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Babies' Cries: Who's Listening? Who's Being Fooled?*

BY NICHOLAS
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CAROLYN OLSON, AND
BRIAN DESSUREAU

The misfortune, I gather, was one of timing. Israel chose the wrong time to cry. A sentry had just come down to report the presence of a rather large force of Germans on Mila Street, and apparently the clatter of preparations together with the palpable apprehension, tautness, and irritability in the bunker somehow upset the baby, and he began screaming. Rutka tried everything. The child was not interested in her breast. Sweetened water, which one of the fighters offered, did no good. Vodka, from the bunker commissary, only burned the baby's mouth and made things worse. Mordecai was no help. He stood over Turka, shouting at her. "Do something! Well, quiet him. Do something, girl!" Rutka, on her knees, working over the baby, dreadfully mortified: "I'm trying. . . ." A shot distantly heard in a moment between screams tipped the balance of the contest. Yitzhok walked to Rutka and spoke to her in a gentle voice. "Give me the baby. Let

* We are grateful for the advice and/or assistance of Sandra Azar, Wendy Grolnick, and Lee and Michael McKenzie, Rosemary Summers, and to Thelma Rowell for her bibliographical assistance and sage conceptual guidance. We are indebted also to Don Owings and David Hennesy for their m/a theory of communication and for the connection it makes to the fundamental concepts of developmental psychology and regulatory biology. Finally, we want to thank Todd Livdahl for hosting the baby cry project in his laboratory during the summer of 1996, when our own quarters were being demolished.

me try to quiet him." He took the child and carried it across the room away from Rutka. Rapaport says he could not see exactly what Yitzhok did: he only saw that the commander was hunched over slightly, and suddenly (too suddenly, Rapaport says) the child was silent.

John Hersey, *The Wall*

THE crying of a baby shares many features with the displays of animals—showy behaviors that have evolved because of their effects on partners in homo- or hetero-specific interactions. Subjected to a sudden shock, such as an injection at the doctor's office or a sustained deprivation such as a delayed feeding, a baby may draw unusually deep and rasping breaths followed with yelps that seem utterly to exhaust its supply of air (Wolff, 1969). The effects of this behavior on social partners is dramatic. Adults find babies' cries extraordinary upsetting, distracting and/or irritating, even by comparison with other unpleasant noises, such as "phased machine noise" (Morsbach, McCulloch, and Clark, 1986). These adult responses bear some resemblance to instinctive responses: they are stereotyped and seem not to be the product of training. Even college-age males, who typically have little experience with young babies, give physiological responses to a baby's cries that are similar in pattern (if somewhat less intense) to those of more knowledgeable young women or adults (Green, Jones, and Gustafson, 1987; Boukydis and Burgess, 1982).

Despite the similarity of babies' crying to the evolved displays of animals, evolutionary analysis has not yet played an important role in our understanding of their cries and of the parental responses they evoke. In fact, most recent research on babies' cries and parents' responses to them has been driven primarily by atheoretical and pragmatic considerations. Researchers have sought to identify those features of babies' cries that may be used as cues to infant health and those features that are likely to lead to favorable parental reactions. The cries

of infants suffering from various complications and syndromes such as *Cri du Chat*, Down's Syndrome, and asphyxia have been examined for any distinguishing characteristics or features that might assist in diagnosis (Wasz-Hockert, Vuorenkoski, Partanen and Valanne, 1968, Zeskind and Lester, 1978). Babies whose health is or has been compromised tend to cry with an abnormally high pitch and with abnormal duration, and adults find their cries particularly distressing (Zeskind and Lester, 1978). To the extent that there has been theory concerning babies' cries, it has been around the concept of arousal. Beginning with Wolff, researchers have assumed that a baby's cry is correlated with—and therefore designed to communicate—high levels of arousal (Wolff, 1969). These assumptions have led to the examination of events precipitating arousal in infants as well as methods for decreasing or controlling infants' arousal levels (Wolff, 1969). Why such high levels of arousal should shape babies' cries as they are and why parents should be selected to respond to infant arousal *per se* has not been explored.

