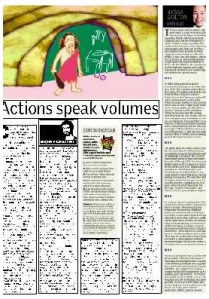

Canberra Times
10-May-2010
Page: 7
Times
Region: Canberra
Circulation: 33511
Type: Capital City Daily
Size: 580.97 sq.cms
MTWTFS-

Actions speak volumes

Cartoon cavemen typically don't say much more than "ugga ugga", but the conversation around a Paleolithic campfire could have been much more subtle and sophisticated. Classical language theories point to human speech as being the jewel in our evolutionary crown, but the timescale of this ability is problematic.

The human larynx (or voice box) only became capable of its wide vocal range about 200,000 years ago yet our early ancestors were making complex tools and living in advanced societies long before this. *Homo erectus*, for example, may have made have the dangerous sea crossings to reach to Polynesia as far back as 700,000 years ago, but how did these early humans communicate such detailed plans if they weren't able to talk?

And how could the larynx of modern humans (*Homo sapiens*) take its lowered position next to the oesophagus to make us the only animal species at risk of choking on our food?

Natural selection would have frowned on this development were vocal communication not able to provide immediate benefits to human survival. This suggests vocal communication must have been able to "piggy back" on some language system already evolved in the brain.

One clue comes from language studies with our chimpanzee cousins. Although there has been no success in teaching chimps to talk, they are capable at learning sign language as adeptly as a human infant.

Further, human babies born to deaf parents specifically imitate the intentional hand signals involved in sign language but not random gestures, suggesting that they are sensitive to linguistic rhythms whether spoken or not. Such observations have led to a theory that human language originated through hand gestures and facial expressions well before it was capable of being voiced.

The instructions for producing speech are generated in a region at the front of the brain called Broca's area, which is highly specialised in humans and lateralised to the front left half of the brain. Patients who have damage to this region struggle to produce sentences with the correct structure or syntax.

The equivalent brain region has also been studied in monkeys, although they produce very simplistic vocalisations. This region contains cells that become active when the monkey performs movements associated with food handling.

Some cells represent manual actions such as grabbing a branch or bringing it to the mouth while others represent facial gestures like kissing (lip-smacking) or grimacing. Most surprisingly, some of these cells also respond when the monkey observes these actions being performed by another individual and have therefore been called mirror neurones.

Remarkably these cells can still recognise an action when the outcome is hidden from the monkey suggesting that the viewer "fills in" the goal of the other's behaviour.

Similarly functional brain imaging studies in human subjects have shown activity in Broca's area specifically when the subjects observe a picture of a hand using a tool but not when it shown simply touching the tool. This brain region is apparently sensitive to the intentions of the observed individual. We take it for granted that the recognition of facial expressions immediately gives us a sympathetic insight into another's emotions. Similarly it is thought that understanding speech depends on mirroring in our own brain the motor patterns that would produce the sounds we've heard. Indeed, researchers have been able to detect tiny "sympathetic" electromagnetic signals from the tongue muscle of a person made to listen to the sound of speech.

It is often said that the use of tools and development of language were driving factors in human evolution, but what is the connection between these very distinct behaviours? One glaring link is that language processing occurs largely in the left half of the brain, which is also dominant in hand control for right-handed people. This right-hand dominance might have emerged from the need to control tools with greater dexterity while holding another object more passively – imagine chipping a stone knife or skinning an animal. Tool handling and its actions on other objects could have forced early humans to understand a whole new library of causal relationships, to think bit more deeply about "who did what to whom using what".

This sort of Caveman Cluedo may have laid out the cognitive grammar that preceded the language systems found in modern human brain. Brain casts show that brain volume had doubled from the beginnings of tool manufacture some 2.5 million years ago to evolution of *Homo erectus*. The brain volume of *Homo sapiens* is another 50 per cent greater again and most conspicuously so in

the left frontal part of the brain.

So if early human languages depended not on speech what would they have sounded like? The earliest communication may have used facial expressions to give emotional content to gestural pantomimes – much like asking for directions to a good restaurant in a country where we don't speak the local language. These facial gestures might then have developed a bit as complex as our own, and have provided further support for the old adage that actions speak louder than words.

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