Varea C.
Bernis C.

*Department of Biology, Madrid Autonomous University, Spain Correspondence to: Carlos Varea, CD Antropología Física, Departamento de Biología, Edificio de Biología, C/ Darwin, 2, Universidad Autónoma, 28049 Madrid, Spain.
E-mail: carlos.varea@uam.es*

Encephalization, Reproduction and Life History

Human extreme encephalization and its final accomplishments (consciousness and language) are the result of a long evolutionary process of adaptive adjustment of life history variables in the framework of Primate evolution. Deep evolutionary roots shaped the great biological plasticity, social learning and cultural innovation characterizing modern humans based on an extended life cycle, new stages of development and co-operative child care. The great biological and behavioral plasticity characterizing modern humans are rooted in these processes, together with social learning. Recent environmental changes open up new questions about the biological future of mankind, particularly those affecting the possibility of overstepping the limits of the plasticity imposed in the environments in which we were selected. The possibility that current environmental changes are interfering with the adaptive responses during fetal and perinatal development is discussed

Introduction

The life cycle, which is the natural frame of reference for understanding a species' biology, is defined by its potential duration and the number, extent and characteristics of its developmental stages, by the phenotypic expression of ontogenetic processes, and by the singularity of the reproductive patterns which allow the species to survive. Human adaptability and so-called life history are the basic wickers on which we build the chassis of theoretical paradigms that, from an evolutionary point of view, permit us to propose models that explain the interaction between the biological strategies which typify our life cycle and the type of behaviour that makes us human. On the whole, the term "human adaptability" is used to describe the capacity of dealing with environmental pressure by means of biological responses and specific behaviour so as to keep an optimum balance between organisms (individuals) and the environment (both internal and external). Adaptability is the central paradigm to which Biological Anthropology refers as an explanation of our species' phenotypic variability, both among individuals and populations over time. The term adaptability, coined in the middle of the 20th century, has changed and not all researchers have updated or accepted this conceptual transformation (Weiner & Lourie, 1969; Harrison, 1977; Baker & Weiner, 1966; Thomas, 2001; Goodman & Leatherman, 1998; Bogin et al., 2007).

Life history is defined as the strategy which organisms use to distribute their energy for growing, maintaining vital functions, reproducing, and avoiding death. The strategies of life history explain the uniqueness of the species' life cycle, according to the energy limitations imposed on them by their biological niches. However, human life his-

tor — particularly female human life history — poses challenges to the classical model because although overall reproductive output is higher than in related primates, juvenile growth is slower and age-specific reproductive rates decline faster with age (Reiches et al., 2009). Furthermore, women have a limited reproductive period since they lose their reproductive capacity when they have yet to complete a third of their potential life cycle (Kaplan et al., 2000; Blurton, Jones, & Marlow, 2002; Kennedy, 2005). These singularities in energy allocation in growth and reproduction, offer key clues for understanding both the evolutionary and ecological processes (Walker et al., 2006), suggesting the development of increased bio-cultural resilience, which promotes greater survival to adulthood, adult survival, longevity, and reproductive success when compared with any other primate species (Bogin, 2009),

The Theory of life history—which is inserted into Evolutionary Ecology—explains phenotypic variations in terms of evolutionary designs to optimise reproductive efficiency (Stearns & Koella, 1986) and considers death from old age and fertility to be the main determinants of life history. These designs generate the characteristics which typify each species' life cycle, so that the age of maturity, adult body size, reproductive patterns, and ageing have been modelled in a coordinated way by natural selection. The differences between such aspects are essential because they condition the distribution of two basic resources during life: time and energy (Worthman & Kuzara, 2005). These resources must be distributed between maintenance, growth and reproduction (Charnov, 1993), bearing in mind that maintenance energy needs differ from organ to organ and system to system, and that the nervous system requires the most energy metabolically per unit of weight. This postulate is summarised in the so-called "Basic Principle of Evolutionary Ecology" (Bogin et al., 2007; Kuzawa, 2007), which basically proposes that individuals distribute available energy between maintenance and productivity, growth and reproduction being the components of productivity.

