Supplementary Electronic Materials for

Pre-Hunt Communication Provides Context for the Evolution of Early Human Language

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Online Appendix 2: Big-Game Hunter's Toolkit

Several functional constraints have to be solved for any successful big-game hunter. A hunting party has to be organized; hunting has to be coordinated; the prey has to be killed; the hunter must be able to open up the thick skin of the prey; and the hunter has to have the means for butchering the prey (Lee 1979). Long-distance (endurance) running and heavy-duty tools gave hominids the ability to kill large prey, stone tools gave them the ability both to open up the thick skin and to disarticulate and butcher the prey. Pre-hunt communication, as argued here and in the main article, gave them the ability both to recruit a hunting party and to coordinate the hunt. It follows that the first hominids, successfully engaged in big-game hunting, must have had a functional "toolkit," i.e., the ability for long-distance running, for making stone tools suitable for killing, opening up, and butchering prey, and finally a system of communication that was suitable for both recruitment and pre-hunt coordination.

Here I argue that this hominid was *Homo erectus*. Several lines of evidence, which I discussed in detail in the main article, show that meat coming from big-game hunting played an important role in hominid diet by the time *H. erectus* emerged. Adding to this the spectacular success of *H. erectus* in colonizing open grasslands, the most parsimonious explanation is that *H. erectus* was a successful big-game hunter, the first hominid fully and successfully adapted to this niche.

This is not to suggest that *H. erectus* relied exclusively on hunting or to suggest that they were not good in collecting other types of food. They could have been excellent tuber collectors and that could have played an important role in their diet. Hunting and tuber collecting are not mutually exclusive strategies, especially considering that more likely than not there was a division of labor between sexes, males being good hunters and females being good tuber collectors (Marshall 1976; Lee 1979). Most probably, *H. erectus* was good at both hunting and tuber collecting, which gave the species a flexibility and upper hand over others.

The rapid dispersal of *H. erectus* out of Africa (Antón et al. 2002) provides further support. The relative rapidity of the dispersal is in sharp contrast with usual primate patterns (Antón et al. 2002) but can be explained by the current model assuming that *H. erectus* quickly populated those regions where big-game hunting was profitable. Both the range of the dispersal and computer simulations of the process show that this was the case, as *H. erectus* quickly spread into the adjacent grassland ecosystems (Hughes et al. 2007) while they could not invade Europe. The failure at invading Europe can also be explained by the current model, viz., that Europe simply lacked the suitable habitat for a cursorial big-game hunter.

How was *H. erectus* able to kill prey larger than their size without projectile weapons and stone-tipped spears? The answer is persistence hunting. As discussed previously, Bramble and Lieberman (2004) show that *H. erectus* was already a good endurance runner. They also argue that this evolved in the context of persistence hunting (Lieberman et al. 2007). The key to persistence hunting is not simply to tire out the prey but to cause heat shock (hyperthermia). This is possible only at running speed because most mammals cannot pant during galloping (Lieberman et al. 2007). In sharp contrast, humans have adaptations like high-density eccrine sweat glands that allow them to dissipate heat during running (Bramble and Lieberman 2004). Thus, early hominids simply “out-thermoregulated” their (large) prey, or put more simply, “out-sweated” them. Prey in hyperthermia faint (as in fact humans do as well—observe exhausted and over-performing marathon runners), and thus prey can be clubbed or beaten to death by clubs or heavy-duty stone axes.

If *H. erectus* was the first successful hominid big-game hunter, then pre-hunt communication and the cognitive machinery behind it must have evolved during the transition from australopithecids to *H. erectus*. The observed non-allometric increase of brain size and the reorganization of the frontal lobe in *H. habilis* (Holloway 1995, 1996), which has the Broca area responsible for speech production, strongly supports this prediction. Australopithecid species were probably habitual bipeds (Ward 2002), but do not show any of the features associated with big-game hunting. They were not adapted to long-distance running. There are no stone tools associated with them. Most importantly, their brain size was close to that of chimpanzees—around 400 cc (Holloway 1995; Tobias 1995). Moreover, their brains do not show any of the features unique to the human brain (Holloway 1995), and as a consequence it is unlikely that their system of communication would have been more complex than existing primate communication systems. As opposed to this there is wide consensus (Holloway 1995; Tobias 1995) that *H. habilis* and thus *H. erectus* (Tobias 1983; Falk 1983) had some form of a communication system between primate communication systems and modern human language. In fact, Holloway (1996: 97) argues that “some form of primitive language was present in early Homo.” According to Holloway (1995), a major reorganization of the posterior parietal cortex took place from a pongid to hominid pattern some 3-4 Mya. He argues that the reorganization involved four behavioral aspects: (1) communication involving multi-model processing; (2) social competence in verbal and non-verbal communication; (3) visuospatial integration related to tool use and making, throwing, and long-term memory of spatial locations; and (4) social intelligence. Reorganization of the frontal lobe, mainly involving the third inferior frontal convolution known as Broca's area, occurred after this event between 2.5 and 1.8 Mya (Holloway, 1995). He concludes that, "Primitive language now had its major neurobiological foundations, and become increasingly elaborate throughout the rest of hominid evolution beginning with *H. erectus*" (Holloway 1995: 50).

All the available evidence, viz., the observed increase of brain size from australopithecids to *H. erectus*, coupled with the reorganization of the frontal lobe involving Broca's area; the adaptation for long-distance running; the use of stone tools for butchery; early carcass acquisition that does not come from scavenged felid kills; the evolution of tapeworms specialized for *H. erectus* as definitive host; the fact that all these changes followed the increase of grassland and bovid species; and the quick spread of *H. erectus* in savannah ecosystems, support the conclusion that *H. erectus* was the first specialized and highly successful hominid big-game hunter.

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