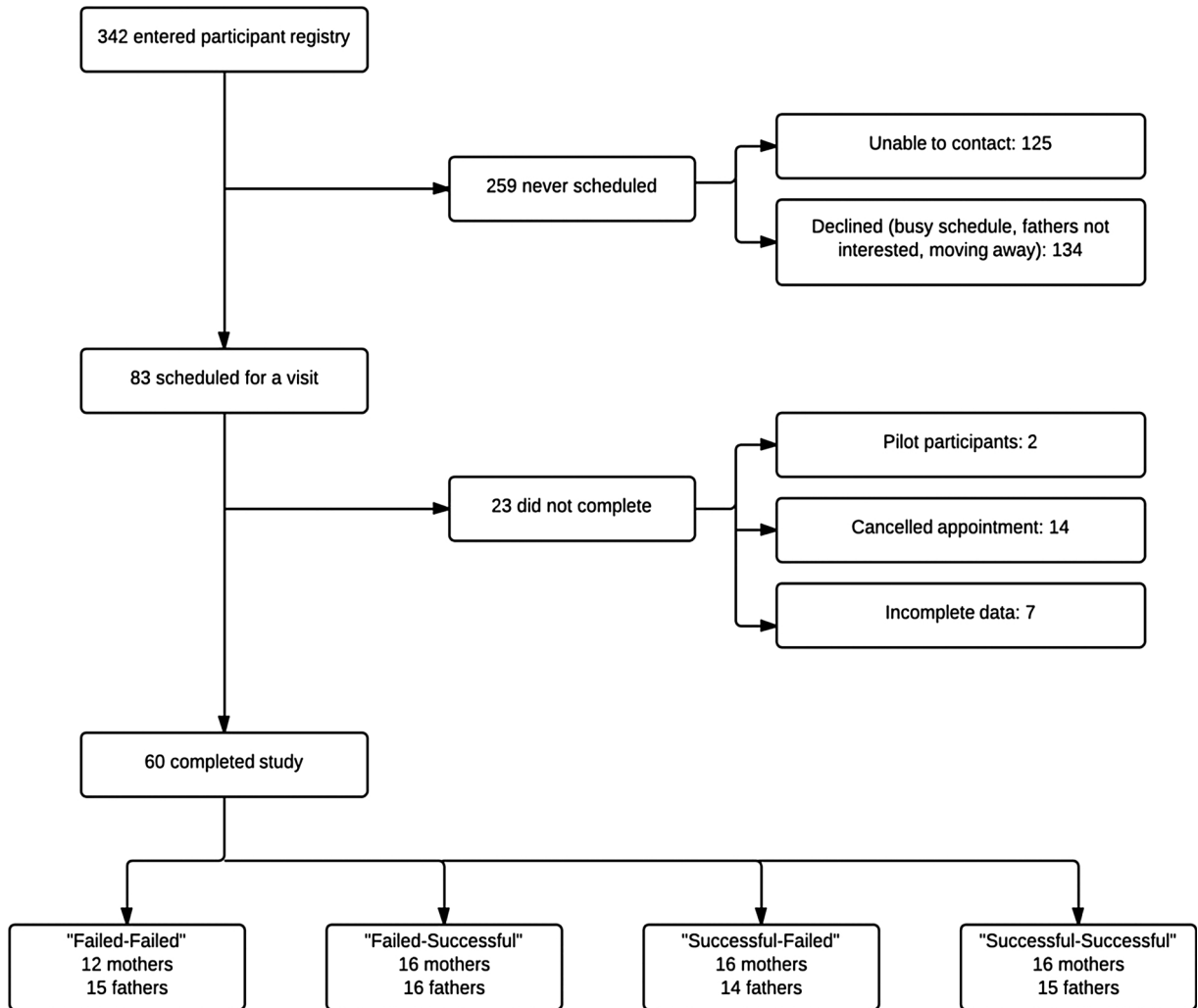


Fig. 1. Participant Flow Chart.

homes. Each parent was individually randomized to (a) an Ethan or Emily condition and (b) one of four experimental groups (Table 2). Participants were unaware of the post-soothing behavioral possibilities.