Primate Life History

Primates have brains between two or three times the size of their corresponding body size, in particular the neocortex, which is the largest area in mammals. Primate encephalization is linked to a remarkable precociality, a feature which is considered ancestral in this order, given that it characterises the vast majority of current species. For a specific maternal body size, precocial mammals have longer pregnancies and an intense intrauterine brain growth, which results in limited or single births of large and mature young. This link between precociality and encephalization (or between gestation time and neo-natal brain size) allowed Sacher and Staffeldt to formulate their 1974 hypothesis that the brain is the pacemaker for growth in placental mammals, in the sense that members of a given species will grow at a rate set by satisfying the energy requirements of the brain. The energy cost of a large brain may explain why, in contrast to body size (Smith et al., 2010), encephalization

has not been a general evolutionary trait in mammals. From an ontogenetic point of view, the brain is an extremely costly organ with high glucose and oxygen demands which must be constant to keep neural functions working. There is no other order of mammals with such a wide adaptive diversification as that of Primates, which can be characterised as a group by their high encephalization (Shultz y Dunbar, 2010). Primates dedicate 8-10 % of BMR (basal metabolic rate) to the upkeep of the brain, double that of other mammals. Given that Primates do not have a higher BMR than other mammals of the same body size we can affirm (Armstrong, 1983: 1.304) that "a major primate adaptation appears to have been the allocation of a larger proportion of the body's energy supply for the brain". As Evolutionary Ecology predicts, this essential primate adaptation consists in sequencing and slowing down the development of systems which are fundamental for the survival of the species but also have a very high energy cost, a strategy which enables the distribution of ever limited resources between brain and body growth and reproduction. In Primates it is brain size that predicts the length of the life cycle stages and potential longevity, rather than body size (Barrickman et al., 2008). Thus, although Primates share features of their life history with the rest of the social mammals, they grow and reproduce at half the rate of other mammals with comparable body weight, and can live as much as twice as long (Charnov & Berrigan 1993). Moreover, there is no compensation for the length of different periods of the life cycle in Primates: following lengthy pregnancies come long periods of development, and then, after a delayed sexual maturity, a late and prolonged ageing process (Bronikowski et al., 2011).

What goes before allows us to explain how humans and non-human Primates manage to generate such relatively large brains, but does not explain what use a large brain is beyond the associated advantages in the neuro-endocrine control of the organism. Allman and Hasenstaub (1999) suggested that relatively large brains offer adaptive advantages related to memory and cognitive strategies in a constantly changing environment, favouring both individual and collective survival by means of prevision, innovation and behavioural flexibility, especially in times of shortage. The slowing down of ontogeny—particularly the prolongation of the juvenile stage—may be a need which derives from this adaptive functionality for encephalization. Primate mothers (with the exception of humans) stop breast-feeding their young at the beginning of the juvenile stage, which in most species practically marks the end of brain growth and the onset of permanent teeth. According to various hypotheses, the juvenile stage is inserted after infancy in the life cycle of social mammals to serve as a learning period, a time for avoiding conflict with same-sex adults, and for mitigating possible nutrition restrictions. In favour of this cognitive functionality is the fact that this juvenile stage is when neurone connections are established (synaptogenesis) and mielinisation occurs, a process which in humans concludes with a massive reorganisation of the brain during adolescence. Thus, although the brain stops growing in size at the end of infancy, it matures sequentially on the basis of experience until, more or less, the beginning of the reproductive stage, the larger and more complex the adult brain, the slower the process. The plasticity of the brain is seen

in the changes to neurone connections according to experience during the learning period, in such a way that adapting to the environment is achieved by channelling energy provision towards the construction and maintenance of concrete neurone networks and circuits and by *pruning* others (Campbell, 2010). This fact allows us to explain why, if the brain basically stops growing after the end of the breast-feeding stage, the duration of the juvenile stage corresponds so narrowly to brain size rather than body size, which continues to increase, in contrast to the brain. As summarised by Allman and Hasenstaub (1999: 447), "the brain is unique among the organs of the body in requiring a great deal of interaction with the environment (learning experience) to achieve adult competence, and thus the brain serves as a rate-limiting factor governing the maturation of the entire body". It is interesting to note that some of the genes which have shown an intense selection in our species (Meyer et al., 2012) favour a greater synaptic plasticity (for example, *SRGAP2*).

