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Infant Cries As Evolutionary Melodrama: Extortion or Deception?

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Abstract

Crying is melodramatic in the sense that crying babies seem to respond to a great variety of distressing situations with behaviors, such as gasping, choking, and panting that would be appropriate to a very specific respiratory emergency. In this paper we develop models to explore whether extortion or deception is the more plausible origin of the melodrama in a baby's cry. According to these models, deception seems a more plausible origin than extortion because extortion requires the incoherent assumption that nature can select against the genetic interests of an organism. By comparison, the assumptions required to rationalize a deception explanation — that the parent share in the benefits given to its offspring — seem relatively harmless and consistent with contemporary sociobiological theory.

The crying of a baby is a thoroughly melodramatic performance. Crying is melodramatic in the sense that crying babies seem to respond to a great variety of distressing situations with behaviors, such as gasping, choking, and panting that would be appropriate to a very specific respiratory emergency. Subjected to

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a sudden shock, such as an immunization injection, a baby draws an unusually deep and rasping breath which it often follows with a with a series of yelps that seem utterly to exhaust its supply of air (Wolff 1969).

Such cries have at least a superficial resemblance to the evolved communicative displays of animals. Like the singing of birds (Catchpole & Slater 1995; Beecher et al. 1998), they are highly stylized and contain species-specific, motivation-specific, and individual specific information. Moreover, like animal displays, human infant cries seem to provoke specific and involuntary responses in fellow species members. Research demonstrates that adults find these cries extraordinarily upsetting, distracting, and/or irritating, even by comparison with other unpleasant noises, such as "phased machine noise" (Morsbach, Mcculloch & Clark 1986). These adult responses 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 the responses of more knowledgeable young women or adults of both sexes (Green, Jones & Gustafson 1987; Boukydis & Burgess 1982).

Given these parallels with the evolved displays of animals, there is remarkably little speculation on the evolution of infant crying. Ann Murray (1985) summarizes the three major approaches to the explanation of adults' responses to crying. The first approach is known as the innate releaser model, and its ideas are derived from the work of John Bowlby on mother-infant attachment (Bowlby 1969/1982). This approach posits that the cry acts as an innate releaser of all forms of parenting behavior. This process is viewed as automatic and biologically determined. The cry is matched with specialized detection capabilities and behavioral patterns in the adult listener. Once these 'sensors' are tripped, they produce an involuntary, automatic caregiving response in the adult listener that requires little or no cognitive processing. Support for this theory is often seen in observations that crying is contagious among groups of newborn infants, and that parental interventions in reaction to crying behavior almost universally involve close physical contact (Murray 1979, 1985).

A second explanation of adult reactions to infant crying, derived from learning theory, posits that the cry of an infant becomes an aversive stimulus which will elicit caregiving responses from adults as a means of reducing the negative reinforcer (Murray 1985). It is thought that the cry is similar in function to any other negative reinforcer, and that the adult's reaction is understood solely in terms of its capacity to stop or otherwise remove the aversive stimulus. One strength of this model is that it does not require the highly specific relationship between the stimulus and its receptor mechanism demanded by the innate releaser model. Rather, it seems to indicate that the cry is an aversive stimulus which could result in a variety of behaviors. Of course, this flexibility in the model can also be seen as a weakness, since the simplest way for the parent to reduce the effects of the aversive crying would be to avoid the infant altogether. So this model, although it might possibly help to account for how caregiving behavior is maintained in individuals, cannot clearly account for why such behaviors develop in the first place.

Finally, the third approach posits that the cry acts to elicit sympathy and altruism from the caregiver (Murray 1979, 1985). This approach is based on the concept, "sympathetic distress", an involuntary and forceful experiencing of another's emotional distress through cognitive and affective channels that is highly correlated with helping behavior in adults (Hoffman 1975, 1984).

These theories are functional theories in the sense that they offer some speculation concerning the possible advantages to infant and mother of infant crying. But they are not strictly speaking evolutionary — even the one that is ostensibly based on Bowlby's work — because they give no account of how infant cries have come to take their particular form. Both functional and evolutionary theories of behavior involve speculations concerning selection pressures on behavior, but a fully evolutionary theory takes the additional step of specifying the historical context in which such selection pressures are likely to have operated and the archaic behaviors that these pressures have modified to produce the current behavior (Symons 1992).

