

Original Article

**IS CHILD DEATH THE CRUCIBLE OF HUMAN
EVOLUTION?**

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Abstract

Child death has played an important role in the evolution of humans. Of all stages of development, and at all historical times beyond Modern history, childhood has been associated with the highest levels of mortality. Compared to other evolutionary pressures such as surviving as an adult or finding a mate and having children, the odds of genetic failure (i.e., failure to directly contribute to one's genetic line) are greatest in childhood. The enormous potential evolutionary pressure exerted by child death should have significantly influenced human psychological adaptations. Despite this potential influence, child death may be one of the least studied influences on human evolutionary psychology. This paper discusses the historical rates of child mortality, the relative odds associated with passing on one's genes, adult mental adaptations to child mortality, and child mental adaptations to child mortality.

Keywords: Infant mortality, Child mortality, Life history, Human evolution, Infant death, Child death, Environment of Evolutionary Adaptedness, Ancient mortality, Historical mortality

Introduction

The ultimate biological goal of human evolution is to pass on copies of one's genes to future generations (Dawkins, 1989). To maximize the likelihood of passing on their genes, humans are believed to have evolved mental adaptations for solving problems that were present in the Environment of Evolutionary Adaptedness (EEA-Bowlby, 1982). The EEA is not a single place in time or location, but rather represents the collective periods and locals of human evolution (Hagen & Symons, 2007; Silk, 2007). By examining the evolutionary pressures present across the EEA, evolutionary psychology has identified plausible psychological adaptations that evolved to help solve the problems our ancestors faced in passing on their genes (Tooby & Cosmides, 1992).

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To further our understanding of the evolution of the human mind, it is important to consider new, or underappreciated selective pressures, and their relationship to known, or well-studied selective pressures.

The goal of this paper is to present one such underappreciated selective pressure: child mortality. We define selective pressure as the degree to which a particular variable (e.g., child mortality) increases or decreases the likelihood of an individual passing their genes onto future generations (Dawkins, 1989). First, we will compare the relative strength of child mortality as a selective force in relation to other more commonly studied selective pressures (e.g., adult mortality, mating). Having made the case that it is a strong selective pressure, we will then examine potential implications of this selective pressure on human psychological adaptations, taking note of some potential adaptations that would allow children to overcome this strong selective pressure.

Relative Selective Pressures

Human psychological evolution should have been most strongly influenced by the evolutionary pressures that had the greatest chance of affecting the successful transmission of genes from one generation to the next in the EEA. This suggests that stronger selective pressures (e.g., survival) can supersede weaker selective pressures (e.g., preferences for eye-lash length) as the latter may be inconsequential if the former are not overcome (Darwin, 1859; Dawkins, 1989). The same logic also suggests that pre-reproductive pressures may, all else being equal, trump ensuing reproductive pressures (Bjorklund & Pellegrini, 2000; Bjorklund & Younger, 2001). Having the potential to be an extremely fit adult does nothing to aid genetic transmission if an individual is incapable of surviving to adulthood. Therefore, strong, pre-reproductive selective pressures had the opportunity to significantly influence human evolution, and by extension, human psychological adaptations.

A potential strong pre-reproductive pressure may be child survival. Child survival clearly precedes adult transmission of genes, and therefore meets the criteria of a pre-reproductive selective pressure. But how important is its relative selective pressure compared to other selective pressures present in the EEA? To provide a relative comparison of selective strengths, we compare the probabilities of passing on genes to future generations associated with the different selective pressures. The greater the impact on the probability of passing on genes to a future generation, the greater the selective pressure. Specifically, we compare the impact of child mortality rates to two well-studied human selective pressures: adult mortality rates and mating success.