This learning experience, which models the brain, is essential and necessarily social in Primates, even in species with extreme social structures, like that of a mother orangutan and her child. What is known as "Social brain hypothesis" (SBH, Dunbar, 1998), evolutionally associates the intense encephalization seen in primate descent with a gradual social complexity, expressed not so much by the number of members in a group as by the intensity of their bonds, which reaches a maximum in small family groups and stable couples (Dunbar & Shultz, 2007). In fact, Primates show a differential development of the prefrontal cortex which regulates social interaction (Semendeferi et al., 2002). SBH suggests that environmental challenges are resolved more efficiently through social co-operation and cultural transmission than through antagonism and instinctive rigidness. This view of a co-evolution of encephalization and of socialisation is highly stimulating as it allows us to characterise Primates as a whole, evolutionally, (particularly our species) by cognitive plasticity and complex socialisation.

Female energetic costs and the singularity of human life history

The unfolding of the life cycle in the Primate species depends on remarkably diversified patterns of brain and body growth, which do not appear to be philogenetically predetermined, and which respond to socially articulated adaptive strategies (Leight, 2001). It is also the case in our species, which shows unique vital features when compared to other Primates. Given that brain growth takes place basically before independent feeding, during the fetal period and infancy, each Primate species' life strategy is essentially based on the mother's capacity for supporting and distributing the energy requirements of her young's brain development, eventually with the help of her group. The key to our life history and our understanding as a species is rooted in this fact.

The maximum speed of brain and body growth in our species takes place during the fetal stage (the duration of which is not significantly longer than that of other Pri-

mate species with similar body sizes) and the early post-natal stage, when the mother must lactate. Among hominoids, human babies are relatively speaking the largest (6% of mother's weight), but are characterized by their extreme cognitive immaturity and their dependence, a surprising derivative feature ("secondary altricity") in a species with a notable precocial strategy. Traditionally, this fact has been explained by the impositions of bipedalism in determining the birth of foetuses with large brains (reducing pelvic diameters), but at the same time fits in with a tendency towards "secondary altriciality" in catarrhines (DeSilva & Lesnik, 2008), in such a way that the greater the encephalization of a species, the less its percentage of fetal brain growth (a human baby is born with 28% of its adult brain size; a chimpanzee with over 40%), a criterion perhaps designed to anticipate brain stimulation outside the womb. During infancy, the brain and body keep growing very intensely in our species, although the rate slows down after the fetal period. The brain reaches adult size at 5-6 years old, nearly a year later than in chimpanzees (Leight, 2004). Our brain is nearly three times larger than that of our relatives, whereas our body is only 1.3 times larger (in females). Such obvious differences in encephalization between the two species are explicable by the highly intense growth rate in the fetal and infant stages of our species. This process stems from a drastic change in the genic expression of our family, particularly in the perifrontal cortex (Somel et al., 2011). During the first 18 months of post-natal life, the human brain trebles, reaching over 1,000 grams. Such a rapid post-natal brain growth during the lactation stage is unique to our species.

