# imagination and rationality

Alan Dix

Lancaster University
alan@hcibook.com
http://www.hcibook.com/alan/

## seeking crossings

It is generally agreed in psychology that we have several different kinds of 'intelligence' or types of cognitive abilities that are associated with specialised situations: social sense, naive physics, numerosity, etc. This view is supported by factor analysis of different types of 'intelligence' tests and central to the work of Gardner [[G83,G93]] and evolutionary psychologists such as Cosmides and Toby [[C89,TC97].

In "The Prehistory of the Mind" [[M96]] Mithen argues that one of the crucial human developments has been the integration of these different intelligences, which in other animals including early hominids were distinct and unable to 'communicate' with one another. In other words the defining human cognitive accomplishment is joined up thinking!

Mithen's analysis is not merely speculative, but based on detailed analysis of the palaeontological record. Early hominids over a million years ago were able to shape flint tools showing advanced forethought. Indeed even chimpanzees do this in the wild, selecting sticks of an appropriate size and shape, stripping them of leaves and breaking them to length so that they can later be used to dig out termites. Tool making itself is complex, but not uniquely human. However, but it was not until around 60-70,000 years ago that modern homo sapiens tied flint heads to wooden handles to make better axes or spears. This is seen as evidence that wooden sticks (previously living things) could now be thought about together with physical (non-living) stones.

Similarly it is only recently that we see the making of clay or stone objects that represent animals or people and the emergence of cave art. The representing of an animate thing (creature or human) using an inanimate medium (clay, stone or paint) again shows evidence of joined-up thinking.

To describe the cognitive architecture of the mind Mithen uses a metaphor of a cathedral with (in order of evolutionary development) a nave of 'general intelligence'[1], several chapels for the specialised intelligences, and a 'super chapel' of meta-representation where the differing intelligences can intermingle with each other leading to 'cognitive fluidity'. This imagery draws on the developments of Gothic architecture where the sections of the cathedral which were separated in earlier styles were linked and opened out into a central area where light flowed freely from one to another.

The central and essentially human area is the 'super chapel'. This Mithen associates with Sperber's 'module of meta-representation' a place where we represent facts about representation itself [[S94]]. This also reflects Karmiloff-Smith's developmental view where 'representational redefinition' emerges from more differentiated abilities during childhood [[K92]].

Mithen mainly traces when this 'super chapel' of cognitive fluidity appeared, but does not discuss in depth what this comprises except in reference to Sperber and some suggestion about the relationship with language [[M96, p. 222]]. It is the nature of the link point between intelligences that I will explore in this essay.

One minor point before continuing is that Mithen's 'super chapel' appears to be an invented word, but the central point at which the nave, transepts and chancel meet is called the 'crossing' in architecture. The point of meeting of the people and priesthood, spiritual and secular, profound and profane. Whereas the idea of a 'super chapel' suggests something super ordinate (perhaps a clerestory[2]) I will suggest that some of these points of meeting are more mundane and so perhaps the seeking of this crossing, or perhaps crossings is a more appropriate metaphor.

## logic and rationality

One of the most obvious ways in which we pull together different types of experience is in logical thinking. For Gardner it is just one of the kinds of intelligence we have, but from Aristotle onwards it has often been regarded as *the* way of clear and reasoned thinking. Indeed many psychological studies of human reasoning are about the way in which we reason imperfectly about the world and the explanations for this [[M00]]. Note especially the felt need in this literature to explain deviations from pure logical reasoning.

It should be noted that computational devices (both artificial intelligence and more prosaic algorithms) that adopt purely logical thinking about problems universally fail when faced with complex problems or ones which involve unknowns. For the omniscient and infinitely patient logic works, but in the press of reality reasoning ceases to be reasonable.

However, logical reasoning is powerful as it does, to a large extent, transcend specialised intelligences to deal with matters of virtually any kind in any domain. Consider the syllogisms in Box 1, all examples of modus ponens. The first is the classic example of Aristotle; the subject matter is a person, Socrates, and a human property, mortality). The second is about a stone. Note that the same syllogism deals equally well with the human and the inanimate which would otherwise recruit very different kinds of innate intelligence.

