
Article:
Spikins, Penny orcid.org/0000-0002-9174-5168 (2012) Goodwill Hunting?:Debates on the 'meaning' of lower palaeolithic handaxe form revisited. World Archaeology. pp. 378-392. ISSN: 1470-1375

https://doi.org/10.1080/00438243.2012.725889

Goodwill Hunting?: Debates over the ‘meaning’ of Lower Palaeolithic handaxe form revisited

Penny Spikins

Abstract

There has been intense debate over the ‘meaning’ of Lower Palaeolithic handaxe form for more than a decade. Handaxes date from around 1.7 million years onwards, and many show attention to elements of form such as symmetry and a conformity to the ‘golden ratio’ which go beyond immediate function. Our challenge in interpreting such patterning is that we cannot assume a ‘modern’ cognition to the makers of Acheulian handaxes nor capacities to negotiate concepts such as status or symbolism which we use to explain non-functional or elaborate forms in modern contexts. Existing interpretations of handaxe form have been dominated by the seminal ‘sexy handaxe theory’ (Kohn and Mithen 1999) which envisaged the production of handaxes as driven by sexual selection processes common to all mammal species. In contrast it is argued here that an emerging concern with reputation building seen amongst higher primates developed within highly collaborative Acheulian societies into a concern with ‘trustworthiness’ and the expression of ‘gestures of goodwill’ to others via handaxe form.

Keywords

Handaxe, biface, Palaeolithic, reciprocal altruism, collaboration, trustworthiness

The Handaxe Debate

Handaxes, or 'bifaces', are the classic 'type fossil' of Acheulian industries, appearing around 1.7 million years ago in Africa and spreading throughout the occupied world of Africa, Europe and western Asia, whilst being exceptionally rare in Asia beyond the 'Movius line' (Lycett & Cramon-Taudabel 2008). They appear to function primarily as butchery implements, being found in large numbers at some sites. They are ubiquitously present in smaller numbers in Acheulian and many later contexts, though are notably absent in some contemporary assemblages such as the 'Clactonian' in Britain (McNabb 2007) as well as being missing from many initial colonising contexts (Pope et al 2006). Their production is more demanding of both time and patience than preceding flake tool assemblages, as well as demanding an understanding of techniques of manufacture which imply a degree of teaching and learning from others (Shipton et al 2010).

Since their first recovery the appealing form of handaxes and the difficulty of their manufacture has inspired much interest into the possible 'meaning' of these artefacts (Gowlett 1984, Wynn 1995). Indeed the enigma of handaxe form and a continuing fascination into its interpretation is well explained by Pope et al (2006) who conclude that '*the finesse, exactitude and apparent aesthetic sense worked into what are essentially meat knives continues to demand an adequate explanation*' (2006: 45).

Whilst handaxes have always held a certain fascination, the debate over the meaning of handaxe form became particularly heated following what has been termed the 'sexy handaxe theory' put forward by Kohn and Mithen in 1999. Kohn and Mithen (1999) argued that an attention to a symmetrical form in handaxes, in demonstrating a level of skill, would have played a role in sexual selection by demonstrating 'fitness' and thus attracting a mate eager to take advantage of a clear signal of advantageous genes. They made an analogy to the excess resources devoted to sexual selection in a peacock's tale, envisaging mate selection in *Homo erectus/ergaster* being conducted in

a manner similar to that of 'leks' where many males would gather to competitively display to a potential female mates. Attention to handaxe form would have an effect on reproductive success under such a scenario, and be selected for, explaining not only a concern to create symmetrical artefacts but also the large numbers of apparently unused handaxes found at many sites. Where assemblages did not include handaxes Kohn and Mithen argued that sexual selection was at a low level (1999: 523).