At birth, a human baby dedicates 87% of its BMR to brain growth, and 55% aged 18 months (Snodgrass et al., 2009), double that of a chimpanzee at the same ages. At this stage, fat accumulation reaches 25% of body weight (maximum over life cycle) so as to guarantee an uninterrupted energy supply to the brain during the post breast-feeding stage. After breast-feeding and until adolescence, growth in our species is extremely slow, much slower than in young chimps that weigh more—both males and females—than young humans until their pubertal spurt, which is much more intense in our species and affects both sexes. Such slow growth may be linked to cognitive maturation, as we have seen, but at the same time gives biological plasticity as it allows us to distribute resources over a longer period of time, helping our phenotype to accommodate environmental restrictions and challenges more efficiently than species with rapid development. The efforts in this long fetal and infant development fall to the mother, who has to compensate for the energy spent with an increase in food consumption (about 500 kcal/day during the third term of pregnancy and first six months of lactation) or by decreasing daily activity, depending on the prevailing ecological conditions. Women are able to increase metabolic efficiency during pregnancy, which allows them to accumulate energy in the form of peripheral fat, which is essential for depositing fetal fat from month seven onwards, and to help with lactation needs. Women with a large number of offspring in highly stressful energy situations show a greater incidence of births with retarded fetal growth, pre-maturity, and infant death.

As Leonard y Robertson (1994: 85) point out, "improvement in the stability and quality of maternal nutrition (to support the high metabolic demands of pregnancy and lactation) was a consequence of the selection for larger brain size in hominid evolution".

The group's nutritional provision must have been fundamental in dealing with the gradual slowing down of infant development, especially during childhood, a critical period exclusive to *Homo sapiens*. In contrast with the pattern in other Primates, breast-feeding ceases very early in our species (in a hunter-gatherer group at an average age of 30-36 months: Dettwyler 1995), several years before the first molar appears at around the age of 6. As a result, a new period is inserted between infancy and the juvenile stage: childhood, a period of great immaturity and total dependence. For this reason, childhood has been a very vulnerable period in our history, to such an extent that, together with infant mortality, it has greatly reduced life expectancy in human populations until recently. Bogin (1997) explains the introduction of childhood into our life cycle as an adaptive mechanism designed to reduce inter-spacing of births (3.4 years in hunter-gatherers, at least half that of chimpanzees) so as to speed up generation renewal in a lineage with such a long life cycle and such slow reproduction: bearing in mind that lactation on demand inhibits the recovery of ovulation, an *anticipated* or early stop to breast-feeding enables another pregnancy. Aiello and Key (2002) add to this advantage, suggested by Bogin (1997), the reduction in maternal energy costs, as this can be transferred to the group. It is important to understand that this evolutionary resource, which explains our species' high fertility in spite of our slow development, was only sustainable thanks to what Lancaster y Lancaster (1983) called "Hominid adaptation", emphasising its importance: collective care of children, a universal but unique feature of human populations (Hardy, 1999) which according to Reiches et al. (2009) could explain the very unusual pattern of energy allocation found in female human life history, which challenges the classical model. Female age at puberty is later than would be expected for a Primate of our size. Humans grow more slowly relative to their body size than do chimpanzees (Bogin, 1999) which might be due to the greater brain growth and increased brain maintenance costs. Mature females also present unexpected patterns of energy allocation to reproduction, as human fecundity begins to decline about ten years before menopause, without evidence of somatic compromise. Because of this, the rate of energy allocation to juvenile growth is lower in humans than in other hominoids, contrasting with the rate of energy allocation to reproduction after maturity, which is much greater.

In the human lineage, the great parental and collective investment in looking after the young enabled the formation of adults with increasingly more developed brains and longer life spans, both versatile and creative, after a long learning period and with an increased capacity for survival. The development of the brain brought cognitive capacities which increased survival in the adult stage, an unavoidable requirement to compensate and assume the long period of infant dependence. But at the same time, there may have been a process of co-evolution in the development of the brain and longevity. The "Cognitive reserve hypothesis" (Stern, 2002) suggests direct selection of longevity linked

to encephalization, arguing that keeping the cognitive capacity intact until advanced stages of the life cycle enables the inter-generational transmission of the environmental information that is essential for collective survival, especially for a highly social species like ours. It has been suggested (Finch & Sapolski, 1999) that the evolution of polymorphism in apolipoproteins (apoE3) would allow us to explain human longevity in relation to the size and cognitive functions of the brain, given that the most widely distributed variant (apoE3) in current humans protects against diseases linked to old age, both cardiovascular and neurological, and its expansion roughly coincides with that of modern human groups. Following a drastic fall in population, anatomically modern human beings expanded across the whole planet, starting 60,000 years ago, occupying extreme eco-systems and diversifying both biological and cultural traits. Without a doubt, this last expansion involved natural selection processes in the face of ecological factors which were very intense and fast, but to a great extent culture allowed us to adjust the environment to our genes rather than vice-versa. The essential mechanisms for our survival were biological plasticity, social cooperation and cultural innovation. But these abilities continue being articulated through a life cycle which has not essentially changed in tens of thousands of years.

