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STONES OF CONTENTION: THE ACHEULEAN HANDAXE LETHAL PROJECTILE CONTROVERSY

by

David R. Samson

Abstract

The function of the Acheulean handaxe is controversial. Several competing usage theories are currently being debated amongst paleoanthropologists. One such hypothesis is the lethal projectile theory. Past experimentation has indicated that the handaxe could have been used as a lethal projectile thrown from a distance to hunt prey. This actualistic study augments such experimentation. The latest argument posed by Whittaker and McCall opposing the utility of the lethal projectile theory indicates vastly different results from O'Brien's experimentation, which was notable for finding that a majority of thrown handaxes landed point or edge first. Whittaker and McCall's study found that a significant proportion of impacts were flat-face landings.

This study increases the data set, using three separate handaxe replicas. It results in an edge/point landing percentage that is comparable to O'Brien's results and suggests that O'Brien's findings are representative of the past situation, although functional hypotheses that support the handaxe as a general utility tool are not discounted. While the evidence produced by this study is equivocal, it generally supports the efficacy of throwing as a function for the Acheulean handaxe.

INTRODUCTION

One of the more controversial lithic tools in the archaeological record is the Acheulean handaxe. There are several competing hypotheses as to its function. The current scientific orthodoxy is that the Acheulean handaxe was the utility tool of the Lower Paleolithic. This theory is supported by actualistic studies that showed that handaxes (and Acheulean cleavers) are effective at slicing through tough hide (Schick and Toth 1993). In addition, microwear studies support the hypothesis that the

handaxe was a general purpose tool for butchery (Keeley 1977, 1980).

Clark (1975) was the first to pioneer the concept that handaxes possessed social or aesthetic functions, but recent studies have gone further, proposing primary handaxe use for sexual selection (Kohn and Mithen 1999) and facilitating communication (Byers 1999). The only direct line of evidence that indicates that the primary usage of handaxes was as a butchery tool derives from use-wear studies performed by Keeley (1977, 1980).

While the handaxe *can* be used to perform the tasks of butchering, cutting, scraping, digging and chopping (Schick and Toth 1993), *Homo erectus* possessed other tools with the potential to perform those functions. Even so, it does not have to be an either/or situation. There is no reason why the handaxe could not have been thrown and then retrieved to butcher a carcass or used to scatter animals from a carcass site. Studies may not be sensitive to this type of variability. In this sense, a pitfall of actualism is the inevitability of engaging in a "Kon Tiki" argument. It is important when weighing the evidence to be aware that, just because it can be shown that it is possible to do something, this doesn't necessarily mean that it was done, unless use-wear or some other means of identifying function can be discerned.

More controversially, beginning with Jeffreys (1965), handaxe function has figured in a hypothesis referred to broadly here as the "lethal projectile hypothesis." Experimentation can measure the handaxe's performance as a thrown implement. Given the results of this and past actualistic studies, a projectile hypothesis should be taken seriously when considering the many possible functions of the Acheulean handaxe. Throwing is one of the possible functions of what was most likely a general utility tool.

HISTORY OF THE LETHAL PROJECTILE HYPOTHESIS

Jeffreys (1965) argued that handaxes (or, in his terminology, "hand bolts") could have been thrown and spun like a knife held from the tip. He suggested further that this technique was probably used to hunt waterfowl, but did not indicate that he performed experiments to test this idea. Nearly twenty years later, O'Brien (1984) conducted the first test of the lethal projectile hypothesis. She used a fiberglass replica of a handaxe and had two student athletes, a discus thrower and a javelin thrower, throw the handaxe replica each in their distinctive styles. O'Brien (1984: 22) summarized her results:

Like a discus, the hand ax spun horizontally as it rose, but changed its orientation in

midair. On reaching its maximum altitude, it rolled onto its edge and descended in a perpendicular position, its spinning motion appearing to decline. Then ... it landed point first, slicing deep into the thawing earth.

When the javelin thrower attempted the overhand throw, it was more accurate, but ultimately unsuccessful. The distance was not as good because the handaxe was difficult to grasp and throw overhand, tiring the thrower after only six throws.

