Language and life history: A new perspective on the development and evolution of human language

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Abstract: It has long been claimed that *Homo sapiens* is the only species that has language, but only recently has it been recognized that humans also have an unusual pattern of growth and development. Social mammals have two stages of pre-adult development: infancy and juvenility. Humans have two additional prolonged and pronounced life history stages: *childhood*, an interval of four years extending between infancy and the juvenile period that follows, and *adolescence*, a stage of about eight years that stretches from juvenility to adulthood. We begin by reviewing the primary biological and linguistic changes occurring in each of the four pre-adult ontogenetic stages in human life history. Then we attempt to trace the evolution of childhood and juvenility in our hominin ancestors. We propose that several different forms of selection applied in infancy and childhood; and that, in adolescence, elaborated vocal behaviors played a role in courtship and intrasexual competition, enhancing fitness and ultimately integrating performative and pragmatic skills with linguistic knowledge in a broad faculty of language. A theoretical consequence of our proposal is that fossil evidence of the uniquely human stages may be used, with other findings, to date the emergence of language. If important aspects of language cannot appear until sexual maturity, as we propose, then a second consequence is that the development of language requires the whole of modern human ontogeny. Our life history model thus offers new ways of investigating, and thinking about, the evolution, development, and ultimately the nature of human language.

Keywords: adolescence; childhood; development; evolution; infancy; juvenility; language; life history; modularity; speech

1. Introduction

It has long been recognized that *Homo sapiens* is the only species that has language. In the late 1800s, there was a great deal of speculation about linguistic evolution, much of it fanciful. In the ensuing century, there were scattered attempts to address this issue – more than four hundred cited in one bibliography (Hewes 1974) – but most of these proposals were also highly speculative.

In the 1990s, work on the evolution of language intensified. At the beginning of the decade, Pinker and Bloom (1990) were pointing to "a wealth of respectable new scientific information relevant to the evolution of language that has never been properly synthesized" (p. 727). Since then, the flow of books on the evolution of language has averaged more than one per year (Bickerton 1990; 1995; Botha 2003; Carstairs-McCarthy 1999; Christiansen & Kirby 2003a; Corballis 2002; Deacon 1997; Dunbar 1996; Gibson & Ingold 1993; Hurford et al. 1998; Jackendoff 2002; Kirby 1999a; Knight et al. 2000; Lieberman 1991; Oller & Greibel 2004; Tallerman 2005; Wray 2002). In this same period, journal articles and book chapters have increased tenfold (Christiansen & Kirby 2003c). Two theorists

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recently labeled linguistic evolution "a legitimate area of scientific enquiry" (Christiansen & Kirby 2003b, p. 300). To a third, Carstairs-McCarthy, the evolution of language has become, for the first time in scientific history, "seriously researchable" (Carstairs-McCarthy 2004, p. 1299).

2. Stages in life and language

For some reason, few of the new proposals have afforded a significant role to ontogeny, though no one doubts that the capacity for language develops, or that languages, to exist, must be learned by the young. This omission is interesting in light of the facts that *Homo sapiens* is also the only species that has a childhood, a biologically and behaviorally distinct, and relatively stable, interval between infancy and the juvenile period that follows (Bogin 1990; 1999b), and that a great deal of language learning now occurs during this stage.

Little attention has also been given to the processes that produced the capacity for speech, the universally preferred modality of language (Locke 1998b). We think vocal and articulatory control, which may be relevant to the evolution of song as well as speech (Merker 2000), evolved as a precursive step in the construction of language (MacNeilage 1998; Studdert-Kennedy 1998; 2005), it making less sense that the capacity for syntax – the focus of many proposals – evolved prior to the physical system responsible for the phonetic units that enable words and massive vocabularies (Bickerton 1995; 2000; Donald 1999; Studdert-Kennedy & Goldstein 2003), or somehow evolved without them.[1]

We believe that some selection pressures may have applied early in infancy, and others in childhood. When childhood expanded, new opportunities arose, especially within families, for the negotiation of more structured and complex forms of vocalization. With a premium in this context on honest signaling, benefits would have accrued to families that were able to deploy these more complex forms meaningfully, and thereby to warn, advise, and inform each other.

Here, we envision an evolutionary connection between language, as qualified above, and the life history stage of childhood. We propose that in evolutionary history, growth factors working in concert with selection for reproductive success initially produced a short childhood that was later used for, and extended by, vocal and verbal learning. With continuing increases in the duration of childhood and the complexity of the new proto-linguistic behaviors, both childhood and essential components of language evolved.

One might suppose the contributions of a life history approach end with childhood, given the developmental linguistic importance of that stage, but humans are also the only species that has adolescence, a stage in which the attainment of sexual maturity is accompanied by a dramatic resurgence of skeletal growth. We suggest that although the basic structure and functions of language are instated in infancy, mastery of language as a social tool – a fluent and flexible means of oral communication, manipulation, and performance – does not approach adult levels of proficiency until adolescence. It is at this developmental stage, in evolutionary history, that performative traits would have facilitated intrasexual

competition and courtship. Selection at adolescence would have reinforced the behaviors occurring then, as well as foundational behaviors that emerged in earlier stages. For this reason, we propose further connections between adolescence and all earlier stages of life history, including infancy, childhood, and juvenility. According to our life history proposal, individuals with longer intervals between infancy and sexual maturity, and greater success in intervening stages, achieved higher levels of vocal and verbal behavior and, therefore, greater competitive advantage.

The approach to human life history adopted here was developed by Bogin (1988; 1999b). It is a biological and behavioral model of human development that both complements and departs from the better-known schemes described by developmental psychology. The model is based on a consideration of comparative mammalian biology as well as primate evolutionary history.

2.1. Stage 1: Infancy

Figure 1 illustrates the amount of growth, or distance (upper panel), and the rate of growth, or velocity (lower panel), of healthy human beings. The velocity changes in growth correspond with stages of human life history. Postnatal growth is rapid, as is its rate of deceleration. During infancy, which extends from birth to 36 months, deciduous dentition erupts and the brain grows at a fast pace.

The infancies of humans and other mammalian species are comparable in many respects – for example, feeding by maternal lactation and appearance of deciduous teeth. However, in most mammals and all the other
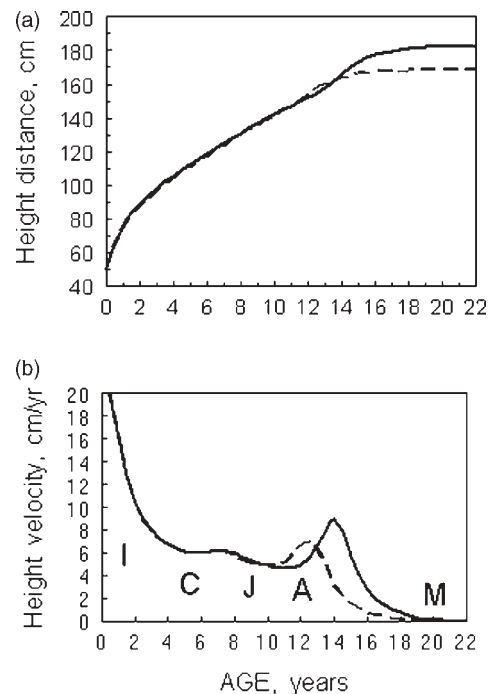

Figure 1. Typical distance (A) and velocity (B) curves of growth in height for healthy girls (broken lines) and boys (solid lines). Postnatal life history stages are labeled as I-infancy, C-childhood, J-juvenile, A-adolescence, M-mature adult (after Prader 1984).

primates, infancy and lactation end with eruption of the first permanent molars (Smith & Tompkins 1995). In humans, by contrast, there is an interval of about three years between weaning – breast-feeding usually is discontinued at 30 to 36 months, according to ethnographic observations in traditional societies and historical accounts from Europe and America – and eruption of the first permanent molars, an event that usually takes place at 5 to 6 years of age.

An important factor in the evolution of human infancy was bipedalism, which realigned the spine and narrowed the pelvis (Leutenegger 1974; 1980; McHenry 1975). This change created an unfavorable ratio between the smaller maternal birth canal and the large fetal head (Leutenegger 1974) – the brain of modern human neonates is larger than the brains of other primates, even though it achieves a smaller percentage of its total growth at birth (Harvey & Clutton-Brock 1985; Lindburg 1982) – and this produced what Washburn (1960) called an "obstetrical dilemma."[2] This dilemma was eased when some amount of skull and brain growth – and motor development – were adaptively deferred into the postnatal period, increasing infant dependency and the need of postnatal care. In a number of important respects, these conditions – in danger of being seen as design flaws – offered more and better opportunities for social, vocal, and lexical learning (Bjorklund 1997; Locke 1993; 1999).

This tendency to view helplessness as a socially and cognitively beneficial trait is supported by anthropological accounts, which indicate that most hunter-gatherer mothers rarely put their babies down, and then do so for no more than a few seconds, usually remaining within a meter (Draper 1976; Hill & Hurtado 1996; Konner 1976; Lee 1979a; LeVine 1980). Separation cries usually evoke pick-up and breast-feeding (LeVine & LeVine 1966). When infants cannot be carried, they are often left in the care of others (Blurton Jones 1993; Estioko-Griffin 1986; Hawkes et al. 1997; Hewlett 1991). In most other primate species, infants are equipped to cling to their mother's body hair, and are less likely to be cared for by other members of the social group. Thus, although the *duration* of infancy is not longer in humans than in some of the other primates, its *quality* is higher because the greater handling required by the human infant produces more intense social stimulation during a period in which the brain grows at a compensatorily rapid rate.

The primacy of brain growth over other body systems is illustrated in Figure 2. In the newborn, 87% of resting metabolic rate (RMR) is devoted to brain growth and function. This has the effect of co-opting, and thus prolonging, the growth of other systems. By the age of five years, the RMR devoted to the brain is still high at 44%, whereas in the adult the RMR figure is 20 to 25%. At comparable stages of development, the RMR devoted to the relatively large chimpanzee brain is about 45, 20, and 9% for a newborn, a five-year-old, and an adult (Leonard & Robertson 1992).

Stages in the development of language correspond to life history stages, to a degree, but language research has not been carried out within a life history framework. Thus, our characterization of language in each of the ontogenetic stages below is based on pre-existing evidence.
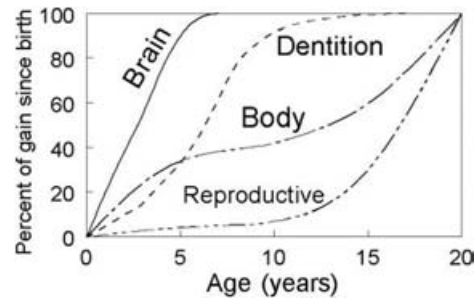

Figure 2.   Growth curves for different body tissues (from Bogin 1999b). The Brain curve is for total weight of the brain (Cabana et al. 1993). The Dentition curve is the median maturity score for girls based on the seven left mandibular teeth (I1, I2, C, PM1, PM2, M1, M2) using the reference data of Demirjian (1986). The Body curve represents growth in stature or total body weight, and the Reproductive curve represents the weight of the gonads and primary reproductive organs (after Scammon 1930).

2.2. Infant language

The basic structure of language is laid down in infancy, which is paradoxical since the word derives from the Latin *infans*, literally "not speaking." In the first phase of development, vocal learning, infants learn and may reproduce aspects of the prosodic and segmental characteristics of the ambient language. This phase commences before birth and continues in infancy (Locke 1997; Locke & Snow 1997). By six months, most infants have heard enough speech to recognize a few words and stereotyped phrases (cf. Locke 1993), and to experience some perceptual reorganization (Kuhl et al. 1992), a process that continues in succeeding months (cf. Werker & Curtin 2005). At seven months, infants typically begin to make alternating jaw movements while phonating (MacNeilage 1998), an act that produces well-formed syllables (Koopmans-van Beinum & van der Stelt 1986; Oller 2000). An apparently universal phonetic repertoire begins to emerge at this time (Locke 1983; 1990; 2000a). Four months later, infants utter sounds in ways that reflect prior exposure to speech (Vihman 1996).

Around the end of the first year, most infants attempt to speak, and may even – then or in succeeding months – improvise sound-meaning relationships that may be treated by the family as invented words (Leopold 1949). A few months later, infants develop a suite of cognitive traits that will enable language to be used at a basal level of creativity and efficiency. These center on the ability to infer, and the disposition to share, the intentions of others (Tomasello et al. 2005). Around this time, several different communicative acts begin to emerge, with many in frequent use by age three or four years (Snow et al. 1996; Wetherby et al. 1988; also see the review in Adams 2002).

Infants usually begin to combine lexical items at age 18 to 24 months. In the following year, having learned something about grammatical structure and rules, infants display the ability to understand and compute novel forms and sequences of words. In the typical English-learning infant, therefore, all areas of linguistic structure – phonological, lexical, morphological, and syntactic – exhibit some degree of development by age

36 months (Locke 1993; 1997). Thus, by the time infancy draws to a close, the rudiments of a structural linguistic system, and basic components of a functional communicative system, are operative.

2.3. Stage 2: Childhood

The childhood stage is peculiar to humans, having been evolutionarily inserted between the infant and juvenile stages that characterize social mammals (Bogin 1990). Childhood is defined by several developmental characteristics, for example, a slowing and stabilization of the rate of growth; immature dentition; feeding characteristics, such as dependence on older people for food; and behavioral characteristics, including immature motor control. The evolutionary value of childhood lies in the mother's freedom to discontinue nursing her three-year-old, which enabled her to initiate a new pregnancy. Doing so enhanced reproductive output without increasing the risk of mortality for the mother, or her infant or older children, for in cooperatively breeding societies others were available to help care for the young.

As shown in Figure 1, the end of the rapid growth deceleration of infancy marks the beginning of childhood, when the growth rate levels off at about 5 cm per year. Stabilization of growth rate is rare in mammals; typically, growth continues to decelerate between infancy and adulthood (Brody 1945; Tanner 1962). In childhood, brain growth tapers off, at least by weight (Fig. 2), with its mass peaking at about age seven years (Cabana et al. 1993), with a small increase occurring later at puberty (Durston et al. 2001; Sowell et al. 2001). Myelination and some nerve proliferation continue into adulthood (Bjorklund & Pellegrinni 2002; Taupin & Gage 2002).

