Gender, Genes, Enculturation: The Origin of Culture and Becoming Human

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ABSTRACT

The hunting hypothesis that developed in the 1960s and 1970s has provided the dominant explanation for how our hominin ancestors invented culture and acquired a human-like social organization. Since then discoveries of genomic processes, data on the expanded hominin fossil record, insights into primate evolution and behavior, and ideas regarding the practices of early hominin females allow for another explanation for the origin of culture and how early hominins evolved into the genus Homo. In this paper I bring these discoveries, data, insights, and ideas together to suggest the enculturation hypothesis to explain the origin of culture and how early hominins became human.

INTRODUCTION

The evolution of the human species was the result of a series of such serendipitous events that transpired over such a long, almost mythic time[1] that the resurrection of *Homo sapiens* following some kind of total species-killing event would be impossible to duplicate, despite the apes' best intentions and most passionate efforts. But the serendipitous change-inducing events that resulted in *Homo sapiens* did occur and over the course of hominin[2] evolution we – *Homo sapiens* – were their products. One of those events, the origin of culture, was crucial to human evolution. Without the advantages culture provided our hominin ancestors to allow them

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to evolve toward the genus *Homo*, we simply would be another naked ape foraging out there someplace in nature.

Currently the 'hunting hypothesis' that originated in the 1960s explains the origin of culture. It attributes the beginnings of culture and human-like social organization among the hominins to hunting, tool use, and eating meat. In this paper I suggest the *enculturation hypothesis* as an alternative to the hunting hypothesis. Enculturation as I use the term refers to the myriad processes by which neonates learn the culture of their society as they grow up.

The hunting hypothesis relied on data from ethnographically depicted hunters and gatherers to support their arguments. Compared to the 1960s and 1970s when the hunting hypothesis developed, new knowledge allows us to entertain new ideas regarding the origin of culture. The new information includes genomic processes behind the morphological, metabolic, and physiological consequences of the fossil record of human evolution (Carroll 2005; Kirschner and Gerhart 2005) and the protocultural behaviors of nonhuman primates. Current thinking holds that culture, as anthropologists think of it, developed with the emergence of the genus *Homo* (Trevathan 1987; Klein and Edgar 2002; Lewin and Foley 2004; Gräslund 2005; Goldschmidt 2006, among others). I shall argue that culture originated with the early pre-*Homo* hominins and had little to do with hunting and eating meat.

CULTURE: CONCEPT AND SIGNIFICANCE

Around 7 million years ago the earliest hominins began a biological evolution (Lewin and Foley 2004; Stringer and Andrews 2005) which, during some indeterminate time thereafter, engaged dimensions of cultural practices as an integral part of hominin evolution. It is sufficient in this paper to provide a unitary idea of culture as the accumulation of those collective, interdependent, malleable, changeable, *learned* and *shared* practices, behaviors, symbols, meanings, and social and material artifacts (institutions and technologies) that human populations create and *transmit* to their offspring generation after generation. This definition emphasizes the learned, shared, and transmitted aspects of culture. Later I will explore how the development of *cultural learning* (Bateson 1972; Whiten 2000) helped to account for the manifestations of culture among the earliest and subsequent hominins by filling 'the gap between [their] encoded genetic instruction and behavioral performance' (Goldschmidt 2006: 18, parenthesis inserted).

Because of our culture we became the only species that is separated qualitatively from all other species. The explanation for this development relies on hypothetical inductions from the hominin fossil record and deductions from logical premises related to the interaction between several factors: the environments that early hominins inhabited, early hominin skeletal morphology, biology, physiology, genomic arrangement, phenotypic manifestations, and their capacity for culture. The critical interactions of these factors for hominin evolution can be inferred from fossil evidence of the earliest hominins and studies of living hominids in their natural habitats. Yet, except for remains of early stone tools that appear about 2.6 million years ago, material evidence of culture is lacking (Klein and Edgar 2002; Stringer and Andrews 2006). It is only through hypothetical inferences regarding the relationship of the accumulation of culture and the evolution of the hominins that we can account for how our earliest ancestors flourished and gradually, over millions of years, gave rise to *Homo sapiens*.

Paleo-anthropologists and paleo-archaeologists explain hominin evolution by focusing on the biological concomitants of becoming human and generally ignore culture. Anthropologists with a sociobiological proclivity subordinate the influence of culture to the power of our genes (Gray 1985; Cronk 1999)[3]. Evolutionary biologists who adhere to the new discipline of evolutionary developmental biology – Evo Devo for short – explain evolution through genomic processes primarily. They acknowledge in passing the role of environmental factors but exclude any cultural influences (Carroll 2005; Kirschner and Gerhart 2005).

At least since Boas (1911), it has been axiomatic among cultural anthropologists that contemporary humans are in all ways, first and foremost, the product of culture, not our biology or genes. Goldschmidt (2006) offers trenchant support for the cultural influence. He introduces the idea of *affect hunger* as a critical aspect of culture that 'trumps the selfish gene' (*i.e.* biological explanations) by satisfying the biologically encoded mammalian hunger for affection. For cultural anthropologists such as me it is hard to account for how *Homo sapiens* could have evolved from the first hominins without considering how their biological evolution related to the origin and accumulation of culture. The hunting hypothesis provides one scenario for this relationship.

THE HUNTING HYPOTHESIS AND THE ORIGIN OF CULTURE

Introduction

Advocates of the hunting hypothesis in the 1960s argued that the origin of culture and human social organization was the result of an increasing reliance of australopithecines, the best known of the early hominins at the time, on hunting and meat eating. To support this proposition they relied on two methodological strategies which they often applied concurrently. One extrapolated from observations of nonhuman primates, especially the great apes, to make hypothetical inferences regarding the behavior of our earliest ancestors (Washburn 1961; Washburn and DeVore 1961). The second and more common strategy extrapolated from theoretical deductions regarding the presumed cultural behaviors and practices of our early ancestors to the cultural practices of contemporary hunters and gatherers (Sahlins 1959; Lee and DeVore 1968; Murdock 1968; Leacock and Lee 1982), especially the !Kung San of the Kalahari. The hunting hypothesis is based largely on the assumption that the cultural patterns of contemporary hunters and gatherers co-varied with those of our hominin ancestors and therefore revealed what their culture most probably was like (Sahlins 1959; Lee and DeVore 1968; Murdock 1968; Leacock and Lee 1982). From these comparisons they decided that hunting and tool use provided the catalyst that allowed culture to become an epiphenomenon of the australopithecines' anticipatory protocultural repertoire of primary culture traits. They identified these traits as predispositions to cooperate, share, divide labor along sexual lines, communicate, remember information, and plan for the future (Washburn 1961; Geertz 1962, 1966; Washburn and Moore 1974; Cartwright 2000).