How, then, is a fully evolutionary theory of behavior possible, given that no humans were around to make observations of the differential survival and reproduction of the historical populations that give rise to modern populations? The answer is that, because natural selection is a great tinkerer, the evolutionary history of a trait often leaves traces in its contemporary form. A classic source for this idea is Konrad Lorenz's (1951/1972) work on the geese and ducks in which he traced the evolution of their displays in part from their degree of resemblance to the non-communicatory behaviors from which they evolved. Recent years have seen a great revival of combined comparative and historical

analyses leading to inferences not only of why a particular behavior or structure has evolved, but from what and under what specific conditions (Coss & Goldthwaite 1995; Foster 1995).

The human science that has attempted to make use of these ideas is Evolutionary Psychology. 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, during which human beings were hunter/gatherers (Tooby & Cosmides 1992; Bowlby 1969/1982). The environmental circumstances that presided over human evolution are known in the literature of evolutionary psychology as the Environment of Evolutionary Adaptedness, abbreviated EEA. Although direct knowledge of human social organization during the EEA is obviously 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 before there were cries as we now know them, babies' inhalations and exhalations must have contained crucial information that adults were selected for monitoring (Blumberg & Alberts 1997). It further suggests that babies should have been selected to use those cue variables in such a way as to alter the behavior of monitoring adults in ways advantageous to the babies and not necessarily advantageous to the adults.

When one regards baby cries from an evolutionary psychological perspective, one is lead to wonder what characteristics of babies' sounds adults might have been monitoring in the pleistocene that would have led to the evolution of babies cries as methods for managing adult behavior. In pursuing this question, we are applying to babies' cries a more general theory of animal communication developed by Donald Owings and collaborators known as the management/assessment theory (Owings, Swaisgood & Rowe 1991; Owings & Hennesy 1984; Owings & Morton 1997). For human beings, with their complex speech anatomy and the compromises it has imposed on the respiratory apparatus, respiration is an important issue and the pace and pattern of that respiration might be a particularly important variable for caregivers to assess. Slowed, irregular or rasping respiration can be indicative of obstruction of the breathing passages; rapid respiration can be an indication of fever or other forms of physiological distress.

Thus the basic premise of our research program has been that the existence of such a respiration-monitoring mechanism in adults was the fundamental precondition for evolution of babies' cries as we now know them, that babies have evolved to manipulate this mechanism in adults, and that the form of cries bears traces of this evolutionary history. Listening to the cries of babies, both our own and those of others, we thought we detected a melodramatic quality to the cries, as if the babies were either simulating or threatening respiratory distress. We have in an earlier paper developed the evolutionary logic behind this hypothesis (Thompson, Olson & Dessureau 1997) and some specific predictions derived from the theory concerning the respiratory patterns projected by babies cries (Dessureau, Olson & Thompson 1998; Thompson, Wheeler, Barth & Siegel 1996).

The idea that young animals are capable of extracting benefits from their parents by manipulating them with threats or deceptions has its origin in Robert Trivers early text, *Social Evolution.* In the course of a discussion of conflicts of interest between offspring and their parents, Trivers proposes two sorts of manipulation: deception and extortion. Deception, he argues, can arise when an infant overstates its needs in its communications with its parent:

> Both parent and offspring benefit from ... [a] ... system of communication, but once such a system has evolved, the offspring can begin to employ it out of context. The offspring can cry not only when famished, but also when it merely wants more food than the parent is selected to give. Likewise, it can withhold its smile until it has gotten its way. Selection will, of course, favor parental ability to discriminate the two uses of the signals, but still subtler mimicry and deception are always possible.

Extortion, he argues, arises when an infant acts in ways that, if continued, will result in harm to itself. Trivers interprets temper tantrums as extortion attempts:

> Temper tantrums are an interesting behavior by youngsters since in many circumstances infants have not had an opportunity to learn such behavior through studying others, and since the behavior seems to threaten the parent by suggesting that the offspring may actually harm itself. For example, among pelicans, chicks sometimes indulge in convulsions. [Citations to Schaller 1964 and to van Lawick-Goodall 1968] [Trivers 1985, pp. 155–6.]

