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Functional Analysis of Excessive Crying in Infancy: Two Empirical Case Studies

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FUNCTIONAL ANALYSIS OF EXCESSIVE CRYING IN INFANCY: TWO EMPIRICAL CASE STUDIES

by

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Excessive crying and infantile colic account for a significant percentage of caregivers' calls and visits to the pediatrician early in infancy. Despite myriad research studies across medical and psychological disciplines over the years, there is no conclusive evidence regarding a cause for excessive crying in early infancy; as a result, there is no gold standard for treatment. The goal of this study is to develop and test an experimental functional analysis methodology to determine a cause for excessive crying in infants. The study involves the development of an interview and paper-based functional assessment tool for excessive crying in infancy, as well as experimental manipulation of social and sensory reinforcement conditions in two case studies. Following the experimental sessions, the data sets for both case studies suggest a social-positive reinforcement contingency as the maintaining variable for distressed crying. The caregivers were given treatment recommendations emphasizing the use of differential social-positive reinforcement as a management strategy. The analyses of subsequent reductions in crying levels are described. Crying was reduced relative to baseline by the end of the study for both participants. On social validity measures, caregivers reported that the study was beneficial. Limitations of this study include the small number of participants, the possibility that social consequences were a parental reaction to excessive crying rather than a maintaining variable, and the challenges in ruling out maturation as a confounding variable.

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INTRODUCTION

Excessive Crying and Colic

Excessive crying in infancy can be a common and troubling concern for parents in the first few months, or longer, of a child's life (Golton & St. James-Roberts, 1991; Keefe, Kajrlsen, Lobo, Kotzer, & Dudley, 2006; McKim, 1987; Ventura, 1987; Zeifman & St. James-Roberts, 2017). Much of the literature related to unexplained, excessive crying in infancy is associated with infantile colic. The defining symptoms and conditions of infantile colic were characterized by Wessel and colleagues as excessive fussiness or crying of unknown origin that occurs more than 3 hours per day, 3 days per week, for more than 3 weeks in an infant under 3 months of age that is in otherwise good health (Wessel, Cobb, Jackson, Harris, & Detwiler, 1954). Wessel's criteria has come to be known as the "rule of three"; these criteria are often used by pediatricians or other physicians in "diagnosing" a child with colic after potential medical causes have been ruled out (Johnson, Cocker, & Chang, 2015). By comparison, typically-developing infants cry an average of 1 to 2 hours per day (Roberts, Ostapchuk, & O'Brien, 2004) and crying is often traceable to acute or more diffuse sources of discomfort (e.g., hunger, gas or other source of pain, tiredness, wet or dirty diaper, etc. [Epstein, 2012]). For the majority of infants, crying progressively increases after birth, with the highest crying levels occurring around 6 weeks of age, followed by a steady decline after the 3- or 4-month mark (Brazelton, 1962; Wake et al., 2006). While this general pattern is also often demonstrated in infants "diagnosed" with colic, the overall duration of crying occurs at a much higher rate in children with colic compared to their same-age peers without colic (Barr, St. James-Roberts, & Keefe, 2001). Other significant features of colic include sudden paroxysmal onset of crying, hypertonia during crying episodes, drawing up of the knees, increased crying during the night, and crying that often persists despite

exhaustive and varying attempts to soothe the child (Bell & Ainsworth, 1972; Lester, 2006; Lester & O'Neill, 2005; Weissbluth & Weissbluth, 1992).

Data suggest that colic occurs in 10 to 40% of infants worldwide (Lucassen et al., 2001); the large variation in reported prevalence may be due to slightly varied criteria definitions and different methodologies for "diagnosing," such as the use of a questionnaire versus clinical interview (Lucassen et al., 2001; Reijneveld, Brugman, & Hirasing, 2001). Despite the fact that colic is usually identified as being self-limiting, typically resolving between 3 and 4 months of age (see Weissbluth & Weissbluth [1992] for the potential implication of melatonin circadian rhythms in the decrease in colic symptomology between 3 and 4 months), studies have found that some infants who meet the defining criteria continue to cry excessively beyond 3 months. In one particular study, a large sample found that about 40% of children exhibited excessive crying past 3 months (Wurmser, Laubereau, Hermann, Papousek, & von Kries, 2001). In another study (von Kries, Kalies, & Papousek, 2006), 16% of the general population interviewed had infants who exhibited excessive crying in the early months of infancy; of that subgroup, 64% exhibited excessive crying only in the first few months of life, while another 20% had excessive crying resolve by 6 months, and in 16%, excessive crying persisted beyond 6 months of age.

Potential Impacts of Colic

Additional research has been conducted over the years to provide insight into the longer-term outcomes of infants who cry excessively. Findings from these studies suggest that persistence of crying, especially beyond 6 months of age, is correlated with feeding and sleeping problems (von Kries et al., 2006; Wolke, Meyer, Ohrt, & Riegel, 1995; Wurmser et al., 2001); though the mechanism underlying this correlation is not clearly understood, some researchers

have implicated the role of reflux (Miller-Loncar, Bigsby, High, Wallach, & Lester, 2004) or caregiver behavioral patterns related to management of night waking in infancy (Wolke et al., 1995). Research has also shown that infants who cry excessively may be at greater risk in childhood and/or adolescence for hyperactivity and academic problems (Wolke, Rizzo, & Woods, 2002), behavioral and mood disorders (Santos, Matijasevich, Capilheira, Anselmi, & Barros, 2015; Smarius et al., 2017), migraines (Romanello et al., 2013), as well as lower IQ scores and poor fine motor skills (Rao, Brenner, Schisterman, Vik, & Mills, 2004) compared to typically-developing peers. Many of these studies have been exclusively correlational, or have had small samples, implying that additional research is needed. However, some studies have implicated potential mediating variables to explain the relationship between excessive crying and future medical and/or behavioral issues, such as common "pathogenetic mechanisms" (Romanello et al., 2013), neurological issues (Rao et al., 2004), and the maternal burden of infant care (Smarius et al., 2017).

Colic may impact the wellbeing of the child in other ways as well. The stress associated with caring for an infant with colic can be daunting for caregivers. Myriad unsuccessful attempts to soothe the child can often result in frustration and sleeplessness on the part of the parent, increasing the likelihood of neglect and/or abuse (e.g., shaken baby syndrome; Carbaugh, 2004; Castiglia, 2001; Papousek, 2000; Papousek & von Hofacker, 1998). Studies have also linked colic and excessive crying to the emergence of family dysfunction and maternal depression (Rautava, Lehtonen, Helenius, & Sillanpaa, 1995; Vik et al., 2009).

Research on Etiology and Treatment

A plethora of research has been conducted to determine the etiology of colic and develop effective treatments (see Hall, Chesters, & Robinson, 2012; Perry, Hunt, & Ernst, 2011 for reviews of articles examining etiologies and corresponding treatments for colic). Despite this long history of research, studies have reached mixed or contradictory conclusions. Colic has become a diagnosis of exclusion once other medical causes have been ruled out and infant crying patterns fit Wessel's criteria. As a result, reliable diagnostic processes and empirically supported interventions have been slow to develop.

Medical research. Medical researchers often attribute colic to gastrointestinal upset, postulating causes such as intolerance of formula solutions or allergic reactions to breastmilk resulting from an offending culprit in the mother's diet (e.g., from drinking dairy beverages [see Hide & Guyer, 1982; Leung & Lemay, 2004; Sampson, Sicherer, & Birnbaum, 2001]). Some studies have found the use of hypoallergenic formula solutions to be helpful in reducing crying levels in some children with colic (Duygu, Handan, Gozum, Orbak, & Cifci, 2008; Oggero, Garbo, Savino, & Mostert, 1994). Researchers have also studied the role of changes in gut hormones (Lothe, Ivarsson, Ekman, & Lindberg, 1990), increased prevalence of gut microflora (Savino et al., 2004), central nervous system imbalance (Halpern & Coelho, 2016), and issues of gastrointestinal malabsorption (Lothe, Lindberg, & Jakobsson, 1990). While gastrointestinal explanations have prevailed in the medical community for years, convincing arguments have been made to counter these claims. Studies have incorporated x-rays to assess gastrointestinal functioning during colic crying episodes and have found evidence against gastric abnormalities (Harley, 1969; Illingworth, 1985). Additionally, some studies have shown that anti-gas medications are no more effective than placebo in reducing colic-related crying (Garrison &

Christakis, 2000; Lucassen et al., 2000). More recent reviews on the use of probiotics in the treatment of colic have found mixed results (Sung et al., 2013). Thus, despite the extent of medical research over the years, theories regarding biological etiologies of colic have emerged with inconsistent and contradictory findings.

Some research has suggested that approximately 5% of cases of excessive crying may have an organic origin (Douglas & Hiscock, 2010), or that colic may be an early manifestation of later health problems such as gastrointestinal issues or allergic disorders (Savino et al., 2005). However, most cases of excessive crying may occur without an obvious, verifiable physiological cause, leading some experts to speculate that it may be a variation of normal development (Barr et al., 2001; Douglas & Hiscock, 2010; Hall et al., 2012) or have a behavioral, rather than biological, etiology (Savino, 2007).

Research in mainstream psychology. With the absence of verified biological or medical causes or colic, a range of psychological constructs and behavioral variables have been proposed as causal or correlational factors for colic. A considerable amount of the developmental psychology literature hypothesizes that colic is a state regulation disorder (Taubman, 1984; Keefe et al., 2006). According to Brazelton and Nugent (1995), infant "state" is a continuum of arousal level, ranging from deep, quiet sleep to hyper-arousal and crying. In early infancy, the child often has difficulty with self-soothing, and therefore, must rely on the assistance of caregivers to help regulate. Developmental theorists have asserted that as changes in the infant's state occur, caregivers may either respond appropriately or "incorrectly" to the child's needs (e.g., being hungry, tired, or over-stimulated) to re-regulate, and therefore, crying may persist if or when caregivers respond inappropriately (Brazelton, 1962; Taubman, 1984). As crying continues, caregivers may subsequently "overcompensate" by increasing their efforts to soothe

the child, leading to overstimulation of the infant's arousal level, and thereby, further contributing to the persistence of crying.

State-based theories, on their own, tend to be descriptive rather than explanatory. For example, they seldom stipulate independently testable factors that may cause overstimulation in some colicky infants, but are absent in other infants who do not display excessive crying. As a result, practical management strategies are seldom suggested. Along a related theme, Kirjavainen et al. (2001) examined the role of autonomic nervous system arousal as a cause of colic symptoms by measuring heart rate variability (HRV), a physiological measure of arousal, in colicky versus non-colicky infants at two time periods in infancy. The study showed that comparisons of HRV between the colicky infants and a control group, performed at both 2 months and 7 months of age, did not differ significantly with age or between groups, thus minimizing the role of autonomic system arousal states in the etiology of infant colic. Theories on physiology have not been empirically supported as an independent cause for excessive crying but may be a helpful component, in conjunction with other psychological theories, in understanding how infant physiology may contribute to excessive crying.

Other realms of psychology have suggested that colic stems from having "difficult" temperament (Barr & Gunnar, 2000; Thomas & Chess, 1977) or infant-caregiver attachment disorders (Akman et al., 2006). Unfortunately, there are no independent, validated assessments of temperament and thus no specific, evidence-based treatments that are derived from temperament theories.

Publications in psychology have focused primarily on providing interventions or guidance on how to soothe the infant (and potentially decrease crying levels) and/or help the caregiver cope with the stress of caring for an infant who cries excessively. Some infant-oriented

studies have implemented the use of different kinds of sensory stimulation and have trained caregivers to respond more systematically to crying episodes and the child's cues (Keefe et al., 2006; St. James-Roberts, Sleep, Morris, Owen, & Gillham, 2001; Taubman, 1984). Oft-suggested methods to help soothe infants include: carrying, rocking; gently stroking the child's head or "third eye," back, or chest; swaddling; singing or talking; playing soft music; walking with the child in one's arms or in a stroller; riding in a car; using rhythmic noises or vibration; burping the infant; or putting the infant in a warm bath (Barr et al., 1991; Huhtala, Lehtonen, Heinonen, & Korvenranta, 2000; Shelov, 2005). Many studies have used lists of suggestions or broad treatment packages, so discerning specific variables responsible for reductions in crying has been difficult. Another issue with many studies is that reported reductions in crying episodes are solely reduced to non-statistically-significant or non-clinically-significant levels. Carrying therapy (Barr et al., 1991), specifically, was found to have no effect in reducing crying levels compared to control. In another study, the amount of "colicky" crying was reported to be reduced in an intervention testing the use of infant massage or a crib vibrator (Huhtala et al., 2000), in which infants in both groups had significant reductions in crying levels following a one-month intervention period.

Some studies have focused on both providing both infant- and caregiver-based interventions. In one study (Keefe et al., 2006), infant interventions were based on having the caregiver learn to read the child's cues to provide regulation, training sleep/wake cycles, providing repetition and structure, and utilizing touch and holds. Caregiver interventions focused on providing the caregivers with reassurance, empathy, support, and advocating for the caregiver to take a time-out from parenting for a short period of time per day (i.e., while the child is in the care of another). Keefe et al. (2006) reported that the treatment group showed a statistically

significant reduction in crying levels compared with the control group (whom were provided with standard care) at the end of the study; however, visual analysis of the graphic data displays showed that hours of crying and intensity of fussiness, for both the experimental and control group, decreased in a very similar manner across the time of study (i.e., consistent decreases occur for both groups across time), suggesting that there could be other factors responsible for decreases in crying levels, such as the passage of time and developmental factors (see Discussion section for further analysis on this issue, and see Branch, 1999; 2014 for a relevant critique of statistical significance testing).

Caregiver-focused interventions have typically aimed to provide caregivers with more information, management techniques, or social support until colic symptoms dissipate later in infancy (Keefe et al., 2006; Parkin, Schwartz, & Manuel, 1993; St. James-Roberts et al., 2001). Many of these studies have reached mixed or contradictory conclusions or have suffered from methodological issues (e.g., Barr et al, 1991; Keefe et al, 2006; Parkin et al., 1993; St. James-Roberts et al., 2001; Taubman, 1984). In one particular study (Parkin, Schwartz, & Manuel, 1993), participants were either provided with counseling and support, a car ride simulator to help soothe the child, or were placed in the control group. The authors found no significant differences in infant crying levels or caregiver anxiety when comparing groups.