There is an indisputable logic to the idea that these primary traits were important to the development of human culture. Still, it is not likely that in and of themselves they distinguished australopithecines sharply from other primates at that time. In one form or another, these traits can be identified among chimpanzees and other apes. But they always are more rudimentary than when they are practiced by ethnographically depicted hunters and gatherers.

The hunting hypothesis

The original hunting hypothesis of the 1960s and 1970s – the time frame in which its adherents cast the following argument – is attributed largely to ideas provided by biological anthropologists, paleo-archaeologists, and primatologists (Washburn 1961; Washburn and DeVore 1961; Washburn and Lancaster 1968; Washburn and Moore 1974; Isaac 1978, among others). Less well acknowledged are the contributions cultural anthropologists made to flesh out the cultural dimensions of the hypothesis (Sahlins 1959; Geertz 1962, 1966; Lee and DeVore 1968; Murdock 1968; Leacock and Lee 1982). The hypothesis has persisted and not changed much since its inception (Cartmill 1993; Hawkes 2003).

The hunting hypothesis argued that the transition to humanness began about 20 million years ago in the early Miocene. At that time the earth's climate was changing from a wetter, more tropical pattern to a dryer, more temperate one. Under those conditions the evolutionary lineages that led to the apes and the hominins diverged around 5 million years ago and resulted in the evolution of australopithecines by about 3 million years ago. Primary culture traits, such as reciprocity and cooperation, had their origin in the protocultural behaviors of early australopithecines and their ancestors between 5 and 3 million years ago. These traits became fundamental to the origin of culture as australopithecines adapted to a hunting way of life and meat eating. By 3 million years ago, several changes among the australopithecines and their environments had occurred that were crucial to the origin of culture.

Early australopithecines responded to the decline of forests that began in the late Miocene, about 7 million years ago, by moving onto the developing savannahs where they had to compete with other hunting and scavenging predators. As they adapted to life on savannahs other changes occurred that benefited their survival. They began to stand upright and assume a bipedal mode of locomotion. With their hands free from the requirements of knuckle-walking quadrupedal locomotion, they began to make and use stone tools. Hunting and gathering therefore became more efficient and gave the australopithecines an adaptive advantage over other fauna on the savannahs. Morphological changes related to bipedal locomotion were accompanied by physiological changes, especially in females. Reproductive potentials and sexual moods of females had been subjected to an estrus cycle – heat or rut. Females now were able to engage in coitus any time. The year-round availability of females capable of sexual relations reduced conflict among males over mates, encouraged permanent male-female bonding, and provided the genesis of the human family, several of which together constituted a hunting and gathering band.

Pair bonding and the family created a sexual division of labor. Hunting, because it is not compatible with infant care, became a male activity and, to be successful, required male cooperation. Because females were sometimes pregnant and largely responsible for child rearing, they contributed to the family larder by gathering vegetable foodstuffs. Patterns of food sharing and reciprocity developed within the family and band at large to insure survival.

Gradually the fundamental cultural traits and practices were complemented by other cultural traits induced by hunting and tool use. As australopithecine hunting bands expanded their territory and range of exploitation, individuals, largely males, created cognitive maps of the territory they were exploiting, continually refined their memories regarding locations of plants and animals in different seasons, and planned more efficiently the hunting strategies that were important to future successes. Communication among members of the band were important to these and other activities, such as learning how to make stone tools, read signs regarding climate changes and animal migrations, follow spoors, and stalk animals. It is unlikely that communication involved symbolic talk. Instead the band members provided the necessary information by kinesics, signing, perhaps a gradual expansion and refinement of existing vocal call systems by which they identified food, danger and other conditions.

Stimuli emanating from the culture traits induced by hunting and gathering required individuals to process the increased amounts of knowledge. Storage of these data resulted in a gradual increase in neural complexity and the size of the brain which, in turn, exerted selective pressures on female skeletal morphology. Selective forces favored females who were able to survive the ‘obstetrical dilemma’ (Washburn 1961) of passing fetuses with larger crania through their birth canals. Because the larger crania required an earlier parturition, infants were born increasingly immature and therefore required longer periods of dependency.

Because infant care among hominins is a reflexive and learned behavior, not an instinct, females expended considerable energy learning how to care for and manage their offspring. With their hands free, females were able to carry their infants, hold and tend them more intimately, and provide for their needs better, perhaps, than nonhuman primates to whom infants must cling as their mothers move about quadrupedally. As they matured, children learned the primary culture traits through play, repetition, observation, imitation, and the expanding modes of communication. The synergistic sum of these behaviors provided australopithecines an adaptive advantage that enabled them to evolve into the genus *Homo*[4].

There is much that is laudable about the hunting hypothesis and it retains a certain cachet. But the hypothesis has been justifiably criticized on two accounts, one explicit, the other implicit. Explicit criticism is leveled at the emphasis it placed on the importance of males in hunting and tool making while undervaluing the role of females in these activities and the origin of culture (Claassen 1997; Gero and Conkey 1991; McBrearty and Moniz 1991; Hawkes 2003). Implicit criticism focuses on the emphasis it places on material dimensions of cultural origins – tool making and hunting – while ignoring the role of learning and intelligence in the origin of the genus *Homo* and culture (Jolly 1988; Humphrey 1988; Byrne and Whiten 1988; Goody 1995; Whiten 2000).

To account for the origin of culture, the enculturation hypothesis relies on a variety of intertwined data and information that did not exist in the 1960s. Inferences and extrapolations from the fossil record and comparisons with nonhuman primates have continued to appear over the years. More recent insights regarding culture origins derive from concerns with genomic processes (Carroll 2005; Kirschner and Gerhart 2005), the role of women in evolution and enculturation (Trevathan 1987; Hawkes 2003, 2004), cultural learning processes (Bateson 1972; Byrne and Whiten 1988; Goody 1995; Whiten 2000), and the significance of 'affect hunger' (Goldschmidt 2006). The enculturation hypothesis relies on some of the same data that support the hunting hypothesis. But the enculturation hypothesis reorders priorities and begins from different assumptions.