Calvin (1990) argued that "projectile predation" was a key characteristic separating *Homo sapiens* from other mammalian species. His cerebralisation model suggests that the neural connections in the brain needed for accurate throwing are the same as those used for higher-level thought processes (e.g., speaking, mathematics, music), providing a type of "throwing recruitment" on neural machinery. He suggested that the explosive brain growth in the human lineage that occurred during a period when tool development appears stagnant is related to the possibility of long-range hunting, opening a new niche survival strategy (Calvin 1990: 186).

More specifically, Rilling (2004) suggested throwing as a mechanism for the allometrically larger cerebellum in humans as compared to apes. He suggested throwing as a prime candidate for expansion. Given that throwing long distances accurately requires a well-developed cerebellum, if natural selection was pushing for improved throwing abilities in hominids, then the co-functions of the cerebellum would increase in capacity, as well.

Subsequently, Whittaker and McCall (2001) presented a critique of the lethal projectile hypothesis and reverted to the view of handaxe function mainly tied to butchering activities. Their actualistic study was similar to O'Brien's (1984), yet their results showed differences. In contrast to O'Brien's results, in which 93% of landing impacts were edge/point first, 86% of the landing impacts in Whittaker and McCall's experiments were flat-faced. Considering the disparity between the results of these two experiments, an-

other actualistic study seems justified.

MATERIALS AND METHODS

Two subjects were used in these experiments: Thrower A was the author, and Thrower B was Jon Miller. Thrower B had no previous throwing experience, which provided a control factor in contrast to my several years of throwing experience throughout junior high and high school competition in discus. At the time of the study, Thrower A was 21 years old, 1.82 m tall, and weighed 89.81 kg; Thrower B was 22 years old, 1.80 m. tall, and weighed 75.75 kg. The implements used for throwing were three handaxes produced by Dr. Frank Cowan. The size and weight of these tools are summarized in Table 1 and top and side views of handaxe #2 in my experiment are illustrated in Figure 1. In addition, one 1.245 kg rock that had been sparingly knapped was also thrown. The handaxes used in my actualistic study are composed of chert, which was a material commonly used for handaxe manufacture and analogous to the flint used at sites such as Boxgrove, St. Acheul, Caddington, and Lion Springs (Schick and Toth 1993).

The handaxes were thrown side-arm discus style from the front of the discus ring without the full body spin associated with the discus event used to maximize distance. This was done in consideration of the procedure most likely used by hominids in light of the "lethal projectile hypothesis" due to increased accuracy from front-ring throws, which are stationary throws performed without spin. We threw the rock side-arm discus style to compare the difficulty in throwing something that was coarse and barely worked on, in contrast to the more refined Acheulean handaxe. Throws were measured for distance as well as accuracy (Table 2). Accuracy was quantified by measuring deviation from the center line of trajectory, which was determined by bisecting the semi-circle located at the front half of the discus ring and projecting the bisection with a tape measure that spanned the length of the field. Landing impact results were recorded under three categories: flat-faced, edge or point. A point-first landing result was counted only if it landed on the front point of the biface.

This study, which includes 150 throws (75 per thrower) with three separate, morphologically different handaxes, more than doubles the amount

Table 1. Comparative handaxe data

Handaxe	Length (cm)	Width (cm)	Thickness (cm)	Weight (kg)
O'Brien	29	14	4	1.975
Samson - Handaxe #1	16	11	3	.403
- Handaxe #2	17	9	6	.555
- Handaxe #3	15	10	4	.410
Whittaker & McCall - Large	24	14	4	1.457
- Small	17	11	4	.620

Table 2. Thrown handaxe distance mean and standard deviation accuracy, and range in meters. N = 150.

