

INTERACTION OF DEVELOPMENTAL AND EVOLUTIONARY PROCESSES IN THE EMERGENCE OF SPOKEN LANGUAGE

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Evolution is a two-stage process (West-Eberhard 2003). In the first stage, a plastic phenotype responds to environmental variation, producing novel forms that vary genetically. In the second stage, selection acts on the variants. From Mivart (1871) and Garstang (1922) to the new evolutionary developmental biologists (Northcutt, 1990), it has been argued that the first stage---the origin of novel characters---can only occur in development. While vigorously supporting this view, the new Evolutionary Developmental Biology (termed “evo-devo”) has also demonstrated reverse order (“devo-evo”) effects of evolution on development (Gilbert, 2003; Hall, 2000; Jablonka & Lamb, 1998; Wagner et al., 2000). Indeed, for some, each of the two processes---evolution and development---is an *explanandum* as well as an *explanans* (Robert, 2002).

Since traits that emerge in development frequently do so as the result of a change in behavior (Bateson, 1988; Gottlieb, 2002), it is essential that theories of linguistic evolution place a high valuation on developing behaviors. Recently, in collaboration with Barry Bogin, I have argued that evolution produced a new ontogenetic stage and remodeled an existing one; and that developmental processes, operating in the new and remodeled stages, produced novel behaviors that were naturally or sexually selected (Locke & Bogin, in press). The net effect of these evo-devo and devo-evo changes, as proposed, was an increase in the frequency of genes supporting precursors to, and ultimately the components of, spoken language.

An example of a revision of an existing ontogenetic stage is the effect of bipedalism (and antecedent events) on infancy. It has been suggested that this change redesigned the hominid nervous system (Eccles, 1989) and introduced new ways of interacting (Jablonski et al., 2002). Bipedalism also narrowed the pelvis (Leutenegger, 1980). This caused an “obstetrical dilemma” for the expectant mother and her large-headed fetus, a dilemma that was solved by shifting skull and brain development into the postnatal period. This shift increased helplessness, extending the period and intensity of interactions between offspring and their vigilant parents.

New levels of care and sibling competition would have escalated conflict

between the infant and its parents (cf. Trivers, 1972). One solution was for infants to signal for care more strategically. I propose that infants who issued more effective care signals were more likely than others to receive care and live to reproductive age (Locke, in press). I also propose that infants who cooed and babbled at appropriate intervals were unusually likely to engage with adults, to receive more sophisticated forms of care as infancy progressed, and to generate and learn complex phonetic patterns. These benefits would have accrued particularly to infants who monitored adult reactions (Chisolm, 2003) and adjusted their vocal output accordingly.

At some point, it became possible for infants to “cry wolf,” that is, manipulate their voices in such a way as to appear more needy or worthy than they really were (Hauser 1986). If mothers wanted to devote more time to other infants and tasks, they would have had to monitor their infants’ vocalizations more carefully, and learn to discriminate the sound of tactical signals from sincere ones. Thus, I suggest that the increase in infants’ helplessness would also have enhanced parental ability to interpret infant vocalizations (Brockway, 2003; Locke & Bogin, in press).

An example of a new ontogenetic stage is childhood, a uniquely human stage that entered the *Homo* line about two million years ago (Bogin, 2001; 2003). Coterminous with weaning, chimpanzee infancies last five years. During this period, maternal lactation suppresses ovulation, limiting the rate of population growth. Hominid mothers weaned their infants earlier, decreasing inter-birth spacing and increasing the number of possible offspring. The years liberated by an earlier weaning created a short, two-year childhood, with different characteristics than infancy and the juvenile stage that follows. These characteristics would have favored the invention of vocal and symbolic behaviors by the young (Locke & Bogin, in press), conferring benefits that contributed to the extension of childhood, additionally, to its present four-year duration.

New childcare pressures would also have increased reliance on *surrogate* parents, or babysitters (Hrdy, 1999). In traditional societies---the social arrangements most closely resembling the environments of evolutionary adaptedness---cooperative breeding is essential. A possible linguistic benefit was decontextualization---a special feature of human language (Hockett, 1977)---inasmuch as infants would have encountered a wider range of individuals who (a) knew less about them, (b) operated on broader and less certain schedules of caregiving, and (c) felt less responsibility for them than the mother would have. A natural result, presumably, was an added measure of vocal and

communicative flexibility, and increased ability to manipulate, and read, caregiver intentions.

The effects of an altered infancy and new childhood would also have jacked up the value of parental instruction. In human societies, the young are exposed to a range of potentially dangerous objects and conditions, new risks emerging with the development of walking and other motor functions. Those who pointed and vocalized in response to visual attractions would have learned more about their environment, and negotiated those environments safely and successfully (cf. Caro & Hauser, 1992). It is proposed that the joint use of manual and vocal signals increased fitness over the course of numerous ancestral ontogenies. A secondary effect was increased command of vocal behavior, for there is evidence in modern infants that manual activity increases the frequency and syllabicity of vocalization (Ejiri & Masataka, 2001; Iverson & Fagan, 2004), and it has been reported recently that manual-vocal combinations are unusually likely where the infant's intentions are communicative (Locke, in submission). Thus it is claimed that motoric and referential functions jointly contributed to our species' volubility, and roused the mandibular and articulatory systems responsible for the production of speech-like sounds.