The enculturation hypothesis asserts that the catalyst for the evolution of humanness and the origin of culture was provided by the evolution of bipedal locomotion among early hominins (Trevathan 1987; Klein and Edgar 2002; Gräslund 2005; Stringer and Andrews 2005). Bipedalism and erect posture required morphological changes in the hominins from head to toe and complementary physiological and metabolic changes that affected females in particular (Trevathan 1987; Rodseth *et al.* 1991; Hawkes *et al.* 1998; Pawlowski 1999; Cartwright 2000; Carroll 2005; Gräslund 2005; Stringer and Andrews 2005). When the adaptations that bipedal locomotion evoked are considered *in toto*, Gräslund is quite correct to assert that 'Bipedalism is the key factor that defines early humans' (2005: 70).

BIPEDAL LOCOMOTION

The evolution of bipedal locomotion and subsequent changes in hominin evolution are attributable to events that occurred around 6 million years ago that separated the evolution of the hominins and bipedal locomotion from that of the hominids and quadrupedal locomotion (Lewin and Foley 2004; Stringer and Andrews 2005). What caused the clades (evolutionary lines) to diverge and why the hominins became bipedal and stood erect is subject to considerable hypothetical speculation[5]. Regardless of these prognostications, bipedal locomotion resulted in an animal that was not very big, strong, or fast, but who apparently possessed potentials that differed from other fauna for survival in the environments it inhabited. According to the hunting hypothesis, tools provided the australopithecines that adaptive edge because bipedal locomotion freed their hands, thus enabling them to make stone tools between 3 and 2 million years ago (Washburn 1961; Washburn and Moore 1974; Goldschmidt 2006)[6].

The manufacture of tools by early hominins was a watershed event for the accumulation of material culture. But if culture is a causal force in the evolution of humanness, the manufacture of tools alone does not account for hominin evolution. Even if tool making did require more intelligence, it was not the most important cultural factor that drove hominin evolution inexorably toward the genus *Homo*[7]. Instead tools were simply one component of other, less obvious changes in social relations and learning practices that were selected by bipedal locomotion and allowed cultural solutions to other puzzles early hominins confronted in their environments.

Bipedal locomotion and sexuality

Bipedal locomotion exerted selective pressures on hominins that tended to develop in tandem in males and females. Evolutionary modifications in female anatomy, metabolism, and physiology were especially important for the origin of culture. These include changes in the structure of the pelvis (Berge 1998; Lewin and Foley 2004), location of genitalia (Gräslund 2005), the loss of estrus and onset of the ovarian cycle and menses (Pawlowski 1999; Cartwright 2000), different coital practices (Cartwright 2000), and more complicated parturition (Trevathan 1987). Most of these changes and their significance for the origin of culture are better understood by comparing hypothetical practices of early hominins to those of contemporary chimpanzees.

The chimpanzee pelvis is long and narrow. This shape accommodates quadrupedal locomotion but impedes and renders awkward any prolonged bipedal walking. It also places female genitalia in a backward-facing position common to most four-footed mammals and exposes them. Bipedal locomotion selected for a shorter and wider pelvis among the hominins and moved the females' genitalia forward and hid them between the females' legs (Trevathan 1987; Berge 1998; Lewin and Foley 2004; Gräslund 2005). Compared to the hominids, the evolution of the pelvis turned female hominin genital organs upside down[8] and moved the womb and birth canal forward. Male hominins experienced nothing that radical, although their penises and testes did become larger. Along with these changes, hominin females also underwent a loss of estrus and the beginning of the concealed ovulation and the menses cycle (Trevathan 1987; Cartwright 2000; Gräslund 2005)[9].

Coitus among nonhuman primates and most other mammals, excluding humans, is regulated by the female's estrus cycle, which occurs at regular intervals and often is widely spaced. As noted, estrus is the periodic condition of sexual excitement that precedes ovulation during which nonhuman females are receptive to mating. Among nonhuman primates, estrus is represented by a swelling and reddening of the female genitalia and the emission of olfactory and other signals that are attractive to males. Among female hominins, on the other hand, ovulation occurs monthly and is related to the menses cycle. With the genitalia now hidden from view between the legs genital swelling, coloring, and olfactory signals are not very prevalent and females are physiologically capable of coitus all the time[10] (Palowski 1999; Gräslund 2005).

As with other changes related to the transition to bipedalism, why estrus was lost and ovulation concealed among the hominins is open to speculation (Pawloski 1999). But, as the hunting hypothesis acknowledged, these changes resulted in females who could engage in coitus any time. As noted, adherents to this hypothesis argued that the reduction of male conflict over sexual favors provided an inducement for males and females to bond as pairs on a permanent basis and thereby establish the human family. This idea remains popular (*Ibid.;* Wrangham *et al*. 1999). But prolonged pair bonding also may have been assisted by changes in copulation practices (Gräslund 2005).

Because of the shape of the hominid pelvis and the location of female genitalia, coitus generally occurs by males mounting females from the rear (ventro-dorsal)[11] and copulation is perfunctory, routine, and quick (*Ibid.*). The conformation of the hominin pelvis renders coitus by a frontal, face to face mating position (ventro-ventral) the most comfortable (but certainly not the only one). This position also allowed mating to become more intimate, in part because of changes in female primary and secondary sexual organs and characteristics (Cartwright 2000; Gräslund 2005). Breasts became larger and fuller. Lips and a pleasing countenance, culturally determined, became more inviting. Vaginas became less obvious, more mysterious, and more secretive as the coloring, scent, and swelling that nonhuman primate males find so inviting disappeared. Copulation still may have been perfunctory, routine and quick. But coitus also may have taken considerably longer and rendered a female's climax more difficult – and perhaps more exciting – to attain. In part at least, this is because the female's vagina and clitoris are farther apart and the male's scrotum and lower body parts do not stimulate the clitoris as they do in nonhuman primate coitus (Pawloski 1999; Gräslund 2005). To what extent any of these sexual inducements were the basis for early hominin bonding and mating practices is hypothetical. But it is less speculative to assert that as these inducements were augmented over time with other culturally defined accouterments – perhaps the ability of someone to cook a good meal over a hot fire (Sauer 1961; Levi-Strauss 1969; Wrangham *et al.* 1999) – they did enhance the bonding that characterizes human families.