The subsequent examples become more and more abstract. The third is about an activity, writing. The fourth is about a class of property, colour, and the properties of that class, ability to visualise. That is it is about properties of properties. Finally the last is about the idea of a 'moral issue' and the properties of that idea.

all men are mortal
Socrates is a man
therefore Socrates is mortal

all stones are hard
the thing in my hand is a stone
therefore the thing in my hand is a hard

writing is enjoyable
what I am doing now is writing
therefore what I am doing now is enjoyable

colours are easy to visualise
red is a colour
therefore red is easy to visualise

moral issues are hard to agree about
abortion is a moral issue
therefore abortion is hard to agree about

Box 1. Syllogisms

It is this domain neutrality of logic that makes it a potential focal point for different kinds of intelligence. Knowledge from different domains can be coded neutrally, combined with one another and the results re-interpreted in the appropriate specialised domain.

For example, imagine Brian has said something to upset Alison and she is in a different room. Brian's social intelligence knows he must apologise to her. This can be encoded logically "in order to be in Alison's good favour I must apologise". However there is also knowledge about the state of the world "Alison is in another room" which then combines with encoded domain knowledge about the physical world "in order to be in a different room you must go there and open the door". So Brian's logical reasoning tells him that he needs to open the door of Alison's room, which can then be translated into action by his physical and motor capabilities.

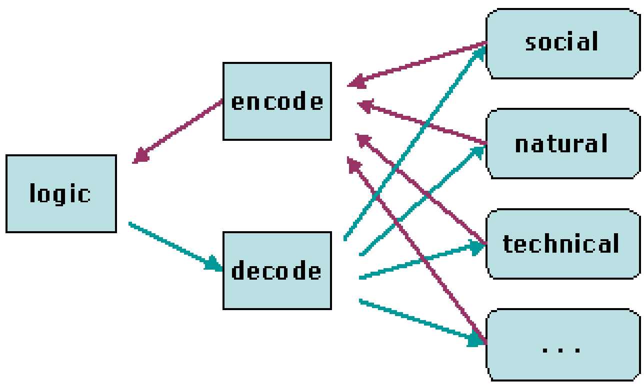


Figure 1. logic as the focus

Now this is probably close to how people do reason about particularly abstract problems, and certainly close to how we may account for our actions to others, but sounds a somewhat contrived account of what actually happens in this situation!

Despite this caveat, although this is not the universal point of crossing between intelligences it is certainly one point of crossing.

## the world kicks back

A more likely account of the apology scenario is as follows:

- Brian knows he needs to apologise (social intelligence)
- He wants to go and talk to her (social)
- He starts to go (action)
- He finds a door in the way (the real world)
- He realises he needs to open the door (technical)
- He opens the door (action)
- He finds Alison (real world)
- She shouts at him for entering her room (social)

Notice that Brian does not pre-reason that he needs to open the door, but it is when he encounters it he realises it is necessary. Each individual action is dependent only on one or other form of intelligence, but the different forms coordinate through action in the real world.

This view of reasoning through interaction with the world is the fundamental principle of situated action [[S87]] and of distributed cognition [[H90b]]. Traditional cognitive models (caricatured) regard cognition as the building of internal models of the world within individuals' heads who then plan their actions. In contrast distributed cognition regards cognition as something that happens as an emergent property of the interaction between groups of people and their environment. In fact more traditional models of cognition have also sought to model this more interactive mode of thinking [[H90]].

In the scenario the world can act as the meeting point between intelligences in two ways.

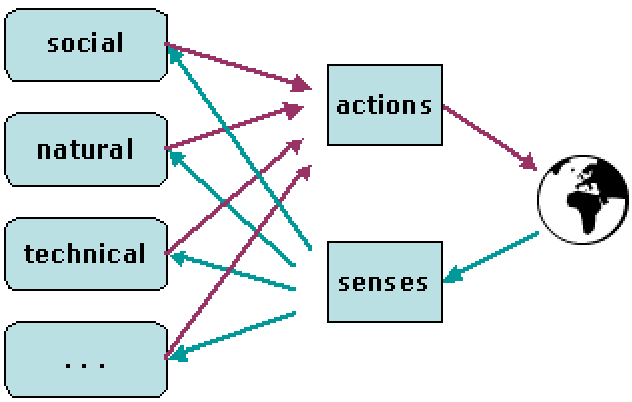


Figure 2. the world kicks back

First the sensorial data from the world is available to all innate intelligences (or at least to several forms). For example, whilst Brian is approaching Alison's room, a friend, Clarise starts to enter the flat by another door. Brian's technical intelligence says "if you open both doors the wind will slam one of the doors". At the same time his social intelligence may make him want to hurry to calm things with Alison before Clarise notices something is wrong.

Second the actions prompted by one type of intelligence are available (by internal kinaesthetic sense and through their effect on the world) to all other parts of our mind. So, the act of getting up to cross the room is sparked by our social intelligence, but available to our technical intelligence.