The lack of a well-developed theoretical perspective on infant crying is surprising because crying is so obviously one of the suite of behaviors by which infants achieve and maintain attachments with their caregivers (Bowlby, 1978; 1982). The developing body of theory known as evolutionary psychology may provide a deeper foundation for understanding these results and for predicting others. Evolutionary psychologists interpret human behavior in terms of the operation of information-processing mechanisms that were developed during the 2 million years of the pleistocene, a time when human beings were hunter/gatherers (Cosmides and Tooby, 1992). The environmental circumstances that presided over human evolution are known in the literature of evolutionary psychology as the Environment of Evolutionary Adaptedness, abbreviated EEA (Bowlby, 1978/1982). Although direct knowledge of human social organization during the EEA is inevitably scanty, it can be inferred from the study of contemporary

hunting/gathering cultures and from the study of the social organizations of mammals, particularly primates, living in ecological circumstances similar to those thought to exist for humans during the pleistocene. An evolutionary psychological approach to babies' cries suggests that adults have been selected to monitor cues to crucial survival variables when they listen to babies' cries. It further suggests that babies should have been selected for manipulating those cue variables in such a way as to alter the behavior of monitoring adults in directions advantageous to the babies and not necessarily advantageous to the adults.

*A Brief Introduction to the Evolutionary
Psychology of Communication*

Evolutionary psychology makes free use of vernacular ideas and terms that may be misleading if they are understood in their ordinary ways. One idea of evolutionary psychology that seems odd to non-evolutionists is that the evolution of behavior is guided by a kind of economy in which genes function as a monetary unit. Genes as monetary units differ from dollars or pounds in that the economic system in which they are units (Natural selection) rewards individuals for giving them away, rather than for accumulating them. According to this way of thinking, we should expect organisms to behave in ways that maximize the number of copies of their own genes that they place in future generations (Trivers, 1972; 1985). This expectation does not seem odd to evolutionary biologists because it follows directly from the tautology that present day organisms are composed only of genes that have constructed organisms that have placed those genes in what was then future—but are now present—generations (Dawkins, [1976] 1989). It leads in turn to the expectation that organisms, other things being equal, should, cooperate just to the extent that they are related, since helping a relative—who shares many of

your genes—just as surely places your genes in the next generation as helping yourself. In fact, from this perspective, having children is just a special case of this general principle, and social organisms, such as bees, jays, marmosets, and humans, may be expected to sacrifice their own reproduction to that of their relatives whenever helping relatives have offspring produces substantially more offspring than having offspring of one's own (Dawkins, 1982). Both are always by which the organism can increase its "inclusive fitness"—the total number of genes that it contributes to subsequent generations.

The concept of inclusive fitness has been central to the evolutionary analysis of development and caregiving in animals ever since the pioneering work of Robert Trivers on parental investment and parent offspring conflict (Trivers, 1978). The central insight of this work is that parents and their current offspring should be expected to differ over whether parents should expend any effort in having future offspring. For an example, consider the parents of a monogamous pair, who have a single offspring a year. To such parents, the future siblings of the current youngster are, like the current youngster itself, related by one-half. To the current youngster, those future siblings are related by *ONLY* one-half, in fact by half as much as the current youngster is related to itself. So when a parent tries to prepare itself for next year's young by weaning the current year's young, the current year's young may be expected to resist, since the genetic economy provides that each unit of parental aid directed toward a future sibling is only half as effective at distributing the current young's genes as a unit of aid directed toward itself. That protest will continue until the gain it provides the young directly is more than offset by the loss it provides the young through damage to future offspring of its parents. Trivers original insight has been contested, defended, quantified, and qualified, but the general conclusion remains standing, that offspring should be

expected to demand more from their parents than the parents are selected to give (Clutton-Brock, 1991).

