composite system with multiple organisms, emergent supervised learning/teaching may be part of a larger self-organizational or evolutional paradigm.

It should be emphasized that evolutionary and developmental theories of language both extend well beyond the usual domain of linguistics and linguists and are intrinsically multimodal. For, the sensory-motor and affective states of the individual and his peers and caregivers are all involved, not just in the emergence of language, but in the development of a physical and social world view – an ontology that encompasses our understanding of space and time, our learning to discriminate between superstitious and causal relationships, as well as our learning to affect and control our environment directly at a physical level and less directly through social and linguistic interaction. Only in the context of learning and evolutionary robotics are all these diverse aspects of evolutionary and developmental theory able to be modelled.

Language and life history: *Not* a new perspective

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Abstract: The uniqueness of human cognition and language has long been linked to systematic changes in developmental timing. Selection for postnatal skeletal ossification resulted in progressive prolongation of universal patterns of primate growth, lengthening infancy, childhood, and adolescence. Language emerged as communication increased in complexity within and between communities rather than from selection for some unique features of childhood or adolescence, or both.

From the middle of the twentieth century onward, a scholarly literature has linked evolutionary changes in the developmental profile of hominins to terrestrial bipedalism, the narrowing of the birth canal, encephalization, prolonged neocortical plasticity, behavioral flexibility, and profound changes in hominin social organization (e.g., de Beer 1930; 1951/1958; Eisley 1946/1957; Gould 1977; Jerison 1973; Montague 1962). Comparative research has suggested that humans share the growth patterns typical of primates, but with a relatively greater prolongation of each developmental phase than any other mammal of comparable size (e.g., Finlay et al. 2001; Schultz 1960; Watts 1990). Prolonged cell division in one phase led to delayed closure of later phases. For example, a greater number of neurons required more time to divide, migrate to their final positions, establish dendritic connectivity, and become myelinated (McKinney 2000). With respect to brain development, the largest perturbation occurred in the latest developing regions in the neocortex, in particular, the prefrontal cortex (Deacon 1997; Finlay & Darlington 1995; Finlay et al. 2001). Greater numbers of cortical neurons resulted in data compacting and added levels of information processing that produced increasingly abstract representations of the compacted input (Calvin 1996; 1998; Kien 1991). Gould (1977) argued that these changes were systematic, and led to qualitative changes in the complexity and automaticity of human cognition and communication. Gould and Lewontin (1979) proposed that language emerged as a by-product of general increases in brain size, coincident with an increased need for communication within and between tightly organized primate social groups.

This well-documented view of language emergence contrasts markedly with Locke & Bogin's (L&B's) proposal of independent selection for aspects of language during childhood and adolescence. What is most surprising about their proposal is the suggestion that childhood and adolescence are unique to humans, in the face of forty years of contrary evidence (e.g., Harvey et al. 1987; Hobson et al. 1981; Schultz 1969). Using skeletal and hormonal evidence from both monkeys and apes, Watts (1985; 1986; Watts & Gavan 1982) documented a distinct juvenile dependency comparable to human childhood and an adolescent growth spurt that preceded delayed sexual maturation in all higher primates. Extended human childhood and adolescence appear to be concomitant with the systematic changes in fetal and postnatal development (Gould 1977; Ragir 1985; 2001a; 2001b; Shea 1990). If anything, given the length of childhood and the life expectancy of humans, sexual maturation occurs relatively early as compared to other apes (Shea 1990). The observed non-uniqueness of these life history phases is indicative of the systematic patterns of primate growth and development described above. The purported uniqueness of human childhood and adolescence is seriously undermined by the similar patterns of monkey, ape, and human growth after infancy, and weak links between patterns of tooth eruption, facial morphology, weaning and changing social-sexual and cognitive competence (Watts 1990).

L&B's proposal offers an unconvincing combination of kin- and sexual-selection pressures that operate during different life history phases and select for seemingly dissociated competence and performance aspects of language. The kin-selection argument for language formation is seriously flawed; all nonhuman primates communicate with and successfully raise their infants without language. Language between parent and offspring would not necessarily improve the survival of juveniles, nor ensure "honest" communication. Studies of emergent Sign Languages and Creoles indicate greater complexity and systematicity in the negotiated exchange of information within and between groups composed of relative strangers as opposed to close kin (Kegl et al. 1999; Kendon 1980a; 1980b; 1980c; McWhorter 1997; Senghas et al. 2004; Washabaugh 1986).

We also strongly disagree with L&B's emphasis on sexual selection and the competitive aspects of language performance. Primates practice opportunistic mating in which females fail to show a general preference for alpha males, and males mate with any estrous female. Male displays of strength and cunning temporarily position them in a relatively unstable male dominance hierarchy that is likely to confer upon dominant males preferential access to estrous females for only a limited part of their mature reproductive life. In contrast, dominant females and their female kin show greater reproductive success over the entire period of reproductive maturity (Grant 2003; Lee & Bowman 1995; van Schaik & Hrdy 1991). On the other hand, adolescence is likely to be important in the formation of languages for other reasons; humans tend to disperse at adolescence to mate, carrying their local communicative practices to nearby groups. This dispersal would promote the exchange of skills and information, expand regional political affiliations, and create mutually intelligible language dialects.

