occupations includes intrusive worries concerning the parents' adequacy as parents and the infant's safety and well-being. Even before the child is born, parents preoccupy themselves with creating a safe and secure environment for the infant. Major cleaning and renovation projects are commonplace as the human form of nest building unfolds. Uppermost among parental concerns are safety and unimpeded access. Safety issues include the cleanliness of the infant's immediate environment. After birth this same sense of heightened responsibility will compel parents to check on the baby frequently, even at times when they know the baby is fine. Cleaning, grooming, and dressing behaviors also carry a special valence inasmuch as they permit the closeness between parent and infant and provide for frequent inspection of the infant's body and appearance.

The central role of maternal care in early life is also well demonstrated in rodent studies, in which maternal behavior involves a complex set of activities, including nest repair, sniffing and exploration of pups, mouthing, pup retrieval, licking, grooming, and various forms of nursing (Pryce et al. 2001), behaviors that bear some phenomenological similarity to the intense cleaning, checking, nesting, and proximity maintenance seen in humans. Classic lesion studies done in rodent model systems have implicated the medial preoptic area (MPOA) of the hypothalamus, the ventral part of the bed nucleus of the stria terminalis (BNSTv), and the lateral septum (LS) as regions pivotal for regulation of pup-directed maternal behavior (Kalinichev et al. 2000a; 2000b; Numan 1994; Numan & Numan 1997; Numan & Sheehan 1997; Sheehan et al. 2000). Estrogen, prolactin, and oxytocin can act on the MPOA to promote maternal behavior (Bridges et al. 1990; Numan et al. 1977; Pedersen et al. 1994). Oxytocin appears to play an especially important role in facilitating the onset, rather than the maintenance, of maternal attachment to pups (Insel 1997). Ascending dopaminergic systems associated with reward pathways (Koob & Le Moal 1997) also appear to play a crucial role in facilitating maternal behavior. And there may be a critical interaction between dopaminergic neurons and oxytocin pathways. For example, pup retrieval and assuming a nursing posture over pups were blocked in parturient dams by infusions of an oxytocin antagonist into either the ventral tegmental area (VTA) or MPOA (Pedersen et al. 1994). The initiation of maternal behavior thus involves specific neural circuitry; and with pregnancy, structural and molecular changes occur in specific limbic, hypothalamic, and midbrain regions. Furthermore, at least nine genes have been identified as necessary for the expression of one or more aspects of maternal behavior (Leckman & Herman 2002).

Given the intricate cascade of neurobiological and genetic events that appear to set the stage for early parental behaviors, it is reasonable to presume that parents are also primed to respond to their infants' cries as signals of need and potential danger and also, that there may be considerable individual variability in the parental response based in part on individual differences in the neurochemical and genetic systems regulating early parental behaviors. While these individual differences have been largely unexplored in humans, it is worth considering how parents "receive" and "process" crying as a part of the initiation of parental behavior, and then how parental response shapes the infants' continued signaling. Recent neuroimaging studies have begun to examine human parental response to infant cries (Lorberbaum et al. 2002; Swain et al. 2003). In these studies, more activity has been measured in medial prefrontal, orbitofrontal and cingulate cortices, thalamus, midbrain, hypothalamus, and striatum in response to infant cry versus control noise conditions. This underlines the importance of these structures in normal human parental cry response and lays the groundwork for considering the neural substrate of caregiver behavior that is affected by mental illness. Parental psychopathology could either increase the latency to the provision of care as in the case of mood disturbances (e.g., depression or anxiety) or make it noncontingent, as in substance abuse or parental psychosis. These disturbances in affect regulation may also influence how a parent receives and processes the infant's cry – and in turn affects the feedback loop between parent and infant. Finally, a parent's own cry-response behavior is also shaped by his or her own early life experiences, family, and culture. Indeed, infant cry and caregiver feedback may be part of each infant's early development of meaning, and set protective and vulnerability factors for its own future mental health.

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Shouldn't mother know best?

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Abstract: We find the idea that infant crying arises from thermoregulation more consistent with a coregulatory account of its evolutionary history than it is with the informational account advocated in the target article.