Because of the conflict that may exist between offspring and their parents over parental investment, each may be expected to "manipulate" the other. Unlike the notions of genetic interest and parent offspring conflict, the idea of evolutionary manipulation is not particularly radical, and readers unfamiliar with evolutionary psychology and its ways of speaking may be tempted to over-interpret its meaning (Thompson and Derr, 1995). Such readers should be forewarned that cognitive terms do not always have the same meaning in evolutionary psychology as they do in other subfields of the discipline. Language that in ordinary psychological discourse would refer to the goal of an activity—that toward which an activity is directed—refers often in evolutionary psychological discourse to its function—that *by* which an activity has been naturally selected during its evolution. So, the suggestion that babies "manipulate cue variables . . . to alter the behavior of . . . adults" is not the claim that the babies are aware of what they are doing or even that their behavior has that outcome as an unconscious goal. It is only the claim that our babies cry under those circumstances today because nature has in the past selected them for doing so, selected them on account of the benefits that adult attention has brought to infant survival.

Although the evolution of babies' cries has not been much considered in recent literature, the theoretical analysis of the evolution of animals' displays has been an especially active area of research for the last decade. One theory based in the study of animal communication that seems particularly relevant to babies' cries is the theory of communication as assessment and management developed by Donald Owings and various collaborators' (Owings and Hennessey, 1984; Rowe and Owings, 1980). According to the *a/m* theory², communication systems are an extension of an organism's homeostatic systems into the social world around it. Communication systems arise because organisms assess each other's states, and because

assessment of one organism by another provides opportunities for the second organism to manage the behavior of the first. If Alfred and Bertha are two monkeys in a social interaction and Bertha is assessing the likelihood that Alfred will attack her, then Alfred has the opportunity to manage Bertha's behavior by varying those behaviors that Bertha is using to assess him. So, for instance, if both monkeys are tempted by a bit of ripe fruit, and Bertha is watching Alfred's gaze to assess his likelihood of fighting for it, then Alfred may be able to cause Bertha to back off from the fruit simply by gazing at her. Similarly, if Bertha is a mother monkey, monitoring her infant Charley's sounds as he engages in his first attempts to join the troop's juveniles in play, then Charley has the opportunity to manage Bertha's behavior with the sounds he makes.

Understanding how the *a/m* perspective applies to human babies requires understanding the relation between cues and the functionally significant variables they represent. Assessment/management systems, like all homeostatic systems, make use of cues. Just as a thermostat makes use of the bending of a bi-metallic strip to assess room temperature, so Bertha makes use of Alfred's gaze as a cue of his resolve to defend the fruit and of Charley's squeaks as a cue to his reception by his newfound playmates. A cue is a correlate of a functionally significant situation that is taken by an organism as equivalent to that situation. So, for instance, sweetness is a cue to the sugar content of food because it is related to the presence of sugar in food and because organisms treat sweetness as equivalent to sugar content. This equivalence can be demonstrated by artificially disjoining the cue (sweetness) from the functionally significant variable to which it is related (sugar content) through the use of artificial sweeteners such as aspartame. Classical ethology is full of demonstrations of analogous equivalences (Thompson, 1986). For instance, David Lack (1946) demonstrated that the stick-like legs and red breast of a male English robin is a cue to his whereabouts by

showing that a red tuft of feathers attached to a wire was treated as equivalent by other male robins.

That ethologists can provide cues in the absence of their functionally significant correlates illustrates that cues are fallible. The inherent fallibility of the cue/function relation is the basis of evolutionary manipulation through deception (Thompson, 1986). One organism gains an advantage with another by providing the cue to a functional variable without providing the functional variable itself. For instance, in classical Batesian mimicry, a tasty viceroy butterfly gains an advantage with a predator such as a blue jay by looking like a distasteful monarch butterfly, whose flesh is laced with toxins from the milkweed plant on which it feeds (Wickler, 1988). Implicit in the idea that a baby's cry is a cue to a functionally significant variable is the possibility that the baby can manipulate the parent by altering the cues to functional variables in the absence of any changes in the functional variables themselves.