In virtually all other mammalian species, and in all non-human primates, maternal lactation continues until the eruption of the first permanent molar (Smith & Tompkins 1995). With adult molars and other teeth in place, the other primates move on to the juvenile stage and must forage for food and otherwise care for themselves with little or no assistance. In the human infant, of course, other foods are supplied prior to weaning. But the cessation of lactation places a great nutritional burden on the weaned infant, with the high metabolic demands of a brain that is still growing rapidly. The typical three-year-old is too motorically immature to forage or prepare its own food, and too limited by deciduous dentition and a small gastrointestinal tract to eat and digest the adult diet.

The solution to this "feeding crisis" is for older members of the social group to provide specially prepared foods that are high in energy and nutrients until self-care becomes possible, and in various hunter-gatherer societies this is what is done (Blurton Jones 1993; Estioko-Griffin 1986; Hewlett 1991).[3] Summarizing the data from many human societies, Lancaster and Lancaster (1983) called this type of childcare and feeding "the hominid adaptation," for no other primate or mammal is so actively involved in these ways. The long period of food provisioning, extending from ages three to seven years, largely defines the childhood stage of human life history. By age seven, usually, the four permanent first molars have erupted and the permanent incisors have begun to replace "milk" incisors. With parallel changes in the size and strength of the jaws, and in the muscles of mastication,

children – on the threshold of juvenility – become able to eat the same foods as adults.

During this period, mothers often participate in childhood feeding if they are neither pregnant nor nursing a new infant, but new reproductive efforts are likely to consume most of their free energy and time. This is the case for all other mammals, and it is the reason why the birth interval between successful pregnancies is equal to the age of first molar eruption in species without the human style of social care after weaning. For humans, early weaning (by age three years) relative to molar eruption (age six years) reduces the birth interval and allows the mother to successfully produce two offspring in the time it takes chimpanzees and orangutans to successfully rear one. Thus, we see childhood as an adaptation that enhances the quantity of maternal reproductive output without sacrificing the quality of any offspring. We discuss the other aspects of the evolutionary basis for childhood in more detail later.

On the social front, childhood typically produces new extrafamilial friendships, frequently co-timed with growing disenchantment with siblings (Dunn 1996). In some modern societies, social hierarchies have already developed by the age of five. In these hierarchies, low-status children direct positive behaviors to their higher status peers, evidently without reciprocation (Strayer & Trudel 1984). Children with good communication skills are likely to be particularly popular (Asher & Renshaw 1981; Gottman et al. 1975; Putallaz & Gottman 1981), whereas children with speech and language disorders tend to be unpopular and lonely, and may even be victimized (Blood & Blood 2004; Conti-Ramsden & Botting 2004; Davis et al. 2002). Children with pragmatic or higher-level language processing disorders are at risk of serious peer interaction problems (Botting & Conti-Ramsden 2000), and similar problems may arise in later stages of development (Place & Becker 1991). Significantly, patterns of friendship and rejection in childhood set up modes of relating that frequently persist through succeeding stages into adulthood (Kohlberg et al. 1972).

In what has come to be known as the "five to seven year shift" (Sameroff & Haith 1996), new learning and behavioral capabilities emerge, and these enable greater social independence (Bogin 1999a). Walking becomes adult-like by age seven years (Bogin 1999b). Cognitive and emotional developments permit new levels of self-sufficiency (Tomasello & Call 1997). Seven-year-olds can perform many basic tasks, including food preparation, infant care, and other domestic tasks, with little or no supervision (Rogoff 1996; Weisner 1996). The nonlinguistic traits associated with human childhood therefore include:

1. slow and steady rate of body growth and relatively small body size
2. large, fast-growing brain
3. higher resting metabolic rate than any other mammalian species
4. immature dentition
5. dependence on older people for care and feeding
6. motor and cognitive advances.

No other mammalian species has this entire suite of features, or a developmental period that is comparable to childhood.

2.4. Child language

Some structural developments that begin in infancy continue into childhood, with consequences that affect speech and language. One qualitative change involves the relationship between pharynx height and oral cavity length, which changes from birth until six to eight years, when it reaches, and stabilizes at, the (1:1) ratio that permits adult vowel production (Fitch & Giedd 1999; Lieberman et al. 2001). A second, quantitative change is a decrease in the rate of brain growth by weight. During childhood, there are continuing improvements in phonology, vocabulary, and sentence length (cf. Berko Gleason 2001), as well as syntax (Clark et al. 1986; Karmiloff-Smith 1985).

As childhood draws to an end, a discontinuity in native language learning occurs. Languages acquired after the age of six are often produced with an accent that reflects interference from previously learned languages (Asher & Garcia 1969; Flege & Fletcher 1992). In large epidemiological samples of Midwestern American children, six years of age was also treated as the approximate age of native language mastery, based on standardized tests that are oriented to school performance (Shriberg et al. 1999; Tomblin et al. 1996; 1997).[4] Thus, in one modern society much of the childhood period is deemed necessary to master the basic structure and elementary vocabulary of a knowledge-based linguistic system. We will see later that if language is delayed at this age, there are likely to be continuing problems in juvenility, adolescence, and adulthood, though these may have less to do with linguistic knowledge than later emerging capabilities in the area of vocal and verbal expression.

But there is more to be accomplished in childhood. One advance involves verbal fluency, which continues to improve throughout this stage (Starkweather 1987). Another development relates to automaticity. If something goes wrong with the sensory system that guides ambient learning during childhood, there is likely to be significant deterioration of speech. Clinical studies indicate that all of childhood is needed to achieve a speaking ability that can tolerate the discontinued stimulation entailed by acquired deafness (Binnie et al. 1982; Cowie & Douglas-Cowie 1983; Plant 1984; Waldstein 1990). Deafness in later life stages poses less of a threat to speech.

Some of the communicative skills arising in childhood do so in tandem with certain cognitive advances. One such development is the "theory of other minds," which typically emerges between ages two and four years (Baron-Cohen et al. 1993), enabling children to take the perspective of others. Another is an improvement in autobiographical memory, which usually occurs between ages three and eight years (Nelson 1996), allowing children to describe sequential events and to share memories of their own experience. Other skills that improve during childhood include discourse and narration (Girolametto et al. 2001).

Some of the developments that occur in childhood relate to verbal competition and performance. These include joking (McGhee 1979; Shultz & Horibe 1974) and the use of preassembled verbal routines (Gleason & Weintraub 1976). In many cultures, children play verbal games with peers using material learned from family members earlier in infancy, or from unrelated children and juveniles later on. These games mark the beginning of various sorts of verbal competition (Gossen 1976a; 1976b; Sanches & Kirshenblatt-Gimblett 1976). They also point to a disposition toward verbal creativity that, we will suggest, may have played a key role in the evolution of language (see sect. 3.4).

During childhood, there is a trend for males to speak assertively to get and maintain attention and to make evident their desires, and for girls to speak softly in order to promote interpersonal closeness and harmony (Austin et al. 1987; Cook et al. 1985; Miller et al. 1986; Sachs 1987). The linguistic acquisitions of infancy are thus joined by factors in childhood, and succeeding stages, that influence mode of expression and facilitate development of vocal and verbal skills (Dundes et al. 1970; Gossen 1976b; Sherzer 2002).

Since it begins with weaning, childhood would also have liberated the young from continuous maternal restraint. The freedom of irresponsible progeny to range unsupervised over greater distances elevated the need for parents to warn and instruct, giving them and other kin selfish reasons to send honest signals (see sect. 3.5). But childhood also put the young in a position, for the first time, to know about, and thus to convey information about, events occurring in the absence of others. Therefore, we also suggest that childhood handed children and their extended families a key ingredient of human language – displacement – in the form of new opportunities, and needs, to talk about things not immediately present (Hockett 1977).

Other advances in maturation, learning, and consolidation are necessary for the young to speak informatively, attractively, and persuasively, and hence, competitively. If in evolution, as now, these developments occurred during a stage that follows childhood, communicative ability in *preceding* stages would have been relevant. We propose that individuals with longer intervals between infancy and adolescence would have had more opportunity to improvise and learn vocal material, and any rules of deployment. Selection for vocal ability and, ultimately, for language, would thus have worked reciprocally to extend childhood.

2.5. Stage 3: Juvenility

Juvenility is the next stage of human development. In mammals generally and primates particularly, juveniles are sexually immature but independent of others for survival (Pereira 1993; Pereira & Altmann 1985). It is not unusual in traditional human societies for juveniles to find much of their own food, avoid predators, and compete with adults for food and space (Blurton Jones 1993; Weisner 1987). The beginning of human juvenility is marked by adrenarche and, in some juveniles, a progressive increase in the secretion of adrenal androgens. These hormones may launch the growth of axillary and pubic hair. The physical changes induced by adrenarche are accompanied by cognitive and social advances, and there are sexually dimorphic vocal changes during this stage as well (Wuyts et al. 2003).

In juvenility, rate of growth declines once again, giving this stage the slowest growth rate since infancy (Fig. 1). Frequently, the decline follows a mid-growth spurt, in

those children who experience it, but the rate of growth declines even in children without a detectable spurt. The cause of this decrease in growth rate is unknown, but Janson and van Schaik (1993) have proposed several benefits. The first is that it provides additional time for the brain growth and learning required for reproductive success in various species of social mammals. Social carnivores, elephants, and primates must all learn how to live within the social hierarchy of the group. Juvenility also offers opportunities to learn complex feeding skills such as how to hunt, how to open fruits or seeds with protective coverings, and where and when to find food. Reproductive skills must also be learned, including ways to compete for mates and care for offspring. Joffe (1997) has reported positive correlations between the length of juvenility and both group size and the volume of social areas of the brain.

Janson and van Schaik (1993) also proposed that slower growth reduces feeding competition and maintains a smaller body, which is less threatening to adults. Growing up in a social group that is composed of individuals of different ages and social status can be difficult. This is especially true for juveniles who must compete with older, more experienced, individuals for food, space, and other resources. Fortunately, their relatively small and slowly growing bodies require less food than adult bodies, and may also afford them some protection from adult competition and attack as they present a non-threatening juvenile morphology.

In humans, the decline of growth rate bottoms out at about age 10 years in girls, two years before it does so in males, and this marks the end of the juvenile stage. As for the function of juvenility, it seems reasonable to suppose that in humans, like the other primates, this stage offers opportunities to prepare for the social complexities of adolescence, as well as adulthood. We propose that juvenility also provides the young with chances to learn and perfect skills associated with the social, pragmatic, and performative uses of language.

2.6. Juvenile language

Coates (1986) has pointed out that, for all the advances occurring in childhood, "a knowledge of grammar, phonology and [the] lexicon is not enough – it does not make the child competent; children need to master not only the formal rules of language, but also rules for the appropriate use of language" (p. 121). To be sure, juvenility accommodates additional syntactic advances (cf. Nippold 1998), with some English forms continuing to emerge in early adulthood (Marchman et al. 1991), but many of the new developments affect performance. These include an increase in speech-breathing capacity (Engstrom et al. 1956; Hoit et al. 1990) and further increases in fluency (Starkweather 1987). Prior to the adolescent "voice break," there are anatomical changes that affect the ratio of the fundamental frequency to the ratio of higher formant frequencies (Sachs et al. 1973; also see Austin & Leeper 1975; Vuorenkoski et al. 1978).

There are changes, too, that occur beyond the sentence level, in the quality of extended discourse and narratives (Bamberg 1987; Burleson 1982; Karmiloff-Smith 1985). These pragmatic advances facilitate a variety of socially relevant activities, from gossip to storytelling, and contribute to successful competition and courtship in the run

up to sexual maturity. In Turkey, boys engage in verbal duels – ritualistic insults and replies that require "skill in remembering and selecting appropriate retorts to provocative insults" (Dundes et al. 1970, p. 135). These duels occur primarily from ages 8 to 14 years, effectively bridging juvenility and adolescence.

In one sense, juvenility is analogous to infancy. Whereas the linguistic knowledge and structure gained in infancy will help to satisfy the informational needs of childhood, juvenility provides opportunities to achieve the persuasive and attractive use of speech, and the ability to fluently manipulate elaborate and socially appropriate utterances, that will be valued in adolescence.

2.7. Stage 4: Adolescence

In humans, uniquely, there is a distinct skeletal growth spurt in both sexes and in almost all skeletal elements of the body after several years of gently decreasing juvenile growth. The onset of this spurt, along with puberty or gonadarche (an event of the neuroendocrine system) marks the onset of adolescence (Bogin 1999b). Neuroendocrinological changes differentially affect the vocal tract and fundamental frequency of the two sexes, females revealing negligible changes, males displaying a significant increase in tract length and decrease in frequency, with further drops in the transition from adolescence to adulthood (Fitch & Giedd 1999; Lieberman et al. 2001; Pedersen et al. 1986; 1990; Vuorenkoski et al. 1978). The critical variable is testosterone, which increases the length and mass of the vocal folds, lowers the fundamental frequency, and alters the vibratory characteristics of the vocal folds (Abitol et al. 1999; Beckford et al. 1985; Titze 1989).

Development of other secondary sexual characteristics and a growth spurt in height and weight also occur in adolescence. These physical changes are accompanied by intensification of preexisting friendships and the development of new relationships. The new affiliations, and membership in peer groups, facilitate intimacy and mutual support (Whitmire 2000). Adolescence ends with the attainment of adult stature and the biosocial skills needed for successful reproduction. This occurs, on average, at about 19 years of age in women and 21 to 25 years in men (Bogin 1999b; 2001).

It is significant that the secondary sexual development of boys and girls progresses differently through adolescence. Boys become fertile about two years after puberty and the onset of the adolescent growth spurt. At this time they still look like boys, as their body hair, stature, and muscularity are still juvenile in appearance. The peak of their growth spurt (called "peak height velocity," or PHV) is still, on average, one year away, and patterns of body hair do not become adult-like for three years, with a muscle spurt and adult stature still four years away (about age 18 on average). Girls, in contrast, will have completed about half their breast and pubic hair development by the time of their PHV. Menarche occurs about a year after PHV. At this point in development, girls have the outward appearance of women, but they are not fertile. Development of an adult frequency of ovulation and adult size of the birth canal do not occur until approximately age 18 (Bogin 1999b).