While caregiver-focused interventions are likely to be beneficial in helping the caregivers cope with the stress of their infant's excessive crying, it does not help elucidate the cause of excessive crying. Behavior analytic research with a strong emphasis on robust empirical methodology, such as the use of "single-subject" designs that feature repeated measures over time, designed to demonstrate experimental control and functional analysis, may be valuable where other psychological and medical research strategies have failed.

Behavior Analysis and Child Development

Behavioral perspectives on child development, in general, gained momentum in the 1960s with the release of Bijou and Baer's (1961) seminal book on child development. At the most basic level, behavioral interpretations of child development can be viewed as changes or progressions in the way an organism (human, in this case) interacts with the environment (Bijou & Baer, 1961). In a behavioral account of the early development of infants, it is important to analyze both biological and environmental determinants of behavior. Respondent behavior may originate with innate reflexive behavior, in which a stimulus in the environment elicits a response, and become conditioned behavior that develops through pairing of unconditioned and conditioned stimuli. Reflexes are innate and occur without prior learning (e.g., the pupillary response in which eye pupils constrict or dilate in the presence of bright or weak light, respectively). For example, with respect to behaviors present in early infancy, rooting and sucking are innate capabilities that help the infant acquire food. With respect to rooting, a tactile stroke on the mouth or cheek with a bottle or breast (unconditioned stimulus) elicits the infant to turn in the direction of that stimulus (unconditioned response). This sets about a respondent behavior chain; when the infant turns in the direction of the stimulus or food source, it results in that stimulus touching the inside of the mouth, which elicits the sucking response. Respondent behavior may involve both unconditioned and conditioned responses that are elicited by the stimulus that precedes it. Related or unrelated stimuli that occur repeatedly within close temporal proximity to the unconditioned stimulus may come to elicit a conditioned response, and additionally affect operant behavior (i.e., Donahoe, Burgos, & Palmer, 1993). For example, a newborn baby that is nursing may begin to exhibit sucking behavior as soon as they are held in a position that is akin to nursing, regardless of who is holding the child. This behavior is likely to

change over time, as the child learns that rooting and oral motor movements are only reinforced with milk in the presence of the mother. However, stimuli associated with the mother, such as specific smells or clothing, may come to elicit rooting and sucking behavior from being paired with the mother, and therefore, could elicit nursing-related behavior even in the mother's absence (e.g., if the child's father was wearing a piece of the mother's clothing).

Skinner (1981) discussed that operant behavior constitutes a form of behavioral selection (a function of consequences); this analysis on the origins of human behavior has been further discussed in terms of phylogenic contingencies (those occurring for a species from natural adaptation) and ontogenic contingencies (those occurring over the course of the lifespan of an organism) (Donahoe & Palmer, 1994/2004; Skinner, 1966). While some behaviors may have origins as unconditioned responses, they may quickly come under operant control (see Epstein, 2012 and Whittingham, 2014 for theoretical discussions on the roles of respondent and operant behavior in infant crying).

Research relevant to infant crying. Behavioral explanations of developmental phenomena emphasize both respondent and operant conditioning. Developmental theory on state regulation as a cause for colic can be explained using basic principles of conditioning. Behavior produces stimulus consequences, some of which reduce states of deprivation or aversive stimulation (often called unconditioned motivating operations) and as a result, these behaviors are reinforced and become more probable in future situations that involve the same motivating operations (see Laraway, Snycerski, Michael, & Poling, 2003; Michael, 1993). A study by Hart, Allen, Buell, Harris, and Wolf (1964) identified respondent and operant functions of crying. Crying is likely to be elicited in early infancy in response to noxious stimuli or issues with regulation (e.g., pain, hunger, anger [Wolff, 1969]). According to studies, these cries have

different sound qualities (i.e., hunger is lower-pitched and repetitive, whereas the pain cry is said to be louder, higher-pitched, and much harder to ignore). Both the child's cries and caregiver response are unconditioned responses to unconditioned stimuli—a connection that is likely established as a result of natural selection; infants who failed to cry in response to noxious stimuli might have failed to attract attention and help from caregivers, thus increasing the likelihood that those infants might not survive to reproductive maturity. Furthermore, as caregivers respond to crying, stimulus properties of the caregivers (e.g., facial features, auditory properties, etc.) or environments (e.g., particular rooms in the house or public settings) readily paired with caregiver presence may become conditioned stimuli that elicit crying. Those instances of crying, in turn, could eventually be selected in an operant relation as development and learning continues.

Indeed, crying may come under control of environmental events, a demonstration of operant behavior. Research has suggested that operant crying may begin as early as 3 weeks of age (Wolff, 1969), when it is reinforced by caregiver attention or may have self-reinforcing properties for the infant (e.g., auditory or other sensory reinforcement). Thus, crying may come to have different functions (i.e., attention, escape, sensory, etc.) for different infants depending on the antecedent variables (any environmental events that may precede and evoke crying, such as a caregiver ceasing holding the child, changes in temperature, white noise being turned off, etc.) and consequential variables that follow the child's crying behavior (a caregiver picking up, swinging, or rocking the child; sensory stimuli being presented or removed).

After a reinforcement history of a caregiver responding to the infant crying in a particular pattern (e.g., regularly providing attention, such as picking the child up, rocking the child, talking to the child, etc.), the presence of the caregiver and other environmental stimuli that are routinely

present when a crying response is reinforced may become discriminative stimuli, thereby signaling that the reinforcement is available when the relevant motivating operation is in effect (e.g., deprivation of attention). In future interactions, the caregiver could incidentally respond with the functional response by chance, reinforcing crying in that instance and creating a discriminated operant function. Just as behaviors that originate as respondent behavior may take on operant properties, it is possible to remove just the acquired *operant* function. This is an important component for reducing (not eliminating) operant crying levels, as crying should still maintain its respondent contingencies to indicate distress and the need for caregiver care.

Behavioral approaches for the treatment of excessive crying have led to more promising results than other approaches. In one of the earliest studies using a behavioral methodology, Williams (1959) utilized caregiver-attention extinction to effectively reduce the frequency of crying in a 21-month-old child, who had previously had medical problems and had been accustomed to high levels of attention, during nap and sleep times. After medical approval from the child's physician, the caregivers ignored cries after putting the child to bed, and crying levels gradually decreased to zero levels after approximately seven trials. This suggests that *excessive* crying might partially be a function of operant reinforcement, in the form of caregiver attention.

Etzel and Gewirtz (1964) documented a similar effect of attention extinction in a children's hospital for two infants who were postulated to engage in "operant crying" behavior that was motivated primarily by the response consequence (i.e., operant crying) rather than by antecedent stimulation alone (i.e., respondent crying). The experimenters were able to successfully utilize attention extinction without completely eliminating contingent attention (i.e., a caregiver used a neutral, unresponsive facial expression when interacting with the infant while crying) to reduce the frequency and duration of crying, for both participants. Additionally, after

extinction, appropriate communicative and social behavior incompatible with crying, such as smiling and eye contact, was reinforced using stimuli such as higher quality adult social attention (i.e., smiling, praise), as well as visually- and aurally-appealing objects. During the reinforcement phase, appropriate behavior increased and crying was reduced to near-zero levels.

Other researchers have demonstrated similar effects of operant extinction for crying. For example, Larson and Ayllon (1990) replicated the methodology of a prior study (Finney & Christophersen, 1983), using operant principles to decrease crying in children with colic. Eight participants completed the study, which helped to control for extraneous demographic variables that might influence effects on crying (e.g., sex, gestational age, race, birth weight, delivery method [including with or without medication], feeding method [formula vs. breastfed], intact families vs. single parents, employed vs. stay-at-home caregiver, and socioeconomic status). The experimenters utilized three experimental conditions: a baseline phase in which the caregivers were instructed to respond as they normally would prior to experimentation, a response-independent music phase in which caregiver-selected music played on a response-independent schedule during the observation sessions, and a treatment phase in which music and caregiver attention were delivered contingent on quiet behavior, and subsequently terminated when crying resumed. The treatment phase also utilized a 3- to 5-min timeout procedure that was initiated when crying would begin after a quiet period, in which the infant was placed in a carrier away from the caregiver during this time. Results showed that high rates of crying persisted during baseline and that response-independent music did not decrease the percent of time that children cried in observation sessions compared to baseline. However, when the music was included as part of the differential reinforcement treatment package with contingent caregiver attention, a significant decrease in the amount of crying per observational session occurred. Overall, the

authors reported an 80 to 90% decrease in the amount of time crying from baseline to the completion of the treatment condition. Despite these positive results, it is difficult to assess the abative (i.e., the decrease in frequency/duration of crying behavior) effect that contingent music might have on crying since it was confounded with the presentation and/or removal of caregiver attention. Since these variables were not separately manipulated, and instead used as a treatment package, it is possible that contingent music had no effect at all on decreasing crying, and that caregiver attention was the sole variable controlling the changes in infant behavior.

While the above-mentioned behavioral studies were successful in reducing excessive crying levels in infants and young children, dissemination of behavioral principles in the treatment of infant colic or cases of excessive crying has not been widespread. While the exact reason for this is not known, use of extinction- and time-out-based procedures may not be appealing to caregivers, as these procedures often involve letting the child cry for long periods of time without providing caregiver attention.

Behavioral research relevant to caregiver responses to infant behavior. Additional research has more recently been conducted on the role of caregiver consequences on infant crying behavior. More specifically, a series of studies have examined the impact of negative reinforcement in caregiving, demonstrated when subjects are presented with high levels of crying in simulations. Thompson, Bruzek, and Cotnoir-Bichelman (2011) conducted a translational study that involved college students in a caregiving simulation in which various caregiving responses terminated the sound of an infant cry; the study concluded, in part, that infant crying is an aversive stimulus that evokes caregiving behavior, implicating a significant role of negative reinforcement in the caregiving of young infants. In a related translational study, Tye (2014) first exposed individuals to a negative reinforcement and extinction condition with an infant

simulator, in which caregiving responses such as feeding and rocking were negatively reinforced (i.e. by termination of crying by the infant simulator); the second portion of the study involved use of a task analysis and behavioral skills training for caregiving responses amidst an "inconsolable" crying simulation. While these studies have interesting implications for caregivers to engage in appropriate care responses, it is difficult to assess the validity of the findings in the absence of actual caregiver-infant interactions, which is likely to produce different patterns of caregiver behavior compared to a simulation.

Glowdowski and Thompson (2017) evaluated whether distracting activities (e.g., playing with a stress ball, completing a crossword or Sudoku puzzle, engaging with an iPhone that had different games installed) would help mitigate the aversive effects of infant crying for college students. For half of the participants, there was a longer latency until the participant terminated the sound of infant crying during a distraction condition versus no-distraction condition, suggesting some mitigating effects for those participants; there was little difference between conditions for the other participants.

While this may be a line of research that has utility to reduce stress and increase coping abilities for parents, more socially significant research must be conducted with actual caregivers of infants and amidst in-situ environments. Additionally, while the above studies look at how adults respond in infant crying stimulations within a behavior analytic framework, there is a lack of focus on understanding why crying occurs, and how to manage excessive crying in a functional way.

There is a need for further behavioral research relevant to infant crying, as the effects of colic are potentially life-changing for infants and their caregivers, and may be the result of variables that are easily manipulated through behavioral intervention, as is typically

demonstrated in the use of functional analysis methodology. Regardless of the success of some of the above-described behavioral interventions that utilized interventions with crying infants, there have been no published attempts to systematically manipulate and isolate contextual factors that might be maintaining an infant's excessive crying. Over recent years, behavior analysis has developed and refined a methodology to identify the maintaining variables for a range of challenging behaviors (e.g., self-injury, aggression, tantrums) and documented the efficacy of interventions that are informed by the identification of maintaining variables (Iwata & Dozier, 2008). The focus of the case studies presented herein are to evaluate the feasibility of using functional analysis methodology to assess and possibly decrease excessive infant crying levels.

Functional Analysis as a Tool for Assessment and Intervention

Functional analysis (FA) refers to a methodology that features the manipulation of experimental variables to determine the function, or contextual factors that "cause" a particular behavior. Functional analysis is a term for explanation in behavior analysis (and other sciences) that refers to an experimental analysis and is more conceptually consistent than "cause and effect" (Schlinger & Normand, 2013; Skinner, 1953). FA is a major tenet of behavior analytic research and treatment. An experimental FA consists of sessions in which antecedents and consequences of a target behavior are systematically manipulated so that the various reinforcement contingencies that may be maintaining behavior can be isolated and evaluated for their potential impact on the behavior of interest (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). Traditional functional analyses utilize challenge, or test, conditions to examine modes of reinforcement previously established as maintaining problem behavior. In the original conceptualization of functional analysis methodology, these conditions typically consist of:

social-positive reinforcement (contingent attention condition), social-negative reinforcement (escape from demand condition), automatic reinforcement (alone condition), and a control condition which accounted for the effects of an enriched environment. More recent research has greatly expanded the range of variables that are included in "test conditions" (Davis, Kahng, Schmidt, Bowman, & Boelter, 2012; Hanley, 2012; Schnell, Sidener, DeBar, Vladescu, & Kahng, 2018).

The research designs pursuing functional analyses (or functional relations) of behavior and environmental variables have been single case experimental designs (Kazdin, 2011; Sidman, 1960); these designs allow for variables to be tailored to each individual and include multiple exposures of the variables, allowing for replication of effects within the individual, thereby providing an exceptional model for assessment. Research on applying the single case experimental model to applied problems has been very successful with a variety of behavioral problems (e.g., aggressive behavior, self-injury) in research and practice, and is the gold standard for creating function-based treatments in applied behavior analysis (Beavers, Iwata, & Lerman, 2013; Hanley, Iwata, & McCord, 2003).

As increased research has been devoted to functional analysis over the years, new applications of the methodology have resulted: to those exhibiting social avoidance behavior (Harper, Iwata, & Camp, 2013), sleep problems (Jin, Hanley, & Beaulieu, 2013), as well as determining variables to increase physical activity in children (Larson, Normand, Morley, & Miller, 2013). More recently, Bowman, Hardesty, and Mendres-Smith (2013) applied functional analysis methodology to the crying behavior of an adolescent boy with disabilities; the results of the study pointed to a clear maintaining variable (vocal sympathy and physical attention). The results of the functional analysis were then used to deliver function-based treatment

recommendations. The caregiver was instructed to ignore crying (under the condition that the child was not in any severe pain), and prompt the child to use their communication binder to indicate what he wanted; functional communication was reinforced by the caregiver and crying levels decreased by 63% compared to baseline. These results are promising, and although the specifics and conditions must be changed for a clinical functional analysis with infants, the data suggest that the method is useful in identifying contingencies maintaining excessive crying behavior.