To view the crying from an assessment/management perspective is to see babies as managers of parental behavior, to see parents as assessors of important functional variables in babies, and to see babies' cries as fallible cues to these functional variables. This perspective leads to two central questions: (1) What functional variable is the adult assessing, and what cue is the adult using to assess it and (2) who are the social partners that the baby is managing with its cries? In this essay, we offer what may seem counter-intuitive answers to both of these questions. In answer to (1), we suggest that the crying of babies is a kind of lying: that babies manipulate adults by deceptively supplying the cues to engage a primitive human mechanism for the identification of respiratory distress in social partners. Their cries contain cues to respiratory distress, even when no primary state of respiratory distress exists. In answer to (2), we suggest that babies cries are directed to people at a distance, not their current caretakers,

and often toward relatives and associates of their parents and not necessarily toward the parents themselves.

The Deceptive Origins of Babies Cries

According to the assessment/management perspective of Owings and his collaborators, communication systems arise when one social partner is attempting to assess some functional variable in a second, giving the second partner an opportunity to manage the first by varying the assessed variable. One important feature of the perspective is the logical asymmetry between assessment and management: while it is quite possible for one animal to assess some feature of another without the other managing, it is logically impossible for the other animal to manage without being assessed. Thus, the evolutionary foundation of a communication system will always consist of some features of an animal's behavior that provide information about that animal but have not as yet been selected for doing so. This foundation can be recognized because it gives form to the communication system that arises from it.

When one regards baby cries from an assessment/management perspective, one is first led to ask, What variables in the baby is the caretaker assessing when the baby cries? This assessment question is an evolutionary psychology one because it is not just asking which features of the baby's cry the adult is responding to. It is further asking what are the underlying functional variables for which these features have in the course of evolutionary history served as cues. Several developmental studies have shown that the pitch of a baby's cry is a feature that strongly determines adults' responses (Gustafson and Green, 1989; Porter, Miller, and Marshall, 1986; Adachi et al. 1985; Zeskink, Klein, and Marshall, 1992). Why pitch? What underlying functional variable does pitch represent, and how in the course of evolution has pitch come to represent it? Age is a possibility. Pitch is a plausible cue to age in human beings.

Eugene Morton (1977) has pointed out that vocalization pitch in any species is likely to be an honest signal of body size because the lowest sound one can make is determined by the size of resonant spaces within the body. This principle seems to be generally true in humans. Although we have all known big adults with squeaky voices and small adults with deep voices, still, the average dominant pitch of human vocalization declines from infancy to adulthood as the young person increases in size. The problem with this idea that adults assess age through the pitch of a child's cry is that by itself age seems to be a singularly uninteresting variable to monitor. An infant's age varies only slowly and, in most cases, is well-known to any likely caregiver. Thus, while the pitch dimension of baby's cries almost certainly contains age information, provision of this information by itself seems an insufficient explanation for the evolution of crying behavior.

But putting age information into the cry might assist in the rapid assessment of some other variable that does change from moment to moment and might, therefore, be unknown to a caregiver. What might this variable be? For human beings, with their complex speech anatomy and the compromises it has imposed on the respiratory apparatus, respiration is an important issue, and degree of respiratory disturbance might be a particular important variable for caregivers to assess. Slowed respiration can be indicative of obstruction of the breathing passages; rapid respiration can be an indication of fever or other forms of physiological distress (Rosenberg and Thilo, 1995).

But degree of respiratory disturbance cannot just be assessed by assessing breathing rate. Because breathing rate varies with age, to assess the degree of respiratory disturbance in another human being, we have to interpret that person's respiratory rate in terms of that person's age. A respiration rate that was abnormally slow in a baby would be just normal for a child; a respiration rate that would be abnormally slow in a child would be just normal for an adult, and so forth. So, if a