Each couple reviewed the consent forms together, then one parent participated in the procedure while the other tended their own infant in another room, wearing headphones playing music to block out the sound. The decision of which parent participated first was randomly determined. Once the first parent finished, the parents switched tasks. The couple was debriefed together at the end.

Individually, parents completed a demographics questionnaire and a measure of depressed mood. They were introduced to the model infant and told that “Ethan” (or “Emily”) “has been programmed to behave like a real infant, and as such, will cry and fuss during the time that he/she will be spending with you, and be responsive to your actions some of the time.” They were told to assume that Ethan/Emily has been “fed and changed, is not sleepy or tired, and is in good health.” They were asked to try to soothe Ethan/Emily as they would a real infant; then, when they heard a tone, to choose from among three soothing objects provided (a stroller with back reclined appropriate for a newborn infant, a bouncy chair with an on-off switch for gentle vibration, and a portable CD player with a lullaby CD inside) and perform their chosen soothing technique. The research assistant briefly demonstrated each technique. Parents then engaged in two consecutive soothing trials and rated their frustration at the end of each trial. Their behavioral soothing choices were discretely recorded by research assistants. We opted to limit parents’ choice to only three pre-determined soothing techniques because we did not want individual differences in soothing technique preference to bias the likelihood of repeating a response.

After completing both trials, parents (a) answered a manipulation check question, (b) rated the realism of the model infant, and (c) verbally provided reasons why they switched or did not switch soothing techniques on the second trial. In appreciation for their time and effort, each parent received a \$10 gift card to a coffee shop.

Table 1
Demographic Characteristics.

Variables	Mothers (n = 60)	Fathers (n = 60)
Age [Mean in Years (SD)]	32.5 (4.2)	34.8 (5.9)
Years of Education [Mean (SD)]	17.4 (2.8)	17.3 (3.9)
Parent Employed		
Yes	75%	72%
No	25%	28%
Parent Ethnicity		
Caucasian	48%	60%
South Asian	3%	3%
East Asian	32%	30%
South East Asian	10%	0%
Other	7%	7%
Parents' Marital Status		
Married	83%	
Common-law	17%	
Yearly Family Income		
< \$30,000	10%	
\$30,000–\$50,000	13%	
\$50,000–\$70,000	20%	
\$70,000–\$90,000	17%	
> \$90,000	37%	
Missing	3%	

Table 2
Experimental Groups.

		Trial 1	
		Calmed	Increased Crying
Trial 2	Calmed Increased Crying	“Successful-Successful” Group “Successful-Failed” Group	“Failed-Successful” Group “Failed-Failed” Group

2.3. Measures

2.3.1. Edinburgh postnatal depression scale (EPDS)

To rule out postnatal depression as a potential confound, parents were administered the EPDS, which is a widely used 10-item self-report measure of depressed mood, validated for use with both mothers and fathers (Cox, Holden, & Sagovsky, 1987; Eberhard-Gran, Eskild, Tambs, Opjordsmoen, & Samuelsen, 2001; Edmondson, Psychogiou, Vlachos, Netsi, & Ramchandani, 2010). Parents respond to items on 4-point Likert scales (total score = 0–30).

2.3.2. Post-soothing questions

After each trial, parents were immediately asked: “How frustrated do you feel right now?” (0 = ‘not at all’ to 6 = ‘extremely’). After completing both trials, parents answered a manipulation check question to verify whether they accurately and differentially perceived the outcomes of their soothing attempts: “Please indicate whether you successfully soothed Ethan/Emily the first time you performed your chosen technique (‘yes’ or ‘no’); the second time you performed your chosen technique (‘yes’ or ‘no’)?”

2.3.3. Realism of model infant questions

Parents answered three questions to assess the model infant’s degree of realism: (a) “When you were caring for Ethan/Emily, how much did it seem to you that you were caring for a real baby?”; (b) “How realistic did Ethan/Emily’s response to your soothing attempts seem to you?”; and (c) “While you were looking after Ethan/Emily, how responsible did you feel for his/her safety, care and emotional well-being?” using 4-point Likert scales (0 = ‘not at all’ to 3 = ‘extremely’).