While experimental functional analyses are an important step in identifying causal variables maintaining problem behavior, researchers have also developed pencil-and-paper based screening tools as predictive measures of these variables. If such measures are reliable and valid, they can be helpful assessments when presentation of the problem behavior can be detrimental to one's health or difficult to measure. Within the field of behavior analysis, researchers have developed the Motivation Assessment Scale (MAS; Durand & Crimmins, 1988), Questions about Behavioral Function scale (QABF; Matson & Vollmer, 1995), and the Functional Analysis Screening Tool (FAST; Iwata, DeLeon, & Roscoe, 2013). In addition, screening tools geared toward special populations, such as gamblers, have also been developed from previous functional assessments (see The Gambling Functional Assessment (GFA); Dixon & Johnson, 2007; the Gambling Functional Assessment-Revised (GFA-R); Weatherly, Miller, & Terrell, 2011). Thus, an extension of such methods to the excessive crying behavior of infants is a logical step in the development of screenings to help determine functional variables for specific behaviors.

Functional analysis research into infant behavior may prove fruitful for reasons beyond selecting the most effective treatment, as the systematic manipulation of variables related to colic may reveal differences among subsets of colicky babies, accounting for some of the

contradictions in the literature. It would be expected that systematic manipulation could reveal maintaining functional contingencies that are specific to each infant; the maintaining reinforcer(s) could then be withheld contingent upon crying and could be applied contingent on the absence of crying or some other appropriate behavior that serves the same function. Functional differences may also reveal differentiation in levels in severity of crying or adjunctive behavioral "symptoms" that occur in addition to crying, such as feeding or sleeping problems. Additionally, failure to see differentiated results on the functional analysis may suggest an underlying biological cause.

The use of functional analysis for excessive crying may help to determine a controlling variable for crying, which could in turn, have an impact on health care by reducing excessive crying shortly after caregivers express concerns to a doctor. Studies have been completed in Australia and the United Kingdom demonstrating the overwhelming economic cost of colic (Bennett, 2009). Beyond its use in infancy, a functional analysis of excessive crying may also be useful in hospital settings or following childhood trauma, as persistent crying may develop and persist long after the trauma has passed as a result of attention, physical consoling, and other behaviorally-active functions that might maintain crying.

Thus, the goals of this research project were to develop and test an experimental functional analysis methodology to be implemented with infants exhibiting symptoms of colic or excessive crying, and test the predictive agreement of a caregiver-completed, paper-based functional assessment tool (which could be used to help to predict causal variables without having to do more time-consuming experimental functional analysis). Additionally, treatment recommendations were given to caregivers, and follow-up data were collected and analyzed.

The development of a functional analysis for excessive crying in infancy applies a critical behavioral assessment technology to a new area of analysis that will inform more direct, function-based treatment alternatives to a population in need of research attention.

METHOD

Experimental Design

The experimental functional analysis was conducted in a multi-element design, as is commonly incorporated into functional analyses (Iwata et al., 1982/1994; Iwata & Dozier, 2008). A multi-element design involves experimental sessions occurring in rotating succession with repeated measures. Prior to the multi-element conditions, there was a baseline session. Multi-element conditions included social-positive reinforcement, social-negative reinforcement, sensory-positive reinforcement, and sensory-negative reinforcement (these conditions are described in detail in the **Procedures** section).

Participants

Selection criteria. Recruitment criteria included children between the ages of 0 and 9 months who exhibited crying behavior for at least two cumulative hours a day, occurring at least three times a week, or who exhibited bouts of continuous crying lasting more than 30 minutes at a time (see Appendix A, consent form, for recruitment criteria). The criterion including families whose infants had long bouts of crying was added at a later date, to account for infants who displayed occasional long bouts of crying, but not necessarily long durations of crying levels throughout the day. Families who had previously sought professional advice or services for their child's crying behavior were eligible to participate in this study, if the caregivers believed that

the prior or present treatment had not been successful in reducing crying to exclusionary levels. If the family previously determined that their child had a diagnosed medical condition (e.g., reactive airway disease/asthma, disorders accompanied by medical issues such as Down Syndrome, Failure to Thrive, etc.) that could potentially be the cause of excessive crying, these children and families were not able to participate in the study if not approved by their physician.

Participants were recruited by posting flyers (advertising a research study for infants who cry often) in relevant venues such as consenting physician's offices, daycare and preschool centers, and community message boards in the Philadelphia metro area and greater Kalamazoo area. Two families completed the study, but several others were referred or initially expressed interest in recruitment. Initially, the HSIRB protocol specified that the study be completed in person with the participant families. An addendum to the HSIRB protocol was submitted to include an online consulting option when a family in California with a 3-month-old infant, who had a history of excessive crying, expressed interest in participating; however, by the time the addendum was approved a month later, the child was no longer crying at problematic levels (fitting a common hallmark of colic, in which crying levels reduce around 3 or 4 months of age). Two additional cases were referred to the study by professional acquaintances. In one case, the potential caregiver subject did not respond to email inquiry. In the other case, the student investigator spoke with the caregiver on the phone, but the caregiver eventually declined to participate due to her work schedule and overall stress with the infant and older children in the home. Another caregiver expressed difficulty managing their crying infant, was sent the consent form, but decided she wasn't interested in pursuing the telehealth option and would instead, wait for crying levels to hopefully reduce. An additional caregiver expressed interest in participation, was sent consent documents, but lived in a very rural area with poor internet reception, and was

unable to get the HSIRB-approved, secure telehealth application to work; the student investigator offered to travel to the area to complete the study, but the caregiver reported that crying levels reduced drastically within a couple weeks of the initial consultation (prior to two months of age).

Participant characteristics. Only two of the seven potential participants who originally expressed interest in the study were enrolled in and completed the study.

Participant one, Ronald. Participant one, Ronald, was 30 days old upon starting participation in the study. Ronald lived with his mother, father, and older brother, age 2, in the greater Philadelphia area. Ronald was born full-term. At birth Ronald had a heart murmur, but it closed a few days after birth. Around the time that Ronald's excessive crying began, the family pediatrician assumed that reflux was a contributing factor in the child's colic presentation, and suggested utilizing probiotic drops and changing to a sensitive feeding formula. According to Ronald's parents, levels of crying did drop slightly after starting the drops and new formula, but still persisted at excessive levels per the study criteria, and approval was given by the physician to participate in the study.

Intake data (facilitated by the use of a caregiver questionnaire, see Appendix B) for Ronald and his family began when the child was 4 weeks and 1 day old, with the caregivers reporting that excessive crying first began at around 1 week of age, which was approximately three weeks prior to the initial session. Caregivers did not report any distinguishing features of the cry, except that if Ronald began to cry and was not quickly attended to, his cry would become louder and more guttural over time. Prior to starting the study and during the baseline condition, Ronald cried an average of 3 hours per day, with bouts (periods of relatively continuous crying) lasting between 45 minutes and 3 hours, despite active attempts to soothe the child. They reported that when he would begin to cry, they would try to change, feed, and burp

him first, and then subsequently attempt to soothe by swaying, walking around, swinging, or positioning him on his side (i.e., suggestions that the family had read about in Karp [2002]). Ronald's mother stated that she found that he would settle more easily when with his father. Both caregivers noted that strategies used to help soothe the at one period of time would no longer work to soothe the child during later crying bouts (i.e., later that day or another day). While they had tried the "cry it out" method (see Watson [1928] for an early behavioral conceptualization, and Ferber [2006] for a more modern approach) in the past (waiting up to 15 minutes to attend to the child's cries), Ronald's mother found the process to be emotionally difficult, and so they typically attended to him quickly once crying began.

Ronald's caregivers did not express any other major concerns about their child, developmental or otherwise. Additional information obtained during intake included that Ronald would occasionally cluster feed at night, in which he would engage in repeated feeds close together in time over the course of a few hours. Also, in relation to nighttime routines, the caregivers noted that Ronald was moved from a bassinet in his parent's room to a crib in his own bedroom, about one week prior to the intake session. The caregivers reported that the child typically slept for 2- to 4-hour periods. In the middle of the night, the child would often be awake for approximately an hour or longer, crying continuously without settling.

Participant two, Eli. Participant two, Eli, was 6 and a half months old at the start of the study. He was born full-term and lived at home with his mother and father in the Philadelphia metropolitan area. There were no other children or family members that lived in the residence.

The intake data and parent interview for Eli was conducted with the child's mother only; the child's father did not participate in the study. During intake, his mother expressed no medical or developmental concerns with her child other than prolonged episodes of crying, which had

been an issue since birth. At the start of the study, crying occurred at an average of about 113 minutes a day, with bouts lasting about an hour, especially during the night.

The child's mother reported that she had previously mentioned Eli's high rates of crying to the family's pediatrician, but that she and her husband found the behavior to be manageable and did not seek further consultation until hearing about this study. Eli's mother reported that while Eli cried often since birth, the overall duration of crying decreased slightly at around 4 months of age. Prior to the 4-month mark, the child's mother stated that Eli often had to be vigorously rocked, bounced, and/or shushed for at least 20-minute-periods in order for him to calm down; she reported that he also calmed quickly if taken outside, but that wasn't always feasible due to weather constraints or time of day. At 6 and a half months when the study began, his mother would often attend to him if possible when he began to cry, and if crying persisted despite delivery of attention, would then try to soothe by feeding, walking around, going outside, or changing his diaper (often in that order). During the daytime, Eli's mother reported that he might cry continuously for 20 minutes if not attended to (i.e., if he was left in his portable crib with toys while she attended to household chores such as washing bottles or cleaning the house). She also stated that crying was more likely to occur if another caregiver was present, and that the child calmed more easily when she attended to him or nursed him (in comparison to him being attended to by his father or another caregiver).

With regard to other developmental intake information, Eli's mother reported that he was being breastfed throughout the day, and was currently eating some solids in the form of fruit-, vegetable-, and grain-based purees. Though not relevant to his current eating patterns, his mother reported that he had been a cluster feeder earlier in infancy (between 1 and 2 months), and would often feed continuously between 9pm and 2am. With regard to sleeping, Eli's mother reported

that while he typically napped every few hours, he had trouble sleeping at night and often woke up after 4 to 6 hours to feed. Nighttime bouts of crying involved the child often crying continuously for an hour, especially if he was attended to by his father and not his mother.

Setting

All sessions took place in the participants' homes, as that was the primary setting in which excessive crying occurred. For Participant one, Ronald, all sessions took place in the main living area of the home. For Participant two, Eli, some sessions took place in the main living area of the home, while others took place outside.

Approvals

All components of the study were approved by the Human Subjects Internal Review Board at Western Michigan University (see Appendix A).

Consent. The process to obtain consent began with a meeting with the experimenter in the home of the potential participant. This meeting involved securing informed consent for participation, along with other preliminary tasks. During the meeting, the experimenter provided the potential participant (infant's caregiver[s]) with an informed consent form (Appendix A), summarized the form, and then allowed time for the potential participant to read the form in full. Following any questions, the caregivers of each participant child were asked to sign the form if they were interested in participating in the study. There were no potential participants that were met with *in person* that then declined to participate. When the potential participant caregivers (hereafter referred to as participant) agreed to participate in the study, they were provided with a copy of the consent form to keep.

Due to the age of the infant participants, they were not able to provide assent or consent. However, informed consent was secured from the child's primary caregiver(s) and the infant's subjective distress was continuously monitored by the experimenter and caregivers. No other family members were recorded on camera other than those that signed consent forms.

Measures and Materials

Dependent variables and response measurement. The primary target behavior measured for this study was crying and/or fussiness, defined as 3 or more seconds of distressed vocalization, with or without the presence of tears or rapid breathing; a 5-second absence of crying was necessary for a new instance of crying to be counted.

Crying measures. Duration, response latency, magnitude (measured as changes in volume), and topography were all measures used for analysis. Duration (i.e., the total time in which crying behavior occurred) was used as a measure of analysis for crying across sessions and over the course of the study. Duration, in minutes, was used to evaluate the amount of time per day, each day, that the child cried during baseline, experimental, and post-experimental periods of the study (both in and outside of actual session time during the experimental period). Caregivers were instructed to keep data on the total duration of crying per 24-hour period; caregivers were given a diary (Appendix C) with which to record the start and stop time of each colic episode, as well as space to provide additional information about each episode. Overall duration of crying behavior was compared throughout the study using graphical visual inspection to determine the influence, if any, of the experimental conditions on crying behavior, as well as the efficacy of the follow-up recommendations given to caregivers.

Response latency, the time from the onset of a particular stimulus to the occurrence of the target behavior, was used to evaluate patterns of crying behavior during some experimental conditions. Experimenters measured the amount of time, in seconds, from the onset of stimulus presentation or removal (in this case, social attention by the child's caregiver) to the time in which crying began and/or ceased.

Changes in magnitude of crying behavior (i.e., changes in pitch and volume) are described to indicate changes in crying behavior. Initially, the experimenters tried to measure these changes in decibels using sound analysis software, but the software was not reliable, as it could not make accurate distinctions between crying and other background noise, and therefore, graphical data analysis for this measure was not feasible.

Due to the fact that crying behavior never occurred as a discrete response and often persisted for long periods, partial interval recording was used for data collection purposes, calculating the percent of 10-second intervals per 10-minute session in which crying occurred; therefore, intervals in which at least 3 continuous seconds of crying (per the operational definition) occurred during the interval were scored as positive. The experimenters analyzed differences in mean level, trend, and variability between the conditions to determine potential functions and influencing factors for crying. Measures of duration, magnitude, and topography were compared against baseline data, exploring differences using video/audio analysis or analyzing intervals with higher-magnitude crying or other relevant behavior. These measurement distinctions were especially critical for participant one, Ronald, who cried consistently throughout some experimental sessions and emitted very noticeable variations in pitch and volume as a result of contingency manipulations.

Data collection was aided by the use of videos. During the baseline period, caregivers were asked to start recording at the start of crying episodes or just prior to times in which it was common for the child to start crying, in order to provided cues toward significant antecedent and consequent variables. Video recording was also used for all subsequent experimental sessions. Videos were shared digitally given caregiver consent. The videos were then downloaded onto the experimenter's computer and encrypted.