Bogin (1999a; 1999b) has hypothesized that these sex-specific patterns of adolescent development confer

significant reproductive advantages on our species, partly by allowing adolescents to learn and practice adult economic, social, and sexual behaviors before reproducing. He noted that girls best learn their adult social roles while they are infertile but perceived by adults as mature, whereas boys best learn their adult social roles while they are sexually mature but not yet perceived as such by adults. The perception of fertility in girls allows them to enter the social-economic-sexual world of adult women, and to practice many skills without the risk of pregnancy. The hormonal status and fertility of adolescent boys primes them to attend to the social-economic-sexual world of adult men. As these boys are still juvenile in outward development, they can interact and learn from older adolescents and adults without seeming to compete for important resources, including women. The younger adolescent boy can "apprentice" to older adolescents and men, make mistakes that would be very costly to adults, and otherwise learn and practice skills that may be essential to adult survival and reproduction.

Without the adolescent growth spurt, and the sex-specific timing of maturation events that occur then, this unique style of social and cultural learning could not occur, but there is considerable variation in the ways adolescence is treated by individual cultures. Human adolescence is therefore best understood in terms of its biological underpinning and its cultural manifestations.

2.8. Adolescent language

In adolescence, there are further changes in linguistic communication in three broad areas. The first is linguistic content, including vocabulary, the more nuanced grammatical operations, and idiomatic phrases (Nippold & Taylor 2002), including slang. The second area of adolescent development involves delivery, including improvement in speaking rate and fluency. There is a huge increase in respiratory capacity at this stage, which may influence some aspects of speech and voice (Cook & Hamann 1961; Hoit et al. 1990). The third area involves a host of functions that begin to surface in childhood but flower in adolescence.

One such function is social talking, a predominantly relational use of speech in which the topic is frequently other people (Gottman & Mettetal 1986). This disposition to gossip steadily increases during adolescence, especially in females (Raffaelli & Duckett 1989; also see sect. 6), whereas the tendency to tease peers is more evident in males (see review in Eckert 2003). Other functions – several, like gossip, falling outside the area of pragmatics as usually defined – include joking, deceiving, mollifying, negotiating, and persuading, with increases in the use of sarcasm (McTear & Conti-Ramsden 1992; Nippold 1998; Paul 1995). These skills are not highly appraised by classroom teachers and language clinicians, who place a higher value on the logical expression of thought (Reed et al. 1998; Reed & Spicer 2003), but they facilitate achievement of two things that matter a great deal to adolescents and adults: status and relationships.[5]

This discussion of the emergence of grammatical and pragmatic functions should not distract us from a basic fact about the role of language in this stage of life. Adolescents do not merely learn additional linguistic features and practice new rules of usage. They also modify material learned in earlier stages, thereby changing aspects of

their native language (Eckert 1999; Labov 2001). Because adolescents are more parentally independent than ever, but still geographically limited, a strong local affiliation tends to influence their personal and social identity. An effective way to signal this affiliation and increasing autonomy is through linguistic markers, particularly phonetic and vocal ones. "The relatively high degree of phonological innovation in the adolescent age group," wrote Eckert (1988), "is an indication that the development of adolescent social structure provides a major impetus for phonological change" (p. 197).

3. How did vocal-verbal behavior evolve?

Reports suggest that apes and monkeys do not vocalize as often as humans. Wild chimpanzees are silent much of the time (Gardner et al. 1989), evidently preferring the manual to the vocal modality (Tomasello et al. 1985; 1989). Trivers (1974) once commented that gorillas appeared to be "selected for silence." By contrast, our own species is given to near-constant chatter in familiar social circumstances even when it appears that very little is being said (Locke 1998c). How – under what environmental pressures – did human sound-making capacities evolve?

3.1. Natural selection

To evolve, biological traits must offer a selective advantage, even if it is small and inconsistent, and this advantage will usually be linked to food, defense, reproduction, or some combination of these. Building on key contributions in evolutionary biology (Dawkins 1986; Maynard Smith 1969), Pinker and Bloom (1990) argued that natural selection is the only way to explain the origin of language and other complex abilities. In doing so, they said little about any role that selection might have played in development. But as Hogan (1988) has pointed out, natural selection "should operate at all stages of development, and not only on the adult outcome, since any developmental process that reduces the probability of reaching adulthood will be very strongly selected against" (p. 97). Hence, we begin this section with several new proposals relating to vocal and verbal selection as it may have operated in infancy and childhood.

3.2. Parental selection

With evolutionary changes that narrowed the female pelvis and deferred fetal brain development (sect. 2.1), infants' need of care would have increased. As care requirements grew, conflict and competition between the infant and its parents would also have escalated. Responsibility for one solution, according to Trivers (1974), would have been borne largely, but not exclusively, by the infant – a behavioral change that included more effective use of care-elicitation signals, and possibly an improvement in the signals themselves.

The *parental selection* hypothesis proposes that some of the vocal ability presupposed by spoken languages emerged from infancy, having been asserted initially by hominin infants and supported by interactions with their parents (Locke 2006). According to the hypothesis, infants who issued more effective care-elicitation signals

(e.g., measured or strategic levels of cry) were better positioned to receive care than infants who issued stress vocalizations noxiously or inconsolably – behaviors that invite neglect and abuse in primates generally, and forecast language-learning problems in humans. The hypothesis also envisions that infants who cooed and babbled at appropriate intervals were more likely to engage with adults, to be liked by them, to receive more sophisticated forms of care as infancy progressed, and to generate and learn complex phonetic patterns. Infants who were able to monitor adult reactions to their behaviors (Chisolm 2003) would have been able to discover which vocalizations had the most beneficial effects, and thus could use structured vocalization to maximum effect.

It is also possible that syllabic and articulatory activity played a "decoupling" role (Oller 2004), making available for recombination the discrete movements, hence the phonetic segments, that make phonological systems possible (Studdert-Kennedy 1998; 2005; Studdert-Kennedy & Goldstein 2003). Further elaboration of vocal repertoires, we propose, would have occurred later in development under different pressures, potentially enhancing fitness in one or more of these stages, particularly adolescence.

3.3. Trickle-up phonetics

We have suggested that heightened dependency, and impending withdrawal of parental support, encouraged more complex and clever ways of vocalizing in infancy. It is plausible that some of these more sophisticated patterns of sound making trickled upwards.

While there is a disposition to think about infants as imitators of adult behavior, there is, in fact, a stronger tendency for *parents* to copy their infants (Uzgiris et al. 1989). One reason that they do this may be to control their infant's attention. Meltzoff (1990) found that 14-month-olds attended to an adult if he precisely replicated the infants' own actions, doing so far more frequently than when the adult performed unmatching actions. The infants' motivation to attend may relate to the fact that contingent responding causes infants to smile, and may be innately pleasurable (Watson 1972; 2001). This arrangement – movements by infants and replications by adults – constitutes a dyadic system that the infants can control (Chisholm 2003).

Such effects are also demonstrable in the case of speech. Pawlby (1977) reported that at age 17 to 43 weeks, more than 90% of the phonetic matching in her study was attributable to mothers imitating their children; Pawlby commented that infants "pay special attention (in that they laugh and smile and appear to be pleased) when the mothers themselves imitate an action which the child has just performed" (p. 220).

These interactions can produce durable changes of adult speech, changes that we have termed "trickle up phonetics" (Locke 2004b). For example, in a number of disparate cultures, parents use specialized "baby words" (Ferguson 1964). The constituent consonantal sounds are primarily stops, nasals, and glides, frequently recurring, reduplicatively, with low vowels (Locke 1983). These items resemble the familiar forms of babbling, a behavior that is favorably regarded by parents (Bloom et al. 1993). Such standard lexical items as "mama" and "papa" further illustrate the strength of the tendency to

incorporate infant vocalizations into the adult lexicon (Jakobson 1960; Locke 1985).

Since Mivart (1871) and, later, Garstang (1922), it has been recognized that for a species to evolve, changes must occur in development (de Beer 1951/1958; Gottlieb 1992; Gould 1977; Northcutt 1990). This does not mean that the principal agent of change, or one of the principal agents, must itself be a developing infant or child, but that is exactly what we propose in the case of parental selection and trickle-up phonetics (see sect. 13).

3.4. Instinct for inventiveness

These cases, in which developmental changes appear to influence evolution, suggest that human infants and children may possess "instincts for inventiveness" (Marler 1991, p. 63). Marler was thinking about songbirds when he used that phrase, but it appears that when linguistically deprived children are exposed only to fragmentary symbolic behavior, whether in the form of vocal pidgins or manual gestures, they also improvise lexical material and grammatical structure (Bickerton 1984; Goldin-Meadow & Feldman 1977; Goldin-Meadow & Mylander 1998; Newport 1981; Senghas & Coppola 2001; Senghas et al. 2004). In effect, *they invent language*.

It could be argued, of course, that since *modern* children have all the genes required for language, their vocal and verbal creativity is a *product* of linguistic evolution. But there is evidence that other primate infants and juveniles also come up with creative solutions to environmental problems. These behaviors have included food washing in Japanese macaques (Kawai 1965; Kawamura 1959), food acquisition and social behavior in chimpanzees (Wrangham et al. 1996), and tool use in orangutans (van Schaik 2004). In the macaques, adult animals were later observed carrying out the same behaviors as the infants. Among the chimpanzees, behaviors originating with infants or juveniles tended to diffuse laterally, remaining at the subadult level. But if questions remain about transmission (Galef 1990; Hauser 1988), few seem to doubt the observation that new behaviors frequently originate in the young. One investigator has even raised the idea of a "critical period" for the development of a new skill (nut cracking) in chimpanzees (Matsuzawa 1996).

3.5. Mother tongues

At some point, of course, there had to be pressures not merely to improvise new and more complex signals but also to use them meaningfully, and this is the focus of a recent kin selection proposal by Fitch (2004; also see Brockway 2003, p. 120). Where it had been assumed that breeding was the sole means of gene transmission, kin selection theory proposes that individuals also pass along their genes by helping genetically related individuals on their way to reproductive success (Hamilton 1964), at least if the cost of doing so is not too great (Trivers 1974).

Fitch (2004) extended kin selection theory by proposing that parents benefit by preferentially communicating accurate information to their offspring. He reasoned that in hominin families there would have been a role for "cheap honesty" – the ability of parents to exchange accurate information with their offspring and with other kin who shared their genes. They could do this without significant cost or

effort, Fitch suggested, because speech is metabolically inexpensive. Systems of communication that evolved in the context of kin selection were labeled "mother tongues."

The better-informed young, according to Fitch's (2004) proposal, would be more likely to survive into adulthood, passing on to their own offspring genes associated with this improved system of communication. Although he took no position on *how* language evolved, his proposal does address *pressures* within kin groups to achieve some means of exchanging information. These arrangements would have broadened later, according to Fitch, to include genetically unrelated individuals, and elaborated to meet the requirements, and pressures, associated with information transmission.

We suggest, then, that the kin group provided a context in which it was advantageous to exchange information, and that infancy and childhood furnished raw vocal material that would have favored any system of spoken communication. But selection would have needed to operate in other stages if that material was ever to elaborate beyond some restricted core. The performative and creative nature of in-group verbal behavior in juvenility and adolescence suggests that these stages may have played an important role in the process.

3.6. Peer effects in adolescence

In section 2.8 we discussed the fact that adolescents not only manipulate language in new ways, but also revise it. In evolution, similar things may have occurred, whether in song or a more speech-like format, in response to the hormonal and social conditions that characterize the approach to sexual maturity. At the phonological level of language, changes, which frequently involve an increase in the complexity of articulation, serve to identify members of social groups (Labov 2001). Of significance to one of our major claims (see sect. 4.3), nonstandard forms tend to originate preferentially with males, doing so at some point between late juvenility and early adolescence (cf. Eckert 2003).

4. The social context of vocal-verbal evolution

We assume that at sexual maturity, vocal and verbal performances increased fitness by facilitating attainment of social rank and mating relationships, thereby improving access to associated benefits. Links between vocal and social factors may be found in arrangements bearing some resemblance to the contexts in which language evolved – oral societies. We turn our attention to these now, and then look at natural and sexual selection as they may have applied at adolescence.

4.1. Oral societies

Oral societies are of interest because they appear to resemble ancient and evolutionary societies more closely than do other extant groups (see Lee 1979b, p. 32), and may provide a clearer view of the initial benefits of vocal and verbal behavior in our species. Life in modern societies makes it difficult to think of the human capacity for verbal communication as anything but the ability to learn and use a linguistic code. This is largely because the prevailing definition of language, according to Linell

(1982), "is deeply influenced by a long tradition of analyzing only written language" (p. 1), a practice encouraged by "objectivist linguistics" (Lakoff & Johnson 1980). To witness what may be the vestiges of earlier effects, we will evaluate evidence from tribal and other oral cultures.

Fortunately, oral societies have been a popular target of anthropologists, who have noted a belief in the "magical" power of words (cf. Tambiah 1983). This power, and rhetorical force more generally, have been available to those who used an exceptionally broad range of words, and phrases that are "ornamented" by material from outside the more limited repertoires of their listeners (Abrahams 1970c; 1989; Garrett 1993; Sherzer 1990; Strathern 1971). Content has included archaic or esoteric language, metaphors, metonymy, formulas, riddles, and special prosodic patterns as well as over-learned phrases (e.g., Bauman 1975; Comaroff 1975; Gossen 1976a; Malinowski 1935). These devices have been witnessed in places as dispersed as Melanesia, Amazonia, Africa, and North America. Examples come from:

The Trobriand Islands of New Guinea, where Malinowski (1922) noted that lexical "power" was achieved through the use of "archaisms, mythical names and strange compounds, formed according to unusual linguistic rules" (p. 432).

Central Brazil, where the "plaza speech" of Suya Indians "has a special rhythm, sets of formulas, place of delivery [the center of the village plaza], and style of delivery" (Seeger 1981, p. 85). "The phonetic and rhythmic features of speech are altered, generally by exaggerating rhythms and stressing unstressed syllables. All plaza speech is also highly repetitive" (p. 186).

