data to isolate components of the language faculty. Only an adaptationist analysis, of the sort seen in evolutionary psychology, can carve language at its joints and lead to testable predictions about how language works.

Locke & Bogin (L&B) begin their paper by describing the recent history of scholarship in language evolution. The key point they draw out is that ontogeny has been largely ignored, and their aim is to rectify this omission. What they do not state is that most of the work has been on phylogeny; research has predominantly focused upon the evolutionary transitions that may or may not have led to human language as it is now.

Mapping out phylogenies is not the only use for evolutionary theory. Evolutionary psychology (EP) is in the business of individuating traits through adaptationist analyses, such that organisms are looked at in terms of the ecology in which they live and predictions are made about the kinds of psychological adaptations (mechanisms) required to meet ecologically relevant task demands (Andrews et al. 2003; Dickins 2005). Sometimes this is done against a backdrop of hypothesised environments of evolutionary adaptedness, and such hypotheses are generated from, among other things, comparative data. This kind of functional analysis provides key constraints for subsequent discussion of proximate mechanisms.

If we accept that language has evolved, and there is little reason not to, we can then apply EP reasoning to the subject matter – language itself. By carefully thinking through the adapted functions that language delivers we can begin to individuate components of this faculty. Then, once we have an EP theory of language we can, perhaps, begin to think about its phylogeny, for we know what has been selected for. This is a long project, and not without methodological problems, not least the absence of fossil evidence; but anything else would run the risk of generating just-so stories. However, once the EP project has been completed it is hard to imagine what use phylogenetic hypotheses could be put to other than to demonstrate that the already isolated adaptations could have evolved.

Ontogenetic hypotheses can be used slightly differently from phylogenetic ones, in that they can be tested in the laboratory and, in so doing, aid in the individuation of psychological adaptations. Nonetheless, before one goes into the lab one needs to propose a sound evolutionarily based hypothesis about how ontogeny would pan out. Again, adaptationist analysis should come first.

L&B appear to have operated a somewhat mixed strategy, but one that mostly falls in line with the tradition of speculating on phylogenies. Their initial observations about what language is clearly originate from thinking about its adapted functions. So, as with much contemporary EP, they see language as fulfilling a variety of social signalling tasks. What is more, they move away from the traditional Chomskyan focus upon grammar and content, and note that language is a many-stranded communication system. They rightly point to the qualities of voice, pragmatic inference, and verbal fluency, among many other things, as sources of signal and information. However, they only use this insight to broadly define the aspects of language they are interested in. After this, L&B go on to outline various key features of language development, which they in turn use to speculate about phylogeny. So, they note that as we develop from infancy to adulthood social contexts become more complex and this is matched by increased communicative sophistication. In particular, they claim that adolescence is a period of near-adult social complexity in which the rules of adult life can be learnt and to some extent implemented without the cost. During this period, language develops such that grammar becomes more sophisticated, speech is more fluent, more and more pragmatic communication is engaged in, and the native language is modified. Adolescence sees the onset of gossiping about others, as well as "joking, deceiving, mollifying, negotiating, and persuading, with increases in the use of sarcasm" (sect 2.8). In brief, the social uses of language become more prevalent.

L&B discuss the possibility that human infancy has been foreshortened by natural selection in order to allow maternal resources to be diverted to new offspring more rapidly, and that this in turn led to childhood. Children are semi-independent and require less care, and, importantly for L&B, are able to engage in verbal interactions with adults that will shape their linguistic development. It is during this period that what could be referred to as a Chomskyan basis for linguistic communication is established. L&B further hypothesise that the social practice functions of adolescence were directly selected for and this allowed for the emergence of the other strands of linguistic communication discussed above.

L&B have essentially married detailed observations about language development with a loose thesis about the phylogeny of ontogeny, and without engaging in a detailed adaptationist analysis. They are undoubtedly right that ontogeny is a product of natural selection, and their life-history approach, which looks at maternal trade-offs, makes evolutionary sense. But it is unclear what predictions we can now make about the kinds of proximate mechanism underlying language that we could not make prior to this argument. One reason for this is the slight circularity of the adolescence argument. By observing how adolescents use language, and assuming that this life-stage is a product of natural selection, L&B suggest that the social complexities of adolescence drove selection for the social signalling functions of language. But it is equally possible that social complexities were able to emerge as a consequence of social signalling abilities. There is nothing in the current argument that can resolve this, and no obvious testable predictions are made.

The target article concludes by stating that the various strands of language "were stitched together in evolution, as they are in modern times, by the whole of human ontogeny" (sect. 14). This is a different claim from the authors' predominant one that developmental stages were selected for – indeed, this is a claim for a role for ontogeny in phylogeny, and is perhaps the main point L&B wish to make. But it does not follow from any of their observations. Developmental stages, as L&B have discussed, are the consequence of evolution through natural selection. Any developmental "decision" made by natural selection will have consequences that in turn may provide selection pressures and lead to phenotypic change, but this is not coded into the developmental process. In this way, ontogeny does not stitch together various capabilities in phylogeny, but rather specific ontogenetic pathways are selected for and this establishes further selection pressures, the outcomes of which are readily observable in contemporary development.

L&B are right to discuss ontogeny and right to think about the multiple strands of language, but they should have moved away from historical speculation and toward EP if they wished to have made substantive and testable claims about the nature of the language faculty.

The evolution of language: Present behavioral evidence for past genetic reprogramming in the human lineage

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Abstract: Language and life history can be related functionally through the study of human ontogeny, thus usefully informing our understanding of several unique aspects of the evolution of species. The operational principles outlined by Locke & Bogin (L&B)

demonstrate that the present can provide a useful framework for understanding the past.