Subsequent critiques have focused on different elements of Kohn and Mithen's argument. Most notable has been the reply (also in Antiquity) by Machin (2008) entitled 'Why handaxes are just not sexy', and focused on the lack of empirical support for the theory (a criticism echoed by Nowell and Chang 2009). This reply was countered by a response from Mithen entitled 'Whatever turns you on' in which he provocatively concludes '*Why does it feel so enthralling to hold a finely made symmetrical handaxe in ones hand? ... My guess is that the thrill of holding a finely made symmetrical handaxe is an echo of the Stone Age past, of a time when these objects played a key role in sexual display and to which our modern minds remain attuned*' (Mithen 2008: 768). The debate continued with further discussion by Hodgson (2009) who argued that symmetry could not be reliably linked to greater genetic 'fitness' or attractiveness, and subsequently Hayden and Villeneuve (2009) arguing for a functional role to symmetry in producing a longer lasting edge to a bifacial tool. Debate in *Antiquity* was curtailed by the editor*,* later reappearing in *Palaeoanthropology* where Nowell and Chang (2009) argued contra Mithen (2008) that sites with apparently large numbers of unused handaxes can accumulate through repeated visits, and that little evidence for use-wear may relate to the particular sedimentological conditions rather than being evidence of concentrated manufacture and discard without use.

Other additions to the debate have continued to provide further evidence for an unexplained element to handaxe form, without a coherent alternative interpretation to that of Mithen and Kohn. Notable additions to the evidence include Machin et al.'s (2005) experimental research illustrating

that handaxes are less efficient at butchering carcasses in comparison with simple flakes, as well as more in depth analyses of handaxe form from both global and regional studies. In this context Lycett (2008), Lycett and Gowlett (2008) and Hodgson (2011) discuss the issue of symmetry in more detail whilst Pope et al (2006) illustrates that alongside symmetry a conformity to the 'golden ratio' defines standardised handaxe form across the Acheulian world, with such conformity explored in detail by Gowlett (2011).

An *attention to final form* which goes beyond what might be purely functional and embodies *an aesthetic element and greater costly investment in production than strictly required* by setting remains clear. Since Kohn and Mithen's paper it has been generally accepted that the concept of 'leks' is not supported, and that large numbers of unused handaxes may reflect a low level of repeated use, or the use of handaxes as a potential source for flakes. However not only attention to symmetry but conformity to the golden ratio remains to be explained as common elements to handaxe form. At sites as far apart as Boxgrove in England, Kilombe in Kenya, and Nadaouiyeh in Syria, the ratio between length and breadth of handaxes matches exactly the aesthetic 'golden ratio' of 0.62 (Gowlett 2011; Pope et al. 2006), figures 1 & 2 . This ratio also holds true for a sample of over 8000 handaxes taken from 148 locations across Europe, Africa, the Near East and India (Pope et al. 2006). Where adherence to this ratio is broken, such as at San Isidro in Spain where handaxes are wider than the norm we see adherence to a different local aesthetic (Gowlett 2011). Extraordinary efforts are also made to maintain symmetry despite raw material flaws, with examples of such flaws artificially mirrored on other side of handaxes at the English sites of Boxgrove (Pope 2006) or Elveden (Ashton & White 2003), figure 3, and Isimilia, Tanzania (Wynn 1995: 13), figure 4. Additionally, extreme forms also require explanation. Highly symmetrical handaxes can reach sizes well beyond the functional, such as the 39.5 cm Furze Platt handaxe dating to around 300,000bp from Maidenhead, England (Hodgson 2011: 45). Equally remarkable are particularly small handaxes which have only very recently entered the debate (Petitt and White 2012: 200). Examples only 2-

3cm wide are found for example at Wansunt Pit and Foxhall Road in southern England (for a Middle Palaeolithic example of such artefacts, interpreted as children's toys, see Stapert 2007).

Despite a far more sophisticated understanding of the social lives and social cognition of early hominins (Gamble et al 2011) we have seen little alternative explanation for the form of handaxes. Both Shipton et al. (2009) and Nowell & White (2010) draw attention to the wider context of the emergence of handaxes and the collaborative rather than competitive context in which they appear, though without a clearly defined explanation for attention to shape. There is a sense in which is it is felt that the context of manufacture, apparently coinciding with a key threshold in human social behaviour, may hold the key to the enigma of handaxe form.