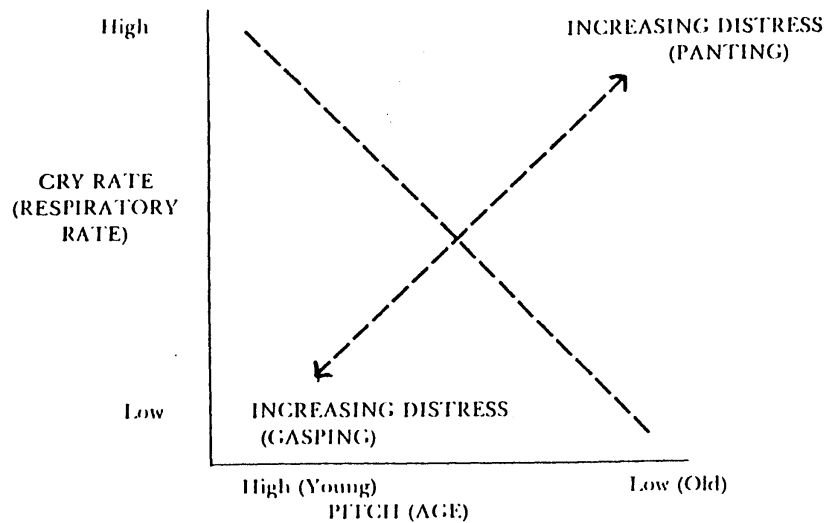
cry is to provide information about respiratory distress, it must contain information about age. Perhaps pitch is an important variable because it provides the listener with the information about age essential to interpret the *REAL* information in the cry: information about respiration. Thus, the role of pitch in crying would be to provide a cue to age so that the degree of respiratory disturbance can be rapidly estimated from the respiratory rate suggested by the cry.

If one accepts that respiratory disturbance was what pleistocene adults were assessing in babies' cries, then crying provided opportunities for a baby to manage the proximity of adults through varying the cues to respiratory distress in a cry. The baby would do so by departing from the normal respiratory rate for the age-appropriate pitch of its cry. To imagine how this may be done, it helps to think of human respiratory patterns as plotted in a two dimensional space, with age represented on the horizontal axis and respiratory rate represented on the vertical axis. As an individual ages, his or her respiratory rate moves down the diagonal of this space from upper left to lower right: that is, from fast to slow. So, normal, resting respiratory rates are found along this diagonal. Abnormal rates are found above or below the diagonal: hypoventilation (that is, gasping) below it, hyperventilation (panting) above it.

If you grant the premise of our argument here—that the assessment mechanism in the listening adult is using pitch as a measure of the age of a crying infant—then a baby could simulate respiratory distress in two ways: (1) It could simulate gasping by any combination of raising the pitch while slowing the respiration; or (2) it could simulate panting by any combination of lowering the pitch while speeding the respiration.

The use of the word "simulate" suggests that we think that the baby's cry is a form of deception. Actually, we have only recently made up our minds on this point. Note that within each of the two methods described above, the infant can

FIGURE 1. A distressed cry is one that suggests an abnormal respiratory rate for a given age, as indicated by its pitch.



achieve the desired simulation either by varying pitch *OR* by varying the respiration rate of the cry. These two methods seem to have a very unequal cost. Although raising and lowering the pitch may place some burden on the vocal apparatus, raising and lowering respiratory rate disturbs respiration and might actually place the baby at risk for respiratory distress: breathing-holding and gasping may result in hypoxia, and panting may result in hyperoxia. Thus, pitch varying has some potential as a deceptive signal, but respiratory rate varying has a much more limited potential. Or, at least, if it is deceptive in the first instance, it rapidly has the capacity to become a self-fulfilling prophesy. In fact, variations of respiratory rate in infant crying could be seen as a kind of blackmail in which the infant places itself at a small risk of respiratory distress because such behaviors have been selected by big gains in parental attention.

We have elsewhere used logical and mathematical analysis to explore whether deception or extortion by kidnapping is the more likely account of the respiratory melodrama in babies

cries (Thompson, Dessureau, and Olson, forthcoming). This analysis shows that *ANY* kidnapping is a deeply irrational activity except under the special circumstances that modern societies make possible and that "self-kidnapping" can be supported by natural selection only if it involves bluffing—that is, deception. However, the same sort of analysis shows that deception among relatives is readily supported by natural selection so long as the benefits to the receiver outweigh the costs to the deceived individual in proportion to their degree of relatedness. This analysis strongly suggests that deception is the more reasonable explanation of the melodramatic qualities of babies cries.