Adult Mortality

Average mortality rate curves for hunter-gatherers and ancient civilizations all show that the odds of survival for adults are relatively high. Even in hunter-gather groups with high levels of adult mortality, per-year survival odds for adults are greater than 97.7%, with most hunter-gatherer groups averaging closer to 99% (Hill, Hurtado, & Walker, 2007). Once a hunter-gatherer is an adult, their modal lifespan is 68-78 years of age (Gurven & Kaplan, 2007). This post-childhood lifespan is similar to the lifespan of adults in 18th-century Sweden, where the modal lifespan was 72 (Human Mortality Database, 2008). Human adult mortality is 2 to 5 times lower when compared to adult chimpanzee mortality and average lifespan is 20-30 years longer lifespan than in

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chimpanzees or gorillas (Gurven & Kaplan, 2007; Hill et al. 2001; Hill et al. 2007; Robbins & Robbins, 2004). Therefore, despite being a critical selection pressure in that survival is required for reproduction, the actual evolutionary pressure exerted by adult mortality may have been relatively low in the human EEA. We acknowledge that current hunter-gatherer adult mortality rates may not reflect EEA adult mortality rates. However, we feel justified in using them as a relative (not absolute) comparison.

Adult Mating

Assuming an adult has survived, their next challenge is to find a mate. Without a mate, passing on genes is impossible, making it another critical selection pressure. Accordingly, perhaps the majority of evolutionary psychology research has focused on mental adaptations aimed at solving this problem. For women hunter-gatherers, the odds of finding a mate are extremely high (approaching 100%; Lee, 1979), leaving infertility as the major cause of childlessness (rates typically 2%, ranging from 1 to 5% - Wood, 1994). For men, the challenges and increased variance associated with polygamous mating can greatly increase the risk of not finding a mate (Buss & Schmidt, 1993; Wilson & Daly, 1992). These rates may approach 10% in some hunter-gather societies, but are typically lower (e.g., 6% Xavante- Salzano, Neel, & Maybury_Lewis, 1967; 2% Dani-Heider, 1991). Like women, men also face a similar infertility rate of 2% (Wood, 1994). Added to this risk for men is the risk of false paternity. While the actual EEA rates of false paternity are virtually impossible to determine, current evidence from a variety of cultures (including some hunter-gatherers) suggests that it may have been a relatively low risk, in the order of 1.9 – 3.3% on average (Anderson, K., 2006). Taken together, the odds of an adult man or woman surviving long enough to find a mate, and having at least one child, are quite high particularly when compared to great apes (Goodall, 1986; Robbins & Robbins, 2004). An exact number is difficult to quantify, but by adding these probabilities together, we may obtain a cumulative percentage for the likelihood of passing one's genes on to the next generation. For example, the yearly likelihood of a man passing on his genes in a high-mortality, high polygyny, high false paternity group, is equal to: 100% chance of passing one's genes minus (2% yearly mortality x 10% failure to find mate x 2% infertility x 3% false paternity), for a final likelihood of 84%. These admittedly rough, and general estimates, lead to average likelihoods of 84-90% (men vs. women) that may suffice for the comparative purposes of this paper. Thus, men and women face a reproductive failure rate of 10-15%, on average. Again, we stress that this range represents a rough estimate of average rates. These rates can, and do, vary significantly across individuals, groups, and times (Anderson, 2006; Gurven & Kaplan, 2007; Kramer & Greaves, 2007). We do not claim that these rates are precisely accurate, rather, we are interested in their relative size for the purpose of comparing their selective pressure to that of child mortality.

Child Mortality

Childhood has changed in many ways over the course of human evolution. However, there are a few universals that stand out over time and across cultures. One of these universals of childhood is the very high mortality rates of infants and children prior to the arrival of modern sanitation and medicine (Stearns, 2006). Before exploring the mortality rates of infant and children, four points need to be addressed. First infants, and

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particularly children, are defined loosely in the literature. For the purposes of this paper infancy ends at one year of age, and childhood ends at puberty (12-15 years of age). Second, children are typically underrepresented in historical recordings, literature, burials, and censuses, making complete and accurate estimation difficult (Perry, 2006; Woods, 2003). These factors may plausibly, if not likely, cause our estimates of child mortality to be too low, rather than too high (Lewis & Gowland, 2007). Third, infant and child mortality is believed to have varied significantly across and within times and cultures (Woods, 2003). Therefore, the following mortality rates should generally be viewed as probable estimates rather than absolute rates. Finally, infant mortality is measured by the probability of dying within the first year of life, while child mortality is measured by the cumulative probability of dying before adolescence/puberty. Thus, the two mortality rates are not additive.