Crying measures reliability and validity. Video coding and procedural integrity measures were conducted and monitored by the experimenters. Initially, there was some discrepancy in correctly recording instances of crying behaviors per the operational definition (as vocalizations needed to be at least 3 seconds long, and needed to cease for 5 seconds for a new instance of behavior to be counted). In a follow-up training process, the experimenter and research assistant watched videos together to ensure that the research assistant accurately recorded instances of the target behavior using the dependent variable criteria (mentioned above). Interobserver agreement (IOA) was conducted for all sessions involving interval recording measures and calculated across 20 percent of sessions using point-by-point IOA. Scoring of the interval data took place independently by observers, and agreement (that the target behavior occurred during each scoring interval) was then compared by calculating the number of intervals agreed upon, divided by the number of total intervals, times 100; for this measure, agreement between observers was 100%. A separate IOA measure was utilized to calculate agreement of the timed latency measure during social-positive reinforcement sessions. IOA was calculated for all six of these sessions using total duration IOA. For each social-positive reinforcement session, the latency durations for both latency to crying and latency to crying cessation were added together; total duration

calculated between observers was compared by dividing the shorter duration by the longer duration, times 100, which yielded an IOA of 98%.

Parenting Stress Index-4 (PSI) measures. The Parenting Stress Index-4 Short Form (PSI-4; Abidin, 2012) was given to one of the primary caregivers at both the start and end of the study. The PSI is a screening and diagnostic measure used to assess stress levels in the caregiver and potential contributing variables. The short form version of the assessment is broken into three sub-scores: parental distress (PD), parent-child dysfunctional interaction (P-CDI), and difficult child (DC), and gives scores across each domain, as well as an overall score, indicating severity of parental stress and the area by which that stress is likely to be attributed. Numerically higher scores indicate greater parental stress. The PSI short form has been shown to be consistent with the long form PSI-4, with high validity and caregiver reliability and test-retest reliability (Barroso, Hungerford, Garcia, Graziano, & Bagner, 2016).

Functional Analysis for Excessive Crying (FAEC) measures. The FAEC (see Appendix D) was developed for the purpose of this study, to help assess whether a short-form functional analysis diagnostic tool could be an appropriate, reliable, and valid measure of assessing the function of excessive crying in infancy in the absence of more extensive experimental and observational data collection. The structure and style of questioning is based on the Functional Analysis Screening Tool (FAST; Iwata et al., 2013), with the questions changed to reflect presumed antecedents and consequences associated with excessive crying. The FAEC consists of 16 questions that caregivers rated on a scale (0 = Never to 6 = Always). Final scoring was completed by the experimenters. Each question filtered into a scoring group according to behavior function, and endorsed scores were added together to get four separate scores corresponding to the main four functions (social-positive reinforcement, social-negative

reinforcement, sensory-positive reinforcement, sensory-negative reinforcement) tested in this study. Assuming that the tool is accurate, it would be presumed that the function garnering the highest score would be the controlling variable for operant crying.

Equipment and materials. The experimental conditions also utilized many apparatus including a Fisher-Price Rock 'n Play™ sleeper, baby swing, activity mats, vibrating seat, Graco Pack 'n Play playard, bouncer, swaddling cloths, cloth baby carriers, sound machine with different kinds of music and white noise, and various toys. Video recording was conducted through the use of a caregiver smartphone with video capabilities, as well as the use of a GoPro HERO3™ mountable video camera; this equipment was provided by the experimenters at no cost. Depending on the comfort level of the caregivers, the camera was either mounted at the head or chest, on a tripod, or hand held by the caregiver or experimenter. Additional materials used included consent forms (Appendix A), the Parenting Stress Index-4 Short Form (PSI-4; Abidin, 2012), a caregiver questionnaire (Appendix B), data recording forms including a crying diary (Appendix C), the Functional Analysis for Excessive Crying (FAEC) diagnostic tool (Appendix D), and social validity forms (Appendix E) for each participant group (i.e., infant and caregiver[s]).

Procedures

Questionnaires. After participants completed the informed consent process, caregivers then completed the PSI-4 Short Form (Abidin, 2012). A caregiverqq questionnaire about the child's eating and sleeping patterns, crying behavior, and other potentially-relevant variables (Appendix B) was also completed. The questionnaire was conducted in the form of a clinical interview led by the experimenter, to gain information about the child's developmental history

and information on caregiver or other environmental variables that may be influencing excessive crying. Following the completion of the questionnaire and clinical interview, caregiver(s) were given the FAEC to complete.

Experimental conditions. The functional analysis consisted of the following basic conditions that are commonly incorporated into most FAs: social-positive (contingent delivery of attention), social-negative (escape from attention), sensory-positive (contingent delivery of sensory stimulation), sensory-negative (removal of sensory stimuli), and control. No additional provoking conditions needed to be used for these participants, but additional variables might be relevant for other infants in future studies (e.g., mild food deprivations, manipulation of ambient sensory stimuli such as lights or background noises, etc.). The sensory-positive condition utilized one or two sensory stimuli for the participants in this study based on caregiver report. Test conditions using additional sensory stimuli were deemed unnecessary for these participants, as within-session data patterns suggested a social-positive function for crying. However, further experimentation with other participants could potentially consist of many sensory sub-conditions to determine the precise nature of sensory stimulation that might be maintaining the behavior, such as varied manipulation of tactile, oral, visual, auditory, vestibular, and/or proprioceptive stimuli.

Participant groups consisted of an infant and at least one consenting caregiver. While caregivers executed sessions, an experimenter was present to guide all experimental conditions and ensure treatment integrity. The target condition time for this FA was 10 minutes, as is typical for FA. A couple of sessions were broken into two shorter sessions for Ronald due to a malfunction with video and/or sensory equipment. Experimental conditions began when the child was calm, and experimental stimuli were then delivered or removed contingent on the occurrence

of crying. Time in between conditions varied, but were at least 2-min in length. Caregivers were free to request additional break time for themselves or their child at any time. In addition, baseline data indicating base duration and topography of crying were used to monitor distress during FA conditions. Experimenters limited overall session (i.e., daily visit comprised of multiple experimental conditions) time to 2 hours per day.

Baseline. Baseline measurements of duration, magnitude, and topography of crying behavior occurring throughout the day were assessed using videos that recorded episodes of excessive crying, as well as through caregiver report through the use of the crying diary. The baseline period was used as a basic assessment period to obtain more information about typical behavior patterns that existed between the infant and caregiver. Caregivers were instructed to care for the child as usual, giving some indication about potentially common antecedents and consequences for crying behavior. Baseline conditions were considered to be complete once stable patterns of responding were shown. At the start of each crying episode, caregivers were instructed to turn on their recording device and dictate a message at the start of the video with the following information: date, time, what activities or events preceded crying, and recent sleeping and eating patterns. Based on the baseline observations, the experimenter attempted to determine the variables eliciting or evoking crying episodes, as well the usual consequences provided by caregivers following the infant's cries. The data from baseline observations helped to assist experimenters in determining which dependent variables to target in FA sessions.

Social-positive (crying-contingent stimulus presentation). In the social-positive condition (which consisted of both social and caregiver-provided sensory stimulation), the caregiver was initially instructed to engage in smiling, holding, eye contact, vocalizations, and playful exchange with the infant for the first 2 minutes of the session; these initial 2 minutes of

attention were not included as part of the 10-minute observation period, and crying behavior was not measured during this time. Following this 2-minute period, the caregiver was then instructed to withdraw attention, thereby depriving the child of attention, and creating a potential motivating operation that would evoke future crying behavior. When the infant began to cry following the attention withdrawal, the caregiver immediately provided attention contingent upon the start of the child's crying behavior, for a period of 30 seconds. The caregiver removed attention following the 30-second interval, but would redeliver attention if crying continued for a period of 3-seconds (per the operational definition for crying behavior for this study). This sequence was repeated throughout the 10-minute session.

The topography of attention delivery and withdrawal varied between participants. The caregiver of participant one, Ronald, would engage in eye contact and vocalizations with him while he lay on his back on a play mat. Ronald's mother also held him and talked to him to provide social attention. When attention needed to be removed, she often turned her back or walked away (if he had been placed on the mat) or, if she had been holding him, placed him on the mat and briefly turned away.

The caregiver of participant two, Eli, also engaged in different kinds of social attention. Eli's mother would sometimes play with him on the floor, and other time would sing, dance, and vocalize while holding him. Due to the fact that Eli was older and more mobile, removal of attention always involved placing him in his playard (for safety purposes) and walking away.

Social-negative (crying-contingent stimulus removal). The social-negative condition began with the caregiver physically playing with and vocalizing to the child. Contingent on crying, the caregiver would then withdraw physical interaction and look away. After a 30-second break, the caregiver re-delivered attention, regardless of whether crying was occurring or not. If

crying persisted for longer than 3 seconds (per the operational definition for this study), attention was again removed contingent on the occurrence of crying. This sequence was repeated throughout the 10-minute session. If crying did not occur, attention was not removed during the course of the session.

Removal and re-delivery of attention occurred in a similar manner to the social-positive condition. For Ronald, attention removal involved placing him on his play mat and walking away; attention re-delivery involved picking him up and talking to him. For Eli, attention removal again consisted of being placed in his playard, followed by his mother walking away. During the second social-negative condition, Eli never cried, so withdrawal of social attention never occurred.

Sensory-positive (crying-contingent stimulus presentation). The sensory-positive condition resulted in the infant receiving sensory stimulation contingent on crying. In order to assess different quality and quantity of sensory stimulation, different materials (e.g., many of the apparatus described previously; bouncing, rocking, vibrating mechanisms, etc.) were available to appeal to different sensory modalities. In order to help separate the effects of social and sensory stimuli, the caregivers were asked to use a neutral facial expression and refrain from vocalization when engaging with the child during the sensory conditions. The materials used during these sessions were chosen based on caregiver report and baseline observations. This session began with the caregiver using sensory materials during interactions with the child, or having the child in a sensory toy (such as a swing or rocker) away from the caregiver. After an initial 2 minutes of engagement with the sensory materials (independent of crying behavior), the sensory stimuli were removed. When crying began following the removal of the sensory stimuli, the caregiver re-presented the sensory stimulus for a period of 30 seconds. Following this 30-second redelivery

period, the sensory stimuli were removed again, but re-delivered contingent on crying behavior. This pattern of stimulus removal and re-delivery contingent on crying was repeated throughout the 10-minute session. If crying were to potentially not occur following the removal of sensory stimuli, it would not have been (re)presented. This did not occur during the course of this study, however, as both participants exhibiting crying during sensory-positive conditions.

Sensory sessions with Ronald utilized a swing that moved side-to-side and played instrumental music. Use of this equipment was based on caregiver report, in which Ronald's mother suggested this swing was his most-preferred sensory toy. Removal of sensory stimulation involved keeping the child in the swing, but ceasing movement and sound. Sensory sessions with Eli involved going in (sensory stimulation withdrawal) and outside (sensory stimulation delivery) while riding in a stroller, with no caregiver vocalization provided.

Sensory-negative. The sensory-negative condition involved removing sensory stimuli from the infant's environment contingent on crying. The same sensory materials were used in this condition as were used in the sensory-positive conditions. This session began with the caregiver engaged with the child using the sensory materials. Contingent on crying, the caregiver removed the sensory stimulus for a period of 30 seconds, but did not remove themselves from the situation. The stimulus was re-presented after the 30-second break, regardless of whether crying persisted, but was removed again if crying persisted for a 3-second period, and this sequence was repeated until the end of the condition. If crying did not occur, stimulus withdrawal did not occur.

Control. An overarching control condition was utilized to eliminate or minimize the effects that were likely to be evoked during the test conditions, as an additional comparison measure between conditions. The control condition consisted of the infant being placed on a

blanket or mat on the floor. A caregiver was present in the room to provide attention and other preferred items (dependent on the variables specifically manipulated in other conditions of the FA) on a response-independent schedule, and light and sound were minimized. There was no programmed consequence for crying.

Treatment recommendations and overall analysis. The results of the FA, in addition to within-session analysis and the information obtained from the caregiver questionnaire and FAEC, were used to make function-based recommendations to caregivers. Caregivers were guided not only to terminate the functional reinforcement contingency for crying, but were also given guidance on how to use that same reinforcer to strengthen appropriate behavior.

For Ronald, treatment recommendations suggested differentially responding to quiet versus crying behavior. When Ronald was calm or quiet, the caregiver was instructed to provide lots of attention in the form of eye contact, talking or babbling, and physical contact such as holding, rocking, or swinging. It was also suggested that the caregivers could use sensory stimulation that he seemed to enjoy, such as music, to help function as a discriminative stimulus to help discriminate between calm versus crying contingencies; thus, music could play in the background when Ronald was calm, but then be shut off when he would begin to cry. The caregivers were also instructed to meet the child's basic needs by feeding, burping, and changing the child's diaper. If Ronald continued to cry after these caregiving tasks, it was suggested that he was placed in a stationary chair or device and turned around, so he would not be able to see the caregiver for a period of 3 to 5 minutes to start with, as a kind of "time out;" he was to be immediately attended to as soon as crying ceased. At follow-up, Ronald's mother reported that she did not use the time out procedure and did not utilize a sensory discriminative stimulus to differentiate reinforcement conditions. As crying persisted at a relatively high duration, a

treatment booster was provided in which recommendations were re-reviewed and demonstrated; the experimenters provided Ronald's mother with a sound machine for discrimination purposes.

Eli's family was given the same treatment protocol for use during daytime hours that was used for Ronald. As Eli was 6 and a half months old at the start of the study, he had sufficient muscle control and the ability to sit up. Emphasis was placed on the time out procedure, if needed, through the use of a high chair or convertible seat that could be turned around to face away from the caregiver. Eli's mother reported that she utilized the treatment recommendations. She mentioned that she tried the "time out" procedure once, but found it difficult to listen to Eli crying (reporting that it was of higher magnitude compared to normal). She reported using a sound machine that played acoustic lullabies for the purpose of discriminating between calm and crying periods.