The emergence of handaxes in wider context

Attention to additional investments in the shape of stone tools emerges at a distinctive episode within human evolution. Coinciding with the emergence of *Homo ergaster*, the appearance of handaxes follows a period of increasing risks imposed on early human groups from several different elements. Particularly extreme cycles of environmental changes occurred at around 2.5 to 1.2 million years putting considerable pressure on biological and behavioural means to cope with variability (Grove 2011). Exploitation of marrow and even meaty parts of carcasses from at least 2.5 million years ago will also have put hominins under competition with predators, making pressure to collaboratively defend carcasses intense; moreover, the exploitation of open and arid environments is also associated with a greater threat of predation, with subsequent larger group sizes also placing pressure on cognitive means of collaboration (Dunbar 2003). Both biological and social developments suggest that it was at this point that long-term collaborative solutions to risk emerged. The appearance of a larger body form, and increasing reliance on meat to fuel brain expansion (Aiello & Wheeler 1995) implies social capacities to collaboratively hunt or scavenge as well as to deal with meat as a more risky and unpredictable resource than plant foods. Stone tool

production using increasingly distant raw material sources implies collaborative resource acquisition. Additionally, hominin biology appears to have been freed from the normal constraints imposed via individual energy costs of pregnancy and childcare on mothers. Adaptations for endurance running emerge, despite the changes in pelvis shape consequent on this increasing pressures on childbirth, whilst increasingly large brains and increasingly vulnerable young (with greater periods of infant dependency) imply maternal provisioning. Taken together, biological changes imply higher degrees of collaboration to buffer a combination of female energy requirements, exceptionally dependant offspring, and unpredictable food resources (Aiello & Key 2002, Burkhart et al. 2009, Nowell and White 2010).

Archaeological evidence adds to the picture of collaboration emerging to buffer risks, including personal shortfalls or illness. Evidence for care of adults 'in need' date from around 1.6 million years ago with the famous skeleton KNMER 1808. This female *Homo ergaster* survived many weeks despite debilitating illness and must have been supported by others (Walker et al. 1982, Spikins et al. 2010). Other examples of apparent care dating from this period onwards include provisioning of a 'toothless' *Homo erectus* individual in Georgia at 1.77 million years ago (Lordkipanidze et al. 2005). Signs of support for others with infirmities are remarkably common and, indeed, Shang & Trinkaus (2008) note that most Lower and Middle Palaeolithic skeletal materials with trauma show signs of healing. The willingness to tackle large game, and to risk high traumas associated with confrontational hunting or scavenging at this time also document both a tendency to take risks and injuries on behalf of the group, and confidence in support for those who are injured to recover (Spikins et al. 2010). These changes may be linked to key developments in the emotional capacities to form connections to others (Spikins et al 2010) and are potentially central to understanding a concern for non-functional elements of handaxe form.

Emotions, reciprocal altruism and the social buffering of risk

Whilst changes in what has been termed the 'social brain' have been discussed for some years, the significance of emotional capacities for social behaviour and particularly collaboration is a relatively new area of study. This is perhaps surprising as emotional capacities to act in other's interests, rather than 'thinking skills', forms the basis of collaboration in many social mammals (Schino and Aureli 2010). Empathetic concern has been shown to drive pro-social behaviour in rats (Ben-Ami Bartal et al. 2011), as well as elephants, whales, monkeys and apes (de Waal 2008). A tendency to see emotions as the domain of animal rather than human intelligence perhaps explains the rather late attention to emotional changes in early prehistory.

Collaboration through emotional investments in others is fundamental to human societies (Frank 1988, Nesse 2001). This collaboration takes the form of strong *interpersonal (reciprocal) alliances* based on emotional commitments with substantial 'give and take', as well as more *generalised reciprocity* (tendencies to generalised altruism such as giving blood or helping through charities), Silk and Boyd (2010). It is not clear when generalised reciprocity emerged, though one might suggest that its appearance may contribute to the extent of collaboration in Acheulian contexts, nonetheless *reciprocal altruism* has its evolutionary history much earlier than the Acheulian and is shared with other higher primates. Reciprocal altruism depends on *empathetic concern* for others and *emotional regulation*, or self-control/patience, that is the ability to hold one's own or another's emotions in thought without being overtaken by them (Ben-Ami Bartal et al. 2011) and we look for both qualities in who to trust. Long term alliances also rely on a capacity to track the other's behaviour or essentially their 'reputation' in our eyes. Reciprocal altruism is displayed by chimpanzees for example where 'favours' such as grooming, alliance support or sharing of meat are often returned over long time scales (Schino and Aureli 2010).

In the largely stable environments occupied by chimpanzee chimps reciprocal alliances rarely play an important role in survival. However in the risky environments occupied by early humans we might

expect reciprocally altruistic alliances (or even generalised altruism) to become increasingly important to 'buffer' resource variability and changes in subsistence risks. Costly signals of a willingness to collaborate are important in initiating and maintaining such long term alliances (Gintis et al 2001) as signs of the great degrees of 'give and take' needed to ensure that others will be prepared to make the investments to ensure our survival in times of need (Wiessner 2002).

