Early infant crying as a behavioral state rather than a signal

Ronald G. Barr

Centre for Community Child Health Research, British Columbia Research Institute for Children's and Women's Health Department of Pediatrics, Faculty of Medicine, University of British Columbia, Vancouver, British Columbia V6H 3V4, Canada. **rbarr@cw.bc.ca**

Abstract: I argue that in the first three months, crying is primarily a behavioral state rather than a signal and that its properties include prolonged and unsoothable crying bouts as part of normal development. However, these normal properties trigger Shaken Baby Syndrome, a form of child abuse that does not easily fit an adaptive infanticide analysis.

In his excellent review on signal functions of early crying, Soltis argues that (1) abnormal crying reflecting pathology may be a cause of adaptive infant maltreatment, and (2) the early increase in crying, including colic, is normal and a signal of vigor that evolved to prevent withdrawal of care. I argue that there is a theoretical perspective, two other properties of early crying, and a different consequence not accounted for by these arguments, but that may be complementary.

The theoretical perspective is that "crying" in the first three months is primarily a behavioral state and not a signal, although it functions secondarily as a signal. Following Wolff (1987), the phrase "infant behavioral state" refers to organized behavioral properties of the infant at the level of the intact organism, as when we refer to an infant as *crying, awake,* or *asleep.* Behavioral states are the set of discontinuous and distinct modes of behavior, into which infant behavior is organized, that are (1) self-organizing, in the sense that a state is maintained until that pattern of events occurs that results in a shift to another state; (2) relatively stable over time (minutes rather than seconds), and (3) nonlinear, in the sense that a stimulus experienced in one state has a different effect than when experienced in another state (Barr et al. 1999; Wolff 1987). In the Soltis article, "crying" is used in a more restrictive sense, referring to negative vocalizations produced by the organism, or to their function as communicative signals. Reasons to consider crying as primarily a behavioral state are (1) the unique age-related n-shaped pattern of crying amounts (Barr 1990c); (2) analogous age-related shifts in organization of sleep and wakefulness (Wolff 1987); (3) the biobehavioral shift at about four months from "expressive" crying, which is relatively independent of context and presumed to reflect physiological state, to "communicative" crying, which becomes more tied to motor gestures and maternal response, and more intentional (Franco 1984; Gekoski et al. 1983; Gustafson & Green 1991) ; and (4) the nonlinear, state-dependent responses to stimuli (Graillon et al. 1997; Wolff 1987). Of course, the crying vocalizations may still function as signals, in that caregivers respond to and act on them and derive what meaning they can from them. My argument is that this is a secondary function at this age.

Two properties that occur primarily in the first three months are that crying bouts are prolonged and unsoothable. Recently, many studies have parsed the overall daily amounts of crying into components such as bout (or event) frequencies and durations. These components do not co-vary. For example, increased carrying and holding reduced daily crying and fussing duration by 43% but did not affect bout frequency (Barr 1989; Hunziker & Barr 1986). Further, the early increase and decrease is due primarily (if not exclusively) to bout duration, rather than frequency, changes (Barr 1989; 1990a; 1990b; Barr et al. 1991; 1992). These longer bout durations hold true for all modalities of distress from fussing to "colicky" crying (Barr et al. 2000; St. James-Roberts et al. 1995). In addition, some crying bouts are demonstrably unsoothable to typical care giving responses in the first three months (St. James-Roberts et al. 1995; White et al. 2000).

A consequence of these properties may be a specific form of child abuse; namely, Shaken Baby Syndrome (SBS). Many anecdotal confessions indicate that perpetrators just wanted to "stop the crying." SBS differs from most forms of child abuse; when the baby is shaken, there is no negative feedback (such as a mark on the skin or a stinging hand). Indeed, the baby may become quiet, rather than cry more. Parents who would never think of physically hitting their infant may shake them in frustration at the crying. Only when repeated and/or severe enough does the shaking come to clinical attention because of the ensuing brain damage. Although not systematically documented, perpetrator confessions (Brewster et al. 1998) and anecdotes culled from court records and media reports kept by the National Center on Shaken Baby Syndrome implicate crying as the most common stimulus. Furthermore, the age-specific incidence of SBS hospitalizations has the same starting age and shape as the age-specific crying curve (Holliday-Hanson et al. 2001). The peak incidence occurs in the third month rather than the second, probably due in part to repeated shaking in many cases (Alexander et al. 1990; Ewing-Cobbs et al. 1998). The effects are devastating: one-quarter die, and 55–65% of survivors are left with major neurological handicaps and blindness (King et al. 2003). The clinical implications of this are that parents need to be aware of these normal properties of crying to reduce their frustration with the crying. To address this, the National Center on Shaken Baby Syndrome has developed an educational campaign called the "Period of PURPLE Crying." The letters of the word PURPLE each refer to one of the six properties contributing to care giver frustration (P for peak pattern, U for unexpected timing, R for resistance to soothing, P for the pain-like grimace even when not in pain, L for long crying bouts, and E for evening clustering).