For both participants, overall duration-based data continued to be taken during and for a few weeks following the implementation of function-based recommendations which were given to caregivers (for comparison of potentially decreasing crying levels compared to the baseline and intervention periods of the study). The PSI-4 Short Form was given again at this time to assess any potential reduction in parental stress levels. The data from the questionnaire were also analyzed and compared to the results of the FA to assess the predictive validity of the survey measure.

Social Validity

Once the FA sessions were completed, caregivers were given a questionnaire to assess social validity of the experimental study at that juncture in time (Appendix E – Questionnaire A). A second social validity questionnaire (Appendix E – Questionnaire B) was given to caregivers

in the month following treatment recommendations to further assess approval of the intervention and the utility of treatment recommendations.

RESULTS

Tables 1 and 2 display information obtained by the participants (caregivers) at the start of the study, including age, results of the questionnaires and screening tools, and baseline crying levels, as well as crying levels at the study's completion.

Table 1. Basic information and results of the questionnaires for all participants.

Participant	**Age at start of study**	**PSI score at BL**	**PSI score at completion**	**Highest endorsed function on FAEC**	**Function determined by FA procedures**	**Avg crying level during baseline**	**Avg crying level during treatment phase**
Ronald	4 weeks, 1 day	96	49	Social-positive	Social-positive*	176 min	90 min
Eli	6 months, 21 days	89	60	Social-positive	Social-positive	113 min	93 min

Table 2. Results of the functional analysis for excessive crying.

Participant	**FAEC Social-Positive Score**	**FAEC Social-Negative Score**	**FAEC Sensory-Positive Score**	**FAEC Sensory-Negative Score**	**Function determined by FAEC**
Ronald	16 (3 out of 4 questions) out of 18 total points	9 (3 out of 4 questions) out of 18 total points	14 out of 24 total points	13 out of 24 total points	Social-Positive
Eli	20 out of 24 total points	8 out of 24 total points	8 out of 24 total points	7 out of 24 total points	Social-Positive

Participant 1, Ronald

PSI results. The PSI-4 was completed only by Ronald's mother. The mother was the primary caregiver and home most often with the child. She reported some personal stress and anxiety in the weeks before and after the delivery, pertaining to the impending birth and new addition to the family. She also reported low levels of stress regarding her older son, who was enrolled in early intervention due to a speech delay. At the start of the study, the mother had a total score of 96 on the PSI-4 (75^{th} percentile), while at the completion of the study the score was 49 (9^{th} percentile), indicating less stress. The assessment done at the start of the study revealed a clinically significant score on the difficult child subscale (44; 97^{th} percentile), which the authors of the scale typically attribute to issues with self-regulatory processes, such as colic.

FAEC results. The FAEC indicated social-positive as the highest endorsed function, with a score of 16 (generated from only three out of four questions, as the fourth pertained to older infants, and therefore, out of a total of 18 possible points), compared to 14 (out of a total of 24 possible points) for sensory-positive, 13 for sensory-negative (out of a total of 24 possible points), and 9 for social-negative (again, only 3 of the 4 questions were applicable, and therefore, out of a total of 18 possible points) (see Table 2).

FA results. Figure 1 depicts the results of the functional analysis, indicating the percent of 10-second intervals (amidst a 10-minute session per condition) in which the participant cried during at least part of the interval. By simply visually examining the across-session data, Ronald appeared to exhibit the highest levels of crying during the sensory-positive condition, followed by the social-negative condition, social-positive condition, and sensory-negative condition, respectively. Ronald did not emit any cries during any of the control conditions. This broad

analysis, however, does not accurately depict nuanced behavior patterns as they occurred within sessions.

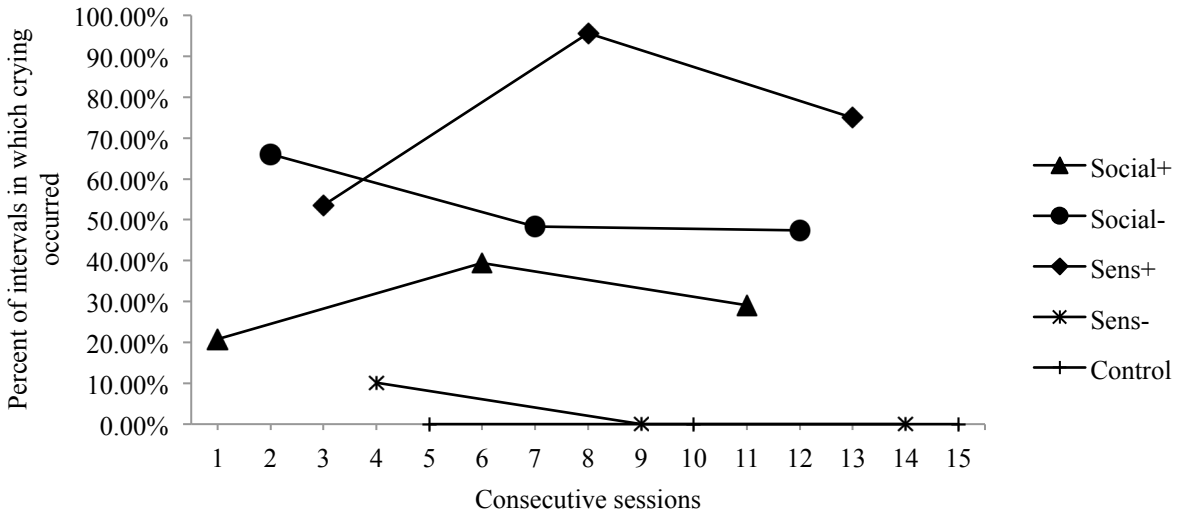

Figure 1. The above functional analysis graph shows the percent of intervals (10-s each) in which Participant 1, Ronald, cried during each experimental condition.

During sensory-positive conditions, in which a baby swing with music was used for the purpose of experimentation, the participant was initially given 2-minute access to the sensory stimuli (movement and sound) as a motivating operation, and the stimuli were then removed (i.e. the movement and sound of the swing were stopped). In most of the sensory-positive conditions, Ronald began crying shortly after the sensory stimuli were removed, and would not cease crying even when the sensory stimuli were re-introduced. In the first sensory-positive condition, the session was divided into two consecutive 5-minute parts due to an equipment malfunction. During the first part of the condition, the child cried almost immediately upon sensory stimulation removal, and did not cease crying for the rest of that session. During the second half of the session, Ronald began falling asleep, and even when awoken, remained relatively calm

throughout the remainder of the session. This accounts for crying occurring during about half of the overall session time, as indicated in Figure 1. In the second and third sensory-positive conditions, crying persisted throughout most of the session following the initial removal at the 2-minute mark, resulting in long durations of crying throughout these sessions (see the Discussion for further evaluation of this phenomenon).

During social-negative conditions, overall crying occurred at high levels, but characteristics of the child's cry, such as loudness and pitch, were susceptible to the changing contingencies within session. In these conditions, the child was held and talked to by the caregiver until he began to cry. Upon being put down on a mat by the caregiver to enact the removal of social attention, however, the volume and pitch of the child's cries would increase dramatically. When attention would be re-introduced after a 30-s interval, the volume of the cries would often decrease; however, this crying vocalization still fit the general operational definition for crying, so removal of attention would be enacted again, in which crying would persist. Thus, while data points are elevated in both the sensory-negative and social-negative conditions when utilizing the traditional percentage measure for FA graphs, the visual data are deceptive, as they do not accurately reflect topographical changes in crying behavior within these sessions.

Behavioral changes were most sensitive to the changing contingency in the social-positive condition, thereby yielding lower overall rates in crying compared to the conditions previously discussed. During Ronald's social-positive conditions, the child was held, played with, and talked to by the caregiver during the initial 2-minute interval, and then attention was removed by placing the child down on a mat and averting eye gaze or walking away. Crying typically occurred immediately or almost immediately after attention was removed, and often ceased soon after attention was re-delivered. Table 3 shows the latency, in seconds, to the time of

removal of attention to the time in which crying began (middle column), as well as the latency to the time in which crying ceased once attention was redelivered (right-most column), during social-positive sessions for Ronald. During social-positive sessions, there was a trend in which, over the course of the session, the latency to crying when attention was removed tended to decrease over the course of the session; thus, with the repetition of attention removal, crying occurred more quickly. As previously discussed, lower levels of crying occurred during this session compared to sensory-positive and social-negative conditions. In the social-positive conditions, crying was minimal or non-existent during the periods in which the caregiver socially interacted with and held the child; these periods accounted for more than half of the overall session time. Across sessions, crying ceased within 9 seconds of attention re-delivery each time, indicating a discriminated and effective contingency. Latency measures did not provide as much descriptive analysis during other conditions in which high rates of crying occurred. During social- negative conditions, crying, itself, persisted despite removal and redelivery of caregiver attention; changes in magnitude of crying were the only variable that was sensitive to the changing contingency. In the sensory-positive conditions, again, crying persisted despite redelivery of the sensory stimuli, and thus, latency was not an effective measure for analysis.

Table 3. Latency to cry when attention is removed and latency to cessation when attention is redelivered during social-positive/attention conditions for Participant 1, Ronald.

	Latency to cry (sec)	Latency to cessation (sec)
Social-Positive Session 1		
Attention Removal 1	50	
Attention Delivery 1		1
Attention Removal 2	46	
Attention Delivery 2		1
Attention Removal 3	16	
Attention Delivery 2		1
Attention Removal 4	10	
Attention Delivery 4		1

Table 3 - continued

Attention Removal 5	20	
Attention Delivery 5		1
Attention Removal 6	19	
Attention Delivery 6		1
Social-Positive Session 2		
Attention Removal 1	25	
Attention Delivery 1		6
Attention Removal 2	6	
Attention Delivery 2		1
Attention Removal 3	25	
Attention Delivery 2		9
Attention Removal 4	9	
Attention Delivery 4		3
Attention Removal 5	13	
Attention Delivery 5		1
Attention Removal 6	4	
Attention Delivery 6		1
Attention Removal 7	3	
Attention Delivery 7		3
Attention Removal 8	7	
Attention Delivery 8		9
Attention Removal 9	3	
Attention Delivery 9		1
Social-Positive Session 3		
Attention Removal 1	64	
Attention Delivery 1		1
Attention Removal 2	27	
Attention Delivery 2		1
Attention Removal 3	10	
Attention Delivery 2		2
Attention Removal 4	4	
Attention Delivery 4		1
Attention Removal 5	4	
Attention Delivery 5		1
Attention Removal 6	4	
Attention Delivery 6		2
Attention Removal 7	6	
Attention Delivery 7		4

Overall duration measures. Data were also collected on daily crying levels throughout the course of the study. Following the initial session, the caregivers collected baseline data for one week using the crying diary, in which they indicated the duration of crying that occurred each day, when it occurred, and any other relevant information regarding crying such as antecedent variables, relevant stimulus conditions, or caregiver consequences for crying. During

the baseline period, including the period in which experimental functional analysis session occurred (and indicated to have taken place on days 8, 19, and 22), crying occurred for an average of 166 minutes per day. On most days, crying occurred for between 2 to 3 hours. However, on the second day of baseline, crying occurred for more than 5 hours (see Figure 2), a clear outlier, but no additional insight was provided by caregivers as to a potential reason. Throughout the baseline period, overall levels of crying were relatively stable (with the exception of the one datum outlier previously mentioned), but with a large range (ranging from 90 to 360 minutes of crying a day).

During the treatment recommendation phase, there is a clear overall downward trend in the data, with an average duration of crying of 137 minutes per day, with crying levels ranging between 80 and 200 minutes per day. At the start of this phase, treatment recommendations were given in written form to the caregivers; verbal consultation was provided to Ronald's mother by reviewing the suggested procedures. Follow up occurred two weeks following the delivery of treatment recommendations. Ronald's mother reported that long durations of crying continued to occur, and therefore, sought further consultation, so the treatment booster was provided. Ronald's mother reported that the use of the sound machine, which played white noise in the background contingent of calm behavior and was shut off when crying began, seemed to help immensely. Following the treatment booster training, data continued to be collected for a period of 6 days. During this period, the average duration of crying per day was 77 minutes, with a range of 20 to 110 minutes per day. It is worth noting that during the baseline phase, the average duration of crying per day was close to three hours, which is the traditional marker for diagnosis of colic. During both the treatment phases, average duration of crying fell below this marker.

Social validity questionnaire results. A social validity questionnaire, which evaluated the experimental methods used in the functional analysis, was administered to Ronald's mother

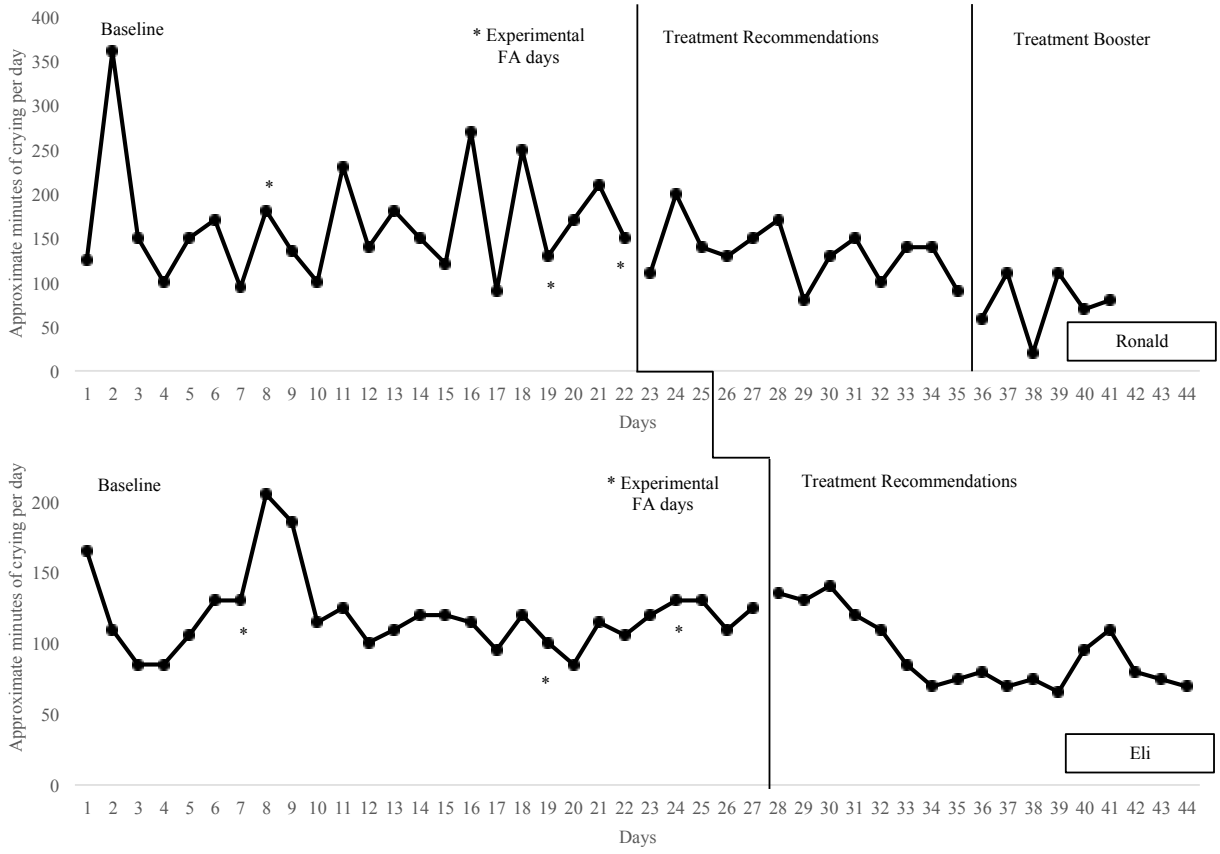

Figure 2. The overall crying duration data are shown here for both participants in a non-concurrent multiple-baseline across participants. The top panel shows the approximate minutes of crying per day for Ronald, Participant 1, across baseline, treatment, and treatment booster conditions. The bottom panel shows the approximate minutes of crying per day for Eli, Participant 2, across baseline and treatment conditions. Days in which experimental functional analysis sessions occurred are marked with an asterisk.