Following Trivers's logic, we are offered two possible ways in which crying may have evolved to capitalize on parental sensitivity to signs of respiratory distress.

In one, the extortion route, the infant in effect, threatens harm to itself if it doesn't receive a "ransom" of increased parental care. In the other, the deception route, the infant, in effect, fakes a respiratory emergency to deceive the parent into providing increased care.

Before we proceeded further with empirical testing of the implications of our management theory of infant cries, we wanted to explore which of these evolutionary routes was the most plausible. In other words, in the history of the evolution of crying, would natural selection have been more likely to have favored a situation in which the parent accurately responded to signs of respiratory distress and the infant exploited these accurate perceptions by threatening to do respiratory harm to itself; or would natural selection have been more likely to favor a situation in which the parent responded to signs of respiratory distress and infant exploited that susceptibility by simulating respiratory distress without actually endangering its respiratory functioning.

The purpose of this essay is to consider the plausibility of each of these ideas, extortion and deception, in turn.

1. THE PLAUSIBILITY OF EXTORTION

The broad structure of extortion requires a threat of the form, if the extortionEE doesn't X, the extortionER will Y, where X is a state of affairs that the extortionER wants but the extortionEE doesn't want and Y is a state of affairs the extortionEE greatly fears but is of relatively little consequence to the extortionER. In the crying baby case, the baby is in effect acting as its own kidnapper, extorting care from its parents by threatening harm to itself. Understanding the implications of such a model requires two steps: (1) understanding in some detail the logical properties of any kidnapping situation; (2) considering how the kidnapping situation is altered when the kidnapped baby is itself the kidnappER and when the argument is conducted in an evolutionary context.

1.1 *The Logic of Kidnapping*

Human kidnappings masquerade as ordinary business transactions, but their logical properties are actually very strange. A kidnappER attempting to extort money from a parent (the kidnappEE) might send a ransom note that says, "Give me the ransom if you want your baby back alive." Some asymmetry in the relative value of the two incentives to the two participants is necessary to make such a threat credible and effective. The kidnappEE must prefer having the baby to having the ransom, and the kidnappER must prefer having the ransom to having the baby. Thus, if we let B and b represent the intrinsic value of the baby to the kidnappEE and kidnappER respectively and R be the value of the ransom, then for a situation to meet the logical specifications of a kidnapping, $B > R > b$.

This sort of situation can often be usefully expressed as a "game table" by representing the behavior options of each "player" and assigning a point value to the outcomes. Table 1 represents the kidnapping situation as a two-player game in which the kidnappER has the option of returning the baby or killing it and the kidnappEE has the option of paying or refusing to pay.

In the analysis that follows, the two items of value, the baby and the money are conceived of as in the hands of the kidnappER and the kidnappEE respectively, so that, when an item changes hands, both kidnappER and kidnappEE experience consequences, but when an item stays where it is, neither kidnappER nor kidnappEE experience consequences. Also, partial payments of the ransom are foreclosed: either the kidnappEE pays the ransom or not and either the kidnappER returns the baby or keeps it irrevocably (or kills it). Finally, for the purposes of this argument killing the baby or keeping it irrevocably are treated as the same event — not returning the baby.

In Table 1, the upper left cell represents one of the two possible fulfillments of the "contract" proposed by the kidnappER: the kidnappEE pays the ransom (−R) and receives the baby (+B) and the kidnappER receives the ransom (+R)

Table 1. Payoffs for kidnapper and kidnappee when the kidnapper either returns the baby or kills it and when the kidnapper either pays or refuses to pays.

		kn'EE	
		Pays	Refuses
kn'ER	Returns Baby	kn'ER gets R−b kn'EE gets −R+B	kn'ER gets b kn'EE gets +B
	Kills Baby	kn'ER gets R kn'EE gets -R	kn'ER gets o kn'EE gets o

and returns the baby (−b). The upper right cell represents the "Let's-just-forget-the-whole-thing" outcome: the kidnappEE doesn't pay the money, but the kidnapper returns the baby anyway (−b to the kidnappER, +B to the kidnappEE). The lower left cell is the worst outcome for the kidnappEE, who pays the money (−R) but doesn't get the baby; the kidnappER gets the ransom and keeps the baby. The lower right cell is the other cell that fulfills the original "contract" proposed by the kidnappER: the ransom is not paid and the baby does not change hands. (Since the kidnappER already has the baby, keeping it (or killing it) results in no change in score.)