One of the striking features of biological explanations of behavior is how often they resort to implicit mentalism. Many interesting instances of implicit mentalism are found in the deception/honest signaling/manipulation literature cited by Soltis. This literature makes no sense in the absence of the mentalistic doctrine of privileged access – the idea that the signaler is in possession of information about its own mind which the signal-receiver needs but cannot know unless the signaler provides it. This mentalist notion has led biologists to ask quasipsychological questions, such as, "When will nature select for organisms that provide accurate information about their own mental states?"

For privileged access models to work as potential explainers of mother-infant interaction, the signaling baby has to have some *self*-knowledge that its caregivers need and don't already have. The notion of self-knowledge is notoriously perplexed. Even if one gets by such tricky questions as "Who is the knower of the self apart from the self that is known?" and "Does the self that is known know what the knower of the self knows about it?", one is still left with the empirical question of how this supposed self-knowledge is gathered and why it should be of inherently better quality than information that can be gathered about the organism by others.

Thompson and collaborators (Thompson 1997; Thompson & Valsiner 2002) have criticized the mentalist model of communication because of its aheuristic commoditization of animal interaction. In their account, the intentional notion of information, "information about" should play no part in theories about animal interaction. We have been exploring an alternative perspective on the evolution of animal interaction, the assessment/management (A/M) perspective (Owings & Morton 1997). Instead of focusing on the transfer of a commodity, *information*, between signaler and signalee, the A/M perspective focuses on the regulatory interaction between them (Bowlby 1969/1982; Powers 1937; 1973).

The A/M perspective makes possible an account of infant crying that does not rely on mentalism and privileged access. The assertion of privileged knowledge on the part of the infant seems particularly questionable in discussions of human infants interacting with their mothers. Perhaps, if humans had evolved in an age of two-job families and nurseries with intercoms, one might make an argument for such a privilege, but human maternal-infant interaction did not evolve under these circumstances. In the environment in which humans evolved, the infant was on the mother's body – or at least somebody's body – 24 hours a day. Under these circumstances, everything that passed into and out of the baby's

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body, came from or was delivered to the body of the mother. To be sure, the baby's nervous system has many highly developed functions, but the mother's is vastly more complex and autonomous. How could the baby possibly have known something the mother did not know a hundred times more precisely? Moreover, if an infant's crying depended on the ability of the infant to give caregivers information they lack, we would expect infants to cry more as they become more knowledgeable about the relation between the world and self. In fact, they cry less.

An advantage of the A/M perspective is that it is ultimately physiological, not psychological, in its imagery. It focuses on organisms as regulatory systems, responding to cue variables that stand in for variables of interest to their survival and reproduction. It thus provides an account of the evolution of signals based on a system of regulatory interactions between parties, not on the exchange of mythic commodities between them.

Soltis' theory that laryngeal braking is the origin of infant crying is compatible with the idea that "communication" arises from assessment/management cycles. Laryngeal braking may be a regulatory maneuver that augments gas exchange in the lungs by elevating intralung pressure, and so may feed the increased metabolic rate needed to heat a cooling animal. (For an alternative maneuver, see Blumberg & Sokoloff 2001.) From an assessment/management point of view, laryngeal braking or some similar regulatory compensation for cooling seems a reasonable first step in a historical account of the evolution of mother-infant "communication." It is characterized as part of a regulation in which an assessment of cues to the consequences of cooling causes the infant's physiology to use the respiratory apparatus to compensate for those changes.

But – the A/M account would continue – the sounds made in the course of laryngeal braking provide opportunities for assessment by the mother. Features of laryngeal braking thus themselves become cues that the baby is in need of thermoregulatory assistance. That such a cue is available makes it possible for the mother to manage the baby's thermoregulation by bringing the baby more closely to her body.

Now the fact that the mother is assessing the laryngeal braking itself provides management opportunities for the baby. By enhancing those features of laryngeal braking that the mother is assessing, the baby is able to manage the speed and quality of the mother's response. This in turn selects the mother for assessing these emphasized features more exclusively.