There is good reason to suggest that it is within the context of increased social emphasis on reciprocal altruism and competition for *attractiveness* or to be a *potential ally* rather than for *power* (Gilbert 2002) that we should place the emergence of Homo ergaster, and in turn within an environment of pressure to signal *collaborative potential* within which we should make interpretations of handaxe form.

'Trustworthy handaxe theory'

There are several grounds for suggesting that a concern with symmetry and with conformity to the golden ratio in handaxe form functioned as a signal of *collaborative potential* in Acheulian societies. The emotional capacities expressed in handaxe form, the role of such capacities in reciprocal altruism in higher primates, a greater significance in modern hunter-gatherers and the match between appearance of handaxes and particular social contexts support the argument that such artefacts signalled 'trustworthiness' to others.

'Trustworthy' capacities displayed in handaxe form

Long term reciprocally altruistic alliances in both chimpanzees and humans are forged by many small unconscious gestures of goodwill, or acts of altruism, such as soothing of those in distress or sharing of food (Schino and Aureli 2010), which as signals of 'trustworthiness' contribute to one's reputation or 'trust metric' (Couch and Jones 1997).

A concern with imposing symmetry and shape on handaxes can be seen as one of many possible such gestures of goodwill or 'trustworthiness' to others. Displaying a willingness to go beyond

immediate rational self-interest and to 'care' beyond the immediate constraints of function, both for an object itself (as if it were a living thing which might benefit from such attention) and for others who might use it and be affected by a 'pleasing' form gives a signal of a willingness to be generous in one's attitudes. The building blocks of such non-functional attention to objects is seen for example in the 'nurturance' of sticks like dolls by infant chimpanzees (Kahlenberg and Wrangham 2010). However handaxe form goes beyond a display of 'irrational' kindness in providing a more reliable indicator of collaborative potential than might other 'gestures'. Overcoming the significant frustrations of imposing form on stone also displays considerable emotional regulation (self-control/patience), the personality trait which most correlates with better relationships, greater mental wellbeing and a reduced tendency towards violence (Metcalfe and Mishel 1999), and well as being correlated with other measures of trust such as fidelity to partners (Gailliot and Baumeister 2007). Making a finely formed handaxe effectively signals not only one's attitude to others, but also one's emotional capacity to be a trusty ally (or faithful mate).

Given their use in butchery, one context in which we might imagine handaxes being produced is in preparation for hunting (or indeed scavenging) involving confrontation of large animals. Reaffirming one's alliances by making gestures of one's investment in others, and one's degree of emotional self control through handaxe form might be particularly appropriate in such contexts, especially given the dangers posed by large animals and the level of reliance on trust in one's allies for survival. One would do well to place the greatest trust in an ally who is best able to withstand the temptation to run away at a critical moment!

Attention to handaxe form is also a uniquely useful gesture in being exceptionally durable, potentially identifiable to the owner through either memory of production or unique styles of technique (Pope et al. 2006), and frequently used in a shared context (Nowell & White 2010, Machin 2009). Handaxe form is thus worth taking considerable effort over as it may demonstrate

'trustworthiness' not only in its production, but also each time it is seen again or re-used (when it might remind others once again of the emotional reliability of its maker).

'Gestures of goodwill' in higher primates

As 'gestures of goodwill' or trustworthiness handaxes require no particular leap in cognitive capacities in early humans to those seen in other higher primates, particularly chimpanzees. Collaboration mediated through a measure of reputation built up through altruistic acts can be seen widely in chimpanzee society (Flack & de Waal 2000, Schino and Aureli 2010). Chimpanzees display altruistic tendencies in a variety of situations, such as in hugging the losers of fights (de Waal 2008) or even including costly adoption of infants in need (Boesch et al. 2010). They mentally map the behaviours of different individuals returning 'favours' over relatively long time spans (Melis et al. 2010, Schino and Aureli 2010). Chimps call to significant individuals to share a food source with them (Slocombe et al. 2010) and those who are reluctant to share food will tend to encounter aggression when they beg for food in the future (Flack & de Waal 2000). Those alpha males who show greatest self-control and concern themselves with 'fairness', such as by showing tolerance or breaking up fights amongst subordinate males, have a longer lived period of high status through support from the rest of the group (de Waal 2006) whilst aggressive alpha males have been known to have been excluded from the group (Flack & de Waal 2000). Although there may be a shift in emphasis no great cognitive leap is required of early humans in the suggestion that reciprocally altruistic alliances structured Acheulian societies.