What makes a kidnapping "contract" so odd is that despite appearances, which behavior is best for the kidnappER is not contingent on the behavior of the kidnappEE. What the kidnappER should do — whether or not the kidnappEE puts up the ransom — is already determined at the outset of the game by the intrinsic value of the baby to the kidnappER. If that intrinsic value is negative ($b < o$), then the kidnappER should always return the baby, no matter what the kidnappEE does, since when the ransom is paid, $R - b > R$ and if it is not paid, $-b > o$. But if the intrinsic value is positive, then the kidnappER should never return the baby, no matter what the kidnappEE does, since when the ransom is paid, $R - b < R$ and when it is not paid, $b < o$. That the intrinsic value of the baby to the kidnappER is negative seems the more plausible assumption, since keeping babies alive is hard work and exposes a kidnapper to capture, and killing babies exposes the kidnapper to severe penalties.

Thus, for a kidnapping to work, the kidnapper must convince the kidnappEE that he is NOT a completely rational self-interested actor because a fully rational kidnappER would not be influenced by the payment of the ransom. So, the extortion will succeed only if the kidnappEE is rational and believes that the kidnappER is irrational enough give up a baby which has a positive intrinsic value when the ransom is paid or fail to return a baby that has a negative intrinsic value if the ransom is not paid. In effect, the kidnappER must convince the kidnappEE that the upper left cell — ransom is paid, baby is returned — and the lower right cell — ransom is not paid, baby is killed — are the ONLY cells in the table. Only when the rational kidnappEE is forced to compare ONLY those cells, is paying the ransom a rational act.

Not returning the baby when the ransom is not paid is rational for the kidnappER only if the game is iterated, that is, if the same players will repeatedly play the same game. If the kidnappER has "a reputation to maintain" for fulfilling his contracts because he intends to kidnap again, then assigning a value for loss of face in the case that the ransom is not paid and the baby returned will assure the rationality of not returning the baby. But, of course, it would be totally irrational for the kidnappEE to participate in such an iterated game if there were any way to avoid it. So, the only way that two participants could rationally play the kidnapping game would be for the kidnappER to believe that he was participating in an iterated game and the kidnappEE to believe he was participating in a one-round game. This could be true only if the kidnappER plans to victimize other kidnappEE's in the future and if the outcome of the kidnapping is widely publicized.[1]

1.2 *When the Baby is Its Own Kidnapper*

Applying the kidnapping model to the evolution of babies' cries requires that the baby be its own kidnapper and that the payoffs be reduced to a common currency, fitness. These requirements in turn require important adjustments be made in the model. The first adjustment is that the harm the kidnapper is threatening is harm to him/herself. This adjustment immediately eliminates iterated games from consideration, since the baby cannot both kill itself and yet continue to play the game another round.[2]

The second adjustment required by treating babies' cries as kidnappers' threats, is that the kidnapper, the baby, must be seen as related to the target of the kidnapping, the parents, by r, the coefficient of relatedness. Thus, the

1. This feature of the kidnapping situation may suggest that an absence of publicity is a crucial feature of defense against kidnappings. The logic of the situation would seem to suggest that if the kidnapper were to suppose that (1) no ransom would be paid and (2) no publicity would follow from the killing of the baby, then a rational professional kidnapper should be less likely to kill the baby even in an iterated game.

2. Or at least it sets up a regress that leads to the same conclusion. Imagine that the baby threatens sub-lethal respiratory harm to itself, h, and then carries through to "enforce" its threat when its parents don't respond. When the second round of the game comes around, the infant's value to the parents has been diminished by h and the parents should be that much less likely to come to its rescue. Thus a sub-lethal threat to the self is not any more rational in an iterated evolutionary game than a lethal one.

model must be adjusted so that the kidnappER and the kidnappEE each share by r in the consequences that the other gets. Let's set the cost of picking up the baby to the parent at P_p, its value to the baby at P_b and the cost of the harm that the baby threatens at [−H]. Then the participants will receive payoffs as in Table 2.

Table 2. Payoffs for parents and baby when the baby is the 'Kidnapper.'