	Distance (mean)	Distance (standard deviation)	Accuracy (mean)	Accuracy (st. dev.)	Range
Samson (n = 75)	41.1	3.8	6.0	5.3	15.2
Miller (n = 75)	28.6	2.7	6.6	4.5	11.5

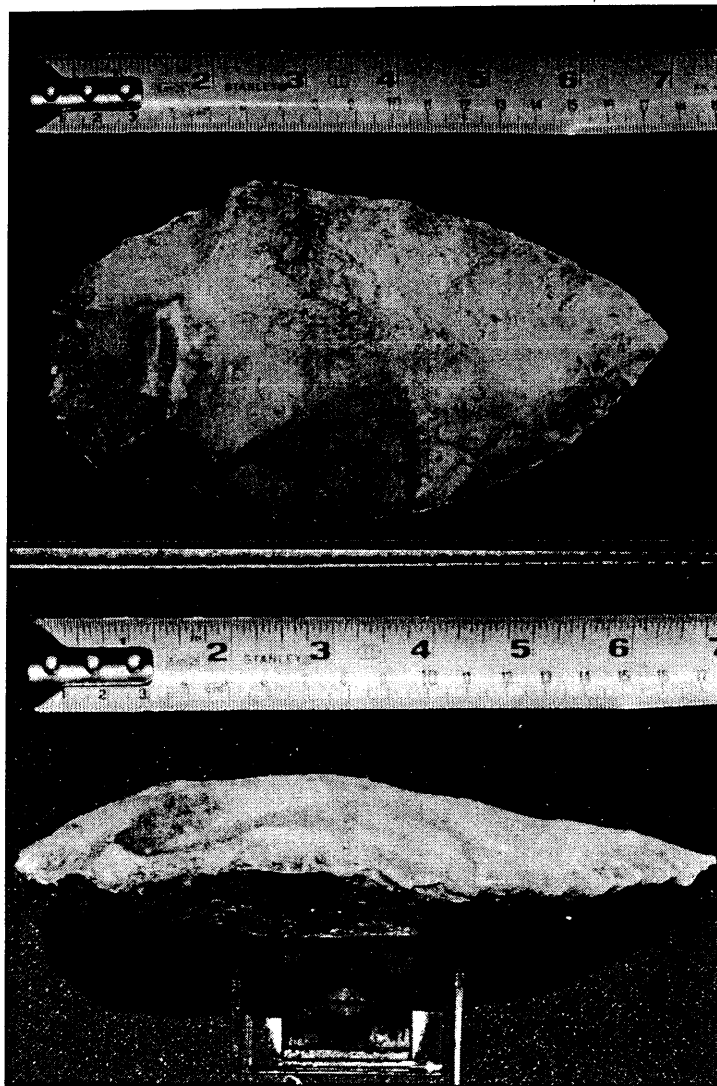


Figure 1. Handaxe #2: top and side views.

of data points presented in past experiments. Given the methodological similarity between the experiments and the goal of estimating a population parameter (edge, flat, and point landing percentage), more data points enables higher fidelity inference because the variability in any sample estimator usually decreases as sample size increases (Fleiss *et al.* 2003).

RESULTS

The mean distance for Thrower A was 41.1 m (standard deviation [s] = 3.8, frequency [n]= 75), while the mean distance for thrower B was 28.6

m (s=2.7, n=75). The average accuracy derived from measurement of deviation right or left of the center line of trajectory was 6.0 m (s=5.3) for Thrower A and 6.6 m (s=4.5) for Thrower B. The range was 33.1 - 48.3 m (r = 15.2 m) for Thrower A and 22.5 - 34 m (r = 11.5) for Thrower B (Table 2).

Out of 150 throws, 120 produced edge/point results, an 80% edge/point landing rate. The majority of landing impacts were edge-first. For Thrower A and B combined, 105 landing impacts were edge-first, 15 were point-first, and 30 landed flat-faced. The rock was recorded at an overall mean distance of 24.9 m. Data for the rock have

been omitted because of an inability to assess landing orientation.

Given a handaxe's six basic surfaces (edge, flat surfaces, proximal point, and distal butt), the probability that it will land edge- or point-first is 67%. A two-tailed exact binomial test (Fleiss 2003) reveals a significant difference between the observed proportion ($120/150 = .80$) and the probability of landing-edge- or point-first ($p = .000$). This means that the edge or point landing proportion (0.80) is significantly greater than the random chance of the handaxe landing edge-or point-first. When this proportion is compared with Whittaker and McCall's results ($10/73 = .137$) using a two-tailed Z-test with a 95% confidence interval, the experiments are significantly different from one another ($z = -12.8, p=0.000$). Distance and landing data are summarized in Table 3.