Trustworthiness in modern human hunter-gatherers

Unsurprisingly, 'trustworthiness' developed through many gestures of goodwill to others plays a clear role in individual survival and as a mechanism for collaboration in modern hunter-gatherer groups. Food sharing in such groups is mediated by reputation for generosity for example, rather than any tit-for-tat exchange, or tallying up of contributions (Wiessner 2002: 36). Amongst the Ache those hunters who were seen to be most generous or selfless in sharing their kill were most

conscientiously looked after when ill or infirm and provided with food during frequent shortfalls in hunting success (Gurven et al. 2000). Game targeted by hunters is also more influenced by the potential benefits to a generous reputation than by economic considerations (Wiessner 2009). Conversely, a failure to show concern for others' welfare may result in ostracism (Bird-David 1990), and there are many ethnographic accounts where ostracism and even assassination may result from loss of self-control and displays of anger (Briggs 1970; Boehm 1999; Spikins 2008). Whereas both expressing and being sensitive to 'gestures of goodwill' plays a role in social success in chimpanzees, it is essential to survival in modern hunter-gatherers.

Variations in gestures of trustworthiness in large scale perspective

Gestures of apparently 'irrational' investments in others' interests are clearly more elaborate in modern hunter-gatherers than those seen in the earliest periods of prehistory. Amongst the Jo'huansi for example children are taught from an early age to give non-functional gifts which may take many hours to manufacture (such as ostrich eggshells or beads) as 'gestures of goodwill' to hxaro partners who they will later trust to provide them with food and shelter in times of famine (Wiessner 2002). Over a large time scale we might expect such investments to vary according to the 'riskiness' of the situation, with greater attention to be made to one's 'trust metric' and to expressions of emotional investment in other's wellbeing where reciprocal alliances are most critical to survival. Whallon documents exactly this relationship between exchange of non-functional items and environmental risks in Upper Palaeolithic contexts (2006), whilst in modern hunter-gatherers Weissner documents greater exchanges of non-functional goods where resources are more risky amongst the Jo'huansi (2002). However psychological studies demonstrate that there are limits to altruistic alliances. In extremely harsh conditions 'trust' breaks down as seen in street gangs in the US (Gilbert 2002, 2005) as well as in 'outcast' groups of ostracised individuals amongst the Inuit (Boehm 1999; Spikins 2008). In these situations 'gestures of goodwill' are no longer useful and instead might invite exploitation, potentially providing an explanation for the lack of handaxes in the earliest stages of colonisation of new environments where risks will have been exceptionally high.

Their role as expressions of 'trustworthiness' also explains the remarkable conformity of handaxes over more than a million years. Where one's 'generous' behaviour affects a reputation for being trustworthy and the social support needed for survival, one would be foolish to 'rock the boat' by exploring novel gestures. Only when theory of mind abilities, pressurised by competition for allies into a better understanding of motivations (Nowak & Sigmund 2005), reach a level where reputation can be based on *intention*, rather than behaviour alone, will more novel gestures be possible, perhaps explaining the later proliferation of new forms of handaxes, such as twisted ovates, ficrons and bouts coupés toward the end of the period (Pope et al. 2006) contemporary with changes in theory of mind capacities (McNabb 2007).

Particularly large or elaborate handaxes occurring later in the Acheulian, such as the Furze Platt handaxe, might have been created where a particularly important gesture of collaborative potential was desired, perhaps even with somewhat more conscious intent than that seen in earlier periods. Equally such excessive gestures might be made where a potentially damaging misdemeanour (such as display of anger/loss of self control) warranted particular 'reparative' attention to demonstrating trustworthiness. Miniature handaxes on the other hand might have been created for children, in common with 'toy' artefacts made by hunter-gatherers, and thus illustrate the importance of teaching and learning both emotional self control, and how to use handaxes socially as well as functional items.