3. Analytic strategy

The primary outcome measure was whether parents in the Successful vs. Failed Soothing Conditions differed in their rates of switching soothing strategies. Parent and infant gender effects were checked for first, then rates of switching were compared using a chi-square test. The secondary outcome was a comparison on the post-Trial 1 caregiver frustration ratings between Successful vs. Failed Soothing Conditions, with mothers and fathers examined separately after checking for infant gender effects. All analyses of both mothers’ and fathers’ responses adjusted for pairing with linear mixed effects models that incorporated random couple effects. None of the analyses of infant gender effects were significant. Therefore the data were collapsed across Ethan and Emily conditions.

Table 3
Rates of Switching and Frustration Ratings.

	Total (N = 120)	Mothers (n = 60)	Fathers (n = 60)
Rates of Switching			
Failed Soothing Condition			
Count	47/59	24/28	23/31
Percentage	80%	86%	74%
Successful Soothing Condition			
Count	32/61	19/32	13/29
Percentage	53%	59%	45%
Mean Frustration Rating (Standard Deviation)			
Failed–Failed Group			
Trial 1	n = 27 1.8 (1.3)	n = 12 2.2 (0.9)	n = 15 1.5 (1.5)
Trial 2	2.3 (1.0)	2.6 (1.0)	1.9 (1.5)
Failed–Successful Group			
Trial 1	n = 32 2.1 (1.5)	n = 16 2.6 (1.6)	n = 16 1.6 (1.4)
Trial 2	1.5 (0.8)	2.1 (1.6)	1.5 (1.5)
Successful–Successful Group			
Trial 1	n = 31 1.3 (1.2)	n = 16 1.4 (1.3)	n = 15 1.3 (1.2)
Trial 2	1.6 (1.4)	1.9 (1.4)	1.5 (1.3)
Successful–Failed Group			
Trial 1	n = 30 1.7 (1.6)	n = 16 1.8 (1.6)	n = 14 1.7 (1.5)
Trial 2	2.5 (1.6)	2.2 (1.7)	2.6 (1.9)

4. Results

Mothers' and fathers' mean EPDS scores were 4.4 ($SD = 3.3$) and 4.3 ($SD = 3.0$) respectively, with 8% of mothers and 7% of fathers scoring at or above 10, the cut-off score suggestive of depression (Earls & The Committee on Psychosocial Aspects of Child and Family Health, 2010). There were no gender differences on depressive mood levels, $W = 599.5$, $p = .55$.

On Trial 1, 35%, 38%, and 27% of parents chose the stroller, bouncy chair, or CD player respectively. On Trial 2, 38%, 34%, and 28% of parents chose the stroller, bouncy chair, or CD player respectively, suggesting no strong *a priori* preferences biasing parental choices. Eighty-eight percent and 92% of mothers and fathers on Trial 1, and 92% and 87% of mothers and fathers on Trial 2 accurately perceived their soothing outcomes.

4.1. Rates of switching as a function of soothing outcome (Table 3)

No parent gender effect on rates of switching in either the Failed Soothing ($\chi^2[1] = 1.23$, $p = .27$) or Successful Soothing ($\chi^2[1] = 1.35$, $p = .27$) Condition was found. Therefore, data across mothers and fathers in the primary outcome analysis was combined. The main finding was that significantly more parents switched soothing techniques in the Failed Soothing Condition (80%) than in the Successful Soothing Condition (53%), $\chi^2(1) = 11.2$, $p < .001$.

4.2. Parental frustration as a function of soothing outcome (Table 3)

The mean frustration values in Table 3 were derived by averaging the individual frustration ratings of the participants that belonged to each of the 2 (parent gender) X 4 (conditions) X 2 (Trial 1 vs. Trial 2) cells. The following analyses compared parents' frustration levels after Trial 1, collapsing the two cells with the same experimental conditions in Trial 1. Due to the small numbers in each of the $2 \times 4 \times 2$ cells, we limited our analysis in the current study to comparisons of frustration levels after Trial 1 only (i.e., mothers vs. fathers after a single successful vs. failed soothing attempt), and did not pursue any analysis of potential interaction effects between parent gender and Trial 1 vs. Trial 2.