The proposal here is that SBS – and possibly other forms of infant physical abuse – are due to these normal properties of crying; namely, the prolonged and unsoothable bouts that occur in an age-specific and context independent pattern during the early months. Admittedly, it cannot be determined with certainty that SBS cases are limited only to those with normal cry acoustics. Further, SBS does not easily fit an adaptive infanticide analysis since the abuse is not apparent, death occurs in only one-quarter of SBS infants, and the remainder require increased rather than decreased parenting resources. In short, although normal and having possible signal value as vigor, this crying also results in maltreatment, and this maltreatment may not be "adaptive." If so, the paradox is that the very crying that advertises the infant's vigor may result in its being killed.

Changing brain activation needs determine early crying: A hypothesis

Elliott M. Blass

Department of Psychology, Program of Neuroscience and Behavior, University of Massachusetts, Amherst, MA 01003 and Department of Pediatrics, Boston University School of Medicine, Boston, MA 02118. **eblass@medusa.sbs.umass.edu**

Abstract: A proximal mechanism is proposed whereby early crying helps maintain ideal levels of brain activation during the first three postnatal months. The proposal is consonant with both animal and human infant literatures, and new data are presented in its support.

Soltis has provided an evolutionary perspective on the signal function of early crying (i.e., crying during the first three postnatal months). The upper end of the normal crying distribution, anchored by infants with colic, has provoked extensive medical and evolutionary hypotheses, none of which are very compelling, as **Soltis** suggests, and I concur. The lower end of the distribution, in which the very sick infant's cry signals weakness and vulnerability – that is, a poor bet for enhancing the parents inclusive fitness – also does not hold out much hope. The weak, grating cry of the very sick infant confirms that which the parent witnesses and

https://doi.org/10.1017/S0140525X04240109 Published online by Cambridge University Press

may contribute to the relatively greater incidence of infanticide and neglect suffered by infants at risk for health or born in very unfavorable circumstances. Minimizing losses from sick or weak infants presumably benefits the parents, and as such, infanticide and neglect are traits that can be selected. Yet why should the sick infant signal his weakness to the parents, possibly hastening his demise – particularly among humans in which very few offspring survive, so that indirect kinship benefits are very modest? Other difficulties present themselves. Infanticide is a very rare event. The high frequency of "kangaroo care" of premature infants by both parents and the very high rates of adoption relative to infanticide and neglect, at least in the West, both speak against parental investment as a driving evolutionary force. Ultimate explanations also do not account for the distribution of crying above the low threshold of parental rejection. Nor do they address the *n*-shaped function of crying during the initial three months.

Proximal analyses may prove more profitable. As detailed by Soltis, all agree that crying serves as a discomfort signal that attracts the parents to the isolated infant and through graded intensity attracts attention to the proximal source. I propose an additional function for early crying. Crying, with its attendant endogenous central stimulation is recruited when exogenous stimulation does not meet levels of central activity required for normal brain development.

A number of lines of internal (to crying) and external evidence support this view. First, as Soltis notes, there is substantial cultural variation in crying frequency that is inversely related to daily external stimulation. !Kung San infants who are in contact with their mothers for up to 80% of the day, present the *n*-shaped function; but it is enormously dampened at each point. At the other extreme, colicky infants also present the *n*. Their need for stimulation may be sufficiently severe that it cannot be met through standard parental care. It is interesting in this regard that some parents of colicky infants have found the solution through early hour auto rides or by placing the infant on top of the washing machine during the agitation cycle.

According to a substantial animal literature, dendritic development, especially in hippocampus, reflects stimulation provided by the mother (Gonzalez et al. 2001; Meaney et al. 1989). Moreover, ideal levels of stimulation, attained via the natural pathway of anogenital stimulation, activating central noradrenergic pathways, or pharmacologically via amphetamine injection, maximizes both behavioral preference and neural change (Pedersen et al. 1982; Sullivan et al. 1989). It is of considerable interest that both measures of affect and brain development of infants of depressed mothers are diminished relative to normal (Dawson et al. 1999). Remarkably, children who had suffered a single infant epileptic seizure scored considerably higher in a prospective study on a variety of cognitive evaluations than matched control infants (Chang et al. 2001).