Pregnancy is one outcome of coitus, and parturition follows pregnancy. Evolution resulted in different birth outcomes for the hominids and hominins (Trevathan 1987; Rosenberg and Trevathan 2001). Because of the structure of the hominid pelvis, mothers assume a squatting position during parturition and are able to deliver the fetus without assistance; the fetus appears with its face toward the mother and the mother is able to reach down and pull it up toward her. The conformation of the hominin pelvis requires the fetus to emerge from the vagina facing away from the mother and in a location under the mother that renders unassisted births difficult and dangerous to the well-being of mother and fetus. Because of the pelvic structure and additional problems related to breech births, third degree lacerations (tearing from the vagina to the anus), hemorrhages, infections, and other traumas associated with hominin parturition, Trevathan (1987) argues convincingly that hominin parturition evoked midwifery, a universal cultural trait, and complementary cultural traits and practices, such as concoctions and paraphernalia to facilitate birth accompanied by soothing and practical communication from the midwife to the mother. Midwifery helped natural selection respond to the problem of how hominin females could overcome their ‘obstetrical dilemma’ and survive the passage of fetuses with large crania through the birth canal.

Paleoanthropologists commonly point out that the size of the early hominin brain was about the same as modern gorillas and chimpanzees, between 400 cc and 600 cc. But, regarding the problem of birthing fetuses with larger brains, this comparison is misleading for two reasons: the earliest hominins were smaller in body size than modern gorillas and the brains of modern apes are probably larger than those of their three-million-year-old ancestors (Lewin and Foley 2004). The implications of brain size for the evolution of early hominins and their capacity for culture are accounted for better by considering the relationship of the size of hominin brain to the size of the hominin in question. These data show that the hominin brain had already increased in size by the time *Australopithecus afarensis* appeared about 4 million years ago (*Ibid.*).

Encephalization refers to the increase in the size of the brain in relation to body size; the encephalization quotient (EQ) is the calculated measurement of that relationship (Lewin and Foley 2004; Gräslund 2005). The EQ was 2.5 for *Australopithecus afarensi*, who lived between 4 and 3 million years ago. The modern chimpanzee registers an EQ of 2. Each succeeding hominin showed a higher EQ: *Africanus* 2.6, *Paranthropus bosei* and *robustus* at 2.7 and 3.1 respectively, and *Homo habilis* and *Homo ergaster* at 3.1 and 3.3 respectively (Lewin and Foley 2004; Gräslund 2005). Correlatively, the convolutions of the early hominin brain impressed in their fossil crania suggest an increasingly human-like brain and, therefore, intelligence[12] (Holloway 1975; Shore 1996).

The caveats above regarding the smaller body-larger brain size of early hominins and the larger brains of contemporary apes suggest an increase in hominin intelligence long before the evolution of the genus *Homo*. It is difficult to account for this intelligence without considering seriously the intervention of something cultural at work that was more developed than a simple protocultural behavior. Midwifery may have helped mothers and fetuses survive parturition. But the most experienced midwives would have difficulty coping with the birth of a fetus with a cranium too large to pass through the birth canal. Under these conditions it is likely that mortality of mothers and fetuses was high during those millions of years that selection came to favor females who could birth fetuses with larger brains. The selective solution to this dilemma was the birth of fetuses who, compared to most mammals, were altricial, or premature (Trevathan 1987; Diamond 1996; Cartwright 2000; Gräslund 2005). The parturition of altricial neonates had other culture-evoking consequences.

Most mammals, excluding primates, give birth to offspring that are ambulatory and able to fend for themselves, or at least to begin to learn how to do so, shortly after birth. The offspring of apes require a longer period of time to accomplish these feats. Infant chimpanzees, for example, become ambulatory after about six months, relatively independent of their mothers in two or three years, and reach maturity a few years after that. The offspring of contemporary hominins, *Homo sapiens*, take about a year to become ambulatory and attain maturity in their teens. Among early hominins the prolonged period of dependency of offspring is crucial to the attainment of culture; it extends the early time during which the satisfaction of children's biological craving for affection helps to ‘finish’ them as responsible and capable members of their societies (Goldschmidt 2006). As midwifery helped to resolve the problem of giving birth to fetuses with large crania, ‘grandmothers’ – postmenopausal females who also may have been midwives – helped to resolve problems related to the prolonged dependency of hominin children.

The care of altricial neonates became a problem for early hominin mothers when evolution selected for female hominins who were able to birth infants while previous children were still dependent (Hawkes and Blurton Jones 2005). Care of dependent children remains a problem among contemporary *Homo sapiens* that is resolved in much the same way it was hypothetically among early hominins: someone other than the mother, commonly consanguine grandmothers, help to care for and extend the mother's affection for children after they are weaned (Hawkes 2004). Evolutionary life histories for ethnographically depicted hunters and gatherers[13], for other contemporary human populations, and for the hominids have been extrapolated to the hominin fossil record (Smith and Tompkins 1995; Gage 1998; Hawkes *et al.* 1998; Hawkes 2003; Hawkes and Blurton Jones 2005). The inferences support the hypothesis that ‘grandmothers’, postmenopausal females who may or not be related to the mother, played a novel role in hominin evolution and the accumulation of culture. To fulfill these roles and allow their assistance, grandmothers were themselves the product of a unique evolutionary selection.

Evolutionary life histories suggest that long life spans among the hominins and hominids are an ancient trait (Gage 1998; Hawkes and Blurton Jones 2005; Smith and Tompkins 1995). Both species share the decline and ultimate termination of female fertility during the mid-late 40s. After that a critical difference has been identified between the species.

Among the hominids, senescence speeds up shortly after menopause and results in an early death. On the other hand, senescence slows down among menopausal hominins. Female hominins live more than twice as long as, for example, female chimpanzees (Hawkes *et al.* 1998) and longer than male hominins. The grandmother hypothesis argues that the relatively long survival of female hominins after menopause is a response to the hominin pattern of parturition, which allows females to give birth to additional neonates while previous children are still dependent (Hawkes 2003, 2004; Hawkes and Blurton Jones 2005).