Of course, sounds without symbols only go so far (Hurford, 2004). Fortunately, the developments discussed above would also have favored the evolution of sound-meaning relationships. This issue was partially addressed by Fitch (2004), who argued that parents would have benefited by communicating accurate information to their offspring. The better informed young, according to Fitch's functional proposal, would be more likely to survive into adulthood, passing on to their own offspring genes associated with the improved system of communication. Continuity being a hallmark of human development, infants and children who achieved effective use of sound-meaning signals would have carried some form of the relevant control behaviors into juvenility and adolescence. In those stages, I claim, vocal and verbal skills facilitated the quest for status and sex (Locke, 2000; Locke & Begun, in press), selection automatically strengthening---in a second hit---precursive behaviors that persisted, in some form, from earlier stages.

There is evidence across all the stages of life history to the effect that speech attracts attention, that attention raises status, and that highly vocal individuals enjoy higher status than less vocal individuals. Dominance hierarchies begin to form as early as five years (Strayer & Trudel, 1984), and these are based largely on vocal and verbal behavior (Hold-Cavell & Borzutsky, 1986). Among the status-enhancing developments, depending on the culture,

are riddling (McDowell, 1979), joking (McGhee, 1979; Shultz & Horibe, 1974), and dueling rhymes (Dundes et al., 1970). In 3- to 5-year old African American boys, Wyatt (1995; 1999) has observed an elementary form of “the dozens,” a duel---usually “fought” by adolescents and young adult males---and a clear case of “rap.”

I suggest that in traditional (oral) societies, the vocal and verbal abilities that enabled adolescents and young adults to engage and compete with others, and to perform in public arenas, indexed fitness and were selected. If so, there may be a genetic basis for verbal expressivity and dominance in modern humans, a prospect supported by several adoptive twin studies (Gangestad & Simpson, 1993; Lykken, 1982; see also Snyder, 1987).

My claim, then, is that insertion of new or remodeled ontogenetic stages into human life history produced new developmental processes that fashioned novel communicative behaviors, and that these increased fitness. If so, reciprocal action by evolutionary and developmental mechanisms---specifically an “evo-devo-evo” sequence---may have played a major role in the evolution of language.

References

- Bateson, P. (1988). The active role of behaviour in evolution. In Ho, M.-W., & Fox, S. W. (Eds.), *Evolutionary processes and metaphors*. London: Wiley.
- Bogin, B. (2001). *The growth of humanity*. New York: Wiley-Liss.
- Bogin, B. (2003). The human pattern of growth and development in paleontological perspective. In Thompson, J. L., Krovitz, G. E. & Nelson, A. J. (eds.) *Patterns of growth and development in the Genus Homo*. Cambridge: Cambridge University Press.
- Brockway, R. (2003). Evolving to be mentalists: the “mind-reading mums” hypothesis. In Sterelny, K., & Fitness, J. (Eds.), *From mating to mentality: evaluating evolutionary psychology*. New York: Psychology Press.
- Caro, T. M., & Hauser, M. D. (1992). Is there teaching in nonhuman animals? *Quarterly Review of Biology*, 67, 151-174.
- Chisolm, J. S. (2003). Uncertainty, contingency, and attachment: a life history theory of theory of mind. In Sterelny, K., & Fitness, J. (Eds.), *From mating to mentality: evaluating evolutionary psychology*. New York: Psychology Press.
- Dundes, A., Leach, J. W., & Özkök, B. (1970). The strategy of Turkish boys’ verbal dueling rhymes. In Gumperz, J. J., & Hymes, D. (Eds.), *Directions in sociolinguistics: the ethnography of communication*. New York: Holt, Rinehart and Winston.
- Eccles, J. C. (1989). *Evolution of the brain*. London: Routledge.