Thus, from the assessment/management perspective, variations in duration of cries and pauses between cries should have an effect on perception of cry urgency by adults. As with pitch, there is ample evidence that variations in duration of cry elements affects how they are perceived but no consensus about the nature of these effects. The most widely observed effects are that cries increase in length when a baby is aversively stimulated and a corresponding increase in the perceived urgency of a duration with an increase in its duration (Rosenberg and Thilo, 1995). But a recent study by Zeskind, Klein, and Marshall (1992) produced the opposite effect. they altered a natural baby cry to produce a series of ten second stimuli that varied in durations of their cries and pauses. Although their publication does not evaluate the question directly, the stimuli with short cries and short pauses produced higher ratings of urgency than the unaltered cries, which produced higher ratings of urgency than the long cries with long pauses.

This study was particularly interesting not only because it reversed a frequently noted result, but because of the sophistication of its methodology. Because the authors employed digital technology to alter the durations of their stimuli, they could easily alter cry duration and pause duration independently. If the theory under consideration here is

correct, abnormal relationships between cry duration and pause duration should be alarming to parents because they suggest a disturbance to the ratio of air drawn in and air expelled. Particularly alarming should be long cries with short pauses between since these suggest that the crier is potentially running short of oxygen. The data relevant to this expectation are ambiguous. The second highest ratings of "urgent" were produced by long cries with short pauses, but these were equaled or exceeded by *short* cries with short pauses, and the lowest ratings of urgent were produced by short cries with *long* pauses.

The Zeskind, Klein, and Marshall experiment made no modifications to the frequency of their stimuli, so while their experiment offers no consistent support for the notion that respiratory distress is what crying is "about," still it provides no evaluation of our specific hypothesis that relates pitch to cry rate.

In summary, our attempt to provide an evolutionary psychological explanation of babies' cries has led to a theory that these cries are a form of deception. The deception has arisen in the course of evolution because populations ancestral to modern human adults monitored the breathing of children as an indication of their health and wellbeing, and this monitoring provided an opportunity for children to manage the behavior of adults by melodramatically varying cues to respiratory distress in their vocalizations.

*Who Are the Social Partners That the Baby Is
Managing with Its Cries?*

No one would doubt that modern Western babies manage their primary caretakers with their cries. Crying holds a central place in the relationship between contemporary caregivers and their babies, and considerable pediatric practice is devoted in turn to managing crying and its effects on parents. Research shows that contemporary caregivers are closely attuned to their

babies' crying. Caregivers assume that a baby cries for a reason and closely scrutinize the cry for evidence of the ill they manifest (Lester, Boukydis, Garcia-Coll, Peucker, McGrath, Vohr, Brem, and Oh, 1995). Research also shows that babies soon get very good at conditioning their parents to approach with their crying, so good, in fact, that training parents not to over respond to a baby's cries is an important pediatric cottage industry (James-Roberts, Hurry, Bower, and Barr, 1995).

But the idea that such management is through a form of deception is hard to believe because caregivers and their infants seem so intimate. How could it be that an infant could fool a parent who knows so much about its history and circumstances? Indeed, why would it try? But this is not a problem just for a theory of babies' cries as deception. It is a problem for our understanding of babies' cries in general. If babies' cries are designed as communications between individuals that are physically intimate and share all interests in common, why are they so loud? If they presuppose a hearer who is attuned to the cryer's needs, why are they so melodramatic? Why do babies shriek when a whisper would suffice?

Is it possible that our assumption that a baby's cry is a communication to its parents is an unwarranted and ethnocentric extrapolation from our own obsession with the nuclear family as a unit of childrearing? To demonstrate that modern Western parents respond to babies' cries is not sufficient to demonstrate that babies' cries were designed primarily by their consequences on parents. On the contrary, a consideration of the organization of parenting and social organization in the EEA would make it highly implausible that babies were designed to cry solely—or even primarily—for an audience of their parents. A perusal of what we know about pleistocene social organization would seem to imply that the maternal/infant feeding system is designed to function in a group setting comprised of 30 to 60 adults, grouped into lineages of strongly related individuals (Barkow, Cosmides, and Tooby,

1992). This sort of social organization is characteristic not only of the majority of hunting/gathering cultures, but also of a great many primates, particularly those living in circumstances remotely similar to the EEA. It is true, for instance, of chimpanzees, bonobos, gorillas, vervet monkeys, baboons, and many others.