		Playing against Parent who	
		Picks up	Ignores
Payoff for Baby who	Stops Crying	Baby gets $+P_b+[-P_p]/2$ Parent gets $P_b/2-P_p$	Baby gets 0 Parent gets 0
	Harms itself Crying	Baby gets $[-H]+[-P_p]/2$ Parent gets $[-H]/2-P_p$	Baby gets $[-H]$ Parent gets $[-H]/2$

In this version, the rational baby will stop crying when the parent picks up and

$$+P_b-[P_p]/2>[-H]+[-P_p]/2$$

which is equivalent to

$$P_b>-H$$

or when the Parent doesn't pick up and

$$0>-H$$

Thus, as long as the harm the baby threatens is actual, the baby will always stop crying whether or not the parent picks up. Once again, the baby's rational interest is independent of the payment of the ransom and a rational parent who presumes the baby to be rational should not pay the ransom, i.e., should ignore the crying.

If the analogy with the human kidnapping is apt, an extortionEE that presumes the extorting baby to be only partially rational, might be forced to compare only the upper left and the lower right cells of the table (pay/return with refuse/kill). Such a rational extortionEE acting in the face of a partially rational extorting baby, should pay the ransom when

$$P_b/2-P_p>-H/2$$

which is equivalent to

$$P_p<[P_b+H]/2$$

In other words, if a forced choice is made between picking up the baby or seeing it harmed, then the parent will be selected for picking up, just so long as the parent doesn't pay more in direct costs of picking up than it gains from the sum of the indirect gains of picking up and indirect savings from harm-avoidance. This analysis thus far suggests that if the infant-extortioner can be considered irrational, then extortion by kidnapping might be considered a plausible model for babies cries.

But is this feature of the analogy apt? Can irrationality ever be a feature in an evolutionary games analysis? In evolutionary games theory, a strategy is successful just in case the sum of its consequences across all partners is greater than the sum of the alternative's consequences across all partners. The behavior that is selected must represent the genetic interest of the individual BY DEFINITION. If irrational action is understood as action against one's own best genetic interest, then selection for irrationality is a contradiction in terms. Thus, if the selection pressures operating on the parent are predicated on selection operating on the baby, then selection should favor the parent ignoring the ransom request; if, on the other hand, the selection pressures operating on the parent cannot be predicated on selection operating on the baby, no such inference is justified. But this conclusion has devastating consequences for the whole modeling enterprise, because if we cannot presume that an individual is selected by its own genetic interest, then evolutionary games analysis is itself irrational.

But, what if babies were selected for behaving AS IF they are not acting in their own best interest; couldn't irrational-seeming behavior be selected for? Perhaps. But if such behavior is successful it will be because it involves deception. And since we were considering extortion as an alternative to deception, the best we can say about extortion at this point is that it might work in conjunction with deception.

2. THE PLAUSIBILITY OF DECEPTION

The second hypothesis to be considered is that the form of human babies' cries has its origins in respiratory deception. If this hypothesis is correct, then crying

takes its present form because at some point in the evolution of the display and parents' responses to it, parents were induced to behave as if babies were in respiratory distress when in fact they were not. As in all deception models, the crucial task for the modeler is to explain why the deceived individuals have not evolved defenses against the deception. One possible reason, of course, is that even though a baby's cry is deceptive with respect to respiratory hazard, it may be related to the presence of other hazards. Another possible reason is that in checking the baby for respiratory hazards, the adult may provide other benefits to the baby unrelated to any hazard, such as social stimulation, food, or diapering. These benefits may then enhance the fitness of the adult indirectly.

Any model that would consider the evolution of parental responsiveness to deceptive babies cries' has to consider all the consequences of picking up the baby in response to cries in comparison to all the consequences of picking up the baby randomly with respect to the cries. As a baseline, imagine that parents pick up their baby on some random schedule and the baby is subject to hazards on an equally random and unrelated schedule. Imagine that some proportion of the time, h, the baby is subject to a hazard, and that the rest of the time, 1-h, the baby is hazard free.

