What is special about human tool use?

“Technology is probably the most significant element in determining what we are today, not just in forming modern civilisation, but in directing the course of our evolution from an ape-like ancestor” (Schick & Toth, 2000)

“Man is a tool making animal” (Benjamin Franklin, 1706-1790)

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What is special about human tool use?

- Over the last 4my humans have evolved from small-brained, fruit-eating, bipeds, to large-brained bipeds who dominate the planet.
What is special about human tool use?

- We have acquired new technological skills: new means of procuring & preparing food, new types of social organisation, and new levels of intelligence & communicative skills
What is special about human tool use?

Humans have expanded to virtually every habitable part of the planet (habitable is defined by our technology), but chimpanzees are still fighting for survival

Why?

…the technological path we took has separated us
…without this hominins might still be striving for survival on the African savanna or be extinct
What is special about human tool use?

...we can’t live without them

Life expectancy over last 3my
What is special about human tool use?

......its origins and development
Aims of lecture

• Who were the earliest tool makers?
• What types of implements did they have?
• How were they made and used?
• What was life like for our early tool-making ancestors?
• How do early hominin tools compare with technologies among non-human animals?
• How did tools give hominins such an advantage in terms of survivability and increased reproductive success that was selected by evolution?
Definition of tool use (Beck, 1980)

• The tool must be:
  – free of any fixed connection to the substrate
  – outside the user's body at time of use
  – not attached part of the users body,
  – may or may not be animate

The user must:
  – hold or carry tool prior to use
  – establish the proper and effective orientation between the tool and the incentive, (includes alteration of the form/position/condition of another object, organism, or the user)

Tool manufacture:
  – "any modification of an object by the user or a conspecific so that the object serves more effectively as a tool" (Beck, 1980)
We are not alone!

• Mud wasp: hold small unmodified pebbles in jaw to tamp down mud for nest construction

• Galapagos island finches: use spines from cactus plants to probe for burrowing insects inside trees. Insects sense an invader and latch onto cactus spine, finch withdraws it and eats it

• Californian sea otters: crack open clam shells using unmodified stone hammers or anvils

• < 20 non-primate animals that use tools, but
  • remarkable diversity of species
  • separated by long periods of evolutionary time, (>100my)
  • each tool using animal has many closely related species that don’t use tools
• tool use = developed independently in unrelated species
## Tool use in wild apes

<table>
<thead>
<tr>
<th>Tool/behaviour pattern</th>
<th>Chimp</th>
<th>Bonobo</th>
<th>Gorilla</th>
<th>Orangutan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sticks as probes for insect fishing/honey extraction</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wadded leaf sponges</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Leaf vessels to hold food/protect hands</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Leaves as rain hats</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Leaves wiped/rubbed on body</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Branches dragged, torn, dropped in display</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Branches, rocks as hammers for nut cracking</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Roots, rocks as anvils for nut cracking</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocks, branches waved, thrown at opponents</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Tool use hierarchy

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Use</th>
<th>Timespan</th>
<th>Modification</th>
<th>After use</th>
<th>e.g.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>single</td>
<td>immediate</td>
<td>no</td>
<td>thrown away</td>
<td>brandish a stick in defence</td>
</tr>
<tr>
<td>-</td>
<td>many</td>
<td>immediate/future</td>
<td>no</td>
<td>kept for next time</td>
<td>kerosene cans; horseshoe fungus (fire)</td>
</tr>
<tr>
<td>-</td>
<td>single/many</td>
<td>immediate/future</td>
<td>shape to increase efficiency</td>
<td>kept for next time</td>
<td>flake</td>
</tr>
<tr>
<td>tool manufacture</td>
<td>Many</td>
<td>future (collect raw material to make tool in advance)</td>
<td>yes</td>
<td>keep tool &amp; materials to make tool</td>
<td>Arrows -(wood, feather, tendon fibres, bluebell bulbs)</td>
</tr>
</tbody>
</table>
Australopithecines

- Indirect evidence: → hand bones of *A. afarensis* (Lucy, 3mya) = apelike: curved phalanges, thin tips to the fingers and a short, non-opposable thumb
Australopithecines (Paranthropus)

• Robust australopithecine hand bones from Swartkrans (1.7mya) = more human like:
  – thumb is longer and more mobile
  – fingertips are broader \( \rightarrow \) associated with the supply of blood vessels and nerve endings to sensitive fingerpads
  – = robust australopithecine probably had sufficient manipulative skills to enable stone tool making

• Supported by recent discovery of bone digging tools

• But, digging sticks could have been made by Homo, whose fossils are also known at Swartkrans

• Was the fossil hand bone Au. or H.?
Homo habilis

• Oldowan technology (2.6 -1.5 mya)
• Lake Turkana (Olduvai Gorge) - Kenya, Hadar - Ethiopia
• Swiss army knife with 6 attachments

(left to right): end chopper, heavy-duty scraper, spheroid hammer stone, flake chopper; bone point, horn core tool or digger
Homo habilis….or not?