If crying reflects an inadequacy in central arousal, and if central arousal needs are manifest in an *n*-distribution over the first three postnatal months, then a priori predictions can be made about different classes of infant behavior based on the normal crying curve. Our studies (Blass & Camp 2001; 2004) on infant preference for adults based on a single 3.5-minute interaction support this approach. In following a substantial animal and human infant literature on sucrose as a calming and analgesic agent, infants either received sucrose alone or on a pacifier when they were either crying or calm. No single factor accounted for the infant preference at the ages (6, 9, and12 weeks) that we studied. Preference reflected the levels of activation that the infants were in at a particular age. Week 6 infants, who are at the apex of the crying function, preferred only adults with whom they had interacted when agitated. At weeks 9 and 12, infants preferred adults with whom they interacted when calm. Nine-week-olds preferred adults who had given them a pacifier to suck, thereby increasing level of activation (in principle; Cohen et al. 1998). Calm week 12 infants did not prefer such adults. Rather, they strongly preferred ones who had given them sucrose to taste. Sucrose, through opioid mechanisms, presumably further reduced central activity (Blass & Ciaramitaro 1994). These findings map nicely on to the descending limb of the *n*-shaped function. We are currently testing how well the predictions made by the ascending limb hold.

These are clearly early times for the hypothesis and data presented above. Fundamental physiological, energetic, and neural measures must evaluate the putative changes that I have posited. The proposal that early crying reflects central activation needs has the virtue, however, of generating precise testable hypotheses, based on the *n*-function, in affective domains that are independent of crying. This approach may help identify proximal determinants of positive affect as well as those underlying early crying.

Prelinguistic evolution in hominin mothers and babies: For cryin' out loud!

Dean Falk

Department of Anthropology, Florida State University, Tallahassee, FL 32306-4531. **dfalk@fsu.edu**
http://www.anthro.fsu.edu/people/faculty/falk.html

Abstract: Unlike chimpanzees, human infants engage in persistent adult-directed (AD) crying, and human mothers produce a special form of infant-directed vocalization, known as motherese. These complementary behaviors are hypothesized to have evolved initially in our hominin ancestors in conjunction with the evolution of bipedalism, and to represent prelinguistic substrates that paved the way for the eventual emergence of protolanguage.

Soltis cites cross-cultural evidence to support the hypothesis that selective withdrawal of parental care and infanticide were important variables during infant physiological evolution in our species. It is therefore interesting that mothers among our closest evolutionary cousins, the chimpanzees (in whom fathers are unknown), rarely if ever reject their infants when living in the wild, and some have even been observed (sadly) carrying their babies' corpses for some days after the babies have succumbed to non–maternally caused deaths. However, this observation does not contradict Soltis' suggestion that aversive early infant crying is a common provocation of parental rejection or infanticide in humans, for the simple reason that chimpanzee infants do not cry excessively as human infants do. Nor do chimpanzee mothers engage in the continual streams of vocalizations, known as musical speech, baby talk, or motherese, that universally characterize human mothers. I believe that persistent adult-directed (AD) infant crying and infant-directed (ID) motherese are complementary behaviors that evolved initially in our hominin ancestors in conjunction with the evolution of bipedalism, and that they represent prelinguistic substrates that paved the way for the eventual emergence of protolanguage (Falk 2004).

The target article's analysis of the signal functions of early infant crying is consistent with the "putting the baby down" hypothesis, which focuses largely – but not exclusively – on the signal functions of motherese (Falk 2004). As Soltis documents, human infants frequently cry as honest signals of need, the most common of which appears to be the desire to reestablish physical contact with caregivers (Small 1998; Wolff 1969). Unlike helpless human babies, chimpanzee infants older than approximately two months cling unaided to their mothers' abdomens or backs, so they have little to cry about (although they do whimper and complain on those rare occasions when they fall off [Plooij 1984]). Because of structural constraints that were imposed on the human birth canal by selection for bipedalism in combination with relatively enlarged fetal brain/head sizes, human infants today are born at relatively early stages of development (when their heads are still small enough to negotiate the birth canal) and never develop the ability to cling unaided to their mothers. Therefore, compared to their apelike ancestors, early bipedal hominin mothers literally

https://doi.org/10.1017/S0140525X04240109 Published online by Cambridge University Press