Any parent that picks up a baby from time to time will receive payoffs that come from three sources. The first source might be called the cost (c) of picking up. It represents the negative consequences of taking time from other concerns to come to the aid of the baby. The second source is the indirect benefits (b) on the parent's fitness that accrue via the baby because picking up the baby is good for the baby, whether or not there is a hazard. In accordance with inclusive fitness theory, this benefit is weighted by the degree of relationship (r) between the baby and the parent and is, therefore, rb. The third source is the negative consequences to fitness that the parents experience when they fail to pick up during the occurrence of a hazard. Like the benefit, this source is also weighted by degree of relatedness, giving a cost (a negative) of rH to the parent.

Even in the absence of any warning about hazards, the parents randomly picking up the baby will avert a hazard (h) of the time and receive the payoff rb-c, the same payoff they receive on those (1–h) occasions when there is no hazard. But on (h) of the occasions that the parents do not pick up, a hazard will be present and the parents will receive a payoff of (-rH). Finally, on those

(1–h) occasions when the parent fails to pick up and no hazard is present, the parent receives no payoff at all. These values are provided in Table 3.

Table 3. Payoffs for parents whose picking up is random with respect to hazards.

		When a hazard is	
		Present (h)	Not Present (1–h)
Outcome for Parents who pick up at random	When they pick up	[h] [rb−c]	[1−h] [rb−c]
	When they don't pick up	[h] [−rH]	[1−h] [o]

A parent picking up it's infant on such a random schedule will receive a total payoff which consists of the sum of the four cells in Table 3, or

$$\begin{aligned} F_{rand} &= (rb-c)\,(h)+(rb-c)\,(1-h)+(-rH)\,(h)+(o)\,(1-h) \\ &= rb-c-hrH \\ &= rb-(c+hrH) \end{aligned}$$

The result tells us that the total payoff from random helping will be sum of the weighted positive payoffs received from picking up the infant less the sum of the costs of picking up and the weighted losses incurred when a hazard was not everted.

Now, stipulated in the deception argument is the premise that crying is deceptive with respect to respiratory hazards; but there is no reason to suppose that it is necessarily deceptive with respect to all hazards: i.e., while the argument presupposes that in the course of human evolution, parents were induced to pick up their babies because mechanisms attentive to respiratory hazard were activated inappropriately, nothing in that presupposition prevents the cry from having some information about some NON-respiratory hazard. If the cry DOES contain such information, then the probability of at least one of two sorts of appropriate responses will increase: the probability of the parent picking up the baby when there is a hazard will increase by some amount (call it x) and the probability of the parent NOT picking up the baby when there is NO hazard will increase by a different amount (call it y). How informative would crying have to be before natural selection would prefer responding to the cries over random responding?

To determine the answer to this question we need first determine the fitness payoffs that arise from responding to the baby's cries as if they were signs of the existence of a hazard. These are given in Table 4.

Table 4. Payoffs for parents who respond to infants' hazard-related crying.

		When a hazard is	
		Present (h)	Not Present (1–h)
Outcome for Parents who pick up contingently	When they pick up	[h+x] [rb−c]	[1−h−x] [rb−c]
	When they don't pick up	[h−y] [−rH]	[1−h+y] [0]

The effects on the parents' total fitness from cry contingent interactions with the baby will be the sum of the four cells in Table 4, hence

$$F_{cont} = [h+x]\,[rb-c]+[1-h-x]\,[rb-c]+[h-y][-rH]+[1-h+y]\,[0]$$
$$= rb-c-hrH+yrH$$

It will profit the parents to respond to the baby's cries when cry-contingent responding is fitter than cry-random responding or when

$$F_{cont} > F_{rand}$$

or when

$$rb-c-hrH+yrH > rb-c-hrH$$

or when

$$yrH > 0.$$

Thus, cuing on the crying infant should fail to evolve only if listening to the baby's cry provides the parent with no information (y=0) or if there is no hazard [H=0], or there is no relationship between the "offspring" and the parent. But if, on the other hand, the cry provides ANY information about ANY degree of hazard to another individual that is related to ANY degree, then natural selection will assure the responsiveness of the parent.

The most startling aspect of this result is that it suggests that responding to false alarms places the parents at no selective disadvantage, just so long as responding to the baby's cry results in hazard avoidance. Why is this result so counter-intuitive? Intuition may confuse the question of whether the parent should cue on the baby's cry with the question of whether the hazard is worth responding to at all. The above inequality, yrH > 0, tells us the circumstances in which natural selection would prefer a contingent parental response to a random one, but leaves standing the question of when natural selection would prefer a contingent response to no parental response at all.