Amazonia (South America), where the Pa'ikwené people are considered "good speakers" based on their "grammatical, rhetorical, and performative competence and vocal quality," as well as "the ethical and emotional weight of their words" (Passes 2004, p. 8).

Northern Transvaal, where the Venda people's knowledge of words gives them a "magical power" that "is often sufficient to impress people, and it need have no practical application" (Blacking 1961, p. 4).

Certain neighborhoods of Philadelphia, where the verbal contests of African-Americans use language that is "different from the everyday language of the contestants" insofar as it includes "changes in pitch, stress, and sometimes syntax ... formulaic patterns ... rhyme within these patterns ... and a change of speech rhythms ..." (Abrahams 1970a, p. 50).

The primary effect of this sort of material, according to Bauman (1975), is that it "fixes the attention of the audience more strongly on the performer, binds the audience to the performer in a relationship of dependence that keeps them caught up in his display" (p. 295).[6] Reliance on speech formulas will prove significant later, for nonliteral material – which also exists in modern languages in the form of idioms and metaphors – does not approach adult proficiency until late juvenility or early adolescence.

A second interesting property of oral societies is the "extraordinarily agonistic" nature of verbal performance. "Orality," according to Ong (1982), "situates knowledge within a context of struggle. Proverbs and riddles are not

used simply to store knowledge, [...] but to engage others in verbal and intellectual combat: utterance of one proverb or riddle challenges hearers to top it with a more apposite or a contradictory one" (p. 44). Later we will revisit this "agonistic" property.

4.2. Speech, attention, and power

If there are links between speech and attention, as the anthropological literature suggests, then individuals may use speech as "an advertising device," and "will compete with each other in eloquence to draw attention to themselves and to obtain status from the audience" (Dessalles 1998, p. 142). In many oral societies, speech and status, or power, go hand in hand. These societies are located in places as dispersed as:

New Zealand, where, among the Maori, "oratory is the prime qualification for entry into the power game" (Salmond 1975, p. 50).

Central Peru, where the Amuesha people "describe a true leader as . . . 'the one who is powerful due to his or her words'" (Santos-Granero 1991, p. 301).

Ethiopia, where, among the Mursi, "the most frequently mentioned attribute of an influential man is his ability to speak well in public" (Turton 1975, p. 176).

Central Brazil, where "plaza speech, described as "a politically important act" (Seeger 1981, p. 185).

Northern Transvaal, where, among the Venda people, "The greatest honour seems to be accorded to those who can manipulate words and sentences" (Blacking 1961, p. 4).

The Trobriand Islands, where the tribal leaders, or "Big men," have also been called "rhetoric thumpers" (Reay 1959).

South Africa, where the Tshidi people consider oratorical ability as "a significant component of political success and the means by which politicians demonstrate their acumen" (Comaroff 1975, p. 143).

Inner city neighborhoods of Philadelphia, where the African-American "man of words, the good talker, has an important place in the social structure of the group, not only in adolescence but throughout most of his life" (Abrahams 1970a, p. 44).

South America, where "Speaking is more than a privilege, it is a duty of the chief. It is to him that the mastery of words falls." Throughout the continent, "It can be said not that the chief is a man who speaks, but that he who speaks is a chief" (Clastres 1987, p. 41).

This relationship between speech and power may be linked to a connection between speech and attention, one in which vocal loudness plays a role. "A great Maori orator," wrote Salmond (1975), "jumps to his feet with a loud call and immediately dominates the speaking-ground" (p. 56). Among the Pa'ikwené, "good speaking" involves speech that is "strong in tone and volume . . . speaking loud-and-strong embodies a person's health, strength, and, beyond that, humanness" (Passes 2004, p. 8).

The effect of vocal-verbal behavior on attention *and then* status is evident as early as childhood. In a classroom study of three- to six-year-old German kindergartners,

Hold-Cavell and Borsutzky (1986) found that glances were frequently preceded by speech, and that children who attracted attention to themselves by verbalizing early in the school year were far more likely than others to rank highly at the end of the year. In adulthood, individuals who speak in long sentences or hold the floor for long periods of time tend to receive more gazes than others, and to be perceived as unusually powerful (Abramovitch 1976; Bales et al. 1951; Dabbs & Ruback 1984; Exline et al. 1975; Kalma 1991; Kendon & Cook 1969; Mulac 1989).

4.3. Verbal performance

Verbal performances and competitions have been documented in oral cultures located, diversely, in Africa, Asia, South America, Mexico, and several different places in North America (Ayoub & Barnett 1965; Dundes et al. 1970; Faris 1966; Gossen 1976b). These performances take a number of forms – in African-American groups, for example, rapping, shucking and jiving, copping a plea, gripping, and sounding (once known as "playing the dozens"). Each of these forms "must be judged as performance art," according to Abrahams (1970b), the evaluation based less on "the elements of the composition, such as complexity and originality," than on its "spontaneity, virtuosity, and command" (p. 147).[7] One also finds in anthropological literatures various references to the use of the *voice* without speech, whether in the songs of the Suya Indians of Brazil (Seeger 1981), the song challenges of the Fiji Indians (Brenneis & Padarath 1975), or the song duels or drum songs of Eskimos (Hoebel 1964; Mirsky 1937).

The social value of performative speech has been attested by African-American teenagers in Los Angeles. Folb (1980) interviewed a black teenage boy who said, "yo' rap is your thing. I's like your personality. Like you kin style on some dude by rappin' better'n he do. Show'im up. Outdo him conversation-wise." Folb commented, "Who you are (and very often how well you survive) depends . . . heavily on how well you talk." Words, she said, "are tools for power and gain . . . a good rap can save your life" (p. 90). That rapping is more of a performance than a verbal exchange is suggested by the fact that African-American men in Chicago ghettos rap *to* rather than *with* their peers (Kochman 1969). Kochman found that rapping and the other verbal registers enable the speaker "to manipulate and control people and situations to give himself a winning edge" (p. 34).

It is of more than passing interest that many of the actors in traditional verbal performances *have been male*. For example:

Among the Limba people of Sierra Leone, "it is a specifically masculine quality to be able to 'speak' well" (Finnegan 1967, p. 70).

In an Ethiopian village studied by Turton (1975), public speaking was "a prerogative of adult males" (p. 170).

The orators in South Bali, according to Hobart (1975), were "usually adult men aged from thirty to sixty with reputations for their knowledge of law and persuasiveness as speakers" (p. 77).

Among the Kuna Indians of San Blas, Panama, Sherzer (1990) reported, "it is most often men who are the public performers of verbal art" (p. 3).

Among the Suya Indians of Brazil, plaza speech "is spoken only by fully adult men, and one of its forms is spoken exclusively by chiefs and ritual specialists" (Seeger 1981, p. 85).

Among African-Americans in various parts of the United States, verbal competitions such as rapping and sounding have been carried out predominantly by males (Abrahams 1973; Ferris 1972; Wilson 1969). "Sounding," according to Abrahams (1970a), "occurs only in crowds of boys" (p. 47).

The male domination of verbal performance in traditional societies has received little recognition. "It is an interesting feature of the scholarship in the field," wrote Kuiper (1996), "that this fact is seldom commented on" (p. 87).

Verbal performances typically have an "audience," which makes it possible for status to change following a verbal victory or defeat (Abrahams 1962; 1989; Mitchell-Kernan 1973). These audiences include women as well as men. Finnegan (1967) found that among the Limba people, "a woman is expected to sit and listen, clap to show her respect and appreciation, or join in the chorus of the songs" (p. 70). In Cat Harbour, a small fishing community in Newfoundland, Faris (1966) found that stories were typically told in local shops by men. The women of Cat Harbour "listen intently and inconspicuously to the conversations of the men," wrote Faris (p. 239), using any new information later to engage other women in social interactions. Similar sexual divisions have been reported by other anthropologists (e.g., Salmond 1975).

Verbal contests tend to create distance between the participants. This frequently appeals to men, who typically place a high value on individualism and autonomy (Kashima et al. 1995). But women are more inclined toward collectivism and intimacy, and they tend to embrace more private forms of speech, ones that reduce the distance between interlocutors. We will see shortly (sect. 6) that there is a female advantage in privately oriented forms of social communication.

5. Natural selection in adolescence

We begin our treatment of natural selection in adolescence by discussing vocal and verbal behaviors that may have facilitated personal rank and social relationships – two critical features of primate societies (Dunbar 1996) – possibly by controlling attention (Locke 2000b).[8] Most primate species live in rigidly structured groups, with a dominance hierarchy. Males typically earn their rank. Noting that socially dominant primates are usually the focus of subordinates' attention, Chance claimed that it is the attention-holding ability of an animal that places it near the top of the hierarchy (Chance 1967; Chance & Jolly 1970). One anecdote suggests that sound-making attracts attention and *thereby* increases rank. Goodall (1998) described a subordinate chimpanzee that elevated his rank by frightening high-ranking animals, which he did by loudly banging kerosene cans together.

Primates may also elevate or announce their rank by vocalizing. In young vervet monkeys, high-ranking individuals have been found to vocalize more frequently than those holding middle and lower ranks (Locke & Hauser 1999). In mature baboons, acoustic properties of the male's voice (in "loud calls") have been found to predict age, competitive ability, and stamina, as well as rank (Fischer et al. 2004; Kitchen et al. 2003). These data suggest that primates who listen to adult male vocalizations are likely to pick up important cues to fitness – and they do listen; Cheney and Seyfarth (2005b) refer to primates as "skilled voyeurs." Primates also derive information about rank from calls made *to* males by *other* males. In studies of chimpanzees, alpha, high-ranking, and mid-ranking males were discriminable based on the frequency of occurrence of pant-grunts that were directed to them by lower-ranking males (Hayaki et al. 1989; Muller & Wrangham 2004).

If, in humans, status may be elevated by unusually elaborate and fluent uses of the voice, one would expect members of traditional societies to be keenly aware of individual differences in verbal proficiency. Gossen (1976b) found that among the Chamula people of Mexico, "the ability to wage a good verbal duel serves as one of the earliest signs of social maturity, intelligence and linguistic eloquence" (p. 141). Firth (1975) commented that in one traditional society, the Southwestern Pacific island of Tikopia, the people "are very conscious of great individual differences in speaking quality" (p. 41). Turton (1975) indicated that among the Mursi, "it seems to be popularly assumed that men either have or do not have the ability to speak well in public" (p. 177). Other work in Africa and elsewhere indicates that unusually good speakers and story-tellers are not only distinguished from others, but honored in various ways, and that poor speakers are subjected to ridicule (Abrahams 1989; Finnegan 1967; Shostak 1981).

In the United States, Labov (1972; 1973) found that African-Americans' use of the black vernacular, including non-standard or within-group forms, reaches a peak at ages 9 to 18 years – that is, in the juvenile and adolescent periods. Those with poor control of the vernacular are known as "lames." Lames lack the ability to participate in toasts, jokes, and verbal competitions. According to Labov, they are forced to operate from outside the group.[9]

5.1. Sexual selection

Although Pinker and Bloom (1990) offered a spirited argument for the natural selection of language, there is no reason to think that they meant to exclude sexual selection – a distinct but related process (Andersson 1994; Harvey & Arnold 1982; Mayr 1972), which was originally proposed for language by Darwin (1879/2004, pp. 109–110). Sexual selection takes two forms: an epigamic variant that involves traits appealing to the opposite sex, and an intrasexual form that involves traits advantageous in competitions among members of the same sex (M. E. Hamilton 1985). It is likely that both forms of sexual selection contributed to the elaboration of vocal and verbal behavior in the hominin line.

In early stages of linguistic evolution, it seems reasonable to suppose that sexually mature individuals benefited from some level of control over, and appreciation of, vocal behavior – later from more heavily articulated vocalization and verbalization – and that displays in this modality may have been performed more commonly by

males, since it is generally the case, across the animal kingdom, that females choose their mates on the basis of perceptible traits (Andersson 1994; Mealey 2000), presumably because they have more to lose if they make a bad choice (Trivers 1972). Accordingly, several scholars have sought support for a sexual selection hypothesis, but not without disappointment (e.g., Fitch 2004; Miller 2000), since the literature, read uncritically, has suggested that males perform *worse* than females on a variety of verbal tests, doing so across the lifespan, beginning in the early stages of language development (Fenson et al. 1994; Huttenlocher et al. 1991; Lutchmaya et al. 2002; Morisset et al. 1995). A more comprehensive review of developmental studies, however, indicates that boys soon catch up with girls (Baron-Cohen et al. 2004); and a closer inspection of the tests that are administered to older children and adults reveals carefully timed, verbally instructed measures of anagram ability, vocabulary, verbal memory, word association, and reading comprehension (Hines 1990; Kimura 2002; Maccoby & Jacklin 1974). The requisite skills are not displayed spontaneously and vibrantly in public before an audience of responsive peers, but quietly and obediently in the seclusion of test rooms, typically with a paper and pencil.

Even on these tests, the female advantage has been negligible; in their meta-analysis of 165 studies, Hyde and Linn (1988) call the gender difference "so small that it can effectively be considered to be zero" (p. 64). But where, one might ask, is the *male advantage that biologists have come to expect*? If it exists, male superiority would be found in vocal or verbal skills that are indicative of fitness. One would expect these to be observable in the *public use* of language by adolescents and young adults, and this is where they are witnessed. Consistent with a sexual selection hypothesis, anthropological research, as we have seen, reveals that performative applications of language in the form of speech and voice *consistently favor males*.

Did performative ability increase fitness? Miller (2000) has argued that sexual selection shaped human language directly (epigamically), through mate choice, and indirectly, through its effects on social status.

> Verbal courtship can be viewed narrowly as face-to-face flirtation, or broadly as anything we say in public that might increase our social status or personal attractiveness in the eyes of potential mates. Sexual flirtation during early courtship accounts for only a small percentage of language use, but it is the percentage with the most important evolutionary effects. This is the time when the most important reproductive decisions are made, when individuals are accepted or rejected as sexual partners on the basis of what they say. (Miller 2000, pp. 356–57)

Spoken language may also have played a role in sexual selection outside of courtship (intrasexually) by publicizing various male qualities. It was through public speaking and debate, according to Miller, that individuals were able to

> advertise their knowledge, clear thinking, social tact, good judgment, wit, experience, morality, imagination, and self-confidence. Under Pleistocene conditions, the sexual incentives for advertising such qualities would have persisted throughout adult life, in almost every social situation. Language put minds on public display, where sexual choice could see them clearly for the first time in evolutionary history. (Miller 2000, p. 357)

We agree that "language" helped to exhibit these qualities, but it could not have done so without the

assistance of a powerful accomplice, one whose action has escaped the notice of most theoreticians. It was speech. Although speech is often thought of as little more than a system for transmitting linguistically encoded information, it has qualities of its own, qualities that attract attention. Without attention there will be few listeners, and little exposure to the individual's language and mind. In the case of speech, unlike language, there are clear and consistent differences between males and females.