The final step comes when the baby increases the range of circumstances in which these emphasized features are deployed. This liberates the cry features from the context of hypothermia and makes it possible for them to be correlated with other features of the baby's circumstances that are crucial to the mother's fitness.

We think a thermoregulatory account provides a much more satisfactory management/assessment explanation for the origins of infant crying than the respiratory drama hypothesis that Thompson and his collaborators have offered. In that account, babies' cries arise because mothers are assessing the respiration of their infants and infant cries broadcast their respiratory patterns. Not only have we been unable to confirm the most interesting implications of this theory (e.g., Falcon et al., under review), but, on reflection, we believe the theory has a flaw which the Soltis laryngeal braking hypothesis lacks. The respiratory distress hypothesis invokes the problematic breathing apparatus of human infants, which is a compromise between avoidance of choking and the demands of speech, which begins to develop around 4 months. Not only does this theory imply that crying would be greatly diminished or absent in the early months, but, more important, it implies that crying should be a uniquely human activity. While it is true that humans cry more than other mammals, human infant crying does not seem all that discontinuous with the crying of other primates, particularly when one takes into account the fact that first-world human infants are being cared for in an environment very different from that for which they were designed (Owings & Zeifman, in press). That being the case, an assessment/management account based on the more phylogenetically general hypothesis that mothers are tracking infant thermoregulation seems to be more plausible. By emphasizing the role of low vagal tone in the mediation of cry pitch variation as well as other responses to stressors, Soltis also offers an explanation for how a mother's attention to thermoregulation could lead by short steps to cries becoming cues to other forms of infant regulatory challenges.

Theremoregulation seems particularly plausible as the anlage for infant crying. What a mother should be assessing is neither the fitness of her offspring nor its present level of distress (in exclusion), but a relation between them, the value to her own fitness of delivering an additional packet of parental effort to the present offspring. This relation is a complex function of current fitness, short-term distress, and the resources mother has available for self-maintenance and caregiving. Cues to greater infant need or fitness should not always lead to greater deployment of care. For example, if the mother has limited resources, then cues to greater need might actually result in termination of care, since the level of resource demanded would be greater than the level the mother is capable of providing. Even if the mother has adequate resources, cues to greater fitness will elicit less care if the infant is so fit that additional care will not result in a proportionate increase in the mother's fitness. Thermoregulation seems a particularly suitable mediator of these relationships: The fact of thermoregulation is a cue to current distress and the ability to thermo regulate is a cue to long-term fitness, since this ability requires energy resources that can be mobilized through muscular activity. By crying vigorously, the infant therefore not only provides cues to the damage to mother's long-term fitness, of not providing immediate assistance, it also provides cues to the long-term value of aiding this infant as opposed to other present or future ones.

Developmental changes of infant cries – the evolution of complex vocalizations

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Abstract: The signal functions of infant crying cannot be understood properly without due attention to their ontogenetic development. Based on our own research on the development of infant cries, we argue that the controversies in cry literature will not be solved by static models, but that progress will made only when considering ontogenetic changes in interpreting cry data.

There is a remarkable increase of research within the field of pre-speech development. This has been stimulated mainly by new findings of language-relevant perceptive abilities during early infancy (Friederici & Wessels 1993; Jusczyk 1997; Jusczyk et al. 1993). Although there is a general agreement on the importance of earliest pre-speech phases for later speech and language development, we are still confronted with a great bias toward studies focusing on babbling and later sound productions. Soltis' article is highly relevant as its reevaluation of the state of the art serves to promote the somewhat underrepresented cry research. However, Soltis' attempt "to illuminate the human infant cry from an evolutionary perspective" (target article, Abstract) lacks a crucial aspect, namely, the consideration of ontogenetic changes of cry features.

There are a number of reports dealing with developmental processes in infants' crying, but most of them investigate simply aspects of quantity (e.g., the amount of crying during the first weeks or months). In our studies (e.g., Lind & Wermke 1997; Mende et al. 1990; Wermke 2002; Wermke et al. 1987; 1996), we focused on structural changes of infant cries. We could show that

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