Infant Cries as Calls for Help to an Absent Mother

But what is the relevance of human social organization and band size to the crying system? Human infants are not the sort of creatures that can shuttle back and forth on their own power among potential caregivers. Before independent locomotion and weaning, an infant would not be expected to be more than a few inches from the body of a caregiver. Everything about the maternal/infant system suggests that infants are designed to be carried closely by adults and fed tended often (Blurton-Jones, 1972). And indeed, in hunting/gathering peoples and primates alike, a healthy infant is rarely off the body of its mother or another group member. So tight is the physical bond between caregivers and infants in some primate species that dead infants are often carried diligently and groomed scrupulously for hours or even days after their death. For mediating a relationship between a caretaker and an infant that are never more than inches apart, crying seems much too elaborate and costly a vocalization. Assuming a communality of interest between caregiver and infant, a "whispered" vocalization would seem much more likely to have evolved than a "shouted" one. Indeed, in cultures where infants are kept constantly on a caretaker's body, crying is rare. All of this suggests that much of what we take to be the normal crying of contemporary Western infants arises from the enforcement of routines necessary for modern life that do not accord with the design of the human infant system.

There is, however, one set of circumstances in which babies

in the EEA might be expected to direct their cries to their mothers. If pleistocene humans were similar to other highly social primates, related group members would be expected to take a strong interest in a female's infant. Moreover, coalitions among non-related individuals should be an important feature of social organizations. Members of such coalitions should also be expected to take a strong interest in one another's infants. These inferences are drawn again from the study of primates. The related—and sometimes unrelated—individuals of many primate species are attracted to newborn babies and try to groom them or even temporarily adopt them for short periods of time. Mothers of various species vary widely in the degree to which they accept such approaches, but, in some species, infants are passed around among the females of the group.

Given this evolutionary history, it is reasonable to consider that infant humans may be adapted to spend some time away from the mother and on the bodies of other group members, particularly females related to the mother. Because of relatedness and reciprocity relations between the adopting female and the mother, such females may usually be expected to treat an infant well. But because of differences of relatedness, they may also be expected not necessarily to direct as much care to the infant as would the mother. Thus, one function of infant crying that does involve the mother as a target—and a function fulfilled by analogous vocalizations in primates—would be to summon the mother to the infant in the event it was being mishandled.

Other Lactating Females as Targets for Crying

However, an evolutionary perspective on crying suggests that the mother might not be the only group member toward whom crying is targeted. In fact, under some circumstances, an infant's mother may not be the best source for nutrition or protection. Given some seasonality in fertility and synchrony of

ovulation among females, a greater than random number of females should give birth annually within a short span of time. Thus, the birth mothers of a year should be somewhat synchronized in their stage of lactation. In mothers whose infants survive through infancy, lactation would be expected to continue to up to three years, and birth cycling should be expected to occur at most in a 3-year cycle. Thus, assuming an infant mortality of 50 percent up to weaning, lactation-suppressed ovulation, gestation of 9 months, every female of reproductive age should be expected to be lactating at least two years in every four. This means that half the reproductive-age females of a group should be lactating at any one time. Therefore, other things being equal, half the females in a group should be potential sources of nutrition for an infant.

These circumstances create an ideal background for the evolution of lactation-sharing through kin selection and reciprocal altruism. Given variation in the health of mothers, food availability, and the daily energy requirements of infants, some mothers will have surplus lactation, others lactation insufficiency on any given day. Milk is a perishable resource that cannot be stored. Studies of animal behavior have recently turned up an excellent example of the sharing of a perishable resource in animals associating in a complex social system. Vampire bats survive on a highly perishable and spotty resource: the blood of warm-blooded creatures. Hunting success varies among individuals from night to night. Because the bat is a flying creature, large quantities of excess energy cannot be stored as fat. Because flying is an energy intensive activity, a bat that has not fed on a given night is in serious trouble. But reciprocal arrangements make it possible for a bat that has a bad night to receive food from one that has had a good night and for a bat that has a good night to earn credit for a future night in which it might come up dry. Close study of blood sharing indicates that it is primarily with an individual that has donated blood in the past or with close relatives (Wilkinson, 1984).