Shaping the face of the Acheulian

It is argued here that within collaborative groups of *Homo ergaster* and their descendants, displays of empathetic concern for others and the emotional self-control to act on their behalf were key to the formation of long term alliances and social support. Such capacities were signalled in a concern with the form of handaxes which can be seen as a display of *trustworthiness*. An attention to the shape of handaxes, alongside gestures such as consoling another's distress, giving away food, or

helping those who are vulnerable *appear* to be against immediate rational self-interest. However, whether in chimpanzees, early humans or modern societies they are 'functional' in that they demonstrate a willingness and ability to forgo self-interest for the sake of others, and thus to forge and maintain reciprocally altruistic alliances with much 'give and take'. In this context 'trustworthy handaxe theory' provides a better explanation than existing suggestions for a concern with conformity to the aesthetic 'golden ratio' and to symmetry in handaxe form, for the conservatism of handaxe industries, and for the structure of temporal and spatial variations in handaxe emergence and patterning.

The implication that it was an instinct towards *trust* (rather than one towards *lust*) which shaped the face of the Acheulian is particularly significant in our understanding of such societies, and sets a challenge for developing a social interpretation of material culture in the lower Palaeolithic without recourse to interpretations based on the complex cognitive concepts which structure modern societies.

Acknowledgements

I greatly appreciate the help of those who were willing to discuss ideas, read through drafts, make enthusiastic comments or point out flaws, particularly John McNabb, Mark Edmonds, Anthony Sinclair, Matthew Pope, Isabelle Winder, Andrew Needham and Katie Slocombe. Thanks are also due to Allan Hall for patient proof reading of an earlier version of this document. All errors are my own.

References

Aiello, L. C. and C. Key. 2002. Energetic consequences of being a *Homo erectus* female. *American Journal of Human Biology* 14, 5: 551–61.

Aiello, L.C. and P. Wheeler. 1995. The Expensive tissue hypothesis: The brain and digestive system in Human and primate evolution. *Current Anthropology* 36: 199–221.

Ashton, N. and M.J. White. 2003. Bifaces and raw materials: flexible flaking in the British Earlier Palaeolithic, in M. Soressi and H. Dibble (ed.) *From Prehistoric bifaces to human behaviour: multiple approaches to the study of bifacial technology*: 109–23. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology.

Ben-Ami Bartal, I., J. Decety and P. Mason. 2011. Empathy and pro-social behaviour in rats. *Science* 334: 1427–1430.

Bird-David, N. 1990. The giving environment: another perspective on the economic system of gatherer-hunters. *Current Anthropology* 31: 189–96.

Boehm, C. 1999. *Hierarchy in the forest, the evolution of egalitarian behaviour*. Cambridge MA: Harvard University Press.

Boesch C., C. Bolé, N. Eckhardt and H. Boesch. 2010. Altruism in forest chimpanzees: the case of adoption. *PLoS ONE* 5(1):e8901.doi:10.1371/journal.pone.0008901.

Briggs, J. 1970. *Never in anger: portrait of an Eskimo family*. Cambridge: Harvard University Press.

Burkart, J. M, S.B. Hrdy and C.P. van Shaik. 2009. Cooperative breeding and human cognitive evolution. *Evolutionary Anthropology* 18: 175–86.

Couch, L.L. and Jones, W.H. 1997. Measuring levels of trust. *Journal of Research in Personality* 31: 319-335.

De Waal, F.B.M. 2008. Putting the altruism back into altruism: the evolution of empathy. *Annual Review of Psychology* 59: 279–300.

Dunbar, R. I.M. 2003. The social brain: mind, language and society in an evolutionary perspective. *Annual Review of Anthropology* 32: 163–81.

Flack, J.C. and F.B.M. De Waal. 2000. 'Any animal whatever': Darwinian building blocks of morality in monkeys and apes, *Journal of Consciousness Studies* 7, 1-2: 1-29.

Frank, R.H. 1988. *Passions within reason: the strategic role of the emotions*. New York: W.W. Norton and Co.

Gailliot, M. T., and Baumeister, R.F. 2007. Self-regulation and sexual restraint: Dispositionally and temporarily poor self-regulatory abilities contribute to failures at restraining sexual behaviour. Personality and Social Psychology Bulletin 33, 173-86.

Gamble, C., Gowlett, J., and Dunbar, R. 2011. The Social Brain and the Shape of the Palaeolithic, *Cambridge Archaeological Journal* 21, 1: 115-135.