following the conclusion of the experimental sessions. She indicated that she had a clear understanding of the procedures, which she found to be acceptable, and that the child experienced no discomfort during the experimental procedures. She also indicated that she believed that the experience was of some benefit to her and her child, and that she may have

developed greater awareness of how environmental variables may affect the child's behavior. A different social validity questionnaire was administered following the treatment booster, but not after the initial round of treatment recommendations. Following the treatment booster, the caregiver reported that the recommendations were acceptable and very clear, and that the child did not experience any discomfort as a result of the treatment recommendations. She believed that her son received benefit from the treatment recommendations and that she definitely planned to continue to utilize a function-based approach in managing the child's behavior. In providing feedback, she stated that after the initial treatment recommendations, she did not follow them very closely, and that the child continued to cry for long periods of time. However, after the treatment booster, she admitted that her child appeared to still cry to obtain caregiver attention, but that utilizing the provided treatment recommendations more closely caused crying levels to decrease significantly.

Participant 2, Eli

PSI results. The PSI was completed only by Eli's mother. The mother was the primary caregiver and home most often with the child. She did not report high levels of stress during the pregnancy, immediately after birth, or at the time the study was conducted. At the start of the study, the mother had a total score of 89 on the PSI-4 (70^{th} percentile), while at the completion of the study the raw score was 60 (26^{th} percentile) indicating less stress. Similar to the sub-scoring with Ronald's mother, Eli's mother had the highest scores on the Difficult Child subscale.

FAEC results. The FAEC indicated social-positive as the highest endorsed function with a score of 20, compared to 8 for both social-negative and sensory-positive, and 7 for sensory-negative (see Table 2).

FA results. Figure 3 depicts the results of the functional analysis. During social-positive and negative conditions, Eli was interacted with on a play mat or held by his mother, then placed in a portable crib/playard (in addition to the caregiver looking or walking away) when attention was removed. As previously mentioned, Eli was often quiet when taken outside; Eli's mother reported that he would sometimes cry when taken inside following a period of time being outside. Though sensory stimulation was likely not maintaining high levels of crying behavior, sensory-positive and -negative conditions were conducted by going in and outside with the child in a stroller (as opposed to a baby carrier, to reduce the possibility of interference with social attention from being held). There were consistently and significantly higher levels of crying during the social-positive conditions; there was no overlap between data points of the social-positive conditions compared with any other experimental condition. Comparatively lower levels of crying occurred during the first social-negative condition, followed by no crying during the second social-negative condition. Infrequent crying occurred during the sensory-positive conditions. Crying never occurred during the sensory-negative or control conditions.

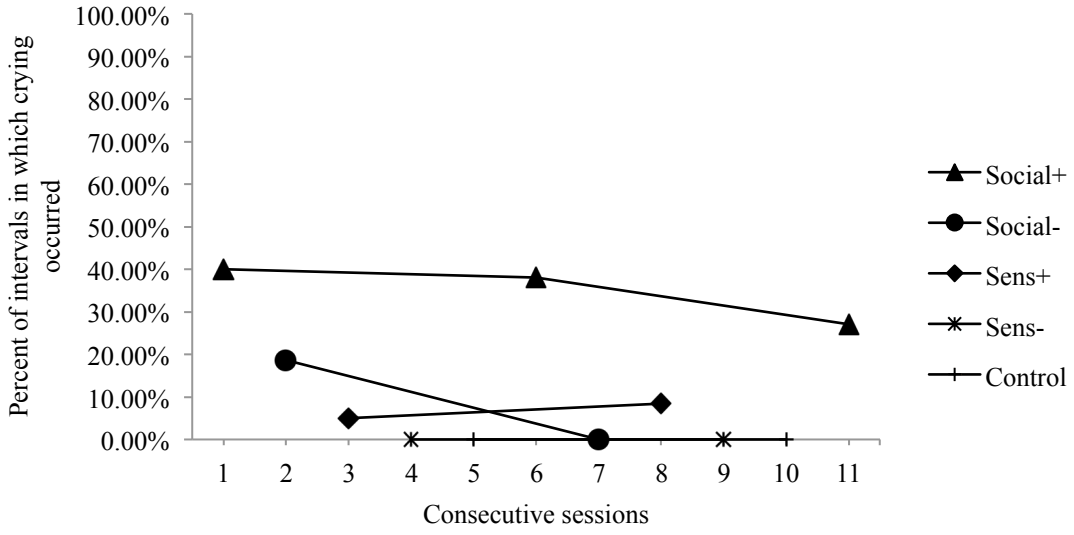

Figure 3. The above functional analysis graph shows the percent of intervals (10-s each) in which Participant 2, Eli, cried during each experimental condition.

Within session analyses were conducted for the social-positive sessions for this participant as well, to help demonstrate behavioral changes to the removal of and re-delivery of social-positive attention (as this was presumed to be the maintaining variable for operant crying). Table 4 displays the latencies, in seconds, of time until crying began following attention removal, as well as cessation of crying following attention re-delivery. In the first social-positive condition, there was one 30-s interval in which Eli did not stop crying after attention was re-delivered (indicated by a dash in Table 4). Following the first several instances of removal of attention by being placed in the playard (in which crying began once placed inside), Eli then began to cry as the caregiver walked him toward the playard, before he approached it or was placed inside. Similar patterns of behavior occurred during the second social-positive condition, in which the latency to crying when attention was removed decreased from several seconds during the first four attention removals, to only one or two seconds during the latter ones. In the last social-positive session for Eli, there were a few instances in which there were long latencies from attention removal until crying began. In the first instance (attention removal 5), Eli began whining immediately upon being placed down, but it only lasted for 2 seconds, which did not fit the study's operational definition for crying behavior. The same thing happened following the seventh attention removal during that condition. During the both the fifth and seventh attention removal, Eli began to engage in other behaviors that likely served an attention function, such as laughing and jumping up and down; crying resumed after 26 seconds and 40 seconds, respectively, and the child was immediately attended to. During the last attention removal of this third social-positive condition, the family dog barked as soon as Eli was put down and caregiver attention was removed; Eli ceased crying when the dog barked and began looking around for the dog.

Table 4. Latency to cry when attention is removed and latency to cessation when attention is redelivered during social-positive/attention conditions for Participant 2, Eli.

	Latency to cry (sec)	Latency to cessation (sec)
Social-Positive Session 1		
Attention Removal 1	2	
Attention Delivery 1		1
Attention Removal 2	1	
Attention Delivery 2		1
Attention Removal 3	1	
Attention Delivery 2		1
Attention Removal 4	1	
Attention Delivery 4		1
Attention Removal 5	1	
Attention Delivery 5		1
Attention Removal 6	1	
Attention Delivery 6		9
Attention Removal 7	1	
Attention Delivery 7		1
Attention Removal 8	1	
Attention Delivery 8		18
Attention Removal 9	1	
Attention Delivery 9		---
Attention Removal 10	1	
Attention Delivery 10		4
Social-Positive Session 2		
Attention Removal 1	4	
Attention Delivery 1		1
Attention Removal 2	6	
Attention Delivery 2		1
Attention Removal 3	6	
Attention Delivery 2		1
Attention Removal 4	8	
Attention Delivery 4		1
Attention Removal 5	1	
Attention Delivery 5		14
Attention Removal 6	2	
Attention Delivery 6		1
Attention Removal 7	2	
Attention Delivery 7		1
Attention Removal 8	1	
Attention Delivery 8		12
Attention Removal 9	2	
Attention Delivery 9		1
Attention Removal 10	1	
Attention Delivery 10		1
Social-Positive Session 3		
Attention Removal 1	1	
Attention Delivery 1		3
Attention Removal 2	1	
Attention Delivery 2		2
Attention Removal 3	1	

Table 4 - continued

Attention Delivery 3		1
Attention Removal 4	1	
Attention Delivery 4		1
Attention Removal 5	26	
Attention Delivery 5		1
Attention Removal 6	1	
Attention Delivery 6		1
Attention Removal 7	40	
Attention Delivery 7		1
Attention Removal 8	34	
Attention Delivery 8		1

As Eli was an older infant at the time of the study, his communicative repertoire far exceeded that of Ronald. In addition to crying, the presentation of distress and attention-seeking behavior varied, including lifting up arms, kicking legs, jumping up and down, and emitting short vocalizations or babbling sounds. Due to the lack of overlap in data points between any of the conditions, in which there were consistently high levels of crying during social-positive attention conditions and much lower levels or no crying present during all other conditions, it was concluded that crying behavior for Eli was under the control of social-positive reinforcement.

Overall duration measures. Data were also collected on daily crying levels throughout the course of the study and are summarized in Figure 2. During the baseline condition (again, which included the period in which experimental functional analysis sessions occurred, of which are indicated at days 7, 19, and 24), Eli cried for an average of 120 minutes per day, with a range between 85 and 205 minutes. During the baseline period, there were two consecutive outlier data points, at 205 and 185 minutes on days eight and nine, respectively. On the crying diary, Eli's mother noted the two of the child's teeth emerged at this time, likely accounting for the higher-than-normal crying levels.

During the treatment phase, the average duration of crying 93 minutes, with a range between 70 and 140 minutes. There was a slight increase in daily crying duration at the start of the treatment phase, followed by a decrease in crying levels and a stabilization in crying levels following a week in the phase. There was a brief increase in crying for a couple of days during this phase; Eli's mother noted in the crying diary that she was ill, and was not as hands-on with the child during the period and did not as closely deliver the treatment recommendations. Crying levels decreased again slightly following these two days. At the conclusion of data collection, Eli's mother reported that the daytime crying behavior had reduced drastically, and that excessive crying only occurred in the middle of the night.

Social validity questionnaire results. Two social validity questionnaires were provided to Eli's mother. The first questionnaire, which evaluated the experimental methods, determined that Eli's mother had a very clear understanding of the procedures used, found the evaluation procedures to be very acceptable, and thought that her son had some mild discomfort as a result of the procedures; she clarified this last evaluation to say that she thought of discomfort as "distress," but stated that the procedures resulted in no more distress than he would usually have in a typical day as a result of lack of continuous attention. She also evaluated that the experience was beneficial and that she believed she was more aware of how environmental variables, such as her responses to the child, influenced her child's behavior. With regard to the treatment recommendations, Eli's mother reported that the strategies provided were very acceptable and very clear. With respect to discomfort during the enacted treatment strategies, she reported minor "distress" again from elevated crying levels during the time out condition. She indicated that she found the strategies to be very beneficial and that she would continue to try to implement a function-based approach to caring for her child.

DISCUSSION

The research reported herein reports a functional behavior analysis of excessive infant crying and an evaluation of a function-based intervention for crying. The overall goals of the study were to develop and test an experimental functional analysis method for infants who presented with excessive crying, develop and test the predictive agreement of a structured interview and/or paper-based functional assessment tool, and examine the effects of function-informed treatment recommendations given to caregivers.

Participant 1, Ronald, exhibited the longest durations of crying during the sensory-positive and social-negative conditions, and high crying levels persisted despite delivery and removal of the contingency being evaluated in these conditions. However, by conducting a within-session analysis, latency measures (i.e., relatively short latency to crying when attention was removed, as well as short latency to cessation of crying when attention was re-delivered) analyzed in conditions supported the sensitivity of crying behavior to the changing contingency during the social-positive condition. The information obtained through clinical interview, results of the FAEC, and within-session analyses all supported a social-positive function for crying behavior, indicating that the FAEC was an effective measure for determining function. Furthermore, the treatment recommendations were reported to abate excessive crying, suggesting consistency between the function and the finding.

For participant 2, Eli, the functional analysis showed much higher rates of crying during the social-positive condition, compared to all other conditions, indicating an attention function. This matched with the endorsed function on the FAEC. Like Ronald, Eli also showed sensitivity to the contingency during the social-positive attention condition, as demonstrated by a typically very short latency to crying once attention was removed, and crying that often ceased quickly

when attention was re-delivered. Treatment recommendations were reported to have led to reductions excessive crying, as well.

The fact that a within-session analysis was not necessary (though latency measures were used for comparative purposes) for Participant 2 is likely due to the age difference between the two participants in the case studies. Due to the very young age of the first participant, Ronald, the child's behavioral repertoire was minimal, and crying was the primary means of communication that could be measured, though adjunctive behaviors such as arm and leg flailing were also noted when conducting the within-session analyses. The broad operational definition of the target behavior was not sensitive to nuances (e.g., volume and pitch changes) of crying for this particular infant, and did not directly reflect other related indicators of distress such as muscle tone (rigidity when distressed) and body movements (flailing arms and legs). For Participant 2, Eli, who was an older infant, the general operational definition of crying appeared to be more appropriate.