Table 1. Infant and Child Mortality Rates Across Time and Cultures

Time	Culture	Infant Mortality	Child Mortality
500 – 300 BC	Greece	25 – 35%	n/a
200 BC - 200 AD	Rome	30%	50%
1300 – 1400 AD	Japan	28%	48%
1500 AD	England	27%	n/a
1600 – 1700 AD	France/Sweden	25-40%	50%
1650-1800 AD	Imperial China	26%	45%
1950 AD	Afghanistan	28%	36%+
Modern	Hunter-Gatherers	23%	46%
Modern	Horticulturalists	21%	39%
Modern	Pastoralists	21%	34%
Modern	Developed Countries	> 1%	1%
Modern	Chimpanzee	20%	55-60%
Modern	Gorilla	20-23%	50%+

With these caveats in mind, we can try to estimate infant and child mortality rates in the EEA. The most ancient attempts at estimating child mortality come from ancient Greece (circa 500 – 300 BC). Golden (1990) estimates a mortality rate of 25-35% amongst infants in ancient Greece. In ancient Rome, infant mortality is similar at 30%, with childhood mortality at 50% (Rawson, 2003). Jumping ahead a thousand years in time, we find similar rates in Medieval and Renaissance Europe. In Medieval England, infant death rates continued to be high (Lewis & Gowland, 2007; Paine, 2000), with estimates of 27% mortality in the first year of life (Orme, 2001). In Renaissance France and Sweden, average infant mortality rates varied between 25-40%, with childhood mortality rates of approximately 50% (Cunningham, 2005; Human Mortality Database, 2008). During the same time period, we find similar mortality rates in the Far East. Estimates of infant and child mortality in Medieval Japan are a very similar 28% and 44% respectively (Nagaoka, Hirata, Yokota, & Matsu'ura, 2006). The last Chinese emperor Aixin Jueluo Puyi (1964) estimated infant mortality rates amongst the Imperial Lineage in China from 1640-1911 as 23% for boys and 29% for girls, whereas childhood mortality rates were 40% for boys and 50% for girls (note that Lee, Feng, & Campbell, 1994 suggest lower mortality rates). Thus, we see remarkable similarities in infant and child mortality rates across different civilizations from different time periods. The first changes in these rates occurred during the middle of the 19th century when improved sanitation, diet, and medical practices caused infant and child mortality rates to plummet

down to >1 – 1% in developed countries (Cunningham, 2005; Stearns, 2006; United Nations Data, 2008). However, in non-developed countries that lacked these modern developments, infant mortality remained high (e.g., Afghanistan 1950, 28% infant and 36% to age five mortality in 1950; United Nations Data, 2008).

While we lack any concrete data for infant and child mortality rates prior to ancient civilization, we may estimate their mortality rates by using those found in modern hunter-gatherer and horticulturalist-pastoralist groups. Again, we note that modern groups are not perfect replicates of ancient groups, and therefore these mortality rates remain educated estimates for ancient mortality rates. Nevertheless, the figures once again converge on similar values as those found throughout pre-Modern history. Studying 9 hunter-gatherer, 10 horticulturalist and 5 pastoralist groups, Hewlett (1991) found active hunter-gatherer infant and child mortality rates of 23% and 46%, horticulturalist infant and child mortality rates of 21% and 39%, and pastoralist infant and child mortality rates of 21% and 34%. These values are similar to those obtained by Hill et al. (2007), but are slightly lower than those estimated by Gurven and Kaplan (2007). While these rates are slightly lower than those found in pre-Modern civilizations, they are much higher than modern infant and child mortality rates of less than 1% in developed countries (Human Mortality Database, 2008). Furthermore, one must be wary of the possible contaminating effect of exposure to modern sanitation and medicine in even the most remote groups (Kramer & Greaves, 2007). This may explain the lower horticulturalist and pastoralist mortality rates as compared to the historical and hunter-gatherer rates.