Those conditions would be met when all the advantages of responding to the babies cries are greater than all the costs which happens when rb − yr[−H] > c, which is equivalent to r [b + yH] > c.

These inequalities suggest two features of parental responses to babies cries as deceptions. First, since "x", the increment in positive appropriate responding, does not appear in the inequality, the calculation suggests that as long as the rule the parent uses to determine its response to crying is to some degree successful in warding off hazardous events and/or provides some other benefit to the baby, its failure to prevent the parent from acting unnecessarily to prevent a hazard is irrelevant.

Second, since rb can by itself be greater than c, rendering the contribution of hazard-avoidance irrelevant, even the capacity to avoid hazards by responding to babies cries may be irrelevant if the weighted direct benefits of responding to the cries overwhelm the direct costs. Thus, the analysis suggests that crying might evolve from a condition of being a warning of respiratory distress all the way to a condition of having no information value at all, if it induced behaviors in adults that were sufficiently beneficial to the infants relative to the costs to the adults.

3. CONCLUSION: WHY IS THERE MELODRAMA IN BABIES' CRIES?

The conclusion of this analysis is that the melodrama in babies cries is more likely to have evolved as deception than as extortion. Deception seems a more plausible explanation than extortion because the latter requires the contradictory assumption that natural selection is capable of selecting against the genetic interests of an organism. By comparison, the assumptions required to rationalize

a deception explanation — that the parent share in the benefits given to its offspring — seem relatively harmless and consistent with contemporary sociobiological theory.

Some might argue that the baby's cry still might be extortion but not by "self-kidnapping" but by threat of drawing the attention of predators to other group members. Such an argument could be modeled on Amotz Zahavi's hypothesis (described in Dawkins 1976, p. 141) that begging cries of chicks in the nest are a summons not to the parent but to nest-predators, a summons that the parent birds must silence by feeding the beggar or loose their entire brood. While perhaps plausible for a small, cryptic arboreal nesting bird with many nest predators and a very short nesting period, this hypothesis makes little sense for a noisy, smelly, ground-dwelling primate such as humans, particularly one that tends to orient around a home base. Given what we know of predator/prey relations in baboons and other large group living primates, it seems unlikely that an crying infant could provide a predator with much information it did not already have.

Others might argue that the baby's cry has the effect of pressuring the parents of the baby because it is annoying to more dominant members of the group. Stated in this simple form, this hypothesis begs the very question that our overall research program is trying to address: what sensitivities in adults are babies' cries designed to exploit and why do adults have these sensitivities. We think there is good reason to suppose that other group members may sometimes be sensitive a crying baby for the very specific reason that they may be adapted, under some circumstances, to render assistance to the parents in its care (Thompson, Olson & Dessureau 1996). In this case, the call would function for the infant as a call for help from other group members, rather than as a threat to incur their disapproval.

REFERENCES

Beecher, M.D., Nordby, J.C., Campbell, S.E., Burt, J.M., Hill, C.E. & O'Loghlen, A.L. (1998). What is the function of song learning in songbirds? In D.O. Owings, M.D. Beecher & N.S. Thompson. *Perspectives in ethology, XII: Communication.* New York: Plenum

Blumberg, M. & Alberts, J.R. (1998). In D.O. Owings, M.D. Beecher & N.S. Thompson. *Perspectives in ethology, XII: Communication.* New York: Plenum.

Bowlby, J. (1967/1982). *Attachment and loss, 1, Attachment* (2nd edition). New York: Harper Collins.

Brooks, D.R. & McLennan, D.A. (1991). *Phylogeny, ecology, and behavior: A research program in comparative biology.*

Catchpole, C.K. & Slater, P.J.B. (1995). *Birdsong: Biological themes and variations.* Cambridge, UK: Cambridge University Press.

Coss, R.G. & Goldthwaite, R.O. (1995). The persistence of old designs for perception. In N.S. Thompson, ed, *Perspectives in ethology, XI: Behavioral design.* New York: Plenum.

Dawkins, R. (1976). *The selfish gene.* Oxford, UK: Oxford University Press.