Recent environmental change and its consequences on the life cycle

Throughout the 20th century, there has been a deep and prolonged global change which affects all the components of the human eco-system and which has determined a revolution in the biology of our life cycle. The effects of this biological change have been isolated by different academic fields to the framework of the so-called "Four Transitions": demographic (Notestein, 1954), epidemiologic (Omran, 1971; Rogers & Hakemberg, 1987; Gage, 2005), nutritional (Komlos et al., 2009; Popkin, 2004) and medical (Meslé & Vallin, 2002). All of them have in common the transformation of human eco-systems, brought about by Man, and our own biological and behavioural responses to deal with this environmental intervention, the widest, fastest and most intense in our biological history. That is to say, they involve human adaptability, which includes the processes that regulate the relationship between living beings and their environment (Ulijaszek, 1996).

The changes registered in our life cycle affect ontogenetic processes and their phenotypic expression, reproductive processes, behaviours linked to these, and the interaction between the two, including, among other elements, fertility control and the number of descendents, the manner of birth, how a breast-feeder is alimented, and medication for the menopause. The bio-sanitary consequences, not as yet well evaluated, show both positive and negative aspects and can be detected in all stages of the life cycle, particularly in the earlier ones which include fetal development, birth and lactation, which in turn affect the health and biological state of later stages, for example the risk of suffering from certain

metabolic diseases. The evolution of our life cycle and of the environmental conditions in which it took place, allow us to understand both the capacity of socio-cultural factors to model our biology, and the limitations which our genes impose on adaptive responses.

Globally, the improvement in social and nutritional conditions, which allow a constant provision of energy, affects ontogenesis and its phenotypic expression, with an acceleration in the process of growth, development and maturation, which has morphological and functional consequences detected in increased height, the change in body proportions (a greater contribution of the legs to height), changes in functional capacity, earlier sexual maturity, and a reduction in the peak of bone mass (Frisancho, 2007; Bogin et al., 2007), and, from a certain point of view, an increase in adiposity in all age groups (Ministerio de Sanidad, Servicios Sociales e Igualdad, 2006; Komlos et al., 2009). The total and relative lengths of the stages of our life cycle are also changing (for example, shorter infancy and adolescence, longer reproductive and senile stages). Reproductive strategies change with later maternity and a decrease in fertility rates to levels which do not allow generation renewal. To a large extent, we have managed to control infectious diseases and, to a lesser extent, nutritional diseases as a cause of death, which means a huge increase in the number of people who reach advanced ages and whose longevity continues to increase, thanks to our control of death from cardiovascular diseases by means of a socio-sanitary environment created specifically for attending to the elderly. In parallel, the incidence of neurological and mental diseases as a cause of death is increasing (Gómez-Redondo, 1995; Robles et al., 1996; Meslé y Vallín, 2002), a fact that may show that the majority of members of our species are reaching the limits of the potential human life-span, which might be limited by the capacity to keep the cognitive and functional capacity of the brain intact. This increase in individual longevity, together with a reduction in fertility to below the levels of generation renewal in over half the populations of our species, has revolutionised differential viability and fertility, the traditional mechanisms assigned to the opportunity to act in natural selection, while we have not been able to measure the possible consequences (Cavalli-Sforza & Bodmer, 1971) .