Mothers reported significantly greater levels of frustration than fathers (means of 2.4 vs. 1.5 respectively; $\chi^2[1] = 5.85$, $p < .05$) when they failed at soothing, but similar levels to fathers (means of 1.6 vs. 1.5 respectively; $\chi^2[1] = .13$, $p = .72$) when they succeeded. When compared within genders, mothers were significantly more frustrated by failed than successful soothing (2.4 vs. 1.6; $t[58] = 2.30$, $p < .05$), whereas fathers in the two conditions reported similar levels (1.5 vs. 1.5 respectively), $t(58) = .09$, $p = .93$.

4.3. Participants' perception of the model infant (Table 4)

No significant parent gender differences on perceived realism were found, $F(1, 116) = 1.27$, $p = 0.26$. Parents felt moderately strongly that they were caring for a real baby ($M = 1.9$), with 30% endorsing the model infant to be "very" or "extremely" realistic. Parents most commonly cited lack of movement and rigidity of the infant's limbs and body as factors that detracted from the model's realism. With respect to the model's response to soothing, mothers' realism rating was significantly higher than fathers, $F(1, 116) = 3.95$, $p < .05$. Parents perceived the model's response to their soothing attempts to be moderately realistic ($M = 1.7$), with 16.7% describing the response as "very" or "extremely" realistic. Parents reported feeling unsure if their soothing attempts were

Table 4
Perceived Realism of Model Infant.

	Total (N = 120)	Mothers (n = 60)	Fathers (n = 60)
Mean Perceived Realism of Model Infant (SD)	1.9 (1.1)	2.0 (1.0)	1.7 (1.1)
Mean Perceived Realism of Model Infant's Response to Soothing (SD)	1.7 (0.9)	1.9 (0.9)	1.6 (0.9)
Sense of Responsibility for Model Infant (SD)	2.5 (1.0)	2.6 (0.9)	2.4 (1.0)

“making a difference” due to lack of facial expression and gesturing, and lack of correspondence between their own behavior and changes in the model’s vocalizations. Finally, mothers and fathers similarly reported feeling “moderately” to “very” *responsible* for the model infant ($F[1, 116] = .74, p = .39$), with 48.3% of participants giving a rating of 2 or above. Given that it was a “model infant” and that these parents had a real infant (their own) in the same house (or building) where the trial was taking place, this was quite substantial support for the reality of the procedure.

5. Discussion

This study was motivated by the clinical observation that caregivers who shake an infant may be positively reinforced to *repeat* the abusive act because the initial shaking episode provided the desired outcome of stopping the infant’s crying by inducing transient brain trauma. The fact that this may be harmful to the infant may be obscured by the absence of external marks of injury. The underlying behavioral principle was empirically investigated by examining whether caregivers would be more likely to repeat a positive soothing technique if they successfully calmed a crying model infant using a chosen soothing technique. Whether successful vs. failed soothing would result in different levels of caregiver frustration was also investigated. Finally, whether there were caregiver and infant gender effects on the caregiver’s likelihood to switch soothing techniques and their reported frustration was explored.

Consistent with our hypothesis, parents who experienced a model infant that calmed after a soothing technique was performed were more likely to repeat the same technique on the subsequent trial compared to parents who experienced a model infant that increased in crying. This supports the general hypothesis that stopping an infant’s cry is a desirable goal that motivates caregiving behavior. Further, this framework sets the stage for an ecologically valid model to explore whether or not cessation of infant crying following an earlier shaking episode may contribute to repeat shaking. Use of an infant model that does not involve living infants may permit difficult questions about the likelihood of shaking to be asked in simulated, otherwise safe situations to better allow us to understand why caregivers might shake an infant.

The purpose of this study was not to determine whether such a mechanism is specific to parents who are perpetrators of AHT. Indeed, it is likely to be true for parents generally. However, the results are consistent with perpetrator confessions that AHT was sometimes repeated because it worked to quiet the infant (Adamsbaum et al., 2010). Not surprisingly, successful or failed soothing is not the only determinant of subsequent soothing choices. Parents also reported doing so from curiosity about how the model infant would respond to other soothing objects or because of their own infants’ preferences.