DISCUSSION

The Experiment

Killing prey from a distance proved a remarkable hominid adaptation. The evidence from this study supports a theoretical model that has hominids throwing from distances of over 40 m. One of the special advantages of throwing is that it circumvents the adaptive advantage of being in a large herd. When herd size increases, the percentage of the herd on the periphery decreases, in turn increasing the survival chances of the average individual. Throwing eliminated the advantage of the two-dimensional system by using a third dimension by use of throwing (Calvin 1990). I refer to the potential effectiveness of the lethal projectile theory around paleo-watercourses, Calvin (1990: 194) used an example from our own military history.

One of the reasons that the cannon was so effective when first introduced was because opposing generals were fond of infantry formations that clustered soldiers together. They make rather easy targets, even for the inexpert gunner – a lesson that I suspect was first learned several million years ago with herds visiting waterholes.

Experience and size are the most probable causes for the difference in throwing distance between the two throwers. The best throw, showing the potential of the handaxe as a lethal projectile, was 48.3 m, with no deviation from the line of trajectory and an edge-first landing.

Unlike Whittaker and McCall's study environment, which was soft and wet, the field on which we threw was hard and dry. Regardless, the edge/point landings produced large scars on the dried earth. The handaxes held up well after 150 throws. None broke, but several showed reduced sharpness of the edges. Additional retouch of the edges would have been appropriate for retaining sharpness.

O'Brien used a fiberglass handaxe replica. Some have asserted that her results are invalid because the material is not analogous to chert or flint, or even stone in general. Another concern regarding past experiments is the appropriateness of the size and skill of the throwers. In O'Brien's study, both throwers were Division I athletes. One of them was 1.93 m tall and weighed 108.86 kg, which is not very representative of *Homo erectus*. Another concern is that past experiments have contained few data points. These differences notwithstanding, the results from this study are statistically comparable to O'Brien's study.

A notable difference between Throwers A and B was the consistency of form in flight. Tosses from Thrower A, who had prior experience, showed consistency in spinning. This results from the release, in which the thrower "squeezes" the projectile as it leaves the hand – a technique that improves distance and is skill-based, requiring practice (Thrower B let the handaxe "glide" out of his hand). Thus aerodynamics plays a significant part in landing orientation and distance. Interestingly, O'Brien's "perpendicular descent" occurred more often with Thrower B than with Thrower A. The amount of forced spin produced by Thrower A's release and the lighter handaxes used (when compared to O'Brien's 1.915 kg fiberglass replica) may have something to do with the higher number of flat-faced landings produced by Thrower A. Results from the use of Handaxe #2 provide a good example of this difference.

Table 3. Comparative handaxe throwing data

Thrower and Handaxe	Number of throws(m)	Mean Distance (m)	Landing %	
			Point/Edge	Flat faced
O'Brien	45	31.9	93.3	6.7
Pipkins - Large - Small	10	30.2	0.0	100.0
	15	41.7	6.7	93.3
Whittaker & McCall - Large - Small	24	18.0	4.0	96.0
	24	25.9	32.5	66.0
Samson - Handaxe #1 - Handaxe #2 - Handaxe #3	25	41.1	80.0	20.0
	25	40.6	60.0	40.0
	25	41.7	92.0	8.0
Miller - Handaxe #1 - Handaxe #2 - Handaxe #3	25	28.5	80.0	20.0
	25	28.5	84.0	16.0
	25	29.0	84.0	16.0

Handaxes # 1 and #3 are both triangular, and had several back-point landings that were remarkable in the way they produced the same deep, point-like scars in the earth as did the front-point landings. While Thrower B remarked that the handaxe produced relatively no major stress on the arm, throwing the rock was exhausting. The rock was not only tiresome because of its weight, but it was ineffective in flight, producing drastically lower distances than the handaxes.