My own perspective on "Language and life history" is conditioned by an extended period of familiarity with the writings of one of the authors. For more than a decade I have used two editions of Barry Bogin's *Patterns of Human Growth* (1988; 1999) as main texts in an upper-level undergraduate course titled Human Growth and Development. On first reading the target article against this background, I recalled the critical comment once offered by Samuel Johnson with ungentle pithiness: "Your work, Sir, is both new and good, but what's new is not good and what's good is not new." However, the work by Locke & Bogin (L&B) merits a much more positive assessment: What is not new (elucidation of the stages, shared and unique, in human life history) remains as good as it ever was, and what is new (the extension of this perspective to furthering our knowledge about the evolution of human language) is even better.

Most readers of *Behavioral and Brain Sciences* are likely to be specialists in functional rather than evolutionary biology; however, as is the case with the authors of the target article, my scientific work overlaps both domains. As a help toward relating these contrasting perspectives, I will paraphrase here part of a keynote address by Bruce Latimer that was delivered to the 2005 joint meeting of the American Society of Biomechanics and the International Society of Biomechanics: Scientists who work with living subjects (from elite athletes endeavoring to set new records to stroke victims and other patients undergoing rehabilitation work) have problems for which solutions must be found. But those of us who study the fossil record of past human evolution can see the adaptive solutions that nature has evolved; it is our challenge to reconstruct the problems that required these solutions in the first place.

The work of L&B is particularly fascinating because it begins with a set of problems, the so-called "obstetrical dilemma" triggered by the assumption of upright posture and bipedal locomotion, that has been the focus of much recent work by my own research group and our close colleagues in several other countries (e.g., Galik et al. 2004). This research has enabled us to establish the origin of bipedalism at about 6 million years before the present, thus bounding the earliest temporal limits of the human lineage that uniquely evolved language. The synthesizing work by L&B goes beyond the limitations of human fossil evidence by using developmental clues still perceivable in human ontogeny to attempt to tease out the stages that must have existed between the rudimentary forms of communication in living chimpanzees and those characteristic of our own species. This sort of approach, escaping the confines of so-called hard evidence by reasoning from soft tissue features and behaviors existing in present populations to comparable attributes in ancestral groups, holds much promise (Eckhardt 2000). It therefore is no criticism to characterize this target article more as a step in the right direction than an ultimate formulation of some end point in our understanding of the evolution of those aspects of brain and behavior science concerned with human language – or even to note that a few of its more unusual ideas have been anticipated (Livingstone 1973).

I suspect that some paleoanthropological colleagues may feel that the approach taken by L&B departs too much from traditional reliance on the hard evidence. But recently the new species *Homo floresiensis* has been hypothesized on the basis of a single skull with a chimp-sized brain of about 400 cc, yet with the supposed behavioral capacity to have manufactured stone microblades as part of complex tools heretofore found associated only with large-brained humans capable of speech. This is a dubious proposition for which there is a better alternative explanation in terms of human biology (Henneberg & Thorne 2004). Appropriate use of developmental clues inferred from living populations promises to provide an approach to behavioral inference in which broadly based theory trumps a narrow evidential base.

Enduring excitement in the brain and behavior sciences will be found in the solid advance of knowledge through hypothesis generation and testing of the sort offered by L&B, rather than through journalistic sensationalism.

Road to language: Longer, more believable, more relevant

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Abstract: A realistic developmental view of language acquisition recognizes vocabulary and pragmatics as well as grammar with a lengthy period of growth in a favorable environment. Cross-fostering is a tool of behavioral biology for studying the interaction between genetic endowment and developmental environment. Sign language studies of cross-fostered chimpanzees measure development in a nearly human environment.

Theoretical linguists of the last century seemed to deny human development.

> We are presenting an "instantaneous model" of language acquisition which is surely false in detail, but can very well be accepted as a reasonable first approximation. (Chomsky 1967, pp. 441–42)

Early followers of Chomsky supported his instantaneous model.

> Children all over the world learn to speak their native language at approximately the same time – 3 to 4 years of age. Within a relatively brief period, the child appears to learn a complicated and abstract system of rules . . . without teaching or training, [they] acquire their native language at about the same time – regardless of just about any variable one cares to look at, short of deafness or severe retardation. (Moore 1973, p. 4)

Chomsky's instantaneous model flattened the landscape of development from toddler to college student. Repeatedly, loyal Chomskians found virtually complete grammar in the speech of the same four-year-olds who cannot yet tie their own shoelaces or use a knife to spread jam on a cracker (Cohen & Gross 1979).

Locke & Bogin (L&B) recognize vocabulary and pragmatics, as well as grammar, and emphasize human development from infancy through adolescence. Their road to language is longer, more believable, and more relevant. They relate detailed aspects of linguistic skill to human development, doing justice to linguistic development as a biological phenomenon. Immature humans hardly spend their lengthened childhood vegetating, they spend it interacting with their parents and their culture.

Evolutionary biologist, Lewontin puts it this way:

> We are not determined by our genes, although surely we are influenced by them. Development depends not only on the materials that have been inherited from parents – that is, the genes and other materials in the sperm and egg – but also on the particular temperature, humidity, nutrition, smells, sights, and sounds (including what we call education) that impinge on the developing organism. (Lewontin 1991, p. 26)

Genetic advances in agriculture produce new breeds that are dramatically different from parent stocks. Under contrasting conditions, seeds that are virtual clones mature into dramatically different plants, often so different that they are hardly recognizable as the same species. Animal agriculture reveals equally dramatic interactions between genes and environment. Behavioral development should be more sensitive to environment, and advanced behavior, such as language, should be still more sensitive.