These differences demonstrate an experimental constraint of conducting behavioral research with infants, especially very young infants, as opposed to older children who demonstrate more clearly and predictably discrete responses and have a much more varied repertoire of responses. Research with infants over a relatively large age range, as was a feature of this study, reveals additional issues with methodology and protocol delivery. Due to the rapidly changing growth and development of infants in their first year, and variation in early developmental milestones, it may be difficult to enact a standard intervention protocol. Procedural modifications to an FA based on individualized information from interview measures of descriptive analyses may, therefore, be a necessary part of function-based interventions with this population.

In a related manner, a change in age of a couple of weeks can yield major differences in cognitive, social-emotional, and physical skills. This may have additional implications for infant studies that have repeated sessions over a course of weeks or months, as behavioral changes over that time may be a result of natural developmental changes, rather than a product of the study itself.

The research constraints mentioned above demonstrate the need for cautious interpretations of the decreases in crying levels that occurred for both participants over the course of this study. While overall levels of crying were reduced following the delivery of the treatment recommendations, it is important to note that decreases in crying behavior may occur due to the passage of time and development, and may not be solely a result of targeted intervention strategies. Threats to internal validity from maturation and the passage of time present additional challenges to conducting research with young infants. These challenges can be partially avoided by subject-as-own-control designs such as alternating treatments and multiple schedule designs that are typical of functional behavior assessment research and allow for repeated comparisons across test conditions within a relative short duration of research (thus minimizing, though not entirely eliminating, the influence of maturation and time passage). Therefore, experimenters could explore the effect of multiple reversals in which caregivers ceased using the treatment recommendations, to see if crying levels increased slightly and/or returned to levels similar to baseline.

While there is a possibility that reductions in crying levels may have been due to the passage of time in this study, the findings do lend support to the influence of independent variable manipulation. Crying patterns in typically developing infants, as well as those with colic, usually tend to decrease on their own around 3 or 4 months of age. At the completion of

data collection, Participant 1, Ronald, was around two and a half months of age, thus, falling into an age range in which high rates of crying typically still persists for infants with colic. Thus, it is likely that reductions in crying levels were impacted by the treatment booster.

Conducting further research on older infants who exhibit excessive crying may be a good way to protect against this issue, as they do not fit into the typical (i.e., Wessel et al., 1954) definition of colic, as crying in these cases would be persisting beyond the typical 3 to 4 months of age, and may imply a longer and stronger history of reinforcement for operant crying behavior. It is important to note, however, that with older infants, there are other variations of development that may contribute to periods of excessive crying, such as stages of rapid growth or teething that could be related to excess fussiness for brief periods of time.

Some other, similar, limitations of the study existed as well, related to dependent variable measurement and methodology. Latency measures were a critical part of the within-session analysis for Participant 1, Ronald. The latency measures were a more effective indicator of behavioral changes for the younger infant, as crying was one of his only emitted behaviors to indicate distress; due to his very young age, he was also more reliant on his caregiver to aid in sensory regulation, which seemed to be a necessary component for decreases in crying levels or crying cessation. The latency measure was also a more representative measure of respondent behavior, measuring the time from stimulus to response. It is possible that much of the crying exhibited by Ronald was still respondent in nature, since the caregiver was often needed to aid in regulation. This latency measure was still a good indicator of sensitivity to the contingency for Participant 2, Eli, as well, but it was clear that Eli had additional behaviors in his repertoire to gain his caregiver's attention (such as jumping up and down and making other noises), had much

more physical mobility, and was more easily distracted by his surroundings which may have contributed to decreases in crying levels at times.

Another potential measurement issue was the use of caregiver report to obtain daily duration values of crying across days of the study (see Iida, Shrout, Laurenceau, & Bolger [2012] and Carp & Carp [1981] for discussions on reliability and validity of using self-report diaries in psychological studies). Due to the fact that crying behavior was recorded across a 24-hour period, it would have been very difficult to videotape and measure duration for the entirety of each day across the entire period of the study, including baseline, experimental, and follow-up phases. However, most colic-based studies utilizing home-based interventions rely on caregiver report to determine crying levels across the course of study. Also with regard to potential limitations of reliability and validity of data, there were no probes to continually assess adherence to the treatment protocol given to parents. However, caregivers did appear to be forthcoming about their failure to adhere to treatment recommendations (which prompted the treatment booster provided to Ronald's family).

Another procedural challenge occurred during the sensory-positive condition for Participant 1, Ronald. In the sensory-positive condition, stimuli were presented (swinging and music, indicated to be preferred sensory stimuli by the caregiver) and then removed to potentially evoke the motivating operation for crying. Those same stimuli were re-delivered contingent on the occurrence of crying. However, for Ronald, crying began almost immediately upon cessation of the sensory stimulation, and did not stop even when the sensory stimuli were redelivered. Anecdotally, it can be reported that crying only stopped once the child was removed from the sensory apparatus and was attended to by the child's mother. If there truly was a

sensory-positive function for crying, the experimenters should have seen crying subside once the sensory stimuli were redelivered.

It is difficult to explain what the reason may have been that the child exhibited no crying initially when the sensory stimuli were presented, but cried continuously once they were removed and despite being re-delivered. This may have been due to some sort of sensory disruption, and the child was not able to effectively self-regulate without additional assistance from the caregiver. As previously discussed, crying is an innate biological ability to help gain attention from caregivers to provide necessary care; from an evolutionary perspective, without such a capability, the infant would not survive. By providing basic care (such as feeding, changing, and holding the child), the caregiver is able to help regulate body temperature, physiological processes, and ease in the understanding of day and night patterns. Research shows that the ability to self-regulate increases with age, as premature, lower birthweight babies have the most difficult with regulatory adjustment during the postpartum period (*From neurons to neighborhoods, 2000)*. Thus, as Ronald was only about a month old when the study began, it is understandable that his self-regulatory abilities were still lacking, as small environmental and sensory changes proved to be very disruptive, and the caregiver was needed to help the child get back to a state of equilibrium. It is also possible that such environmental disruptions, and subsequent increases in crying, may have led to a failure to discriminate the relevant contingencies in place for those conditions.

In a related manner, prior psychological research has suggested sensory overload as a function of crying in infants (Leuchter, Darque, & Huppi, 2013), and such considerations should be included in future extensions of this methodology. It is worth noting that Eli's mother anecdotally reported the likelihood of sensory-maintained excessive crying prior to 4 months of

age, but mentioned that sensory stimulation appeared to be only one of a few components that helped (i.e., a combination of social and sensory variables appeared to be maintaining crying – needing to simultaneously bounce, rock, shush, and hold the baby physically close). This helps to demonstrate how early in infancy, social and sensory variables are often intertwined. If a child is held or rocked, we would likely say that there are both social and sensory components at work, even in the absence of vocalization. For the purposes of this study, social-positive conditions always involved caregiver contact and vocalization. Vocalizations were omitted in the sensory conditions, and physical contact with the caregiver was either omitted or minimized greatly (especially compared to the social-attention condition). So, although this study utilized specific criteria to help parse out social versus sensory variables, it may be a difficult distinction to enact in practice, since these variables are so closely related, especially in early infancy.

There is great potential for follow-up research, including replication and extension. Replicating the methodology with many more children from ages 0 to 1 would be beneficial to better understand relevant functional variables and the extent to which they may vary across individuals and age. Each data set used the logic of a single case experiment, in which each participant served as his own control. A series of single case replications would allow for the accumulation of evidence on the most commonly identified controlling variable for crying, and thus provide empirically-based conclusions about the hypothesized behavioral factors that might contribute to and maintain crying behavior. In addition to replication across various stages of infancy, replications among groups of infants, such as those in different geographic areas or cultural groups may reveal patterns for function based on cultural caregiver practices.

Repeated exposures to consistent, different contingencies of reinforcement resulted in consistent behavior in the social-positive reinforcement conditions for both infants. As both

participants' data yielded a social-positive function, a logical assumption one may make is that a social-positive reinforcement contingency is a prevailing function for excessive crying. However, this would be a premature conclusion, and is not the kind of inference one makes from a single case design. Nonetheless, if this methodology continued to be used in infants and a social-positive function prevailed across participants, the functional analysis would likely still be useful to isolate a behavioral cause of excessive crying, and, thereby, assist in ruling out a medical cause. Additionally, continued replication in many infant participants across a wide age range may point to common patterns that could potentially draw more broad generalizations in infant and caregiver behavior patterns. Further replication would also provide additional support that the paper-and-pencil based assessment consistently matches the results of the experimental functional analysis.

Other potential variations in methodology for future research include: using conditions that are shorter than 10-min, especially latency-based functional analysis (see Thomason-Sassi, Iwata, Neidert, & Roscoe, 2011); utilizing matched stimulation (Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Rapp, 2006) conditions to assess for specific types of attentional and sensory variables that could maintain crying, such as the exercising of vocal musculature, the auditory noise of crying, and body movements occurring with crying such as leg and arm flailing. Additional replications or extensions would also potentially benefit from completing a magnitude-based analysis, if necessary, to evaluate nuanced changes to the dependent variable. In a related manner, it may be necessary to create more distinctions within crying as a dependent variable, such as a crying hierarchy that distinguishes more precisely between mild fussing, and moderate versus severe crying (potentially measured in decibels). This may reveal the need for

additional research that looks at crying norms across populations of infants with and without colic.

Another possible extension of the current research would be to consult with the family regarding the videos conducted during baseline to point out how caregivers may be incidentally reinforcing attention-seeking crying behavior. Providing video feedback in caregiving situations has shown to be a helpful method of intervention (Facchini et al., 2016). Other methods of caregiver training may also be useful; research has suggested that training caregivers specifically on infant behavior and "language" may help caregivers provide more accurate caregiving responses that "match" the needs of the infant (Lohre, 2016).

Follow-up research could also focus specifically on the utility of the FAEC, which, alone, could be a potentially helpful measure for use in primary care. Infants in developed countries are seen frequently by a primary care physician in their first year, and primary care pediatricians are often who caregivers first professionally consult regarding behavioral issues such as excessive crying (Facchini et al., 2016). For both participants, the FAEC appeared to be an accurate predictor of the function of the child's excessive crying. It is hopeful that the FAEC could be an easy and effective tool (to potentially be used by behavior analysts or pediatricians) for determining the function for excessive crying. The diagnostic tool could be paired with a short primer for caregivers explaining how excessive crying and/or colic may come to be under control of varied functions, and include general guidelines or a basic, standardized treatment protocol, based on prior research in behavior analysis highlighting function-based treatments. Replication of the study with additional participants of varying ages exhibiting excessive crying is needed to further determine the efficacy and accuracy of this diagnostic tool.

In conclusion, the FA method reported herein was successful in identifying a functional variable (or a contingency of reinforcement) that maintained crying in two infants. Additionally, infants' crying was then reduced, caregiver stress was reduced, and caregivers rated the procedures favorably. The FAEC matched the social-positive contingency found in the data sets, providing some initial proof of concept for the questionnaire. The method reported herein is a potentially effective extension of a long-standing line of behavioral research into excessive crying in infancy.

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APPENDIX A: Consent

Western Michigan University
Department of Psychology

Principal Investigator: R. Wayne Fuqua, PhD

Student Investigator: Jamie Hirsh, M.S., M.A.

Title of Study: Functional Analysis of Excessive Crying in Infancy

You have been invited to participate in a research project titled "*Functional Analysis of Excessive Crying in Infancy.*" This project may serve as Jamie Hirsh's dissertation for the requirements of her Doctor of Philosophy degree. The project is supervised by Dr. Wayne Fuqua. This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?

This research is intended to study a method of assessing why some infants may cry excessively. This is a research study designed to better understand crying in the infant, not to provide an already validated treatment.

Who can participate in this study?

Persons with infants who cry at least two hours a day or who exhibit bouts of crying lasting more than 30 minutes at a time. Children with diagnosed medical conditions, whose symptoms could be the potential cause of excessive crying, will not be able to participate in the study.

Where will this study take place?

The study may take place in the Behavioral Medicine Laboratory in Wood Hall 2704 at Western Michigan University and/or in your home depending on whether your child's crying occurs more often in or out of the home setting or if the home setting is more convenient. For participants living in geographic areas far from Michigan, sessions may take place in the participants' homes or with the student investigator interacting with the participants through video conference.

What is the time commitment for participating in this study?

If you choose to participate, after signing this document you will be asked to fill out questionnaires about your infant's behavior and your behavior specific to crying episodes. You will be asked to be in contact on a regular basis with an experimenter by phone, video conference, and/or email to collect video recordings, schedule experimental sessions, and if assistance is needed following treatment recommendations. During portions of the study, an investigator will either meet with you to collect video data or this data can be electronically sent to the experimenter through email or another secure, free application called VSee, depending on what is most convenient. The experimenter will schedule visits to your house or schedule video conferencing sessions to observe you and the infant, and may ask you to come to the Behavioral Medicine Laboratory in Wood Hall. This initial meeting should take approximately one hour. During baseline data collection, most of your child's behavior will be recorded, and you will be able to participate in all of your normal activities. Experimental sessions will be scheduled based on joint availability of the caregiver(s) and experimenter(s). During experimental sessions, you can expect to devote a maximum of four hours a week to the study. The maximum overall time commitment to the study is 3 months, but you could be finished with the study in less time.

What will you be asked to do if you choose to participate in this study?

You will be asked to fill out some questionnaires during this study. You will be asked to videotape your child's crying episodes and your interactions with your child during these episodes. You will also attend or participate in scheduled experimental sessions guided by the researchers at your home and/or in the Behavioral Medicine Laboratory. You will be assisting in these behavioral assessment sessions designed to determine potential reasons for excessive crying. In order to assess this, when crying occurs, you will be asked to provide attention, preferred items, sensory input or other stimuli that we believe might be responsible for your child's crying. All sessions will be videotaped in order to be scored, and then the videos will be de-identified. You will be required to coordinate with experimenters during baseline observation periods so that the experimenters can collect video data; this will be done in a way that maximizes convenience for you. If a reason is determined for your child's crying, the experimenters will provide you with treatment recommendations for you to implement on your

own time. One month following the delivery of these recommendations, experimenters will schedule a session to assess any reductions in crying. Experimenters will be mandated to report any inappropriate behavior that is indicative of physical and/or sexual abuse of a child; the experimenter who witnesses any inappropriate behavior will contact Child Protective Services or the police.

What information is being measured during the study?