Contrasting Arguments

Whittaker and McCall (2001) present several arguments in opposition to the lethal projectile hypothesis. Their arguments focus on reported inaccuracies in the technique and therefore on the large number of throws necessary to take down an animal. Beginning with their arguments involving the inaccuracy of a thrown handaxe, they admit that they have no experience in throwing implements (Whittaker and McCall 2001: 570). From seven years of personal experience, I can assert that one can throw the discus with relative accuracy, even at distances of more than 30 meters. Accuracy is dictated by the amount of practice a thrower is willing to dedicate to the task. O'Brien (1984:22) found that the handaxe thrown in her experiment was "accurate within two yards right or left of the line of trajectory." Throws in

our experiment deviated from the center line by 6.0 m for Thrower A and 6.6 m for Thrower B.

Regardless of the accuracy that can be achieved with practice and skill when it comes to discus throwing, the size of the target under discussion is not that of a bulls-eye on a dartboard, but a herd of animals that would have ranged several meters in diameter. According to Matson (2003), the black-faced impala *Aepyceros melampus petersi* travel in herds totaling 100 individuals. It is estimated that 50-70% of the total number in the herd remain within 1 km of a waterbed. When congregated by a waterbed, the target for a group of handaxe-hurling hominids would be more than 30 m in length. Figure 2 shows the accuracy and range of throwers A and B projected on a hypothetical paleo-environment complete with a herd of impala.

In reply to a number of handaxes involved, a hunting party of five-to-ten *Homo erectus* could have proven sufficient. Such a hunting party would have left room for error from misthrown attempts and other variables. Hunting, even in groups, is not a phenomenon restricted to our species. It is probable that the common ancestor of chimpanzees and humans hunted in groups (Speth 2002), so *Homo erectus*, a species that had the intelligence to develop Acheulean technology,