This integration of thought through action is seen in the simplest of creature. The sensor–action reactions that prompt the flagella towards fruitful areas need not be connected to the mechanisms that ingest food sources. Joined up thinking is not essential as they live in a joined up world.

Unfortunately this lived cognition has limitations and Alison's reaction cannot be foreseen before Brian opens the door (although his social intelligence will predict it as soon as the door is open even before she shouts).

To foresee requires imagination.

## imagination kicks back

Imagination is all about internals, things in our heads, the unreal, poetry and art, the, well, imaginary. In fact imagination is remarkably solid.

Brain scanning technology now means we can see which parts of the brain are used when performing different kinds of tasks. The equipment to give the most detailed images is very large and very expensive. Furthermore the large magnets mean that anything metal or electronic cannot be used. So some experiments are still not possible. Also the pictures of brain activity need to be read very carefully, but compared to the previous knowledge that relied largely on accident victims who had destroyed specific parts of their brains, the level of knowledge gleaned in the last few years is phenomenal [[C00]].

One experiment involved imagination. Subjects were placed in a brain scanner and then shown a picture of a landscape. Different parts of the brain 'lit up' (activity). This started with the visual cortex and then included areas of 'higher level' cognition. The subjects were then asked to imagine the same picture. The same areas of their brain lit up, including the visual cortex – that is the part where visual information is first organised in the brain. To a large extent it was as if the subjects were really 'seeing' the image they imagined.[3]

This experiment only concerned vision, but if the same were true of other senses it would mean that the imagined

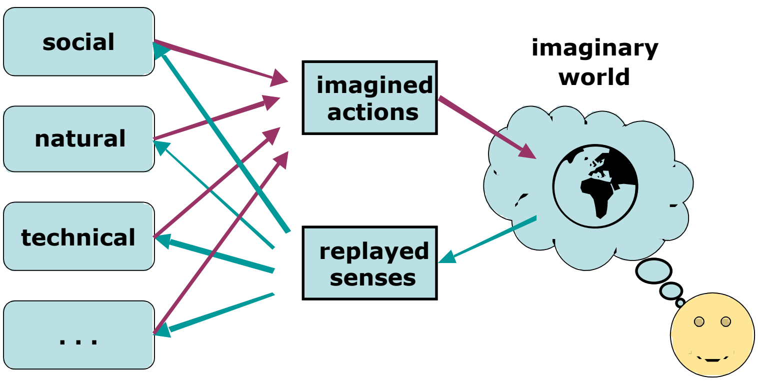


Figure 3. imagination kicks back

experiences were effectively 'played back' through the sensory system just as if they were really happening. Because of this they become available to all our types of intelligence. When these are future imaginings, potential actions, our different intelligences are able to fill in the details.

Let's replay the scenario now with Brian using his imagination:

- Brian knows he needs to apologise (social intelligence)
- He wants to go and talk to her (social)
- Imagines going (imagined action)
- He 'sees' the door is in the way (spatial knowledge)
- He realises he needs to open the door (technical)
- He imagines opening the door (imagined action)
- He imagines finding Alison (spatial knowledge)
- He realises she will be angry at him (social)

If imaginings only took place within the type of intelligence they started in Brian could just imagine going to Alison and never realise that the door was in the way. However, because the imaginings are 'as real', his understanding of physicality and spatial location are able to 'see' that the door will be in the way – imagination kicks back, just like the real world does. Similarly, his social understanding is able to predict Alison's reaction at him coming into her room uninvited. To the extent that we can predict others actions, they too 'kick back' against our immediate desires.

So, the imagined world acts as a locus for combining understanding, just like the real one.

## opposite poles

So, this leaves us with two very different ways bringing together multiple intelligences: through rationality and through imagination. One might be tempted to think of these as almost left and right brain ways of connecting! Certainly they seems poles apart in terms of the way we view people and cognition – one very formal or scientific, the other more intuitive and creative.

In fact, real thinking uses aspects of both and also real world interactions. Even something as formal as mathematical proof involves imagining sets, vectors, abstract structures and of course lots and lots of paper.

However, they still do seem very distinct – two 'solutions' to the same problem co-existing. But perhaps not quite so different after all ...