6. Sex effects in speech

We have witnessed a strong trend for verbal performances to be carried out by adolescents and adults who are male. At these same stages, however, females are more likely to engage in intimate talk, especially talk that includes self-disclosure (Derlega et al. 1993; Morton 1978), whether in traditional or modern societies.

As we saw earlier, the disposition to gossip – that is, to disclose information about others – also increases during adolescence, especially in females. Studies of women across two educational levels, several different cultures, and eight decades in the twentieth century agree that adult women are also more likely to gossip than men (Bischoping 1993; also see Locke 2005). The reason may have to do with the fact that gossip serves an affiliative function (Emler 2001), and that females tend to come together in times of stress (Taylor et al. 2000). In England, gossip networks have existed for at least five hundred years (Capp 2003). Membership in such networks is required for mutual aid, and the cost of membership is willingness to gossip. The rules are simple, according to a report on modern English networks: "no gossip, no companionship" (Bott 1971).[10]

Although sex differences in speaking are frequently attributed to culture (Mey 1985), the patterns identified here cut across cultures. The adolescent male attraction to verbal dueling may also be supported by physiological factors. Consider the widely attested association between testosterone and physical aggression (Dabbs 2000). Since adolescent males, who have relatively high levels of testosterone, need ways to avoid hurting themselves, it may be adaptive for them to use verbal sport and humor in place of combat (Marsh 1978). Consistent with this possibility is the fact that verbal duelists always "lose," and the contests are always stopped, if the participants become angry (Kochman 1969; 1983). Therefore, we speculate that testosterone promotes verbal dueling (see the reference to trial lawyers in sect. 8).[11]

When adolescent females wish to aggress against another member of their sex, they frequently use gossip to enlist the support of peers, greatly surpassing males in this practice. Like males' involvement in public performances, this difference between the sexes surfaces in late juvenility, spans a number of different cultures, and continues through adolescence into adulthood (Björkqvist et al. 1992a; 1992b; 1994; Burbank 1994; also see Crick & Bigbee 1998; Galen & Underwood 1997).

Private disclosures bear little resemblance to public taunts, but their functions are similar. In gossip as well as rap, verbal skill is used to raise one's own status, and to lower that of competitors, while also broadcasting and enforcing community standards (Abrahams 1973). These

sex differences betray dissociations between language and speech, for, approaching maturity, males and females have roughly the same knowledge of the structure and "contents" of language but deploy that knowledge, through speech, in different ways.[12] In males, moreover, speech appears to play a role in courtship.

7. Courtship

If women deliver their first infant at age 19 but usually become fertile one to two years earlier, as cross-cultural evidence indicates (Bogin 2001), it is necessary to ask what the vocal-verbal behavior of courting males is like during the intervening or preceding period. For it is at this time that females are likely to make a choice.

That the voice may play a role in courtship is suggested by some research in nonhuman primates. Among baboons, for example, there is evidence that males who issue quiet grunts when approaching females are more likely to achieve affiliation than those who approach without vocalizing (Palombit et al. 1999). In humans, Anolli and Ciceri (2002) found that successful (Italian) seducers began addressing their female targets with unusual levels of loudness, "orotundity" having been found in other work on male vocalization to evoke perceptions termed "energetic," "healthy," and "interesting," along with several other attractive qualities (Addington 1968). Then, as the conversation proceeded, the men lowered their vocal intensity and frequency, later returning to initial levels of loudness, and a faster rate of articulation – a variable associated with perceived competence and influence (Ray 1986; Scherer 1979; Smith et al. 1975) – by the end of the interaction.[13]

There is also some anthropological evidence on the role of vocal and verbal behavior in courtship, much of it from the African-American community. The male teenager who extolled rap's benefits (see sect. 4.3) went on to say, "you can rap to a young lady, you tryin' to impress her, catch her action – you know – get wid her sex-wise" (Folb 1980, p. 91). Hannerz (1969), who studied rap in Washington, D.C., wrote that "A good line can attract the attention of a woman who passes by in the street and open the way to a new conquest, while at the same time it may impress other men with one's way with women" (p. 84; also see Kochman 1969). In Philadelphia, according to Abrahams (1970a), words "function powerfully in the sexual battle which is typical of adolescent life" (p. 44).

For speech to figure into courtship, of course, females must also have a corresponding perceptual preference for the speech of courting males (Endler & Basolo 1998; Fisher 1930; Harvey & Arnold 1982). A teenage girl from the same neighborhood as the rapper quoted above said, "I likes to hear a brother who knows how to talk. Don' hafta blow heavy, can sweet talk you too. Don' hafta make whole buncha sense, long sounds pretty" (Folb 1980, p. 101).

If females are to evaluate the verbal or vocal qualities of courting males, as Miller (2000) suggested, they need to hear them speak. Males seem only too happy to provide opportunities. When men and women speak, men interrupt more often and hold the floor longer than women, even though females typically speak more often than men when engaged in same-sex conversations (Frances 1979; James & Drakich 1993; Simkins-Bullock & Wildman 1991).

But do women just wait for vocal or verbal cues to fitness, or do they do something more actively? If women choose mates based, in part, on the way they talk, it would not be surprising if they attempted to elicit speech from male suitors (cf. Fisher 1930, p. 152). Ethological research suggests that several behaviors, including female head nodding, smiling, and reclining, may function as displays whose effect is to encourage males to speak (Grammer et al. 2000; Kennedy & Camden 1983), thus to reveal information about their vocal and linguistic skills, along with social, cognitive, and other abilities.

Clearly, a great deal more needs to be learned about the role of verbal behavior in courtship. In the meantime, clues to the role of verbal behavior in courtship emerge from the case of vocal or verbal *deficits*. Studies have consistently observed negative social reactions to speech and voice disorders, regardless of whether the listeners were peers or adults, the errors were real or faked, or very mild (Crowe Hall 1991; DeThorne & Watkins 2001; Freeby & Madison 1989; Lass et al. 1991a; 1991b; Mowrer et al. 1978; Ruscello et al. 1988; Silverman 1976; Silverman & Paulus 1989). If this finding is taken with the fact that many children with language disorders present, in adolescence, with articulatory as well as pragmatic and performative limitations (see sects. 10 and 11), there would seem to be plenty of raw material for a courtship problem. For, adolescents who cannot produce verbally complex material in a timely fashion, and with appropriate prosody, may be unable to impress, amuse, or dominate in the quest for status or reproductive advantage.

Such would seem to be the case with stutterers, who usually have normal knowledge of language but speak disfluently. Interviews indicate that stutterers, who are predominantly male, fear and avoid courtship situations (Sampson et al. 2003) and have difficulty forming and maintaining intimate relationships (Linn & Caruso 1998). Women, for their part, discover that if they marry a stutterer their social life will be greatly limited (Boberg & Boberg 1990). In a survey of attitudes toward individuals with handicaps, only 7% of respondents said they would be willing to marry a severe stutterer (Shears & Jensema 1969).

8. Reproductive advantage

If speech and language problems can compromise courtship, do they reduce sexual opportunities? Recently, a longitudinal investigation was reported in which individuals with language disorders in childhood were seen again in their mid-twenties. It was found that well over half of the subjects had problems in establishing spontaneous, reciprocal relationships. More than one-third of the subjects had no particular friends and two-thirds had never had sexual intercourse – a marked deficiency compared to statistics on comparably aged members of the population at large. Two-thirds also continued to live at home with their parents (Howlin et al. 2000).

Were evolutionary ancestors with conspicuous vocal and verbal talent reproductively advantaged? It may be worth revisiting two relationships of the sort that undergird competitive and performative applications of speech.

In the first, men who speak in a way that secures attention are also likely to be high in dominance, as we saw in section 4.2. The second relationship is between the attractive or forceful use of speech and testosterone. Testosterone is correlated with, and may increase, the boldness with which individuals enter a room, and the tendency to work in public arenas, such as the theatrical stage or courtroom. Actors generally display high levels of testosterone (Dabbs et al. 1990; 2001), and trial lawyers have 30% more testosterone than other types of lawyers (Dabbs et al. 1998).

The more specific link to speech is that trial lawyers, as Philbrick (1949) wrote, "exercise their power in court by manipulating the thoughts and opinions of others" (p. v). They are, according to Dabbs and his colleagues, "good at presenting concrete details in a straight-talking and compelling way that dramatically captures the attention of a jury in trial court" (Dabbs et al. 1998, p. 91). There are obvious similarities between trial lawyers and the "Big men" of traditional societies. In 1984, there were 3,827 members of the American Association of Trial Lawyers. Men comprised 99.9% of the membership (Walter 1988), which is nearly 20% more males than worked as primary care physicians in the following year (Franks & Bertakis 2003).[14] This research suggests that women who are attracted to men with a commanding way of speaking may get a mate for themselves, and father for their children, who has high levels of testosterone and status, and unusual access to valued resources.

There are other, more specific connections between aspects of the male voice and several indices of fitness. These include links between depth of vocal frequency and both testosterone (Dabbs & Mallinger 1999; Pedersen et al. 1986) and testis volume (Harries et al. 1997), where testosterone levels independently predict coital frequency (Halpern et al. 1993; 1998; Udry 1988), social expressivity (Dabbs & Ruback 1988), and social dominance (Schaal et al. 1996). Reduced formant dispersion is also correlated with skull and body size in primates, the magnitude being greater in macaques (Fitch 1997) than in humans (González 2004). It is thus unsurprising that our adaptive ancestors availed themselves of this particular medium, which could broadcast fitness information while simultaneously transmitting the units of language, to say nothing of the social, indexical, and emotional information that would have been embedded therein (Cheney & Seyfarth 2005b). Recently, it was reported that in *both* men and women, opposite-sex ratings of vocal attractiveness predicted age of first sexual intercourse, number of sexual partners, number of competing sexual relationships, and number of partners that were involved in other sexual relationships (Hughes et al. 2004). The authors concluded that "voice may have been an important parameter of mate choice" in human evolution (Hughes et al. 2004, p. 303).

In the previous sections, we identified several different forms of selection that may have applied across the whole of development, from infancy to sexual maturity, including the uniquely human stages of childhood and adolescence. Our goal in doing so was to offer an evolutionary account of our species' capacity to improvise, learn, and control complex vocalizations. It is appropriate now that we examine the evolution of the new stages themselves.

9. Evolution of the new stages

We have proposed that when childhood expanded, new opportunities arose, especially within families, for the negotiation of more structured and complex forms of vocalization; and that with a premium in this context on honest signaling, benefits would have accrued to families that were able to deploy these more complex forms meaningfully, and thus to warn, advise, and inform each other. We have further proposed that this material, arising from infancy and expanding in childhood, persisted into juvenility when it contributed to teasing, joking, and gossip in both sexes, behaviors that would have facilitated achievement of group-oriented goals; as well as into adolescence, when performative skills contributed to intrasexual competition and epigamic selection, reinforcing all previous developments on which those skills depend.

We have proposed relationships between language, a trait unique to humans, and two ontogenetic stages that are also unique to humans. To understand the evolution of language, therefore, we believe it may be necessary to ask how and when these stages came to exist, and this we attempt to do here. In succeeding sections, we look at evidence for developmental continuity between the levels of language, and interconnections between language and the rules and skills that influence its use, offering speculation on how these conjunctions may have come about.

It is obviously difficult to reconstruct the evolution of life history stages from fossil remains alone. Fortunately, it is possible to draw relevant inferences from syntheses of comparative anatomical, physiological, and ethological data, and from archaeological findings. This work is facilitated by parametric data on the brain and body growth of nonhuman primates, as well as of humans and their ancestors (cf. Harvey & Clutton-Brock 1985; Harvey et al. 1987; Martin 1983).

9.1. Evolution of childhood

With an ontogenetic approach to linguistic evolution, structures other than the skull become important. For example, teeth and jaws are useful because of the strong correlation between tooth formation and eruption and other life history events (Smith & Tompkins 1995). Figure 3 is an attempt to represent the evolution of human development, though at present the only reliable data are associated with *Pan* and *H. sapiens*. Known or estimated adult brain sizes are given at the top of each bar. Mean age at eruption of the first permanent molar (M1) is graphed across the histograms, and identified numerically at the base (Smith & Tompkins 1995).

Appearing about 3.9 million years ago, *Australopithecus afarensis* shares many anatomical features with non-hominin pongid (ape) species, including an adult brain size of about 400 cc and a pattern of dental development indistinguishable from extant chimpanzees (Conroy & Vannier 1991; Dean et al. 2001; Simons 1989; Smith 1991). Therefore, the chimpanzee and *A. afarensis* are depicted as sharing the typical tripartite stages of postnatal growth of social mammals: infancy, juvenility, and adulthood (Pereira & Fairbanks 1993). Following the definitions offered earlier, infancy represents the period of feeding by lactation, juvenility represents a period of feeding independence prior to sexual maturation, and
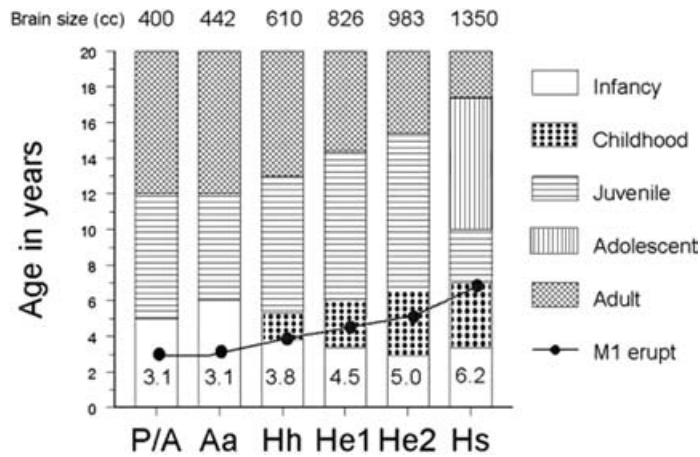
Figure 3. The evolution of hominin life history during the first 20 years of life (original figure from Bogin 1999b; see the text for additional sources of data). P/A = Pan and *Australopithecus afarensis;* Aa = *Australopithecus africanus;* Hh = *Homo habilis;* He1 = early *Homo erectus;* He2 = late *Homo erectus;* Hs = *Homo sapiens.* Mean brain sizes are given at the top of each histogram (calculated from several sources; e.g., Relethford 2006). Mean age at eruption of the first permanent molar (M1) is graphed across the histograms, and identified numerically at the base (Smith & Tompkins 1995).

adulthood begins following puberty and sexual maturation. The duration of each stage and the age at which each stage ends are based on empirical data for chimpanzees. A probable descendent of *A. afarensis* is the fossil species *A. africanus*, dating from about three million years ago. Achievement of the larger adult brain size of *A. africanus* (average of 442 cc) may have required an addition to the length of the fetal and/or infancy periods. Figure 3 depicts a one-year extension of infancy.