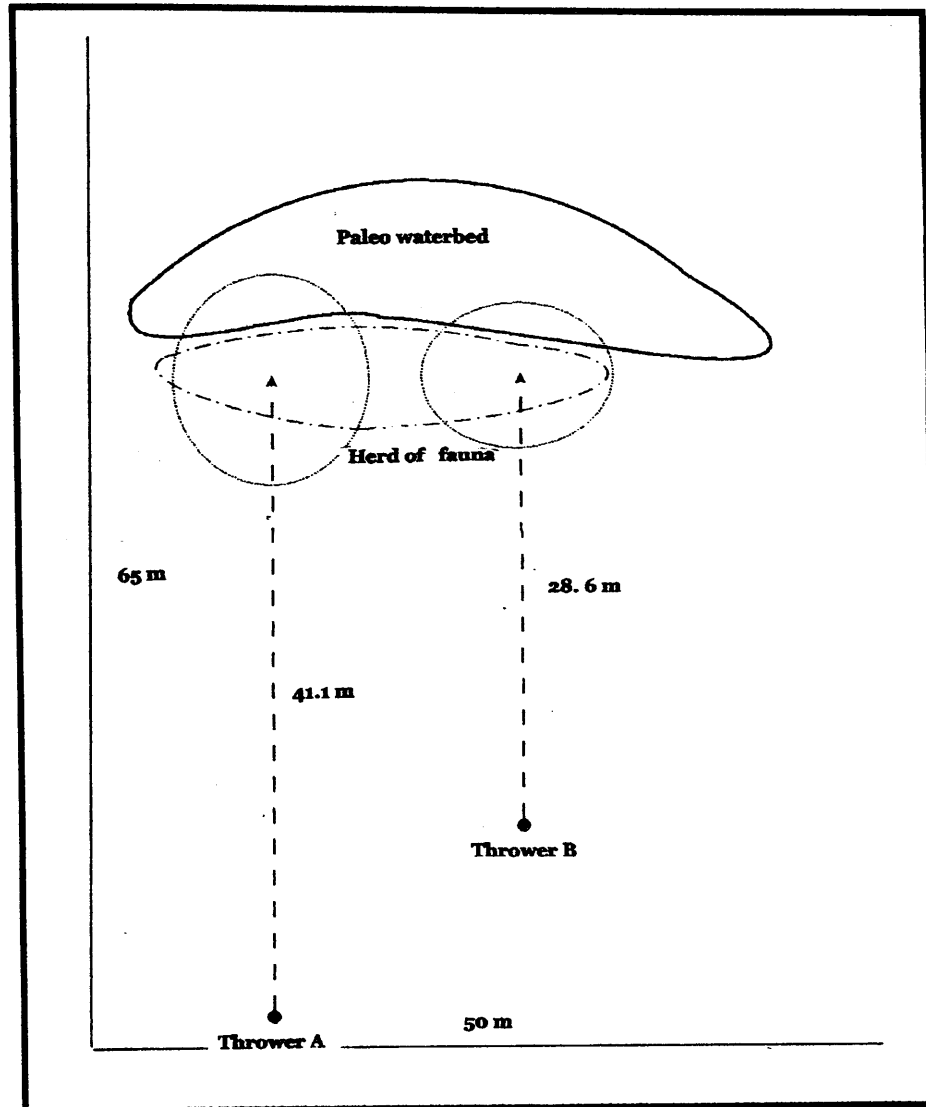


Figure 2. Scaled illustrations of distance, accuracy and range relative to a hypothetical herd.

probably also hunted in groups.

Another argument posed by Whittaker and McCall (2001) involves the variability in handaxe size and weight, and regards the “normal” half-kilogram handaxe too small to be an effective hunting weapon. Calvin (1990) presents an argument that those handaxes that assume the classic form are damaged and have been put into retirement from killing prey. But one must account for variability; it may be shortsighted to assume that hominids of different shapes, sizes, and throwing skill levels threw the same-sized handaxes. In modern discus events, variability in size and weight differ greatly between skill lev-

els. Neophyte throwers begin using a 1 kg discus, while high school throwers may graduate to a 1.6 kg discus. The most advanced throwers at the college or Olympic levels throw a 2 kg discus. With all the variability found among discus sizes and weights today, it makes sense to assume that handaxe variability in the past also mirrored the size and abilities of the wielder.

Whittaker and McCall also question whether a large animal would fall down from a wound on the back – that is, assuming that *Homo erectus* was hunting large game and not smaller prey such as waterfowl. O’Brien (1981) has stated that the average velocity of a handaxe in flight has been

charted at 63 km per hour (36.7 kgF - determination of Impact of Force), enough to tear into the flesh of large mammalian prey, or at least to stun or knock them down to be trampled by the onrush of a frightened herd. Only rarely would a handaxe hit an essential part of the skull or spine, causing death instantly. Yet momentum transfer from the handaxe would trigger the extension of the opposite leg to protect the individual from falling over. Pain caused by the gash created by the handaxe would produce a withdrawal flexion of both hind legs, overriding the extension of the right leg and causing the individual to sit or fall (Wall 1979). This would leave the prey vulnerable to trampling and close-range hunting.

A concern expressed in Whittaker and McCall's experiment was that the back end of the handaxe was too sharp to throw, resulting in damage to the thrower's hands. The handaxes that we threw did not have a dulled base and were quite sharp. Regardless, for the sake of experimentation we decided to throw barehanded. The results proved interesting. On only a few occasions with handaxe #3 did throwing produce any cuts to the skin. After two days of throwing, both of us developed calluses along our index and middle fingers, which provided substantial protection from the sharpness of our throwing implements.

A remarkable aspect of all of these experiments is their disparity. O'Brien observed a 93% edge/point landing, while Whittaker and McCall had a 14% edge/point landing. Given the 80% edge/point landing results of this study, I feel that O'Brien's experiments were the more representative of the two. However, with the analytical focus of previous experiments being on landing orientation, one must be careful not to lose sight of what an edge/point landing propensity means from the perspective of evolutionary adaptation; a handaxe landing edge/point first on prey does increase its lethality. Yet, there are fewer places on an animal that are susceptible to killing blows than the stunning impacts discussed above. In this sense, the "lethal projectile theory" is an extreme expression of general handaxe projectile theory, which encompasses the variation of several different throwing behaviors (e.g., chasing away predators and scavengers, or simply show-

ing off one's physical prowess).