Milk as a resource has many similar properties to blood. the demand for it cannot be precisely predicted, and, once made, it cannot be preserved. Just as there are many sources of blood in the bat flock, there are many sources of milk in a group of nursing mothers. Just as the marginal cost of picking up a little extra blood is small for a bat that has already gone to the effort to find a mammal and open up an incision, the marginal cost of making a little extra milk is small for a lactating mother who is healthy. Just as the value of shared blood is very great to a bat that has had a bad night of hunting, so the value of shared milk is very great to an infant whose mother cannot produce enough on a given day.

But such a milk-sharing system would require a system of negotiation, a kind of inverse system of bidding, in which the infant states its need and lactating females respond depending on the state of their milk surplus, their relatedness to the infant, and the presence or absence of a history of reciprocation between themselves and the infant's mother. Thus, some system is required by which each lactating female in the group can mediate the following information: the degree of need of the infant, the identity and, therefore, degree of relatedness of the infant, the state of reciprocal relationships between the mother and the infant's mother, and, finally, the state of need of her own infant, her own physical condition, and the amount of her milk surplus, if any. This reasoning suggests that a nursing mother's perception of the distressingness of a cry should be in direct proportion to her milk supply, general health, and familiarity with and/or relatedness to the infant.

Conclusions

Thus, an evolutionary perspective on babies' cries and mothers' responses to them suggest that these behaviors are designed in part as a negotiation system by which it is

determined in an emergency which nursing female in a group will supplement the feeding of a baby whose lactation has been insufficient.³ Examination of the melodramatic properties of babies cries further suggests that the form of these cries has been determined in the course of their evolution by their capacity to manipulate a mechanism in listening adults that was originally tuned for signs of respiratory distress. Because adults are not strongly selected to avoid providing benefits to infants that are related by bonds of blood and reciprocity, respiratory melodrama has formed the basic coding by which an infant represents its nutritional and protection needs.

Notes

¹ Cf. Williams, 1986, for a stalwart defense of the use of cognitive language in evolutionary arguments.

² Owings and his collaborators refer to their theory as the m/a theory. This ordering, with its academic resonance, may come trippingly to the tongue, but I found that it slowed my coming to understand the theory because assessment is logically prior to management.

³ Reading this manuscript in proof we were struck by our failure to consider, as Amotuz Zahavi has proposed, that babies' cries are communication to potential predators concerning the group's location, a communication that has the affect of black-mailing the group into providing for the needs of the infant.

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On the Psychology of Self-Deception

BY DAVID SHAPIRO

IT is easy to lose one's way in the subject of self-deception, so I will stay close to actual events as much as possible.

To begin with, an example, in which it seems that knowing something is not as simple and unambiguous a condition as one might imagine: A businessman is talking about his partner and friend of many years. He chooses his words carefully. With obvious reluctance, he says that it is "possible" that this man has been cheating him. He is silent for a moment, then he says quietly that he thinks he has known this "in a way" for a long time. Finally, he adds, "But you don't really know it until you say it out loud."

Thus we learn that there are two kinds of knowing: knowing "in a way" and "really" knowing. Furthermore, the transition from one to the other occurs upon "saying it out loud." The difference, in other words, is not a matter of acquiring additional information, but of conscious articulation of what was already in some sense known but not articulated. One might call it a process of consciousness raising. The earlier state was one in which the speaker did not know (and did not want to know) what he knew; the final state was one in which he realized what he knew, admitting it to his listener and to himself at the same stroke. It appears, therefore, that there is a distinction between what one feels or believes about something and what one imagines oneself to feel or believe.¹ A disjunction between these two is what we call self-deception.