As the figure indicates, the first permanent molar (M1) of the chimpanzee erupts at age 3.1 years, even though infancy continues for nearly two more years. Before age 5 years, young chimpanzees are dependent on the mother and will not survive if she dies or becomes unable to provide care and food (Goodall 1983; Nishida et al. 1990). After the eruption of M1, they may be able to manage an adult diet but still must learn how to find and process foods, and it takes time to learn how to open shelled fruits and extract insects from nests. This may be why chimpanzees extend infancy beyond the eruption of M1. It is likely that early hominins, such as *A. afarensis* and *A. africanus*, followed a pattern of growth and development very similar to chimpanzees and also extended infancy for at least one year beyond the age of M1 eruption. Analyses of postcranial anatomy and archaeological records suggest a similarity between the behavioral capacities of australopithecine-grade hominins and extant chimpanzees (Plummer 2004; Potts 1988).

Tardieu (1998) has shown that the pattern of femur growth in *H. habilis* departed from that of the australopithecines but resembled the pattern seen in later hominins. The distinctive femur shape of the more recent hominins, she suggests, is due to a prolongation of childhood stage of growth. Thus, we speculate that the process of linguistic evolution took a step forward about two million years ago with the elongation of childhood. Others have made a similar suggestion, although they were acting on the assumption that the critical variable was enlargement of the adult brain (e.g., Mithen 1996).

A childhood stage for the earliest members of the genus *Homo* is also supported by a comparison of human and ape

reproductive strategies. There are limits to the delay between birth and sexual maturity, and between successful births, that any species can tolerate. Among wild chimpanzees, for example, females reach menarche at 11 to 12 years of age and have their first births at an average age of 14. The average period between successful births in the wild is 5.6 years, as infant chimpanzees are dependent on their mothers for about five years. Actuarial data collected on wild-living animals indicate that 35–38% of all live-born chimpanzees survive to their mid-20s. The chimpanzee thus operates at reproductive threshold.[15]

The great apes and fossil hominins, such as *Australopithecus*, may have created this demographic dilemma by forestalling weaning. We suggest that early *Homo* overcame this reproductive limit by reducing the length of infancy and inserting childhood between infancy and juvenility. Free from the demands of nursing and the physiological brake that frequent nursing places upon ovulation, mothers could reproduce soon after their progeny reached childhood, and indeed this is what happens in modern humans. Among the Ju/'hoasi, a traditional hunting and gathering society of southern Africa, a woman's age at first birth averages 19 years. Births continue, on average, every 3.6 years, resulting in a fertility rate of 4.7 children per woman (Howell 1979; Short 1976). Among the Hadza, the inter-birth interval is even shorter, as women stop nursing about one year earlier, and average 6.15 births per woman (Blurton Jones et al. 1992).

A brief childhood stage for *H. habilis* is therefore indicated in Figure 3. This stage begins after the eruption of M1 and lasts for about one year. Even one year of childhood would have provided reproductive advantages to the mother. A behavioral consequence of reproductive selection for childhood may have accrued to the child, that is, learning how to find and process adult types of foods while still protected by older individuals. During this learning phase, *H. habilis* children would need to be supplied with special weaning foods. There is archaeological evidence for just such a scenario. *H. habilis* seems to have intensified its dependence on stone tools. For, there are more stone tools, more carefully manufactured

tools, and a greater diversity of stone tool types associated with *H. habilis* than with any earlier hominins (Klein 1989). There is considerable evidence that some of these tools were used to scavenge animal carcasses, especially to break open long bones and extract bone marrow (Plummer 2004; Potts 1988). This behavior may be interpreted as a strategy to feed children. Such scavenging may have been needed to provide the essential amino acids, some of the minerals, and, especially, the fat (dense source of energy) that children require for growth of the brain and body (Leonard & Robertson 1992; Leonard et al. 2003).

A further increase in brain size occurred during the time of *H. erectus*, which began about 1.9 million years ago. The earliest adult specimens have mean brain sizes of 826 cc, but many individual adults had brain sizes between 840 and 1059 cc (Coqueugnoit et al. 2004). Insertion or expansion of childhood would have provided the time needed for a rapid, human-like, pattern of postnatal brain growth.[16]

It should be noted in Figure 3 that the model of human evolution proposed here predicts that from *Australopithecus* to *H. erectus* infancy shrinks as childhood expands. In the time of early *H. erectus* the transition from infancy to childhood took place before M1 eruption. If the new childhood was stolen from infancy, or reduced its length, then *H. erectus* would have enjoyed a greater reproductive advantage than any previous hominin. This seems to have been the case, since *H. erectus* populations increased in size and began to spread throughout Africa and other regions of the Old World (Antón 2003).

Figure 3 also shows later *H. erectus*, with an average adult brain size of 983 cc and a further expansion of the childhood stage. In addition to larger brains (some measuring 1100 cc), the archaeological record for later *H. erectus* shows increased complexity of technology (tools, fire, and shelter) and social organization (Antón 2003; Klein 1989). These techno-social advances, and a parallel increase in learning, may well reflect extended childhood (Bogin & Smith 1996). The evolutionary transition to archaic, and finally, modern *H. sapiens* expands the childhood stage to its current length.

As for how childhood abetted language, we speculate that there was a process of coevolution, according to which an initially short childhood period facilitated the emergence of a small amount of vocal-verbal behavior. Even if the original cause of childhood was nonlinguistic, as we propose, any new time between infancy and juvenility would have provided the young with additional opportunities for vocal-verbal interaction during a time of increased independence, and would have given adults new reasons to honestly inform any dependents in their care (Fitch 2004). The disposition to do so is suggested by the fact that primate mothers appear to prevent their young from eating alien substances, and warn off young animals that approach toxic fruits (Caro & Hauser 1992). Young hominins also would have needed to know about plants as well as game, tools, shelter, and predators. Even a small amount of vocal-verbal behavior would have facilitated warnings and instruction. Childhood lengthened, enabling more language which, in turn, extended childhood, until the new ontogenetic stage reached its present length. Childhood would thus have offered up new behaviors, ones that would also prove beneficial in the run up to sexual maturity.

9.2. Evolution of adolescence

This brings us to the evolution of the other uniquely human stage of development. Nonhuman primates lack childhood, but they also lack a post-juvenile period of dramatic growth of the sort that defines human adolescence. Unfortunately, very little is known about the evolution of adolescence. It is possible, however, to suggest some benefits of this late stage of development in terms of reproductive biology, social ecology, and reproductive success. Our claim, detailed elsewhere (Bogin 1999a; 1999b; 2003), is that adolescence became part of human life history because it conferred significant reproductive advantages on our evolutionary ancestors, in part by allowing adolescents to learn and practice adult economic, social, and sexual behaviors before reproducing. As indicated in section 2.7, the basic argument for the evolution and benefits of human adolescence is that girls best learn their adult social roles while they are infertile but perceived by adults to be mature, whereas boys best learn their adult social roles while they are sexually mature but not yet perceived to be such by adults. The proposed patterns correspond exactly to the course of growth and development taken by boys and girls. On average, healthy girls begin to develop adult-like fat patterns (e.g., breast, hips) at about age 10 to 11 years, which is two years before the peak of the adolescent spurt. Menarche occurs a year after the spurt and is followed by about three years of adolescent sterility, ovulation being rare or absent. The female pelvis also grows slowly during adolescence and does not reach full adult size, a necessity for successful birth, until about age 18 years. Externally, however, these infertile girls look like women and this perception prompts adults to include the girls in a suite of adult social, economic, sexual, and political activities. The girls learn from involvement in these activities and arrive at young adulthood, at about age 19 years, with considerable experience that translates into reproductive success. This may be why humans have the highest rate of birth survival of any species: 50 to 60% in traditional foraging societies compared with 35% in chimpanzees (Lancaster & Lancaster 1983).[17]

In the reverse pattern that characterizes male adolescence, fertile sperm are produced at about 13.5 years of age, and yet external features of male adults (body size, muscularity, body hair, and other sexual features) do not develop until about age 18 years. The hormones that cause spermatogenesis may prime boys to be emotionally and cognitively attentive to the behavior of adult men and women. In most human societies, boys pass through several rites of passage that help them learn and practice important adult male economic, social, political, and reproductive activities. By age 20 or so, these boys graduate to manhood, and are expected to compete successfully with other men and to assume the responsibilities associated with marriage and paternity.

As for when adolescence evolved, it is possible that this stage first appeared in *H. erectus*, a hominin that originally evolved in Africa more than one million years ago (Antón & Leigh 2003). The evidence for this is patterns of tooth formation that are not directly linked to the presence of an adolescent growth spurt, but are nonetheless suggestive. Other research indicates that *H. erectus*, later hominins

such as *H. antesesor* (800,000 BP) and *H. heidelbergensis* (400 – 500,000 BP), and even the Neandertals of 40,000 BP grew up too quickly to have adolescence (Ramirez-Rossi & Bermudez de Castro 2004). Whenever adolescence evolved, and it will take a good deal more evidence to be sure, an ontogenetic approach would ascribe modern human language to some more recent period.

10. Pragmatics and performance

We have sampled evidence indicating that knowledge of the basic structure of language is usually present by the end of childhood. We have also seen that the skill needed to use language adaptively in social and sexual situations is not conspicuous until adolescence. Thus, we believe it is possible that important aspects of language not only *do not* develop until sexual maturity, but *cannot* do so because biological functions associated with that stage played an evolutionary role in their construction, much as they now play a role in their development.

Many of the changes occurring in adolescence (as we saw in sect. 2.8) fall into the categories of pragmatics and performance. Pragmatics refers to the inference of speakers' intentions from the literal meaning of their utterances (Austin 1975; Searle 1972). Inasmuch as the ability to infer intentions presupposes real-world knowledge, pragmatics is the area of linguistic communication that must be, and is, the last to develop.

It is also the area of human language that has least appealed to Linguistics, which has been more concerned with grammar (Haberland & Mey 1977). With grammar as the central focus, there may have been less reason to analyze the things that people actually say, for, as Newmeyer (2004) wrote, utterance material "is all but useless for providing insights into the grammar of any individual speaker" (p. 698).

Clinicians have reinforced this bias by restricting themselves to standardized tests, which typically exclude pragmatics. Ten years ago, several clinical investigators wrote that pragmatics "defies assessment under standardized conditions" (Tomblin et al. 1996, p. 1286). This combination of biases and constraints facilitated the transformation of "language" from a vibrant form of social action into a stable mental code that fit the educational bias of literate cultures, with additional advantages to scholars, who wished to study its organization, and clinicians, who needed to measure it.

Still, infants who are slow to develop the linguistic code frequently experience pragmatic difficulties in childhood (Ninio et al. 1994; Prutting & Kirchner 1987). In some cases, pragmatic problems are correlated with lingering linguistic deficiencies (Leonard 1986; Tomblin et al. 1996); in other cases, pragmatic deficits seem to emerge after earlier language deficiencies have resolved (Girolametto et al. 2001), suggesting some degree of independence between grammar and pragmatics (Culatta et al. 1983; Schelletter & Leinonen 2003). These differences are partially explained by the fact that pragmatics encompasses a number of diverse behaviors, some more closely dependent on linguistic knowledge than others (McTear & Conti-Ramsden 1992).

In juvenility or adolescence, individuals with a history of developmental language delay may appear to normalize,

based on standardized tests, but many are ineffective when it comes to the verbally performative behaviors that blossom during those stages. Bergman (1987) has itemized these deficits in adolescence:

> When communication deficits persist into adolescence, disordered language may produce increasingly noxious social consequences. Inability to keep abreast of verbal exchange usually sets the language disordered adolescent apart socially, with resultant feelings of loneliness and of being misunderstood. These youths are unable to acquire in-group slang expressions; are likely to misunderstand metaphors, jokes, puns, and sarcastic remarks; may be unable to follow verbal dialogues; and are usually poor in rapid humorous verbal exchanges. Speech may be rambling, imprecise, fragmented, and/or tangential. Typically aware of having communication problems, language disordered adolescents may be reluctant to contribute to conversations, be socially reticent, and avoid responding through silence, off-handed gestures, or saying "don't know." (p. 162)

Several of the performative deficits claimed by Bergman have since been documented by researchers (Bishop 1989; Fujiki & Brinton 1991; Ninio et al. 1994; Nippold 1998; Paul 1995). Still, they may escape the notice of teachers, clinicians, and other responsible adults because, as we saw earlier, verbal performances are frequently held when these people are not around.

Individuals who are able to carry out linguistic operations that occur early in infancy, such as lexical storage and object naming, do not necessarily have what it takes to satisfy the performative criteria associated with subsequent stages – at least not on *formal grounds*. But in evolution, individuals who achieved the ability to perform attractively and competitively by adolescence would surely have benefited from doing so, indirectly reinforcing previous accomplishment in earlier stages. As Hogan (1988) pointed out, selection for behaviors in sexual maturity automatically credits relevant developments in earlier stages as well.