Taken as a whole then, one cannot help but be impressed by the similarity in infant and child mortality rates across an enormous range of different cultures and times. This is perhaps more striking given that the causes of these mortality rates are believed to vary between individual groups (Hill et al. 2007) and times (Paine, 2000). How do these mortality rates compare to mortality rates in other species? Juvenile mortality rates are generally quite high across nature (Dawkins, 1989). Yet, when compared to our close relatives, chimpanzees and gorillas, human infant and early childhood mortality are higher than estimates for both species (see Table 1; Groves & Meder, 2001; Hill et al. 2001; Robbins, Bermejo, Cipoleletta, Magliocca, Parnell, & Stoke, 2004). However, chimps and gorillas surpass human mortality by adolescence (Gurven & Kaplan, 2007; Hill et al. 2001; Robbins & Robbins, 2004; Sugiyama, 2004). This unique high-infant mortality pattern in humans is thus not shared by our close primate ancestors, opening the door to entirely novel selection pressures.

Relative Selective Pressures of Child and Adult mortality

How then does child mortality compare to adult mortality and mating success as a selective pressure on human evolution? We previously estimated the adult probability of failure to directly pass one's genes to lie between 10%-15%. When this range is compared to either the average infant mortality rate of 25%, or the average child mortality rate of 40-50% (respectively), it suggests that humans typically face a significantly greater chance of failing to directly pass on any genes to future generations (i.e., total genetic failure) during infancy (~1.7 to 2.5 times) and childhood (2.7 to 5 times) than in adulthood! This may be especially true for women, whose lower reproductive variance reduces their adult likelihood of genetic failure. However the pressure is still very strong for men; even in an extreme *hypothetical* population with a high rate of

cuckoldry (20%), a high homicide rate (20%) borne both before and between the fathering of each child as well as a sizeable chance of never finding a mate (20%), a male still has a 51% chance of successfully fathering one child and a 26% chance of fathering two children. Compared with these very high male adult failure rates, the selection pressures of surviving childhood in this extreme, hypothetical population are roughly equal to those associated with reproduction in adulthood. And while they are equal in likelihood, the childhood pressure is a necessary precursor to the adult selective pressures. Child mortality therefore appears to fit our criteria of a strong, pre-reproductive selective pressure for both sexes. The purpose of this comparison is not to suggest that adult mortality and mating were unimportant in the EEA- indeed, we believe they were both very important. Nor do we wish to suggest that child mortality always supersedes adult selective pressures. Rather, we wish to demonstrate that the well-studied adult selective pressures are relatively equal to, or perhaps even weaker than, the poorly-studied selective pressure of child mortality.

Why then, has the relatively high rate of child mortality received so little attention from evolutionary psychologists? Searching the *Journal of Evolution and Human Behavior* (as well as *Ethology and Sociobiology*), *Evolutionary Psychology*, the *Journal of Social, Evolutionary and Cultural Psychology* and *Human Nature* returned no articles that specifically investigated childhood or infancy mortality rates in relation to adult mortality rates *and* addressed potential adaptations in children and infants. A number of papers, such as Sear and Mace (2008), investigated the role of kin support but did not focus on relative mortality rates (adult versus child) nor investigate potential adaptations in children to secure investment (e.g., child agency). Several articles investigated maternal investment strategies in relation to adult offspring reproductive strategies (Belsky 1997; Belsky, Stenberg and Draper 1991) but likewise did not mention the high rate of child mortality nor child adaptations to secure care and thus increase the chances of survival to adulthood. Other articles that investigated potential adaptations in children to secure care such as Lumaa et al (1998) do not mention the high level of child mortality. Examining the all articles (n=365) published in the *Journal of Evolution and Human Behavior* from 1997 to present uncovered 41 articles (11%) investigating factors that would directly affect child mortality in a meaningful manner, with only a handful specifically investigating adaptive mechanisms in either parent or child to decrease mortality rates. Most of the 41 articles focused exclusively on 2 mechanisms affecting infant and child mortality; paternal resemblance and step-parenting. Thus a gap in the current literature appears to exist, centered on the relatively high rates of child mortality.