- *Paranthropus boisei* and *H. habilis* were contemporary at Olduvai for 1.4m years
- Difficult to separate out remains –
  - Who made tools? Hh/ Pb/ both?
  - *H. habilis* = > brain size than *Paranthropus boisei* (Zinjanthropus) that Mary Leakey decided had to be the tool maker
  - *Paranthropus* may have used them????
- Did one species scavenge prey off the other?
- Were hominins preying on hominins?
Experimental analysis

Nick Toth:

• small flake:
  – Slice through hide
  – Dismembering, and defleshing (human teeth and fingers inadequate)

• large flake or chopper:
  – Chopping residual dried meat from a scavenged carcass

• heavy core / unmodified cobble
  – breaking bone to gain access to marrow or brain

• unmodified stone hammer and anvil: crack nuts

• antelope horns and large broken bones = digging implements

• manufacture of digging sticks achieved:
  – sharp edges chopper - cutting a suitable limb from a tree
  – flake for fashioning point
  – rough stone surface for honing point
Microwear analysis

- Lawrence Keeley - 54 flakes from Koobi Fora (E. side of Lake Turkana, 1.5mya). Evidence of use-wear on 9 tools: 4 - butchering, 3 – wood, 2 - soft vegetation
Significance of stone tools

- Small, sharp flake = technological and economic revolution → significant quantities of meat
- Digging sticks permitted efficient access to underground food resources, e.g. tubers
- Enriched diet & less seasonal = important in further expansion of the brain
Homo erectus

• 1.9mya – c.300, kya
• glaciations from 2.4mya
• intense climatic swings
  – drop in global temperatures
  – ocean levels dropped ca.100m – expose continental shelves & create land bridges
• out of Africa (by 1.8mya – SE Asia)

...what allowed such phenomenal geographic spread and species longevity?
Homo erectus

• 1.9-1.5mya HE cont. to use Oldowan technology
• 1.7 – 1.4mya → Acheulean industry: bifacially flaked tools
• Top-of-the-line gadget…the hand axe
• 1st fully conceived implements
  -final form is regularly patterned, not suggested by shape/ exterior texture of stone made from
Homo erectus

- Oldowan: hit the stone = sharp flake you could cut with it

- Acheulean: shaped implements for specific tasks, flaking all edges, worked to get longer, straighter and sharper implements
  - Need expertise & knowledge of lithic technology
  - Wear patterns – “habitual and systematic butchery, and especially the dismembering of large animal carcasses” (Schick and Toth)
  - Strong dietary shift towards more meat consumption
Movius Line

- Acheulean tools were found throughout Africa, Middle East, Europe and W Asia, but, absent in Far East and SE Asia –
- Striking overlap with natural occurrence of bamboo

- Bamboo can be used to make almost anything including stick knives that can be used to butcher animals
Role of shelter in geographic spread & species longevity

- 400,000 – 300,000mybp Terra Amata (under Nice)
- *Homo erectus* or *H heidelbergensis*?
- 1960’s by Henry de Lumley – ancient postholes & concentrated artefacts of several huts (6-15m long x 4-6m wide)
- De Lumley: roofs supported by 2 or more large posts, walls made of saplings and branches. Hold c.15 people
Role of fire in geographic spread & species longevity

- Terra Amata: in the centre of each reconstructed hut was a hearth (compact area of baked & discoloured sand), some hearths ringed by windscreen of stones.
- No evidence of cooking, fires burnt for warmth.
- Around one hearth impressions on the floor that were apparently made by animal skins, - did inhabitants sleep by the fire at night?
Conclusion

• From 4mya to 400kya technology increasingly allowed hominin populations to adapt by manipulating, transforming their environment, rather than their biology, to survive and reproduce

• Technological developments, and particularly tool use transformed human ancestors from small brained, fruit eating, bipedal apes at the mercy of environmental change, to large-brained, cultured bipeds who dominate the planet