- Ejiri, K., & Masataka, N. (2001). Co-occurrence of preverbal vocal behavior and motor action in early infancy. *Developmental Science*, 4, 40-48.
- Fitch, W. T. (2004). Kin selection and “mother tongues”: a neglected component in language evolution. In Oller, D. K., & Griebel, U. (Eds.), *The evolution of communication systems: a comparative approach*. Cambridge, MA: MIT Press.
- Gangestad, S. W., & Simpson, J. A. (1993). Development of a scale measuring genetic variation related to expressive control. *Journal of Personality*, 61, 133-158.
- Garstang, W. (1922). The theory of recapitulation: a critical re-statement of the biogenetic law. *Journal of the Linnaean Society (Zoology)*, 35, 81-101.
- Gilbert, S. F. (2003). Evo-devo, devo-evo, and devgen-popgen. *Biology and Philosophy*, 18, 347-352.
- Gottlieb, G (2002). *Individual development and evolution: the genesis of novel behavior*. Mahwah, NJ: Erlbaum. Originally published by Oxford University Press in 1992.
- Hall, B. K. (2000). Evo-devo or devo-evo---does it matter? *Evolution & Development*, 2, 177-178.
- Hauser, M. D. (1986). Parent-offspring conflict: care-elicitation behaviour and the ‘cry-wolf’ syndrome. In Else, J. G., & Lee, P. C. (Eds.), *Primate ontogeny, cognition and social behaviour*. Cambridge: Cambridge University Press.
- Hockett, C. F. (1977). *The view from language: selected essays 1948-1974*. Athens, GA: University of Georgia Press.
- Hold-Cavell, B. C. L., & Borsutzky, D. (1986). Strategies to obtain high regard: longitudinal study of a group of preschool children. *Ethology & Sociobiology*, 7, 39-56.
- Hrdy, S. B. (1999). *Mother nature: natural selection and the female of the species*. London: Chatto & Windus.
- Hurford, J. R. (2004). Language beyond our grasp: what mirror neurons can, and cannot, do for the evolution of language. In Oller, D. K., & Greibel, U. (Eds.), *Evolution of communication systems: a comparative approach*. Cambridge, MA: The MIT Press.
- Iverson, J. M., & Fagan, M. K. (2004). Infant vocal-motor coordination: precursor to the gesture-speech system? *Child Development*, 75, 1053-1066.
- Jablonka, E., & Lamb, M. J. (1998). Bridges between development and evolution. *Biology and Philosophy*, 13, 119-124.
- Jablonski, N. G., Chaplin, G., & McNamara, K. J. (2002). Natural selection and the evolution of hominid patterns of growth and development. In Minugh-Purvis, N., & McNamara, K. J. (Eds.), *Human evolution through developmental change*. Baltimore, MD: Johns Hopkins University Press.
- Leutenegger, W. (1980). Encephalization and obstetrics in primates with particular reference to human evolution. In Armstrong, E., & Falk, D. (Eds.), *Primate brain evolution: methods and concepts*. New York:

Plenum.

- Locke, J. L. (2000). Rank and relationships in the evolution of spoken language. *Journal of the Royal Anthropological Institute*, 7, 37-50.
- Locke, J. L. (in press). Parental selection of vocal behavior: crying, cooing, babbling, and the evolution of language. *Human Nature*.
- Locke, J. L. (in submission). Bimodal signaling in infancy: motor behavior, reference, and the evolution of spoken language.
- Locke, J. L., & Bogin, B. (in press). Language and life history: a new perspective on the evolution and development of linguistic communication. *Behavioral and Brain Science*.
- Lykken, D. T. (1982). Research with twins: the concept of emergence. *Psychophysiology*, 19, 361-373.
- McDowell, J. H. (1979). *Children's riddling*. Bloomington, IN: Indiana University Press.
- McGhee, P. E. (1979). *Humor: its origin and development*. San Francisco, CA: W. H. Freeman.
- Mivart, St. G. (1871). *On the genesis of species*. London: Macmillan.
- Northcutt, R. G. (1990). Ontogeny and phylogeny: a re-evaluation of conceptual relationships and some applications. *Brain, Behavior and Evolution*, 36, (2-3), 116-140.
- Robert, J. S. (2002). How developmental is evolutionary developmental biology? *Biology and Philosophy*, 17, 591-611.
- Shultz, T. R., & Horibe, F. (1974). Development of the appreciation of verbal jokes. *Developmental Psychology*, 10, 13-20.
- Snyder, M. (1987). *Private realities/public appearances: the psychology of self-monitoring*. New York: Freeman.
- Strayer, F. F., & Trudel, M. (1984). Developmental changes in the nature and function of social dominance among young children. *Ethology and Sociobiology*, 5, 279-295.
- Trivers, R. L. (1972). Parental investment and sexual selection. In Campbell, B. (Ed.), *Sexual selection and the descent of man, 1871-1971*. Chicago, IL: Aldine.
- Wagner, G. P., Chiu, C-H., Laubichler, M., & Hansen, T. F. (2000). Developmental evolution as a mechanistic science: the inference from developmental mechanisms to evolutionary processes. *American Zoologist*, 40, 819-831.
- West-Eberhard, M. J. (2003). *Developmental plasticity and evolution*. Oxford: Oxford University Press.
- Wyatt, T. A. (1995). Language development in African American English child speech. *Linguistics and Education*, 7, 7-22.
- Wyatt, T. A. (1999). An Afro-centered view of communicative competence. In Kovarsky, D., Duchan, J. F., & Maxwell, M. (Eds.), *Constructing incompetence: disabling evaluations in clinical and social interaction*. Mahwah, NJ: Erlbaum.