It is interesting to speculate how repeating a soothing technique that “worked” (like shaking) would function in the context of a crying baby for whom none of the usual soothing techniques seemed to work. In real life, infants 1–3 months of age do sometimes cry inconsolably, giving caregivers the sense that “nothing works” to soothe them (Barr, Paterson, MacMartin, Lehtonen, & Young, 2005; St. James-Roberts, Conroy, & Wilsher, 1996). In that context, caregivers may be convinced that shaking is the *only* action that can effectively calm an infant, and repeat the behavior with future episodes of prolonged crying. The converse speculation is also telling. It was quite striking that 80% of the parents whose soothing failed tried a different technique. One can only imagine how much less shaking might occur in real life if crying *increased* (that is, soothing failed) when infants were shaken. Given that cessation of crying from soothing rather than from shaking was tested, it remains an open question as to whether these results are generalizable to actual episodes of shaking. What the results do support is that parents make behavior changes contingent on infant crying behavior to achieve an intuitively motivating goal of calming a crying infant.

It was also found that mothers may be more frustrated by failed compared to successful soothing while, perhaps surprisingly, fathers were not. This is probably counter to most assumptions about whether mothers or fathers would be more frustrated by failed soothing, especially in light of the preponderance of male perpetrators (Flaherty 2006; King et al., 2003; Klevens and Leeb 2010; Scribano et al., 2013). It is possible that because fathers perceived the model infant’s response to soothing as less realistic, they were therefore less invested and not as bothered by failed soothing. Alternatively, as the primary caregiver of children, mothers may be more sensitive to feedback about their ability to soothe a crying infant. Nash, Morris, and Goodman (2008) reported that mothers commonly feel it is their fault if their baby cannot be consoled. Interestingly, half of these mothers stated that fathers coped with crying by passing the baby back to them. This suggests that mothers may sometimes be the sole caregivers delegated with the responsibility of calming a crying infant. Finally, the target of frustration may be an important variable to disentangle in future studies. That is, it was hypothesized that failed soothing may lead to higher frustration in fathers *towards the crying infant*, but it may be reflecting higher frustration in mothers *towards themselves* when they failed to calm the crying infant.

This was the first study where adults who were themselves parents were asked to take care of a programmable model infant. Realism questions confirmed that parents generally felt the model infant was moderately realistic. This suggests that use of model infants may be a viable methodology for studying contributing factors to AHT. Parents’ explanations of their realism ratings suggest that some parents perceived responses to be unrealistic because the model infant was not *immediately* responsive to their soothing

attempts. This may reflect a common misperception that inconsolable and unresponsive crying is unusual and suggestive of something being “wrong” with infants when, in fact, such behavior is normative at 1–3 months of age (Barr 2000; Barr 2006; Barr et al., 2005).

Infant gender effects on the variables examined were not found. Possibly, the model infant (as opposed to real infants) was not effective at eliciting gender-specific attributions and expectations from the parents. Alternatively, the gender of the infant may not affect parents' soothing choices.

There were a number of study limitations. First, only couples where both members consented were included, with relatively high average income and education levels. Consequently, parents with less partner support and possibly higher levels of parenting and financial stress may be underrepresented. Another limitation is that some parents made their soothing choices based on factors other than the soothability of the model infant, such as their own infant's preferences. The results suggest that, irrespective of the specific underlying reason, the likelihood of repeating a soothing technique would be about 27% less if the infant (model or otherwise) cried more rather than less when the technique was performed.

6. Conclusions

Using a model infant, it was confirmed that parents were more likely to repeat a soothing technique if they experienced initial success at quieting the crying model infant. In fact, the likelihood increased by approximately 27% compared to what parents would do if the soothing failed. This result is consistent with the expectation that stopping an infant's cry is a desirable goal that motivates caregiver behavior. Future studies may wish to extend these findings by considering the potential effects of parental demographics, caregiving histories, disciplinary practices, and different choices of soothing interventions. Further, it provides a platform for investigating whether or not cessation of infant crying following an earlier shaking episode may contribute to repeat shaking. In principle, similar techniques could be used to explore such questions as caregiver judgements about how much lack of responsiveness to soothing efforts would make a caregiver consider shaking an infant, and what would prevent them from considering shaking as a means of stopping the crying. Understanding who, when, why and under what circumstances parents shake their infants—and what might be learned to prevent this response—is a critically important question. Using programmable model infants is a promising innovative approach for attempting to address some of these questions.

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