What we have described so far refers to the richer countries, for which predictions were made about the end of the processes of demographic, epidemiologic, and nutritional transitions. These predictions have not proved correct because new biological responses are being detected as the result of the continuous environmental transformation (Coale & Watkins, 1986; Rogers & Hakemberg, 1987; Gage, 2005). The least favourable environments for the early stages may have determined early fetal programming, giving rise to more efficient metabolisms, practical if the energy shortage situation is maintained for the whole cycle; if, on the contrary, the energy available increases in later stages, the new situation explains much of the rise in overweight, obesity, metabolic disorders and cardiovascular risks seen in transitional populations (Barker 1997; Hales & Barker, 2001; Eriksson, 2005; Gluckman et al., 2007). To sum up, there is a new situation in our biological history, which, on the one hand, places us in a direction that is contrary to theoretical expectations (the reproductive potential of the species reduces and the proportion

of non-reproductive old people rises) and, on the other hand, may be forcing the limits of plasticity fixed by the "reaction norm", which allows a flexible expression of our genes within a range of possible phenotypes, depending on environmental possibilities.

In this sense, the reproductive and ontogenetic changes which have particularly affected the early stages of development are illuminating. The biology of current fetal and perinatal development—either interfering with the adaptive responses to early environmental stress, or forcing the biological limits of early plasticity further still—is an important matter of debate.

Among reproductive patterns, birthing characteristics of modern *Homo sapiens* are particularly interesting: they reflect multiple responses to different obstetric challenges derived from the adaptation of human reproductive biology to bipedalism, to later encephalization, and to the combined consequences of both factors on presentation during labour. Human birth has evolved as a mosaic of characteristics (anatomical, physiological and bio-cultural), retaining some Primate features and incorporating new adaptations at different times in the evolutionary history of our lineage (Trevathan, 1987; Rosenberg, 1992; Rosenberg & Trevathan, 2002). During the last 30 years, biosocial characteristics of childbearing women influencing birth outcomes have greatly changed in Western populations, coinciding with increased rates of medicalization and intervention in pregnancy and delivery (EURO-PERISTAT, 2008). Increased hospital interventions might be affecting various bio-cultural aspects of birth, transforming the predominant nocturnal pattern into a diurnal one, contributing to the increasing rate of preterm and low birth weight deliveries (which in turn reduces the probability of being breast fed), and eliminating or limiting traditional emotional and social support, all of which are essential aspects of biological adaptations (Bernis & Varea, 2012; Bernis et al., 2013; Varea et al., 2012). A clear understanding of the interaction between behaviour and biology is essential when making decisions to redefine and improve the application of protocols affecting the health of women and their descendants (Stuart-Macadam & Dettwyler, 1995).

The anthropoid radiation to which we belong share nocturnal labours (Ankel-Simons & Rasmussen, 2008) reflecting an ancient evolutionary adaptive pattern which benefits the physiological needs of the mothers and babies, as deliveries are shorter, mother infant bonding is improved and there is a significantly lower risk of intervention. In current western populations, such as Spain, the predominantly nocturnal pattern of births has disappeared; however, deliveries without intervention maintain a predominantly nocturnal pattern (Bernis & Varea, 2012). The benefits of nocturnal labour together with the evolutionary adaptive pattern might be rendered ineffective by unnecessary hospital policies and procedures.

Preterm labour is multifactorial in etiology and presents heterogeneity in perinatal outcome (Villar et al., 2006), it has been described as one of the ''great obstetrical syndromes'' which has to be faced in the XXI century (Romero et al., 2006). Both low birth weight and prematurity are related to stressful situations in utero, presenting considerable fitness costs and high prevalence of neurological disorders, reducing the chances of

experiencing healthy development, and increasing the risk of morbidity and mortality across the lifespan (Kramer, 2003). Stressful situations in utero, are associated with metabolic changes in the fetus, designed to enhance the efficiency of energy storage and utilization, and protect the growth of the brain (Cameron, 2007). Fetal programming have clear impacts on specific life-history traits (Jones 2005), affecting growth and maturation trajectories, gestational age, birth weight and adult body size, (Koscinski et al., 2004) proportions and composition (Frisancho, 2009); it also increases the risk of metabolic and cardiovascular diseases later on in life, both because of increased abdominal fat and higher metabolic efficiency (Hales & Barker, 2001, Frisancho, 2009). These changes are associated with permanent alterations in gene expression regulated by epigenetic factors such as DNA methylation and histone methylation/acetylation (Gluckman & Hanson, 2006).