Gilbert, P. 2002. Evolutionary approaches to psychopathology and cognitive therapy. *Journal of Cognitive Psychotherapy* 16: 263–329.

Gilbert, P. 2005. Compassion and cruelty, in P. Gilbert (ed.) *Compassion: conceptualisations, research and use in psychotherapy*: 9–74. London and New York: Routledge.

Gintis, H., Smith, E. A., and Bowles, S. 2001. Costly Signaling and Cooperation, *Journal of Theoretical Biology* 213, 103-119.

Gowlett, J.A.J. 2011. Special Issue: Innovation and the evolution of human behaviour. The vital sense of proportion: transformation, golden section and 1:2 preference in Acheulean bifaces. *Palaeoanthropology* 2011: 174–87. doi:10.4207/PA.2011.ART51.

Gowlett. J., 1984. Mental abilities of early man: A look at some bard evidence, in R. Foley (ed.), *Hominid evolution and community ecology*: 167-92. London: Academic Press.

Grove, M. 2011. Speciation, diversity and mode 1 technologies: The impact of variability selection. *Journal of Human Evolution* 61: 306–19.

Gurven , M., A-A. Wesey, K. Hill and M. Hurtado. 2000. It's a wonderful life, signalling generosity among the Ache of Paraguay. *Evolution and Human Behaviour* 21: 263–82.

Hayden, B. and S. Villeneuve. 2009. Sex, symmetry and silliness in the bifacial world. *Antiquity* 83: 1163–1175.

Hodgson, D. 2011. The first appearance of symmetry in the human lineage. *Symmetry* 3: 37–53.

Hodgson, D. 2009. Symmetry and humans: a reply to Mithen's 'Sexy Handaxe Theory'. *Antiquity* 83: 195–98.

James, W. 1981/1890. *The principles of psychology.* Cambridge MA: Harvard University Press.

Kahlenberg, S. M. and Wrangham, R. W. 2010. Sex differences in chimpanzees use of play objects resemble those of children. Current Biology 20, 24: R1067-1068.

Kohn, M. and S. Mithen. 1999. Handaxes: products of sexual selection? *Antiquity* 73: 518–26.

Lehmann, L., and L. Keller. 2006. The evolution of cooperation and altruism – a general framework and a classification of models. *Journal of Evolutionary Biology* 19, 1365–1376.

Lordkipanidze, D., A. Vekua, R. Ferring, G.P. Rightmire, J. Agusti, G. Kiladze, A. Mouskhelishveli, M. Nioradze, M.S. Ponce de León, M. Tappen and C.P.E. Zollikofer. 2005. Anthropology: the earliest toothless human skull. *Nature* 434: 717–18.

Lycett, S. 2008. Acheulean variation and selection: does handaxe symmetry fit neutral expectations? *Journal of Archaeological Science* 35: 2640–2648.

Lycett, S. J. and J.A.J. Gowlett. 2008 On questions surrounding the Acheulean 'tradition'. *World Archaeology* 40: 295–315.

Lycett*,S.J. and N.* von Cramon-Taubadel*. 2008.* Acheulean variability and hominin dispersals: a model-bound approach*. Journal of Archaeological Science* 35*:* 553–62.

Machin, A. 2008. What handaxes just arn't that sexy: a response to Kohn and Mithen (1999) *Antiquity* 82, 761-9.

Machin, A. 2009. The role of the individual agent in Acheulean biface variability: a multi-factorial model. *Journal of Social Archaeology* 9: 35–58.

Machin, A.K. R. Hosfield and S.J. Mithen. 2005. Testing the functional utility of handaxe symmetry: fallow deer butchery with replica handaxes. *Lithics: The Journal of the Lithic Studies Society* 26: 23–37.

McNabb, J. 2007. *The British Lower Palaeolithic: Stones in Contention*. Routledge.

Melis, A.P., F. Warneken and B. Hare. 2010. Collaboration and helping in chimpanzees, in E.V. Lonsdorf, S.R. Ross and T. Matsuzawa (ed.). *The mind of the chimpanzee: ecological and experimental perspectives:* 278–393. Chicago: University of Chicago Press.

Metchalfe, J. and Mischel, W. 1999. A hot/cool system analysis of delay of gratification: Dynamics of willpower, *Psychological Review* 106, 3-19.

Mithen, S. 2008. 'Whatever turns you on': a reply to Anna Machin 'Why handaxes just arn't that sexy' *Antiquity* 82, 761-9.