11. Language and speech

Insofar as selection for speech reinforced previous linguistic developments, it may also have strengthened connections between articulation and grammar. For one thing, there is evidence suggesting that "language" problems in infancy may persist as speech, or even purely articulatory, problems in adolescence (Beitchman et al. 1994). In a longitudinal investigation conducted in England, adolescents who had been linguistically disordered in childhood scored significantly lower than controls on a variety of language measures, and were poor at repeating nonwords, sentences, and articulatorily complex material (Stothard et al. 1998). In a similar study carried out in Sweden, language-disordered six-year-olds were still behind at the age of 18, especially when it came to repeating long and complicated words, which they did slowly and erroneously (Nauclér & Magnusson 2002). In the United States, a group of elementary schoolchildren with carefully evaluated articulatory disorders was seen 28 years later, at which time there was evidence of continuing problems with articulation (distortions of /s/, /z/, and /r/ were plentiful), as well as reduced performance on tests of language comprehension and intelligence. Significantly, these adults also evinced abnormalities in the area of prosody,

their speech striking listeners as slow and monotonous (Felsenfeld et al. 1992).

Findings in behavioral and molecular genetics also support links between language and speech, while hinting at previously unexamined contributions of speech to other linguistic domains. In studies of monozygotic and dizygotic twins, for example, the highest rates of concordance have come from twins in whom the disorder was primarily expressive; some had disorders that were purely of the articulatory type (Bishop et al. 1995; Lewis 1990; Lewis & Thompson 1992). In typically developing 7- to 13-year-old children, Bishop (2001) also found that MZ twins were more concordant than DZ twins on rate of speeded articulation of polysyllabic words. These findings seem to fit with the possibility that selection acted on performance, thus on factors relating to precision, speed, complexity, and fluency of articulation. In doing so, it may have reinforced those behaviors, indirectly enhancing related acquisitions and developments that had occurred earlier in development.

The role played by production factors has also been highlighted by studies of a particular family in England. In the early 1990s, researchers discovered the KE family, which had serious communication disorders at each of its three living generations. Although these problems included a severe oral and verbal dyspraxia, accompanied by deficits at other levels of language (Fletcher 1990; Hurst et al. 1990; Vargha-Khadem 1990), a grammatically focused investigation of the family found precisely what it was looking for: grammatical problems (Gopnik 1990; Gopnik & Crago 1991). Nearly a decade later, geneticists found a defective gene in the family, *FOXP2*, which is situated on the long arm of chromosome 7 (Lai et al. 2000; 2001). But, in parallel with the genetics work, other teams of clinical investigators confirmed the dyspraxic disorder, which involved both speech and nonspeech movements of the articulators (Vargha-Khadem et al. 1995; 1998). In functional imaging studies, affected family members revealed significant underactivation of Broca's area in both hemispheres, consistent with a deficit of speech production (Liégeous et al. 2003).

What is relevant here is that the primary problem of the KE family was reconceptualized as an oral-motor difficulty that was *accompanied* by grammatical difficulties. Several theorists toyed with the idea that the KE family's oral-motor difficulties *caused* their grammatical and comprehension difficulties. "One possibility," wrote Watkins et al. (2002), "is that the deviant articulation results in poor phonology, rendering morphological production difficult" (p. 461). "It might be the case," Marcus and Fisher (2003) speculated, "that a deficit restricted to the motor system is fully responsible for the wide-ranging profile of impairment" (p. 261). There could have been a "flow-on effect from articulation to syntax to comprehension," wrote Corballis (2004, p. 548).

How did our ancestors get from articulated phonation to syntax? According to Bickerton (2000):

> The ability to make and distinguish a greater range of speech sounds would make possible a wider variety of sound combinations, which, given a larger and more efficient memory for words, would give rise to a steadily increasing vocabulary. Undoubtedly, these factors and processes would have combined to yield a much richer means of communication among hominins. (p. 157)

This would not automatically produce syntax, as Bickerton noted, but it may have led to other changes that favored phonology, beginning with the ritualization of vocal patterns (Locke 2004a; in press b; Oller 2004; Richman 2000) and ultimately their segmentation into discrete linguistic units (Studdert-Kennedy 1998; 2005; Studdert-Kennedy & Goldstein 2003).

12. What belongs in the language faculty?

Evidence examined earlier revealed continuity between the lexical delays of infancy – even where they appeared to resolve – and the pragmatic and performative problems of adolescence. If we attempt to account for this continuity, two possibilities emerge immediately. According to the first, pragmatics and performance are social applications of linguistic knowledge, and thus depend on that knowledge. This could explain the developmental association between scores on standard tests of language and experimental measures of pragmatics.

A more satisfying possibility is that delayed lexical development points to a weakened faculty of language, since even the earliest use of words requires the action of mechanisms that belong to this faculty. This is consistent with a paradox about language development. Infants rarely vocalize at normal levels of frequency and complexity during the babbling stage; they imitate aspects of their mother's speech and produce isolated words – behaviors that ostensibly require no grammatical ability at all – and *then* stumble as they enter the domains of morphology and syntax (Locke 1998a). Whatever problems arise at the grammatical level of language are typically forecast by deficiencies in early lexical development (Bates & Goodman 1997), and possibly even the precursors to word learning (Oller et al. 1999). These facts suggest that the earlier and later behaviors, as different as they are, belong to a system of linked neural resources, and that weakness in the expression of an early component indexes weakness in others, including the performative areas that happen to develop late. According to this explanation, early lexical delay predicts problems of usage and interpretation in adolescence even if the delay, by tests of structure and content, seems to resolve long before that stage. The second account is therefore able to handle problems of interpretation as well as usage.

At first glance, it may seem adventurous to assign lexical development to the same faculty as other components of language. For lexical development rests on a number of perceptual, attentional, and other cognitive systems that are not, in and of themselves, linguistic. But a wider perspective on the faculty of language has recently become available. In an attempted reconciliation of evolutionary biology and linguistics, Hauser, Chomsky, and Fitch have proposed a broad linguistic faculty that extends beyond a narrow computational core to include the "biological capacity of humans that allows us (and not, for example, chimpanzees) to readily master any human language without explicit instruction" (Hauser et al. 2002, p. 1571; also see Fitch et al. 2005).

The broad model offered by Hauser and colleagues offers hope to those who might like to see linguistic knowledge and structure accommodated under the same theoretical roof as pragmatics and verbal performance.

If developmental evidence suggests that some pragmatic abilities stand in closer relationship to lexical and grammatical knowledge than others, as it does (McTear & Conti-Ramsden 1992), then the faculty of language should include these related, and possibly interdependent, specializations. Certainly the evolutionary account offered here suggests that it should. For, if pragmatic and performative abilities were selected, it is hard to see how they could have escaped some degree of integration with earlier linguistic developments on which they would have depended.

What belongs in the language faculty is a matter that should ultimately be decided empirically, based on evidence of various sorts, including lesion, imaging, and processing studies, even if the interpretation of some findings proves problematic (Thomas & Karmiloff-Smith 2002). Here, we rely on normal and atypical patterns of development, and an additional line of argument and evidence – evolution itself. For the traits that are present in modern humans are traits that evolved. If language evolved, then the components of language were selected. If selection applied to behaviors affecting care in infancy and childhood, and competition in juvenility and adolescence, then the behaviors that were selected during these stages would now be included in the trait. The net result would be a series of functional interrelationships, since the behaviors that appeared early enabled later developments, which, in turn, reinforced their own precursors. Thus, the human faculty of language would extend beyond the ability to learn a linguistic code and to use it simply to inform; it would extend to the ability to speak skillfully so as to compete and cooperate in social and sexual maturity.

13. Vocal ontogeny, linguistic phylogeny

We have discussed selection as it may have applied in adolescence and adulthood, but have additionally proposed a role for infants and children – and their parents – and a role for juveniles. In doing so, we have introduced proto-linguistic content to two pre-existing conceptions of evolution, one relating to the role of development, the other to the role of behavior. The suggestion that development plays a role in evolution was raised by Mivart (1871) and developed by Garstang (1922), who argued that ontogeny was no "animated cinema show of ancestral portraits" (p. 100), as Haeckel had claimed in his late nineteenth century recapitulatory doctrine, but actually plays a reverse role by "creating" evolution.[18] Gould (1977) and Gottlieb (1992) have discussed developmental contributions to evolution in some detail, the latter also claiming, after Bateson (1988), that individuals' behaviors play a central role in evolution, especially when they move about and thus alter their environment.[19]

Gottlieb (1992) offered a three-stage model of the process by which new behavioral developments produce evolutionary change. In the first stage, a modification of developmental conditions forces a previously unexpressed behavior to the surface, followed in the second stage by morphological and physiological alterations, and, in the final stage, by a change in the genetic composition of the population. If we apply Gottlieb's model here, bipedalism is seen as a key event in Stage I, for this was a new behavior

that, in time, produced pelvic narrowing. Remodeling of the birth canal caused a shift of skull and brain development into the postnatal period, increasing the degree and duration of infant helplessness. When weaning was brought forward and sibling competition increased, infants – at an age when their brain was developing rapidly – experienced additional pressures to do things that would preserve the flow of care. In Stage II, hominin infants exploited pre-existing but quiescent means of signaling their needs to, and appraising the reactions of, heavily burdened caregivers, some doing so more effectively than others. In the final stage of evolutionary change, Stage III, the capacity to produce more complex vocalizations made its way through the population, acquiring a genetic foundation.

In the example above, evolutionary change applied to the earliest stage of life history, but infants who achieved effective care and engagement signals would have carried some form of the relevant control behaviors into childhood, juvenility, and adolescence, where they enabled additional capabilities – skills that facilitated, among other things, the quest for status, sex, and additional resources. The new skills were reinforced by reproductive success, automatically strengthening, in a second hit, the precursors that had persisted in some form from earlier stages. In doing so, components and specific applications of the human voice became cues to fitness and a genetic specialization emerged, one that would direct the development, learning, and strategic use of complex vocalizations in future generations.

The developmental conditions that favored evolution of vocal-motor control in infancy – helplessness and dependency – would also have promoted perceptual sensitivity and nurturance in caregivers. For, with more competing offspring to care for, mothers were forced to discriminate honest cries from bogus distress signals (now more plentiful and clever than ever) and to infer signs of physical and social maturation from other vocal cues. They were also forced to provide more intensive care to individual infants. There would have been a range of variation in the disposition or ability to carry out these functions, too, with selection acting on the genetic correlates of perception and care.

14. Concluding remarks

The life history approach taken here has produced several observations, speculations, and conclusions. We began by reiterating an earlier speculation that a brief childhood was inserted into the hominin line around the time of *H. habilis*, offering reproductive benefits to mothers. We then speculated that childhood would have facilitated the evolution of language by extending parental investment to their offspring during a period of intense symbolic creativity and increasing autonomy. Noting that many evolutionary theories are built on skeletal remains, we suggested that a life history approach to language – a behavior that relies on soft tissues – makes additional types of evidence available, including findings on bipedalism and pelvic narrowing, continuation of rapid brain growth after birth, growth of long bones, and dentition.

Selection of linguistically relevant behaviors that occur in infancy, childhood, and juvenility (stages that are

rarely invoked in theories of evolution) may assume both a direct and an indirect form. In the direct case, behaviors of the young (e.g., infants' strategic use of creative and complex vocalizations) forestall withdrawal of care, increasing the probability of survival to reproductive age. In the indirect form, it is the behavior of sexually mature individuals that is selected, typically in the quest for status and mating opportunities, but that behavior is only available to be selected because it, or a precursive form, has a prior developmental history. These cases of selection in adolescence or early adulthood automatically reinforce the earlier, enabling behaviors.

In other primates, it has been proposed that the juvenile period is beneficial because it permits developing animals to prepare for the complexities of adult behavior. Similarly, we reasoned that human juvenility may have provided a period in which capabilities emerging in previous stages could be "practiced," and then, in adolescence, more fully exercised for social and sexual purposes. Although we suggested that selection operated throughout ontogeny, we also speculated that in adolescence, performative behaviors (including socially attractive aspects of articulate vocalization) increased fitness, established a preferred mode of expression, and laid the groundwork for speech as the universal modality of language.

We based our speculation, in part, on anthropological reports indicating that in oral societies – which lack the written language bias of modern cultures and modern Linguistics – fluent, rhythmic, and elegant speech attracts attention and facilitates the acquisition of status and power. This trend is most evident in the case of men, in contrast with the "female advantage" that has been reported in the psychometric literature, discouraging theorists in search of a selection-based model in which males display, and are chosen for, their verbal talent. Witnessing a male bias for performative speech, we speculated that selection produced sex differences that remain evident in verbal behavior today.

If childhood entered the human genome first, the amount of vocal-motor control available to our premodern ancestors may have remained limited, even if enhanced in juvenility, until the evolution of adolescence. Then, the performative applications of such behaviors, and the behaviors themselves, would almost certainly have diversified. Hence, we think there may have been a long period in evolutionary history in which vocal behaviors were displayed within a familial context, before adolescence teased them into the open in more elaborate form.

We proposed that important aspects of language cannot develop until sexual maturity because functions that emerge at that stage played, and still play, a key role in its construction. When selection for vocal and verbal performance in adolescence reinforced previous developments, it swept specializations associated with speech and voice, linguistic content and structure, and rules of usage into one large specialization. It is difficult to escape the conclusion that the faculty of language includes several disparate capabilities, and that these capabilities were stitched together in evolution, as they are in modern times, by the whole of human ontogeny.

NOTES

1. Arbib (2005a; 2005b) has suggested that at some point in evolution, hominins may have used manual gestures and vocal sounds to communicate; the gestures – in pantomime – carrying semantic and possibly sequential information of the sort now conveyed by syntax (Goldstein et al., in press).

2. In human neonates, body weight is nearly twice that of chimpanzees, the difference being due, in large measure, to the abundance of fat. This extra fat provides a source of energy to support the large and still rapidly growing brain of the human infant (Bogin 1999b), which is three times larger than the chimpanzee brain at birth (Martin 1983). In fact, human newborns are neurologically more advanced than eight other mammalian species that have been studied; two months before birth, the human brain is already more developed than the brain of the newborn macaque (Clancy et al. 2001). Further disparities develop at birth, when brain growth tapers off in the other primates, whereas in humans it continues for the next year in a rapid, fetal-like trajectory (Martin 1983). Because of these differences, the brains of human neonates require more nutrition than do the brains of other primate newborns (Leonard & Robertson 1992; see below); and, although comparative data are not readily available, it is clear that social stimulation also plays a significant role in human neurological development (e.g., Rutter & O'Connor 2004).