Other authors have underlined the need to include more social aspects in the interpretation of developmental plasticity in the poorest populations, as the fetus and child who develop in deprived environments will have reduced viability throughout their life, being more susceptible to infections and metabolic diseases and showing reduced expression of their physiological and somatic potential as adults. As long as poor environmental circumstances are maintained, generations with similar characteristics will be perpetuated, not reflecting the presence of adaptive biological adjustments, but the negative effects of deprived environments (Martorell 1995; Bogin et al., 2007; Moffat & Galloway, 2007; WHO 2007; Schell & Magnus, 2007).

Low birth weight (LBW) is the single most significant determinant of infant mortality, and influences the chances of a newborn to experience healthy development, and appears to be related to both adult body dimensions and health (Koscinski et al., 2004) and to higher risks of several important chronic conditions, such as cardiovascular disease, insulin resistance, metabolic syndrome and hypertension (Barker et al.,1993; Hales & Barker, 2001; Eriksson, 2005; Gluckman et al., 2007). The possibility that medical intervention resulting from an increase in low birth weight and/or preterm births could be affecting the biology of fetal and perinatal development—either by interfering with the adaptive responses to early environmental stress, or by forcing the biological limits of early plasticity—is an important matter of debate (EUROPERISTAT, 2008; Bernis & Varea, 2012, Bernis et al., 2013) and raises new ethical issues related to the increasing iatrogenic effects of obstetric intervention in women who do not have a clinical need for it. These interventions are more expensive than natural vaginal deliveries, and, when unnecessary, drain financial and human resources away from situations where they are really required. Besides, Caesarean section is more life threatening and seems to be related to increased preterm and low birth weight babies (Häger et al., 2004; Murta et al., 2006; Liu et al., 2007; Lumbiganon et al., 2010) This is true not only for poor populations, but also for wealthy ones, in which the perinatal environment has been artificially changed through medical intervention, without any further progress in perinatal morbi-mortality, or even with some increase in complications (EUROPERISTAT, 2008). Because of this,

some authors suggest that women applying for elective cesarean section within the public health system should pay for it (Mackenzie, 1999).

As for the changes in the emotional and social support, it has been suggested that physical and emotional support during birth is a recent bio-cultural adaptation incorporated into the bio-sociology of birth (Trevathan, 1987; Rosenberg & Trevathan, 2002) improving mother-child survival; traditional midwifery represents this primitive human help, skipping social class, race, religion, or any other human divisions (Abitbol, 1996). The physiological basis for explaining why women who are accompanied during delivery have shorter deliveries with less intervention and higher new born rates in Apgar tests is related to their increased secretion of endorphins, estrogens, and other hormones, which reduce stress and allow for shorter deliveries (Trevathan, 1987; Backe, 1991; Pike, 2005).

Thus, different questions about the biological future of Mankind open up, questions which need dealing with systematically. Are we overstepping the limits of our plasticity imposed by the environments in which we were selected? Can we predict new tendencies in the biology of the life cycle deriving from the rapid and continual transformation of the environment, and evaluate the mid-term consequences for our health? Are the new environments created by the welfare state and by scientific and technological advances economically viable in the long term, especially in the current financial crisis? Are the abysmal differences in life cycle indicators and in the biological and health state between the richest and the poorest nations acceptable? As bio-anthropologists, we must be aware, as is Short (1994: 424) that "[o]ne thing is certain; we will never return to the reproductive lifestyles of our hunter-gatherer ancestors. But at least we can profit from their experiences, and learn why our reproductive system evolved the way it did. This should enable us to make more rational decisions about how best to adapt to the new demands that our rapidly changing cultures are placing upon us. But let us remember that although our minds have raced ahead, our bodies have remained much as they always were".

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