One reason for the dearth of studies that specifically address the importance of child mortality may be that evolutionary psychologists are primarily social psychologists, not developmental psychologists, and therefore child-related aspects of human behavior and evolution are often overlooked. Furthermore, the vast majority of participants in evolutionary psychological studies are over the age of eighteen, as children are rarely the focus of non-developmental studies. Additionally, developmental psychologists, even if they are adept at evolutionary theory, are not historians or anthropologists and would not necessarily be cognizant of the large discrepancy between child and adult mortality rates in the EEA. This explanation may also be extended to evolutionary psychologists; they may simply be unaware of the impact of child death on human evolution because it is so far removed from their daily existence. Mating, adult survival, adult social interactions, and even child development are omnipresent in modern cultures, whereas child mortality

is virtually absent. Indeed, what is striking about pre-Modern versus Modern lifespans is the tremendous decrease in child mortality as compared to very modest decrease in adulthood mortality (Gurven & Kaplan, 2007). Additionally few professors are themselves parents: male professors are 21% less likely than doctors and 12% less likely than lawyers to have children, while female professors are 41% and 24% respectively less likely to have children (Wolfinger 2008)! As a result, child mortality may very well be out of sight and therefore out of mind, for many modern evolutionary (or developmental) psychologists. Thus, the lack of developmental theories, the paucity of younger research study participants, and the everyday absence of child mortality may have hidden the strong, pre-reproductive selective pressure of child mortality from evolutionary psychologists. Having ascertained that child mortality is indeed a relatively strong selective pressure that has perhaps been under-appreciated, we now examine some of the potential consequences of this selective pressure on our evolved mental mechanisms.

Consequences of Child Mortality

From our conclusion that infant and child mortality represent strong, pre-reproductive pressures, it follows that there should be a correspondingly strong degree of adaptation to this pressure in human minds. It is well beyond the scope of this article to detail all such possible adaptations. Instead, we discuss and provide examples of three categories of such mental adaptations: adult adaptations to provide care, child adaptations to actively secure adult care, and child adaptations for individual survival.

Adult Adaptations to Provide Care

If approximately 50% of all children die before reaching reproductive age, adult reproductive success may be greatly influenced by child survival. Adults who are able to even partially mitigate the mortality rates of their offspring should have had a strong fitness advantage over adults who were less successful in improving their offspring's survival (Trivers, 1972). Adults should therefore have mental adaptations that promote the survival of their offspring (Geary & Flinn, 2001), presumably by increasing the quality and/or quantity of investment that their offspring receives.

Perhaps the clearest adaptation to decrease child mortality is attachment. Attachment is believed to be a mental adaptation that typically allows the formation of a strong, enduring bond to one's offspring that enhances their survival and success (Bowlby, 1982). Indeed, attachment is the first adaptation explicitly studied in the context of the human EEA (Bowlby, 1982). Numerous studies (see Cassidy & Shaver, 1999) have shown that parents who have a strong, positive attachment to their child make effective parents, whereas the lack of a strong, positive attachment to one's child often leads to neglectful parenting that can dramatically increase the likelihood of developmental psychopathologies and reduce the child's chances of survival (Dozier, Stovall, & Albus, 1999; Greenberg 1999; Hrdy, 1999; Schepher-Hughes, 1985). Indeed, it has been suggested that poor quality attachments may be adaptive parental mechanisms for limiting and/or terminating investment in an unwanted child when scarce parenting resources are better conserved for other purposes (Wiley & Carlin, 1998).

In addition to modulating attachment to form a greater bond with a phenotypically fitter child, and a weaker bond with a less fit child, it might be adaptive for parents to feel greater grief over the loss of a child with a larger reproductive value (RV). Crawford et al (1989) found that the intensity of grief that would hypothetically be experienced over a child's death was highly correlated to the RV of the child in both

the !Kung and Canadians. Grief felt was more highly correlated to RV for the !Kung than for Canadians, suggesting an ecological moderating effect. In a related study that directly measured the intensity of grief felt over child loss, Littlefield and Rushton (1986) found that children who were deemed to be healthier were also grieved more by both parents. Additionally, a parent reported more grieving if they reported the child as being more similar to their own side of the family, as opposed to the other parent's family. Suarez and Gallup (1985) suggest that this may be one of the reasons that women are more prone to depression than men- a greater potential activation of attachment-related loss that represents the flip side of attachment (Bowlby, 1982).