Nesse, R.M. 2001. *Evolution and the capacity for commitment*. New York: Russell Sage Foundation Series on Trust.

Nowak, M.A. and K. Sigmund. 2005. Evolution of indirect reciprocity. *Nature* 437: 1291–1298.

Nowell, A. and M. White. 2010. Growing up in the middle Pleistocene: life history strategies and their relationship to Acheulian industries, in A. Nowell, and I. Davidson (ed.) *Stone tools and the evolution of human cognition*: 67–82. Colorado: Colorado University Press.

Nowell, A. and M.L. Chang. 2009. The case against sexual selection as an explanation of handaxe morphology. *Palaeoanthropology* 2009: 77–88.

Pettitt, P. and White, M. 2012. The British Palaeolithic: Human Societies at the Edge of the Pleistocene World, Routledge.

Pope, M., K. Russel and K. Watson. 2006. Biface form and structured behaviour in the Acheulean. *Lithics: The Journal of the Lithic Studies Society* 27: 44–57.

Shang, H., and E. Trinkaus. 2008. An ectocranial lesion on the Middle Pleistocene human cranium from Hulu Cave Nanjing, China. *American Journal of Physical Anthropology* 135: 431–37.

Shennan, S. 2002. *Genes, memes and human history.* London: Thames and Hudson.

Schino, G., and F. Aureli. 2010. Primate reciprocity and its cognitive requirements. *Evolutionary Anthropology* 19: 130–5.

Shipton, C. 2010. Imitation and shared intentionality in the Acheulean, *Cambridge Archaeological Journal* 20: 197–210.

Shipton, C., Petraglia, M.D., and K. Paddayya. 2009. Inferring aspects of Acheulean society and cognition from lithic technology, in B.S. Blades and B. Adams (ed.) *Lithic materials and Paleolithic societies: Chapter 16.* Wiley-Blackwell, Oxford, UK. doi: 10.1002/9781444311976.

Silk, J. B. and Boyd, R. 2010. From grooming to giving blood: The origins of human altruism, in P.M. Kappeler and J. B. Silk (eds.) *Mind the Gap: Tracing the origins of human universals*. Springer

Slocombe, K.E., T. Kaller, L. Turman, S.W. Townsend, S. Papworth, P. Squibbs and K. Zuberbühler. 2010. Production of food-associated calls in wild male chimpanzees is dependent on the composition of the audience. *Behavoural Ecology and Sociobiology* 64: 1959–1966.

Spikins, P.A. 2008. The bashful and the boastful: prestigious leaders and social change in Mesolithic societies. *Journal of World Prehistory* 2008 (3-4): 173–93.

Spikins, P.A., H. Rutherford and A. Needham. 2010. From hominity to humanity: the prehistory of compassion. *Time and Mind* 3: 303–25.

Stapert, D. 2007. Neanderthal children and their flints. *Pal/Arch's journal of Archaeology of Northwest Europe* 1. 2. 1-39.

Walker, A., M.R. Zimmerman and R.E.F. Leakey. 1982. A possible case of hypervitaminosis A in *Homo erectus*. *Nature* 296: 248–50.

Wiessner, P. 2002. Taking the risk out of risky transactions, a forager's dilemma, in K. Salter (ed.) *Risky transactions: trust, kinship and ethnicity*: 21–43. New York: Berghahn Books.

Wiessner, P. 2009. Experimental games and games of life amongst the Jo'/huan Bushmen. *Current Anthropology* 50: 133–8.

Wynn, T. 1995. Handaxe enigmas. *World Archaeology* 27: 10–24.

Whallon, R. 2006. Social networks and information, *Journal of Anthropological Archaeology* 25, 2, 259-270

Biographical Note

Penny Spikins is a lecturer in Early Prehistory at the Department of Archaeology, York. She has published several volumes on the Mesolithic (including *Mesolithic Europe* (CUP) co-edited with Geoff Bailey, and *Re-thinking the Mesolithic: Environment, Population and Settlement* (BAR)) as well as more recent papers on the significance of evolving emotional capacities in early prehistory (on the dynamics of collaboration and competition (in *Journal of World Prehistory*) on the origins and role of autism (in *Cambridge Archaeological Journal)* and, with Holly Rutherford and Andrew Needham, on the evolution of compassion (in *Time and Mind*)).