CONCLUSIONS

Just as there is great variability among handaxes in the archaeological record and variability among modern discus sizes and weights depending on the age, size, and skill of the thrower, one may assume comparable variability among the Acheulean hand-axes used by our hominid ancestors. The handaxe is remarkable for its potential flexibility in function. Throwing should be seriously considered one of its many uses.

Several points must be taken into account when analyzing the results of the latest handaxe throwing study. Not only is the sidearm discus throw the most effective way to throw a handaxe, but it is only efficient for a handaxe. A crude tool that does not share the center of gravity and other characteristics of the handaxe will not perform as well in flight. The 80% edge/point landing results indicate that O'Brien's experiment is more representative of reality than Whittaker and McCall's. The correlation between this study and O'Brien highlights the potential for the handaxe to have been used as a projectile.

The lethal projectile hypothesis complements Calvin's cerebralisation model, which indicates a link between throwing and higher-level cerebral function, given the neural recruitment involved in the act of throwing. Throwing may be the mechanism that produced the increase in allometrically relative cerebellar proportions that would "contribute to the information-processing capacity of the brain, and enable a more complex level of response to the environment, something that would consider a hallmark of hominoid behavior" (Macleod *et al.* 2003: 425). This is consistent with the explosive brain growth that occurs during the million year period in which the Acheulean tool kit persists without any major technological improvements, yet the brain size of *Homo erectus* nearly doubles. It does not support the conclusion that techno-organic evolution was the lone cause of brain expansion. Future research should focus on use-related wear of

handaxes within the context of throwing and other functional hypotheses.

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REFERENCES CITED

- Byers, A. M.
1999 Communication and Material Culture: Pleistocene Tools as Action Cues. *Cambridge Archaeological Journal* 9: 23-41.
- Calvin, W. H.
1990 *The Ascent of Mind: Ice Age Climates and the Evolution of Intelligence*. Bantam Books, New York
- Clark, J. D.
1975 Africa in Prehistory: Peripheral or Paramount? *Man* 10: 175-198.
- Fleiss, J. L., B. Levin, and M. C. Paik
2003 *Statistical Methods for Rates and Proportions*. Wiley Interscience, Hoboken, NJ.
- Jeffreys, M. D. W.
1965 The Hand Bolt. *Man* 65: 153-154.
- Keeley, L. H.
1977 The Functions of Paleolithic Flint Tools. *Scientific American* 237: 108-126.
1980 *Experimental Determination of Stone Tool Uses: a Microwear Analysis*. University of Chicago Press, Chicago.
- Kohn, M., and S. Mithen
1999 Handaxes: Products of Sexual Selection. *Antiquity* 73: 518-526.
- Macleod, Carol. E., Karl Zilles, Axel Schleicher, James K. Rilling, and Kathleen R. Gibson
2003 Expansion of the Necerebellum in Hominoidae. *Journal of Human Evolution* 44: 401-429.
- Matson, T. K.
2003 *Habitat Use and Conservation of the Vulnerable Black-Faced Impala (Aepyceros melampus petersi)*. PhD dissertation, School of Life Sciences of the University of Queensland, Brisbane, University of Queensland.
- O'Brien, E. M.
1981 The Projectile Capabilities of an Acheulean Handaxe from Olorgesailie. *Current Anthropology* 22: 76-79.
1984 What Was the Acheulean Hand Ax? *Natural History* 93: 20-24.
- Rilling, J. K.
2004 *Human, Ape, Monkey Brains: Are They Allometrically the Same Design?* Primate Cognition Conference Proceedings, Indiana University, Bloomington.
- Schick, K. D., and N. Toth
1993 *Making Silent Stones Speak: Human Evolution and the Dawn of Technology*. Simon and Shuster, New York.
- Speth, J. D.
2002 *Were Our Ancestors Hunters or Scavengers? Archaeology: Original Readings in Method and Practice*. Prentice Hall, New Jersey.
- Wall, P. D.
1979 On the Relation of Injury to Pain. *Pain* 6: 253-264.
- Whittaker, J. C., and G. McCall
2001 Handaxe-Hurling Hominids: an Unlikely Story. *Current Anthropology* 42: 566-572.