Dessureau, B., Olson, C. & Thompson, N.S. (1998) A test of an evolutionary psychological theory of infant crying. *Infant and Child Development.*

Foster, S.A. (1995) Constraint, adaptation, and opportunism in the design of behavioral phenotypes. In N.S. Thompson (Ed.), *Perspectives in ethology, XI: Behavioral design.* New York: Plenum.

Green, J.A., Jones, L.E. & Gustafson, G.E. (1987). Incidental emissions, fortuitous effects, and the origins of communication. Perception of cries by parents and nonparents: Relation to cry acoustics. *Developmental Psychology, 23(3),* 370–382.

Griffin, D.R. (1976). *The question of animal awareness.* New York: Rockefeller University Press.

Hoffman, M.L. (1975). Developmental synthesis of affect and cognition and its implications for altruistic motivation. *Developmental Psychology, 11(5),* 607–622.

Hoffman, M.L. (1984). Interaction of affect and cognition in empathy. In C.E. Izard, J. Kagan & R.B. Zajonc (Eds.), *Emotions, cognition, and behavior* (pp. 103–131). New York: Cambridge University Press.

Langlois, Baken & Wilder (1980). Pre-speech respiratory behavior during the first year of life. In T. Murry & J.M. Murry, *Infant communication: Cry and early speech.* Houston: College-Hill Press.

Lorenz, K. Z. (1951/1972). Comparative studies on the behavior of the anatinae. Reprinted in P. H. Klopfer & J. P. Hailman, *Function and evolution of behavior* (pp 231–259).

Morsback, G., McCulloch, M. & Clark, A. (1986). Infant crying as a potential stressor concerning mothers concentration ability. *Psychologia, 29*, 18–20.

Murray, A. D. (1985). Aversiveness is in the mind of the beholder: Perception of infant crying by adults. In B. M. Lester & C. F . Z. Boukydis (Eds.), *Infant Crying: Theoretical and Research Perspectives* (pp. 217–240). New York: Plenum Press.

Owings, D. H. & Hennesy, D. F. (1984). The importance of variation in sciurid visual and vocal communication. In J. O. Murie & G. R. Michener (Eds.) *The biology of ground-dwelling squirrels* (pp. 169–200). Lincoln, NB: Univ. of Nebraska Press.

Owings, D. H. & Morton, E. S. (1997). The role of information in communication: A management/assessment approach. In D. O. Owings, M. D. Beecher & N. S. Thompson. *Perspectives in ethology, XII: Communication.* New York: Plenum

Owings, D. H., Swaisgood, R. R. & Rowe, M. P. (1991). *Context and animal behavior IV: The contextual nature of a management/ assessment approach to animal communication.* Preprint supplied by the first author.

Schaller, G. B. (1964). Breeding behavior of the white pelican at Yellowstone Lake, Wyoming. *Condor, 66*, 3–23.

Symonds, D. (1992). On the use and misuse of Darwinsim. In J. Barkow, L. Cosmides & J. Tooby, *The adapted mind.* Oxford: New Jersey.

Thompson, N. S., Olson, C. & Dessureau, B. (1996). Babies cries: Who's listening? Who's being fooled? *Social Research, 63*, 763–784.

Thompson, N. S., J. Wheeler, J., Barth, D. & M. Siegel, M. (1996). *A pilot test of an evolution-based theory of patterning in babies cries.* [Brief technical report available from the author]. Worcester, MA: Clark University.

Tooby, J. & Cosmides, L. (1992). The psychological foundations of culture. PA-136. In J. Barkow, L. Cosmides & J. Tooby, *The adapted mind.* Oxford: New Jersey.

Trivers, R. (1985). *Social evolution.* Cummings: Menlo Park, CA.

van Lawick-Goodall, J. (1968). The behaviour of free-living chimpanzees in the Gombe Stream Reserve. *Animal behavior monographs, 1*:161–311.

Whitman, C. O. (1899). Animal behavior. In *Biological lectures*, Woods Hole, C. O Whitman, 285–338. Boston: Ginn and Co.

Wolff, P. H. (1969). The natural history of crying and other vocalizations in early infancy. In B. M. Foss (Ed.)., *Determinants of infant behavior, Volume 4*. London: Methuen.