Throughout the lifespan, speech performance is basic to human language, and adolescence is not special in this regard. Language use develops in tandem with lexicon and grammar, with all aspects of language increasing in complexity in ways that reflect and, perhaps, implement changes in cortical organization. Language acquisition is possible because infants are socially connected and sensitized to the dynamics of interpersonal communication from birth. Children acquire language by tuning in to the communicative intentions of others, through active social engagement and participation in conversation (Tomasello 1999). Young children's pragmatic sophistication manifests itself in the form of social routines such as peek-a-boo, vocal turn taking, pointing, use of prosody, and joint attention (e.g., Ninio & Snow 1996; Rochat et al. 1999). Children who are not segregated from adult activities readily imitate and incorporate aspects of mature speech acts into their repertoires. Their personal narratives, sense of self, and autobiographical memory are constructed through conversing and

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reminiscing with others (Nelson & Fivush 2004). Word play and language games emerge fully in childhood (Goldman 1998), with mental simulation serving to decouple representation from the here and now, as children engage in non-literal language in their pretend play. The development of language use across the lifespan is a very important topic that will not be well understood if pragmatics is narrowly conceived as building on grammatical competence (Brooks 2004). Both the acquisition of language and its evolution require an appreciation of how both lexicon and grammar are rooted in participation in social life.

Life stages, put in words: Morning, four; noon, two; evening, three?

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Abstract: The social function of language, as exemplified by "tonic communication," is certainly not restricted to our own species. An individual's cognitive mastering of its environment, moreover, is equally essential for understanding the nature of any language. In the absence of comparative data, it is premature to claim that language skills at a particular developmental stage are uniquely human.

Morning, four; noon, two; evening, three? This is an amazingly concise statement of the ancient riddle the Sphinx posed to Oedipus. This riddle's solution – "during infancy we crawl on all four, grown up we walk on two legs, and at old age a cane serves us as a third leg" – gives us a feel for the antiquity of human awareness of life's stages, put in words (Schleidt 1992). There are additional discontinuities, of course, beyond the number of legs. During the bipedal stage we note several distinct changes: at school age, when the child is allowed to venture into society without constant maternal supervision; at puberty, certainly the most striking incision in the individual's thread of bipedal life, and at menopause, for the female the beginning of grandmothering. Currently, the "eight stages of life" proposed by Erik H. Erikson (1950) are widely accepted, and connections between life history and social competence are beyond dispute (Schleidt 1992). The importance of oral language as an essential tool for the individual's carving its niche within society, in pursuit of its biological fitness, is obvious. So, what is new in the life history approach taken by Locke & Bogin (L&B)?

Childhood and adolescence: Uniquely human? The new perspective on the development and evolution of human language, envisioned by L&B, rests on their claim that two developmental stages, childhood and adolescence, are relatively new insertions into human development: a true childhood, as distinct phases preceding the juvenile stage (only since *Homo habilis*) and a true adolescence, as distinct phases following the juvenile stage (only since *Homo sapiens*). From my own experience with the development of various species of birds and mammals, I cannot follow the authors' argumentation, since the vast majority of social animals, which rely on the use of a language to attain reproductive success, have similar substages within their juvenile stage that justify a separate label. In mammals, for example, we can talk of childhood once nursing has stopped but the individual is still part of the family, and of adolescence when, prior to sexual maturity, new social bonds develop, usually among juveniles of the same gender.

The social function of language. L&B focus on differences in the oral language in each of the four pre-adult ontogenetic stages in human life history. This puts an unusually strong emphasis on the social function of language: talking as a form of communion among the communicants (phatic communion, Malinowski 1923; tonic communication, Schleidt 1973; gossip, Dunbar 1996; etc.). They strike a sympathetic chord with my own interests in bonding and communions, rooted in old concepts of psychoanalysis and ethology that are rarely recalled these days. In a nutshell, Erikson's (1950) eight developmental stages, based on Sigmund Freud's well-known oral, anal, phallic, latency, and genital phases, show a striking correspondence to the stages of bonding in birds, as described by Konrad Lorenz in his 1935 paper (translated as Lorenz 1970) on the various types of "companions" during a bird's life (Schleidt 1992). Considering the recent recognition of grandmothering as a special form of child care (Hawkes et al. 1998), the grandchild can be added as another type of "companion," a cognitive domain in its own right. Thus, I hypothesize that in each of the developmental stages a particular new kind of bond may evolve, a new type of "companion" can be added to the cast of conspecifics, expanding the social skills and cognitive competence (see Table 1).

Cognition without words. Finally I must confess that, while studying L&B's proposal, I was reminded of two aspects of cognitive development that are intimately interrelated with our oral language, but remained strikingly absent in their deliberation: "first words" and "nonverbal thinking." "First words" are only the tip of an iceberg, of course, since the nonverbal mapping of patterns in the environment into its memory is far ahead of the language skills of a growing infant. Thus, one may ask how much sense does it make to discuss language development without reference to the individual's world? This caveat applies not only to infancy, but to all stages. "School age," for example, is dominated by learning the names of many "things" the child is already quite familiar with from its own experience. The child's ability to see "things" as cognitive entities is well illustrated in J. A. Comenius's *Orbis sensualium*

Table 1 *(Schleidt).* Developmental stages

Age (year)	Generic term	Sigmund Freud	Erik H. Erikson	Konrad Lorenz
0–1	Infancy	Oral	Infancy	Parent
1–3	Childhood	Anal	Early childhood	Sibling
3–6	Childhood	Phallic	Childhood	Friend/foe
6–12	Childhood	Latency	School age	Friend/foe
12–18	Adolescence	Genital	Adolescences	Friend/foe
18–25	Adulthood (courtship phase)		Young adulthood	Mate
25–45	Adulthood (reproductive phase)		Adulthood	Child
45–?	Maturity		Maturity[a]	Grandchild

Based on Schleidt (1992), revised. Here I have replaced the German terms ("Elternkumpan," etc.) with English translations of the chief companion of each stage ("parent," etc.) and added the "grandchild" as another type of companion.
[a]Erik H. Erikson used the term "old age" for the age beyond retirement, years 60 to 70.

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