Once hominid infants are weaned they become nutritionally independent and forage on their own. Only after that are other children born. Hominin infants, on the other hand, wean relatively early and are dependent on food from adults for a long time thereafter. This is not a grave problem among those contemporary *Homo sapiens* for whom food is available and easily acquired. But many of the foods available to early hominin infants and children, such as deeply rooted tubers which hunters and gatherers still exploit, were difficult to obtain and prepare. As a result, early hominin infants and children were dependent on help from others – grandmothers – until late in their childhood (Hawkes and Blurton Jones 2005).

The intervention of grandmothers assisted natural selection and enculturation in a variety of ways. Acting as midwives they enhanced their daughters' survival, increased selection against senescence, and helped select for females who could birth fetuses with larger brains. Providing food and caring for the children insured the well-being of future generations and helped their reproduction at a time when selection was still resolving the ‘obstetrical dilemma’ and mortality of mothers at birth had to be high. Finally, grandmothers were important in continuing to satisfy neonates' hunger for affection while mothers tended the needs of younger neonates. Satisfying the mammalian need for affection intersected the dialectic of nature and nurture and transformed dependent hominin neonates into animals who responded more to social and cultural stimuli than potentially less socially responsible biological urges (Goldschmidt 2006). The grandmother hypothesis suggests that postmenopausal women played an unheralded role in the evolution from an ape-like life-history to one more like that characteristic of the genus *Homo* and their associated social organizations, especially the family (Hawkes *et al*. 1998; Hawkes 2003; Hawkes and Blurton Jones 2005).

Advocates of the hunting hypothesis argued that australopithecine social organization approximated that of the band organization of contemporary nomadic hunters and gatherers. According to this supposition, early hominins lived in bands of about 20 to 30 individuals that were organized into a few families. We will never know the actual composition of the early hominin family. But our knowledge of the hominid social organization shows that the family is not a human invention. Indeed, the great apes share most if not all of the structures and practices we associate with hominin families. These shared practices include exogamy, incest avoidance, reciprocity, monogamy, polygyny, polyandry, sharing, cognatic and extended households, age related male and female status hierarchies, inter-band alliances, and patterns of privacy (Gräslund 2005). Regardless of the particular family structure associated with early hominins, bipedal locomotion provided the necessary and sufficient conditions – the menses cycle, coitus any time, consensual mating, female-male bonding, hominin parturition, midwifery, child weaning, rearing and dependency, grandmothers – to evoke the social organization we identify as the human family. The origin of the ‘human’ family provided a framework within which those fundamental and primary cultural traits and practices that are learned, shared, and transmitted over generations could be adjusted and refined to lay the foundation for the culture and social organization that became characteristic of the genus *Homo.* Let us now consider the enculturation hypothesis.

THE ENCULTURATION HYPOTHESIS AND THE ORIGIN OF CULTURE

The enculturation hypothesis incorporates three interlocking processes to account for the origin of culture: *genetic processes* that drove hominin evolution, the development of *cultural learning* among the hominins, and the *role of female hominins* in the origin and dissemination of culture. The enculturation hypothesis contradicts the presumption that human culture originated with the evolution of the genus *Homo* (also see Gräslund 2005). This argument is grounded in a different interpretation of how hominin evolution proceeded and how culture accumulated over 6 million years. Presently anthropologists use two explanations to account for how hominin evolution proceeded.

Genes and evolution

Until recently most thinkers on human evolution favored the post-1940s ‘Modern Synthesis’ that recast Darwinian theory and melded the fields of natural history, population genetics, and paleontology to account for human evolution through the force of natural selection (Carroll 2005; Kirschner and Gerhart 2005). Among anthropologists two schools of thought have prevailed within this framework to explain evolution. One is held largely by archaeologists. It argues that hominin evolution was saltational, marked by abrupt changes resulting from genetic mutations that dramatically changed evolutionary outcomes[14]. As Klein and Edgar put it, ‘The abruptness of each step [of human evolution] is debatable, but the stability that followed is patent’ (2002: 91, parenthesis inserted). The second school of thought is associated with biological anthropologists and favors a gradual, incremental evolution toward humanness (Lewin and Foley 2004). Recent developments in the new field of Evo Devo (Carroll 2005) corroborate, to my satisfaction at least, the second school of thought[15] and goes beyond the explanatory power of the Modern Synthesis. The Synthesis established that living forms changed through natural selection. But it did not tell us *how* forms changed, ‘*how* an altered genotype causes an altered phenotype’ (Kirschner and Gerhart 2005: 29). Carroll (2005) demonstrates how this alteration takes place[16].

Evolutionary biologists recently discovered a common ‘tool box of master genes’ that is found in all complex animal forms and governs the formation, function, and patterning of their body parts (Carroll 2005). Of the dozen or so master genes in this kit, those that are responsible for planning and building eyes, limbs, hearts, and other body parts are most important. Of the approximately 25,000 genes that make up the hominin genome, only a small fraction, hundreds perhaps, are concerned with the construction and patterning of the hominin's morphology and biology (Carroll 2005; Kirschner and Gerhart 2005). The vast majority of genes are involved in other jobs and carrying out routine and specialized functions of hominin cells. Among the dozen or so master genes, hox genes are arguably the most significant (Carroll *et al.* 2001; Carroll 2005; Gräslund 2005; Kirschner and Gerhart 2005)[17].

Hox genes determine the body plan of the embryo that appears as the adult living form; other genes within each segment of the plan determine the finer distinctions and composition of the parts within the plan (Carroll 2005; Kirschner and Gerhart 2005). Hox genes and other genes act as switches which, through mutation or other chemical actions, turn genes ‘on’ and ‘off’ to create the embryo's body plan and its components (Carroll 2005). To the extent that some genes are either ‘on’ or ‘off’ in varying combinations, body parts within the plan can change simultaneously as well as independently of other parts, sometimes over relatively short periods of biological time, hundreds of thousands of years and maybe less (Kirschner and Gerhart 2005). This is, in effect, what occurred in the evolution of hominin morphology, physiology and metabolism described previously that led inexorably, despite evolutionary dead ends, to the evolution of the genus *Homo*.

Based on this explanation, Carroll deconstructs the idea of a saltational evolution. He argues that,

> There is no need to invoke single dramatic mutations as causes of great leaps in form and function or as explanation for the origin of human traits. Nor is there any reason for doing so ... differences between species are often due to many genetic differences that are individually responsible for relatively small effects [which show] that evolutionary [changes] occur in small increments, via changes in ... many genes (2005: 277, parentheses inserted).