We will be measuring behavior related to crying (through video data) in sessions and analyzing your self-reports.

What are the risks of participating in this study and how will these risks be minimized?

As in all research, there may be unforeseen risks to the participant. Some possible risks include stress to the caregiver from sessions in which crying may be temporarily reinforced in order to determine the function. However, high rates of crying will already be typical for this population of participants, and therefore, the in-session crying should not be atypical or unusual. You will be able to stop sessions if you desire, and sessions will be stopped if crying persists for more than 30 minutes prior to the start of a new trial or session if crying did not occur at the start of the session. If desired, sessions can be discontinued and rescheduled for another day. If you need additional services, please contact the Western Michigan University Psychology Clinic (269.387.8302) or a local hospital or clinic emergency department.

What are the benefits of participating in this study?

One way in which you may benefit from participation in this study is from recommendations from the researchers regarding your infant's crying and bringing about other, positive behaviors. There is no assurance of any change in your child's behavior. Researchers and practitioners in the field of behavior analysis, behavioral medicine, and pediatric medicine may benefit from the results of this research as well.

Are there any costs associated with participating in this study?

There are no direct costs associated with participating with the study. Costs may include transportation and parking if traveling to Western Michigan University for sessions and time commitment.

Is there any compensation for participating in this study?

Compensation for participation in the study will be contingent of completion. Participant families will be given $20 at the completion of the experimental data collection phase, and another $20 after follow-up (final completion of the study).

Who will have access to the information collected during this study?

All of the information collected from you is confidential. That means that your name will not appear on any papers on which this information is recorded. The forms will all be coded, and the experimenter will keep a separate master list with the names of participants and the corresponding codes. During the course of the study, the master list will be kept in an encrypted file on a password-protected computer at the Behavioral Medicine lab at Western Michigan University. Once the data are collected and analyzed, the master list will be destroyed. All other paper-based forms will be retained for at least three years in a locked filing cabinet in Dr. Fuqua's Behavioral Medicine Laboratory (2704 Wood Hall) at Western Michigan University. Emails will be stored within a folder on the WMU email server. The videos will be encrypted on the student investigator's computer if collected physically and not digitally, but then will be transferred to a WMU Behavioral Medicine lab computer. The videos will be deleted from the student investigator's computer once transferred to the lab computer. All computers used during the study will be password protected and files will be encrypted. Once scored, the videos will be de-identified or destroyed. De-identification will involve using computer programs to alter or blur physical appearance. If video formats prove this impossible, videos will be destroyed after scored. Procedures have been changed so that recording is more limited. The only people who will have access to these files will be researchers involved in the study.

The data may be used in conference presentations or manuscripts for publication in peer-reviewed journals, but your identity and that of your child will not be reported. If you desire, a report with information regarding your child's results and treatment recommendations will be prepared for you which can be shared with your child's physician or other treatment provider.

What if you want to stop participating in this study?

You can choose to stop participating in the study at any time for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences either academically, if you are a student, or personally if you choose to withdraw

from this study. You will not lose the ability to continue seeking treatment by any treatment provider if you discontinue participation in this study.

The investigator can also decide to stop your participation in the study without your consent. This may happen if you continually do not arrive for appointments or return emails. This may also happen if you indicate you are being adversely affected by the study.

Should you have any questions prior to or during the study, you can contact the primary investigator, Dr. R. Wayne Fuqua at 269-387-4474 or wayne.fuqua@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

I have read this informed consent document. The risks and benefits have been explained to me. I agree to take part in this study.

_____

Please Print Your Name

_____ _____

Participant's signature Date

_____

Please Print Your Name

_____ _____

Participant's signature Date

Please Print Your Name

_____ _____

Participant's signature Date

Parent/Guardian/Legally Authorized Representative:

I give my permission for my child/relative to participate in this research project.

_____

Signature of Parent/Guardian/Legally Authorized Representative

Date: _____

_____

Signature of the Person Obtaining Consent

Date: _____

Name of child: _____

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: September 16, 2015

To: Wayne Fuqua, Principal Investigator
Jamie Hirsh, Student Investigator for dissertation
Mack Costello, Co-Principal Investigator

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number 14-05-02

This letter will serve as confirmation that the changes to your research project titled "Functional Analysis of Crying" requested in your memo received September 10, 2015 [to add compensation ($20 following experimental data collection and $20 after follow up); to add remote data collection option (investigator travel to participant); to revise recruitment and consent materials to reflect these changes; to change Mack Costello to Co-Principal Investigator as a collaborative from Rider University] have been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: May 20, 2016

1903 W. Michigan Ave., Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276
CAMPUS SITE: 251 N. Walwood Hall

APPENDIX B: Caregiver Questionnaire

1. Child's sex: M F

2. Child's age: _____

3. Have there been any complications with the child's health since birth other than excessive crying?

_____

_____

_____

4. Is the child current with immunizations?

_____

5. If the child has a sibling, did any siblings exhibit similar patterns of crying?

_____

_____

6. Are you concerned that the child has not been reaching typical developmental milestones? (chart provided)

_____

_____

7. What method of feeding is being used?

_____

_____

8. What is the child's typical sleep and feeding routine?

_____

_____

9. How long has your child been crying excessively (in weeks or months) and when did these problems begin?

_____

_____

10. Does the child's cry have any distinguishing features (i.e., tone, pitch, etc.)?

_____

11. How many hours would you estimate that your child cries per day?

_____

12. How long do continuous bouts of crying typically last, on average?

_____

13. To the best you can remember, what is the longest that a bout has persisted for?

_____

14. How many hours would you estimate that your child cries per week?

_____

15. What times of day does crying typically occur?

_____

_____

16. What do you typically do when your child starts to cry?

_____

_____

_____

17. What/who are the situations/people present in which crying is most likely to occur?_____

_____

18. What/who are the situations/people present in which crying is least likely to occur?_____

_____

19. What typically happens right before your child begins to cry?

_____

_____

20. What typically happens right after your child begins to cry?

_____

_____

21. If you are trying to soothe your child and stop his/her crying, have you found some strategies or techniques that work well compared to others?

_____

_____

_____

22. Have you sought professional help for your child's excessive crying? (Clarify the extent of treatment or other interventions if professional help has previous been or is currently being sought out)

_____
_____

23. Is the crying cyclical (occurs for days on end then stops), or more likely at particular times of the day/night?

_____
_____

Caregiver Questions

24. Were there any complications during the course of the mother's pregnancy or the child's delivery?

_____
_____
_____

25. Did the mother consume any drugs or alcohol prior to discovering the pregnancy?

_____
_____
_____

26. How stressed or anxious did you feel about the pregnancy or child's birth?

_____
_____
_____
_____

27. Describe any other stressors that occurred during pregnancy or since the child's birth.

_____
_____
_____
_____

	Communication/Language Development	Cognitive Development	Social-Emotional Development	Gross Motor Development	Fine Motor Development
0-3 months	*Cries when hungry, wet, sleepy, or lonely *Responds to loud noises with a startled movement or by looking in the direction of the sound *Able to track objects through their field of vision (2 or 3 mos.) *Babbles and tries to imitate the sounds you make (3 mos.)		*Sucks on toys, a pacifier, or her fist to self-soothe *Engages in eye contact when spoken to *Takes interest in looking at people's faces *Appears interested when new toys are presented (2 or 3 mos.) *Smiles when interacting with others (2 or 3 mos.)	*Begins to reach for objects *Lifts head up from prone position *Eyes follow objects past midline	*Able to grasp a small toy (later months)
3-7 months	*Uses 2 syllable babbling sounds *Responds when name is called *Makes high pitched squeals		*Imitates facial expressions *Engages in caregiver-initiated games, such as peek-a-boo	*Sit up without support from behind *Lifts legs when positioned on back *Tries to get out-of-reach objects with both arms *Able to roll from front-to-back and back-to-front	*Able to hold bottle with caregiver help *Brings toys up to mouth *Able to transfer object from one hand to other
7-12 months	*Responds to differences in tone of voice *Turns in direction of noise *Responds to spoken commands, such as "come here" *Points to desired objects *Able to shake head to denote "yes" or "no" *Begins attempting vocal imitation	*Exhibits object permanence (recognition that an object exists when it is no longer visible) (around 9 mos.) *Able to identify common objects (shoe, ball, etc.) *Explores objects in new ways: shaking, turning, etc. *Understands correct uses for objects (e.g., pretends to eat, brush hair)	*Appears anxious around strangers *Shows preference for typical caregiver over others *Plays with a doll or stuffed animal by hugging it *Imitates the actions of others during play	*Can support own weight standing if caregiver holds the child with both hands (8-10 mos.) *Can take steps forward if caregiver holds the child with one or two hands (closer to 12 mos.) *With assistance dressing, able to help by pushing arms through sleeves or lifting legs to put on pants	*Able to pick up small toys with one hand, using fingertips *Can hold a small toy in each hand *Plays by banging toys against the floor or table, or two toys together *Able to throw a ball in a forward motion *Able to help caregiver turn pages of a book
12-16 months	*Able to say several words other than "Mama" or "Dada" (or cultural equivalent) *Demonstrates joint attention by pointing to objects	*Can identify parts of the body *Imitates gestures	*Able to obtain adult attention by vocalizing or pulling on hands/clothes *Exhibits onlooker and parallel play	*Able to support self in standing and take several steps forward *Able to squat and return to standing position without falling	*Able to stack small toys *Able to turn the pages of a book without assistance *Uses the tip of a crayon or marker to draw
17-20 months	*Uses 2 or 3 words together representing separate ideas *Responds to question "what is this?" when pointing to a common object	* Able to identify objects in pictures by pointing or vocalizing *Scribbles without being shown how *Will turn upside-down objects right-side-up to use appropriately	*Will play with a doll or stuffed animal in a motherly way (e.g., rocking, feeding) *Begins establishing autonomy from caregiver by exploring environment and "checking back in"	*Rarely falls when walking *Able to go down stairs when hand is held for support *Able to kick a ball if modeled for child *Able to run and stop without falling or bumping into things	*Able to hold a spoon upright into the mouth so that food doesn't fall off *Able to copy a single drawn line *Able to twist/turn objects (e.g., doorknob)

APPENDIX C: Crying Diary

Instructions:

1. Write the date

2. Put a line to show when crying behavior begins. Fill in the area corresponding with the entire crying episode. [For example, if a crying episode lasts from 1-4 PM, you would fill in the boxes corresponding to 1 PM, 2 PM, and 3 PM.]

Participant code _____

Date Today	Noon	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	Midnight	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM

Notes: (please specify dates and times at the start of the note)

_____

_____

_____

APPENDIX D: Functional Analysis for Excessive Crying (FAEC)

0=Never, 1=Almost Never, 2=Seldom, 3=Half the time, 4=Usually, 5=Almost Always, 6=Always

Question	Answer Choices						
1. Crying occurs when the child is not receiving attention.	0	1	2	3	4	5	6
2. If crying occurs while being held or during social interactions, the child is given a "break" from interactions.	0	1	2	3	4	5	6
3. Crying is more likely to occur if child is not clothed.	0	1	2	3	4	5	6
4. The child is quiet when (s)he gets lots of attention or when preferred toys/foods are freely available.	0	1	2	3	4	5	6
5. Crying is more likely to stop if feeding occurs.	0	1	2	3	4	5	6
6. The child is fussy when there are a lot of stimuli in the environment (lights, sounds, etc.).	0	1	2	3	4	5	6
7. Crying increases in magnitude over time.	0	1	2	3	4	5	6
8. The child is well-behaved when (s)he is left alone.	0	1	2	3	4	5	6
9. Crying is more likely to stop if child is swaddled.	0	1	2	3	4	5	6
10. When crying occurs, I (the caregiver) try to calm down the child by picking him/her up or engaging in other interactive activities.	0	1	2	3	4	5	6
11. Crying is more likely to stop sensory items or stimuli are removed or taken away.	0	1	2	3	4	5	6
12. Crying occurs when the child's requests are denied or when items are taken away. (More likely with older infants/toddlers)	0	1	2	3	4	5	6
13. Crying occurs regardless of presentation of various stimuli.	0	1	2	3	4	5	6
14. Crying occurs when no person is nearby or watching.	0	1	2	3	4	5	6
15. The child is fussy or resists when (s)he is held or engaged in interaction with others.	0	1	2	3	4	5	6
16. Crying is less likely to occur when sensory stimulating activities are presented.	0	1	2	3	4	5	6

Score Summary	Social Positive	Social Negative	Sensory Positive	Sensory Negative
	1.	2.	3.	6.
	4.	8.	5.	7.
	10.	14.	9.	11.
	12.	15.	16.	13.
	Total:	**Total:**	**Total:**	**Total:**

APPENDIX E: Social Validity Questionnaire A

Participant code: _____

Caregiver A / B

Please rate the following questions on a scale from 1 to 5.

1. How clear is your understanding of the procedures being used and why?

1	2	3	4	5
Not clear at all		Somewhat clear		Very clear

2. How acceptable did you find the evaluation procedures used?

1	2	3	4	5
Not acceptable at all		Somewhat acceptable		Very acceptable

3. Do you think your child experienced any discomfort as a result of the procedures used?

1	2	3	4	5
No discomfort		Some discomfort		Extreme discomfort

4. Do you find this experience to be beneficial for you or your child?

1	2	3	4	5
No benefit		Some benefit		Immense benefit

5. Are you more aware of the impact of environmental variables and how they may influence your child's behavior?

1	2	3	4	5
Not at all		Maybe		Definitely

6. Any other comments?

_____

_____

Social Validity Questionnaire B

Participant code: _____

Caregiver A / B

Please rate the following questions on a scale from 1 to 5.

1. How clear were the treatment recommendations provided?

1	2	3	4	5
Not clear at all		Somewhat clear		Very clear

2. How acceptable did you find the treatment recommendation suggested?

1	2	3	4	5
Not acceptable at all		Somewhat acceptable		Very acceptable

3. Do you think your child experienced any discomfort as a result of the implemented treatment?

1	2	3	4	5
No discomfort		Some discomfort		Extreme discomfort

4. Do you think the treatment used in this study benefitted your child?

1	2	3	4	5
No benefit		Some benefit		Immense benefit

5. Do you think you will continue utilize a function-based approach with respect to your child's behavior?

1	2	3	4	5
Not at all		Maybe		Definitely

6. Any other comments?

_____

_____