Given the importance of proper parenting, adults may also be under pressure to choose mates who exhibit the potential to be good parents. Recent studies show that women in particular, are interested in men who show characteristics believed to be associated with good parenting (Buss & Schmidt, 1993). Both sexes show an increased preference for "good parent" traits in long-term, as opposed to short-term, partners (Buss & Schmidt, 1993; Little, Burris, Jones, DeBruine, & Caldwell, 2008). For a woman the consequences of mating with a "cad" who fails to provide paternal investment may be much more significant than is commonly believed if her "cad" jeopardizes the survival of her infants (Hurtado & Hill, 1992). Indeed, research suggests that a lack of paternal input can not only affect a child's development, but also their future mating patterns and choices (Belsky, 1997; Moffitt, Caspi, Belsky, & Silva, 1992)

A related adaptation may be alloparenting- the provision of care by adults other than the biological parents of the offspring. Grandparents and female friends and relatives appear to be particularly important in this regard. Sear and Mace's recent study (2008) suggests that grandparents may be as effective as fathers in increasing the probability of child survival. From a broader perspective, the potential benefit of female-female cooperation for child survival through alloparenting (Hrды, 1999; 2005; Turnbull 1961) may be one reason why some behavioral aspects of humans more closely resemble bonobos than chimpanzees (deWaal, 2005).

Child Adaptations to Secure Care

Children are not simply passive receptors of parental care. Indeed, Bowlby's theory of attachment is explicitly dualistic, in that both the child and its caregiver are responsible for the creation of the attachment bond between them (1982). It is the dynamic of their mutual interactions that determines the strength and quality of their bond (Bowlby, 1982). Infants may attempt to increase the strength of this bond by engaging in behaviors that elicit (e.g., crying- Donovan & Leavitt, 1989; Zeifman, 2003; Lumaa et al 1998), maintain (mutual eye gaze- Hains & Muir, 1996), or strengthen (smiling- Strathearn, Li, Fonagy, & Montague, 2008; Volk & Quinsey, 2002) this bond. Even at ages as young as 3 months, infants appear to be highly capable of initiating and regulating person-to-person interactions (Gusella, Muir, & Tronick, 1988). From the moment a child is born it is capable of crying. Although there are many hypothesized adaptive reasons for an infant or child to cry (see Lummaa et al 1998), there is strong evidence that crying is an honest signal of the vitality and health of the child. By crying a child is able to accurately and honestly signal its phenotypic quality to its parents and thus receive more parental care (Furlow 1997); Devries (1984) found that quieter babies received fewer resources than fussier babies in the Masai which translated into higher mortality rates for the quieter infants during a famine.

Children may also have physical adaptations that elicit feelings of parental care in adults. Lorenz hypothesized that infant facial cues evolved to serve that purpose. Research shows that infant facial cues of health, cuteness, and resemblance appear to significantly influence adult investment (real and hypothetical) in children (e.g., Langlois, Ritter, Casey, & Sawin, 1995; Volk & Quinsey, 2002). Adults appear to have a unique neural response to infant faces versus adult faces (Kringelbach et al. 2008), and dopamine-associated reward-processing regions of the brain are activated when mothers viewed their own infant's face compared with an unknown infant's face (Strathearn et al. 2008). Research has also shown that adults prefer to invest their hypothetical resources in younger children, even if they appear to be less healthy than older children (Volk, Lukjanczuk, & Quinsey, 2007). Taken together, these results suggest that children's facial features appear to physically equip children for soliciting parental care.

In addition to securing care, it would be adaptive for a child to be able to increase the inter birth interval (IBI) and thus secure a high level of investment for a longer period of time. It has been hypothesized that waking in the middle of the night is such an adaptation; if a child is more likely to wake up (or cry) in the middle of the night he or she is most likely to be soothed back to sleep via breastfeeding. This behavior could easily increase the duration of ovulation suppression of the child's mother and thus directly increase the IBI (Jones and Costa 1987; Lumaa et al 1998). This is a good example of potential parent-offspring conflict, whereby the children actively seek to boost their own fitness at the (limited) expense of their parent's fitness (Trivers, 1974). Presumably, human parents tolerate a degree of this behavior in order to avoid costly, potentially mortality-inducing, conflict.