Following this line of thinking, I contend that if the gaps in the fossil record of human evolution were filled, those abrupt steps to which Klein and Edgar (2002) refer would be marked instead by a seamless transition that would render the *patent stability* they identify as the evolutionary norm instead of the interstitial phases of a ‘punctuated equilibria’ (Elderedge and Gould 1972). But the discovery of *how* genes create variation and diversity in animal forms, in particular the hominins, still begs another question: what causes the switches to activate and the genes to mutate? Carroll (2005) and Kirschner and Gerhart (2005) acknowledge that the environment plays a role in adaptation. But in general, Evo Devo emphasizes the independence of genotypic and phenotypic processes and variations.

Culture, time, and human evolution

I concur that the environment played a role in human evolution. But I hypothesize that over the duration of hominin evolution the switches at work in the hox and other genes of early hominins had their potential for hominin evolution unleashed as they engaged in a positive feedback loop with emergent cultural factors. As the early hominins evolved, any changes induced by cultural practices initially were imperceptible. But over time, at least by 4 million years ago with the appearance of *afarensis,* social learning strategies were morphing into cultural learning strategies (Bateson 1972; Whiten 2000) and setting the stage for developments that would exceed the primary culture traits. Tools became obvious 2.6 million years ago as hominins intervened in nature and altered stones intentionally. Midwives helped resolve the 'obstetrical dilemma' of early hominin parturition. Grandmothers began to have an impact on the survival and enculturation of neonates. Hominin communication improved. The trajectory established by this loop evoked the origin and accumulation of culture through a slow, 'metastatic contagion' of practices and behaviors among the early hominins (Whiten 2000) that led inexorably to the genus *Homo.*

Two factors account for the slowness of the development and accumulation of culture in that feedback loop: the natural and social environments that early hominins inhabited and the slow development of cognitive skills to exploit the cultural potentials of these environments. Their natural environments were endowed with an abundance of raw materials, including stone, wood, horn, reeds, bone, and the like. But cognitively the early hominins were at the starting gate of discovering how to meld those materials and social patterns in ways that would allow them to invent a cultural universe.

Given the embryonic cognition the early hominins brought to their social and physical environments, the 4 to 5 million years that preceded the first items of material culture in the form of intentionally made stone tools may be quite understandable. Years ago Linton (1936) and Kroeber (1948) explained the long persistence of a hunting and gathering way of life. They pointed out that the more things, material and otherwise, there are for people to experiment with, the greater will be the potential to put those things together and make the new discoveries and inventions that enable a richer cultural inventory. Early hominins had to invent human culture from scratch. Even the invention of intentionally fashioned stone tools does not signify the sudden evolution of a hominin cognition and culture. Instead, the use of tools was a consequence of preceding cultural practices.

Perhaps the first inkling that something cultural might be stirring to alter this desultory beginning was, as noted, the fact that at least 4 million years ago evolution had selected for early hominins who had a relatively large EQ (encephalization quotient) that accommodated a higher intelligence and better memory than other animals (Holloway 1983; Shore 1996; Gräslund 2005). The evolution of the hominin EQ associated with *afarensis* already exceeded the EQ of modern chimpanzees (2.5 and 2 respectively) and preceded the invention of sculpted stone tools by at least a million years. The higher EQ was not, I contend, the result of the genotypic independence postulated by Evo Devo. Instead, I suggest that this EQ was attributable to the first stirring of what Linton referred to as that 'restless energy of the human mind' (1936: 87), that meaning-seeking curiosity that is unique to the primates (Shore 1996), and which with *afarensis* was already a step above the nonhuman primates.

The switches at work in the gene pools of early hominins that induced their biological evolution resulted from the interplay of two factors that interacted with the physical environment: the material culture involved in food procurement by hunting and gathering strategies and the ideational dimensions of culture evoked by the interactions of cooperative social life. These changes induced the learning strategies that distinguished increasingly the early hominins from the nonhuman primates (Goody 1995). Somewhere along their evolutionary continuum, learning strategies unique to the early hominins allowed them to surpass the rudimentary protoculture of the nonhuman primates and develop those ideational and material domains of culture that distinguished them from the clade that was evolving into the great apes. How animals learn has been an important question for evolutionary psychologists who have studied social learning among nonhuman primates.

Social learning

Social learning theory[17] is founded on the premise that the evolution of intelligence was an adaptation to a complex social environment and that understanding how nonhuman primates learn will explain the evolution of hominin intelligence and the learning processes that underpin it (Jolly 1988; Humphrey 1988; Tomasello 1990; Goody 1995; Whiten 2000). Evolutionary psychologists have observed that social learning among nonhuman primates relies on a variety of practices and strategies that do not necessarily require language – imitation, observation, trial and error and interactions with others. They work from the hypothesis that learning is a consequence of the anticipation of other's actions in those interactions that effective social living requires (Jolly 1988; Tomasello 1990; Byrne 1995; Goody 1995; Whiten 2000). In testing these ideas, evolutionary psychologists have emphasized imitation as the key to social learning (Whiten 2000). Much of this theory relies on evidence, such as the ability of chimpanzees to use their rudimentary cognition to learn to make and use tools by imitating the actions of other chimpanzees. Examples include stripping a twig of branches to extract termites from their mounds for dinner or crumpling leaves to sponge up water to slake their thirst. While imitation is thought by many evolutionary psychologists to be the wellspring of social learning, others think it is a repetitive and unproductive kind of learning because it rarely results in an accumulation of culture (Tomasello 1990; Whiten 2000).

It is reasonable to hypothesize that somewhere along the hominins' evolutionary continuum the ‘social learning’ that remains characteristic of the apes segued into the deeper and more complicated ‘cultural learning’ that distinguishes the hominins from all other animals (Whiten 2000). By the time *afarensis* acquired an EQ of 2.5, around 4 million year ago, early hominins were beginning to exceed simple imitation by applying other learning strategies to make their environments more culturally friendly. *Deutero-learning* (Bateson 1972; Tognetti 1999) and *emulation* (Tomasello 1990; Whiten 2000) are two such strategies.