3. The "grandmother hypothesis" is indirectly relevant to our discussion. Human beings are the only primate species, and one of only a few mammalian species, in which adult females have a menopause and a cessation of ovulation long before death. Women are usually infertile by the age of 50, but may have two decades of post-reproductive life in traditional societies (Pavelka & Fedigan 1991). The "grandmother hypothesis" posits that this post-reproductive stage of life evolved because older women stand to gain more reproductive advantage by helping their daughters and grandchildren than by investing in more children of their own (Bogin & Smith 1996; Hamilton 1966). Hill and Hurtado (1991) tested this prediction against objective ethnographic data derived from their work with the Ache hunter-gatherers of South America. The Ache data show that offspring with grandmothers survive at somewhat higher rates than those without grandmothers, but the effect is not nearly enough to account for menopause. In a review of the Ache data and other cases derived from hunting-gathering and agricultural societies, Austad (1994) found no evidence "that humans can assist their descendants sufficiently to offset the evolutionary cost of ceasing reproduction" (p. 255). Still, interest in the "grandmother hypothesis" continues; Hawkes et al. (1998) used mathematical modeling techniques to show ways that menopause could have evolved under Darwinian selection.

4. When is the human capacity for language, or linguistic communication, fully instated in the young? When does it become fully operational? In the case of printed language, it was once possible to specify the materials that one needed to read, such as the Bible or newspaper, or to link competence to larger individual or cultural and economic goals. In the case of spoken language, there seem to be no clear-cut criteria for mastery. Therefore, the standard that has developed in modern societies, perhaps by default, is linked most immediately to social reactions in childhood and to academic success, including literacy. At the age of six, more than 96% of Midwestern American children pass normed tests that emphasize phonology, morphology, syntax, and vocabulary. These tests are sensitive to language skills that are deemed necessary for success in educational programs (Tomblin et al. 1996).

5. Some of these functions, including sarcasm, joking, and idiomatic interpretation, are handled primarily by the so-called nonlinguistic (right) cerebral hemisphere (cf. McDonald 2000;

Paradis 1998; Van Lancker 1990). This could be taken to mean that the way people talk is not a linguistic matter, but traditional definitions of language have emphasized message content and creativity. If rules of use are subsumed under "language," then the right hemisphere is also "linguistic."

6. That powerful public men tend to make frequent use of words that are rare, archaic, or esoteric suggests that a command of this material may be related to some other attribute that underlies the ability to persuade or manipulate people. Studies indicate that in modern societies the use of words that are rare, long, abstract, diverse, or unusual is correlated with formal measures of intelligence (Carroll 1993; Gustafsson & Holmberg 1992; Gustafsson & Undheim 1996; Ullstadius et al. 2002; Vetterli & Furedy 1997).

7. In citing anthropological work that concentrates on separate and sometimes "exotic" oral societies, there is a possibility that subgroups within literate societies will be ignored. In a working-class tavern in southern Wisconsin, according to an anthropologist-customer (LeMasters 1975), social success was dependent on "the ability to 'dish it out' in the rapid-fire exchange called 'joshing' … you have to have a quick retort," he wrote, "and preferably one that puts you 'one up' on your opponent. People who can't compete in the game lose status" (p. 140).

8. After submitting the manuscript, we encountered elements of a similar proposal by Darwin. In *The Descent of Man*, he suggested that with "varied tones and cadences" our evolutionary ancestors "aroused each other's ardent passions, during their courtship and rivalry" (1879/2004, p. 639).

9. Discrimination against poor speakers does not necessarily begin in juvenility. When several four-year-olds were encouraged to "play store," an irrelevant utterance by one – a child with limited linguistic skills – caused another boy to advise a peer, "Don't talk to him; he's weird" (Rice 1993). "Preschoolers behave as if they know who talks well and who doesn't," observed Hadley and Rice (1991), "and they prefer to interact with those who do" (p. 1315).

10. That females tend to operate covertly should not be taken to mean that they lack the ability to attract attention or to perform. In early modern England, women raised their voices against sexual competitors in a strident and spectacular way. According to Capp (2003), when threats to their marriage arose, wives "showed considerable skill in formulating taunts" (p. 199), calling other women "drunken fuddling fool" and "drunken pocky-faced rogue" (p. 257). When women hurled such insults, it was not unusual for them to be arrested and charged with "scolding" (McIntosh 1998).

11. Clearly, our focus here is on verbal behavior (competition and performance) as enacted by specific activities, such as insulting and joking; particular kinds of material, such as colloquial phrases; and vocal attributes, such as rate, fluency, and rhythm. When it comes to linguistic operations, testosterone – whether naturally high or experimentally administered – may exert the opposite effect by suppressing scores on language tests (Christiansen & Knussmann 1987; van Goozen et al. 1994).

12. However, one might hypothesize that men are superior to women in the use of idiomatic material. It has been demonstrated that the speed and fluency of auctioneering and sports broadcasting reflect use of over-learned material, and men dominate these professions (Kuiper 1996; Pawley 1991). But there may also be a male advantage on measures of speeded articulation; some studies have revealed a trend toward superior performance among juvenile and adolescent males on diadochokinetic tasks (Fletcher 1972; Robb et al. 1985).

13. In young women's ratings of children's conversational speech, the highest degree of variance was accounted for by a dynamic factor that included the attributes: excitable, loud, uncontrolled, bold, active, uninhibited, spontaneous, assertive, and dominant. Overall, ratings were more influenced by quality

of speech than sentence complexity and grammaticality (Burroughs & Tomblin 1990). Thus, it is possible that vocal characteristics that are favorably regarded in sexual maturity are already present, to some degree, in earlier stages of development.

14. American trial lawyers are also highly verbal, and voluble, in their personal lives. When Walter (1988) interviewed 34 trial lawyers in her dissertation research, she found that many could not be shut up. In one of her late afternoon interviews, "a lawyer talked for two and a half hours with no sign of concluding, and since he had strayed far from the topic, the interviewer terminated the discourse, or tried to, by physically leaving the office. This lawyer followed and continued speaking up to the door of the elevator" (Walter 1988, pp. 31–32).

15. Goodall (1983) reports that for the period 1965 to 1980 there were 51 births and 49 deaths in one community of wild chimpanzees at the Gombe Stream National Park, Tanzania. During a ten-year period at the Mahale Mountains National Park in Tanzania, researchers counted 74 births, 74 deaths, 14 immigrations, and 13 emigrations in one community (Nishida et al. 1990). Chimpanzee population size in each of these two communities was, by these data, effectively in equilibrium. Any additional delay in age of females at first birth or the time between successful births would probably have produced a decline in population.

16. It must be pointed out that there is uncertainty as to the existence of childhood in early *H. erectus* and its predecessor species. One line of evidence is based on the formation of tooth crown enamel. This method indicates that *Australopithecus*, *H. habilis*, and early *H. erectus* all matured at a rate faster than living humans and closer to living apes (Dean et al. 2001; Zihlman et al. 2004). The "Mojokerto child" from Java (dated at 1.8 million years ago) is attributed to *H. erectus* and is the only infant specimen preserved well enough to estimate age at death or cranial capacity. A recent analysis of the infant calvaria (i.e., top portion of the skull) indicates that this hominin died between 0.5 and 1.5 years of age and had achieved 72–84% of adult *H. erectus* brain size (Coqueugniot et al. 2004). Another analysis by Antón (1997) estimates an age at death of 4 to 6 years. If the younger age at death is correct, then the pattern of brain growth is more similar to chimpanzees than human beings. In fact, the Mojokerto fossil would have grown its brain faster than living chimpanzees (Coqueugniot et al. 2004). If, however, the later age at death is correct, then Mojokerto followed the human trajectory for brain growth.

17. There is indirect evidence for the reproductive value of human adolescence in the data on nonhuman primates. The first-born infants of monkeys and apes are more likely to die than are those of humans. Studies of yellow baboons (Altmann 1980), toque macaques (Dittus 1977), and chimpanzees (Teleki et al. 1976) show that 50–60% of firstborn offspring die in infancy (between birth and age one year). In hunter-gather human societies, such as the !Kung, about 44% of children die in infancy (Howell 1979). The human advantage may seem small, but over the vast course of evolutionary time even a 6–16% advantage is a powerful selective force. The !Kung live under very difficult and marginal conditions in a desert environment. Their infant mortality rates are at the extreme high end of human population. For comparison, it may be noted that in most contemporary human societies the infant mortality rate is usually below 20% of live births. The nation of Haiti, for example, is the poorest country in the Western Hemisphere. In 1970 the infant mortality rate was 15% (Bogin 2001). In 1960 in the United States, about 2.5% of all live, firstborn children died before the age of one year (Vavra & Querec 1973).

18. Garstang (1922) also saw phylogeny as "the creation of successive ontogenies" (p. 84), a characterization that prompted Studdert-Kennedy (1991), in recent years, to view human

language as the "product of successive ontogenies" (p. 10; also see Studdert-Kennedy 2005).

19. This process, once termed "niche picking" by Scarr and McCartney (1983), has recently been treated in some detail by Odling-Smee et al. (2003), who rightly regard "niche construction" as a vastly underplayed process in the history of evolutionary thinking. A brief but interesting discussion of niche construction is available in Dawkins (2004), who distinguishes this kind of engineered and adaptive alteration, which is encompassed by his extended phenotype theory, from the less Darwinian processes of "niche change."

Open Peer Commentary

Invoking narrative transmission in oral societies

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Abstract: The ethnographic description of story-telling and narrative transmission of cultural facts is an aspect of Locke & Bogin's (L&B's) article that should be amplified. Innate shared gene patrimony is biased by the kinship structure of particular societies and interacts with the transmission of narratives. Trance experiences are another interesting aspect of verbal and agonistic "performances."

Language acquisition in both its innate and social aspects must affect the oral transmission of culture within traditional societies. The rules of transmission are certainly a matter for multidisciplinary investigation. Ethnology and the specific description of story-telling including performance style and context constitute only one level of approach to the narrative transmission of cultural facts (Degh 1995). Ethnology, however, is uniquely important as an avenue to the complex syntax that articulates human society on both synchronic and diachronic scales.

Essentially, kin groups across cultures strive to reproduce their knowledge across generations, particularly favoring their peers of the same generation. Ethnologists concentrate on recurrent cultural practices, with the supporting genetic relatedness of kind groups less salient to them. In any case, selection on raw vocal ability, improving widely variant types of spoken communication within the kin group in the very early stages of human history (see sect. 3.5 of the target article), seems logically possible, but can hardly be documented.

Kinship structures inform the mechanisms of cultural transmission. Natural kinship is accompanied in practically every society by cultural kinship (previously called fictive kinship). Conceptually put, natural and cultural kinship may lead to two complementary genealogies, with memory-carriers only partially overlapping in each group. Thus, an important patrimony exists that is not "individually" genetic, but "communitarily" genetic. To insiders following the oral prescriptions of a given society, often the personal aspect of information transmission is very secondary. To the ethnologist, the interesting question is not about the origin of oral transmission, or about its evolutionary trajectory, but about its content and mechanisms, easily searched for in present-day field realities. Ethnographic description must complement evolutionary hypotheses regarding oral cultural transmission. Present-day cultures with primarily oral methods of transmission have never stopped generating transmission

content and are far from the static models that the target article suggests (sect. 4).

Ethnographic evidence is richest in the following categories of cultural transmission: kinship – the transgenerational division of goods, both material (e.g., dowry, inheritance) and spiritual (e.g., descent and widely-accepted institutions such as god-parenting; Rivers 1907); narratives from belief-tales to fairy-tales; and ceremonies – including a wide variety of life-cycle or year-cycle ceremonies. All of these kinds of transmission are observed not only in the case of oral societies, but also in urban and literate ones.

A great deal of attention is focused in ethnology on the relation invoked in sections 4.1 and 4.2, between verbal and agonistic performance, and power. Contests of brilliant performers in story-telling and oral narrative transmission show only one aspect of cultural transmission. Another aspect is trance, which is linked to the special qualities of precious individuals within the community – another widespread form of power.

Locke & Bogin's (L&B's) article concentrates principally on individuals consciously manipulating technical ability for power. No less powerful, "ordinary" members of oral societies often achieve high status using transformed linguistic proficiency in altered states of consciousness. I have in mind the many techniques of trance, be it ecstatic trance (whose exemplar model is the classical shaman; Eliade 1951; Humphrey 1996), or induced trance (trances without presumed journeying to other worlds; De Martino 1961). Both types of trances share exquisite performances, complete with assistants/interpreters of often parallel "languages." The audience is prepared, and the performance must fit the expectancies of the community in the form of local myths or legends. For the individuals performing in a trance state, the ability to significantly change their state of consciousness *accompanies* their linguistic proficiency; it does not originate in such proficiency. The stories of first-hand trance experience surely reinvest local narrative patrimony, after necessarily following its trends in shaping the trance/ecstasy experience.

Language use, not language, is what develops in childhood and adolescence

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Abstract: That both language and novel life-history stages are unique to humans is an interesting datum. But failure to distinguish between language and language use results in an exaggeration of the language acquisition period, which in turn vitiates claims that new developmental stages were causative factors in language evolution.

Locke & Bogin's (L&B's) unusually long target article has provided an unusually thorough account of how the life cycle of humans differs from those of other primates. Instead of a solution to the puzzle of how and why language evolved, however, we are left with additional mysteries: how and why childhood and adolescence evolved. Furthermore, L&B fail to make a convincing case that any causal connection exists between novel developmental stages and language evolution.

What selected for childhood? L&B's best suggestion is that it enabled mothers to shorten the interval between childbirths, hence to have more offspring. But since this is desirable for any species, why did childhood evolve in one primate alone? L&B have no answer. When they come to adolescence, what the authors propose does not merely fail to support their claims, it works against them. They characterize adolescence as a period for young individuals to rehearse adult economic, social, and sexual behaviors before being burdened with reproductive chores. Why would such behaviors need rehearsal unless they were noticeably more complex than behaviors of