Child Adaptations for Individual Survival

Bowlby's model of attachment once again provides us with another potential adaptation to child death. According to attachment theory, children not only form a bond with their caregiver, they use the quality and nature of this bond as a template for all future social bonds (Belsky, Stienberg, & Draper 1991). The adaptive purpose of this generalization is believed to be matching the child to the predominant levels of social care they will receive throughout their lives. Children who receive nurturing, supportive, parental care are more likely to continue receiving such care from other individuals (Bowlby, 1982; Cassidy & Shaver, 1999). Whereas individuals who fail to receive such care may often face social climates where they do not receive large amounts of social care and hence have to take a more selfish, and self-reliant, view of human relationships in order to maximize their chances of survival (Belsky 1997; Frodi, Dernevik, Sepa, Philipson, & Bragesjö, 2001; Wiley & Carlin, 1998).

Children also appear to have specific mental adaptations that promote survival at distinct stages of their lives. For instance, infants are born with a variety of reflexes that are believed to have aided their survival in ancestral environments (e.g., rooting, grasping, startle reflex, etc.). As they grow, children appear to show adaptive fear responses that promote their survival. A fear of heights would be inappropriate for an infant, who is routinely carried several times their own height off the ground by caregivers. However, once the child is able to move on their own, and therefore get themselves into trouble with falling, a fear of heights develops (Campos, Bertenthal, & Kermoian, 1992; Gibson & Walk, 1960). Other fears appear to adaptively manifest at age-appropriate levels (Marks & Nesse, 1994) such as animals (age of exploration- 2 years) and agoraphobia

(age of leaving home- adolescents). A fear of strangers is not present when infants are young, and when it may be advantageous for infants to begin forming pre-attachment bonds with a variety of caregivers (e.g., the communal care of the BaMbuti; Turnbull, 1961). However, once infants begin to form attachment bonds, it may be maladaptive for them to respond to strangers who lack such a bond with them and/or who may interfere with their development of an appropriate internal model of attachment (Bowlby, 1982).

Children also appear to have cognitive adaptations that reflect immaturity, but may in reality be ways of maximizing learning at a particular stage (Bjorklund, 1997). For instance, the shorter working memories of infants may automatically help them to break language into more manageable strings of data (Elman, 1994). Rather than understanding an entire paragraph, sentence, or even word, they are able to concentrate on understanding the underlying phonemic structure. Similarly, children appear to have unrealistic, immature meta-cognitions that may in fact represent potent learning adaptations. For example, children often and repeatedly overestimate their ability to complete a new or difficult task (e.g., riding a bicycle). This overestimation of their ability appears to both increase their performance in the task (similar to self-efficacy in adults) as well as their motivation to persevere on difficult tasks (Bjorklund & Pellegrini, 2000). Although it would be premature to call a child's optimism 'self-deception', an unrealistically optimistic outlook may at times be adaptive for a child. This behavior could later underlie the similar, but lesser, tendency of adults to similarly overestimate the performance on a variety of tasks (Williams & Gilovich, 2008).

Conclusion

We believe that the vastly reduced rates of modern child mortality have hidden the true scope of this selective pressure. The literature on child history is relatively underdeveloped, as is the literature on child anthropology in general (Hewlett & Lamb, 2005). As adult researchers, we may have a bias towards looking at ourselves as we are, rather than as we were when we were children. Children are often viewed as immature version of adults, whose only purpose is to grow out of maladaptive, sterile childhood and into adaptive, reproductively capable, adulthood.

We have shown that such a belief may be missing a crucial part of human evolution. Child death appears to be a strong pre-reproductive universal pressure in human evolution. As such, it has likely exerted a strong influence on the evolution of the human mind. Several potential adaptations have been discovered that appear to respond directly to the pressure of child mortality. We believe that further attention to these adaptations is warranted, particularly those that stress the child as an independent agent of selection, and that there are many other adaptations, or aspects of existing adaptations, that serve to respond to the ancestral crucible of child death. Although child mortality may, or may not, in fact be the crucible of human evolution, it has undoubtedly played a significant role in human evolution that researchers should be aware of when testing human evolutionary hypotheses.

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