Deutero-learning is a deeply layered idea of the cultural learning practices that became common among the hominins (Bateson 1972). The foundation of deutero-learning is a positive feed back by which one *learns how to learn* by making corrective changes among alternatives to problems that result in the acquisition of abstract habits of thought and states of mind, including thoughtfulness, passivity, dominance, free will, and curiosity. These habits facilitate solutions to ever more complicated problems (Bateson 1972; Tognetti 1999). *Emulation* is that process by which one learns by selecting from another's behavior just the information needed in combination with one's own practical knowledge to develop advanced strategies to accomplish a goal (Tomasello 1990; Whiten 2000). Deutero-learning in conjunction with emulation among early hominins probably laid the groundwork for what would become the contagion of ideas that fed the progressive accumulation of hominin culture (Whiten 2000).

In the realm of material culture this accumulation might have been achieved as hominins learned through their own expanding cognition to derive from the experiences and interactions with others how to extract from intentionally selected rocks a variety of tools, including flakes, hammer stones, blades, and points. These tools accomplished a variety of tasks – splitting bones for marrow, skinning animals, butchering a carcass, hafting a spear point, and making other tools. Socially, deutero-learning and emulation might be revealed in the attainment of high status by individuals who, through means other than physical strength, learned how to correct behaviors to gain a favorable response from members of their societies. This likely would involve rituals to communicate sensibilities, emotions and feelings among individuals that force them 'to act together for some social purpose or to make …new social roles public' and acceptable (Goldschmidt 2006: 49). Individuals, for example, might learn that they can attain higher status, *primus inter pares* perhaps, and a deferential and respectful following by refining their selection of possible behaviors in certain circumstances, such as distributing food equitably or resolving disputes wisely. More brutish individuals who lacked the perspicacity to alter their behaviors in response to actions by others would be selected against in this competition.

Gradually deutero-learning and emulation perhaps evoked but certainly contributed to the primary culture traits, such as sharing, cooperation, reciprocity, and planning that fed increasingly into the pool of genetic switches of evolving hominins. Deutero-learning and emulation enabled hominins to discover new ways to cope with their environments. On the one hand, they could augment their knowledge and apply it to new applications and practices that increased their finesse in using the materials in their physical environment. On the other, deutero-learning and emulation allowed them to learn and seek increasingly cultural solutions cemented by rituals that helped to establish and perpetuate solutions to problems in their social environments. The applications of learning strategies based on deutero-learning and emulation were not random. Instead they were grounded in practices and behaviors of early hominin women who played a special role in the feedback of cultural learning and the genetic base of hominin evolution.

Hominin females and culture

The enculturation hypothesis approaches the role of women in hominin evolution from an axiom and a corollary. The axiom asserts that females in their roles as mothers are the primary carriers and disseminators of culture in hominin societies; the corollary adds that menopausal females in their roles as 'grandmothers', fictive or consanguineal, reinforce and develop further the dissemination of culture across generations. Grandmothers facilitated the origin of hominin culture by assisting parturition in their role as midwives and then continuing the enculturation of neonates after they were weaned by helping to satisfy their hunger for affection (see below) and enculturate them as acceptable members of their societies.

These practices served several purposes. As midwives, grandmothers represent an evolutionary and cultural solution to the parturition of fetuses with larger crania. As grandmothers they allowed the enculturation of children while previous neonates were still dependent. Over generations, they allowed the hominins to build, as the hunting hypotheses suggested, on the protocultural repertoire of their ancestors that provided the foundation of human culture.

But, as the hunting hypothesis does not, the enculturation hypothesis accounts for behaviors and practices that *anticipate* the primary traits. The practices of mothers and grandmothers enculturated neonates with the proper nuances by which they could learn to render the primary traits more effective foundations for human culture. If Goldschmidt is correct, *affect hunger,* 'the urge to get expressions of affection from others' (2006: 47), is crucial to the origin of culture.

Affect hunger is an inherent, genetically ascribed attribute in mammals, the significance of which for the origin of culture and the evolution of humanness has not been acknowledged. Goldschmidt (2006) argues convincingly that the satisfaction of neonates' hunger for affection is particularly important among primates if neonates are to mature into socially acceptable members of their community. In effect, as noted, affect hunger bridges the dialectic of nature and nurture.

Goldschmidt's idea of affect hunger derives from Harlow's (1959, 1986) work with monkeys. Harlow showed that female monkeys that had been socially isolated were indifferent, even lethal at times, to offspring who craved and struggled for their mother's attention and affection, without which the neonates might themselves become socially pathological. Goldschmidt (2006) argues that satisfying neonates hunger for affection is crucial to the evolution of humanness because it enabled hominins to invent culture as they learned to act differently from other primates. The satisfaction of affect hunger allowed hominins to suppress inherent animal urges, such as aggression, and develop and elaborate instead patterns of mutuality and sociability. There is no reason to assume that the hunger for affection was less important among early hominins than it is today, or that it was conveyed to neonates then much differently than it is now.

Initially the hunger of neonates for affection is satisfied by mothers. But others, such as grandmothers, or other older women who were not necessarily kin, may also slake neonates craving for attention and affection. As family life began to reorder hominin social relations, females enculturated their offspring for longer periods of time with functional behaviors, practices, and rituals, such as patterns of deference and demeanor, comportment, conformity, responsibility, appropriate independence of action and thought, socially acceptable resolutions of conflicts, and modes of communication that senior members of the band found agreeable. By the time male and female children began to learn the technical skills that would make them productive members of the society, they already had learned the rituals, cultural rules of behavior, cognitions, and abstract thoughts that would make them socially adept.

Learning the behavioral and social nuances that enabled the primary culture traits to become effective foundations of human culture certainly was reinforced by observation, imitation, play, and repetitive behaviors as the hunting hypothesis suggested. But at a deeper level, neonates were enculturated and humanized by mothers and grandmothers who learned to build on culturally acceptable and transmittable comportments. Longer periods of neonate dependency enhanced their learning, cognitive functions, abstract knowledge, and advanced their practical skills. They began to develop and apply deutero-learning and emulation to the technical knowledge, such as tool-making. They refined cognitive skills required for hunting and gathering, such as remembering patterns of their prey's behaviors and selecting appropriate plant foods. They engaged automatically in the rituals that communicated feelings to others and bonded individuals emotionally and practically.

As the hominins evolved over generations, communication became more complex. Arbitrary cultural meanings were assigned to animate and inanimate objects in the environment. Whether this was accomplished through some form of language – and there is considerable merit to the idea that culture demands language – communication of some sort certainly played an important role in deutero-learning and emulation[19]. Memory expanded. Brain size increased. Different tools were made. Mothers with the help of culturally constructed midwives were selected to accommodate the passages of fetuses with larger crania through their birth canals. Grandmothers facilitated their education and potential for culture. Early hominins gradually restructured their societies to accommodate the learned, shared and transmitted accumulations of culture in the feedback loop to which they were subject.

This hypothesis is consistent with the role of males in the development of culture. With some justification sociobiologists argue that early hominin males probably were more diligent in disseminating their genes widely than in transmitting the foundations of cultural learning to children. That's not uncommon behavior today. Fathers and grandfathers probably then, as today, disseminated the appropriate culture learning to their male children later, when boys began to engage in the productive skills related to procuring food. But then as now among hunters and gatherers, women probably contributed more vegetable food to the band's larder than men did meat. Grandmothers were of special importance in disseminating to weaned female neonates the skills and knowledge associated with gathering plants that were not poisonous and preparing foodstuffs.

Females as mothers, grandmothers, and midwives were not subordinate to males either in contributing to the material well-being of the band or in the development of its culture. The survival of the band, the evolution of the species, the origin and accumulation of culture, and the transition to humanness relied on the ongoing enculturation of neonates by women and the reliance on learning strategies that improved hominin cognitive functions, transmitted social and affective relations, and provided more culture-sensitive responses to their social and physical environments. The primary traits of the hunting hypothesis became effective foundations for culture only as they were anticipated and incrementally augmented by the cultural knowledge and practices that allowed generations of hominin children to become responsible cultural citizens.

Considering what the early hominins began with and how their curious nature resulted in learning strategies that selectively became genetic capabilities, the ongoing development of culture was not an unremarkable feat. The accumulation of culture and, subsequently, more culturally adept and biologically refined hominin resulted from genetic mutations, especially in their hox genes and the switches they regulated, generation after generation, bit by bit, cultural trait by cultural trait. These processes established a positive feedback loop from beharior to genes over millions of years. Gradually serendipity became less important as a factor in the origin of culture and transition to humanness. Instead the ‘metastatic contagion’ of learning that was basic to human culture took over and resulted in the genus *Homo* and, ultimately, *Homo sapiens* such as ourselves.

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NOTES

[1] The lines of evolution that led to the contemporary hominins and hominids (see Note 2) began to diverge at least 20 million years ago from a common anthropoid ancestor that probably existed in East Africa. Around 7 million years ago (late Miocene) the lines leading to the hominids and the line leading to the hominins diverged. By 6 million years ago the earliest hominins had taken their first steps toward becoming exclusively terrestrial and bipedal and began to adapt to more diversified ecological and nutritional niches. Between 4 million and 2 million years ago the early hominins were represented by several primates of the genera *Australopithecus (amanensis, afarensis, africanus, gahri)* and *Paranthropus (aethiopicus, bosei, robustus).* Some of these primates, *gahri* and *africanus* and *bosei* and *robustus,* for example, overlapped in time, if not in space (Lewis and Foley 2004; Stringer and Andrews 2005).

[2] Around 2000 'hominin' replaced 'hominid' to describe species in the human family, or clade, which includes the line of evolution that led to and now includes *Homo Sapiens.* 'Hominid' now refers to the chimpanzees, gorillas and bonobos (Lewin and Foley 2004: 9), and may also refer generally to the nonhuman primates.

[3] Cronk (1999, also see Cartwright 2000) points out that sociobiological arguments do not necessarily preclude considerations of culture and suggests instead that they segue into the cultural dimension.

[4] See Cartmill (1993), Hawkes (2003), and Lewin and Foley (2004) for other comments on and reviews of the hunting hypothesis.

[5] For reviews of hypotheses regarding the origin of bipedalism see Klein and Edgar (2002), Lewin and Foley (2004), and Gräslund (2005). See Morgan (1982, 1997) and Leonard (2002) for other hypotheses.

[6] Gräslund (2005: 66–67) disagrees with the proposition that bipedal locomotion was essential for tool-making. He attributes it to 'a combination of higher intelligence, more mobile wrists, and a better opposable grip than their ancestors enjoyed'.

[7] On the other hand, Goldschmidt (2006: 26ff.) makes a compelling argument for the necessary relationship between tool making and the origin of language.

[8] Gräslund points out that from a primate perspective, 'All other (female) primates have clitorises and urinary tracts in the lower part of their genitals, and the mouth of the vagina above them, just below the anus. In people everything is the other way around: the anus is lowest down, then the vagina and urinary canal and above this the clitoris' (2005: 101, parenthesis inserted).

[9] See Cartwright (2000) for theories to account for the evolution of concealed ovulation among hominins and its consequences.

[10] This behavior is not species specific to hominins, but, among those animals in which it occurs, they remain non-human (Pawlowski 1999).

[11] Bonobo chimpanzees (Gräslund 2005) and gorillas, recently photographed while mating (Breuer 2008), are sometimes exceptions to this pattern.

[12] Considerable debate continues regarding how to measure and evaluate the EQ of contemporary *Homo sapiens*. Current measurements range between 5.7 and 8.2 (see Jerison 1973; Eglash 1984; Chivers *et al.* 1984, among others).

[13] The !Kung San of the Kalahari, Hadza of Tanzania, and Ache of South America are cited most frequently in this literature.

[14] The saltational account of evolution was postulated first by Eldredge and Gould (1972) who referred to it as a *punctuated equilibrium.*

[15] Apparently the debate between a saltational and gradual evolution has not been resolved in Evo Devo. Using the idea of the conservative and regulatory role of genomic switching processes, Kirschner and Gerhart (2005: 257) support a saltational evolution.

[16] See Kirschner and Gerhart (2005) for a somewhat different interpretation from an Evo Devo view point.

[17] Hox genes have existed for 500 million years and are found in virtually all animals. They consist of sets of eight genes each and hominins have four sets (Carroll 2005).

[18] The epistemological foundation of social learning theory, a component of the field of social intelligence and its concern with the evolution of human intelligence, is the idea of *Machiavellian Intelligence.* The fundamental premise of Machiavellian Intelligence is that nonhuman primate social behavior relies largely on chicanery, deceit, exploitation, manipulation, and the like to out-compete others and rivals for personal gain (Goody 1995; Bryne and Whiten 1988).

[19] I concur with Gräslund (2005) that language – at least some form of communication – is much older than many theorists believe.

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