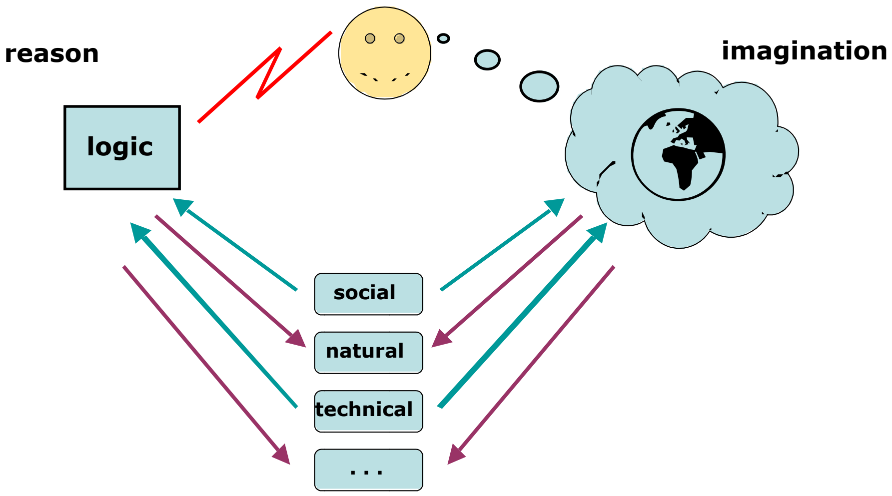


Figure 4. two crossing points, but poles apart

## story

At the same time as stone axe heads were tied to wooden handles with animal gut, at the same time as funereal rites developed, there were also revolutions in social structure. This change is often attributed to language, or perhaps language is due to the change .... or perhaps, even more likely, the two grew in mutually reinforcing one another.

So by fire light under the ageless stars our early forebears, children of that socio-linguistic Eden ... talked: stories of hunting, of the seasons, plans for the future.

As we tell stories we use imagination to call into mind past events or potential things in the future. But to communicate this imagining the ideas must become words: stone, deer, child, ear, moon – the gamut of human existence each represented by sound. Does this sound familiar? Of course, it is the same kind of integration that we see in formal logic and reasoning, the reduction of diverse experiences into a common 'form'.

Although this isn't the whole story, certainly the representation of concepts and things in words is a key part of our ability to reason in a more formal way. We now use many sophisticated notations and diagrams to discuss concepts, but these began in language round the fireside and cave art.

In fact there are two things going on here. One is the representation of things in worlds and the other is the ability to see tokens as representing things. If three stones are placed on the ground around a pine cone to represent three hunters capturing a goat, this is tokenising too.

Which came first? Can we tokenise because we can talk, or can we talk because we can tokenise? Both are about communicating, so perhaps the two were concurrent.

Certainly though it seems likely that narrative and conversation are a bridge between imagination and reason, not just for us now, but developmentally for us as human species.

Imagination is necessary for narrative and it is in putting of these thoughts into words that we gain an externalised token, the word or name, which can be used and reasoned with in a way independent of the kind of object or idea represented by the word.

Imagination is the mother of reason and language is its midwife!

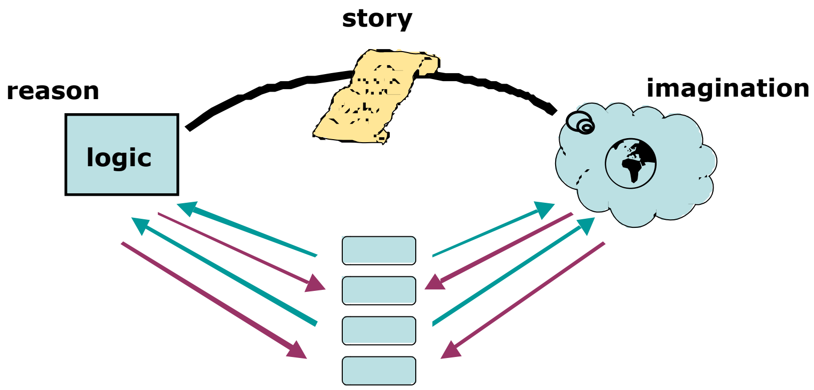


Figure 5. joined in story

## joining points

In summary we have seen that logical reason, the lived world and the imagined world are all points where our multiple innate intelligences can meet. Imagination lines the real world to our internal thoughts beyond the immediate lived moment. Language, narrative and conversation are a link between imagination and logical reasoning.

## Notes

1. Note that the phrase 'general intelligence' here is not meant in the sense of g in IQ tests, but perhaps closer to the generic learning ability that even the simplest animals exhibit in stimulus-response learning.

2. The clerestory is the high gallery that runs above many cathedrals. See [[E02]] for definitions

3. Edelman considers that it is feedback between neoron layers (which he calls reentry) give rise to consciousness [[E92]].

# Bibliography


[[C00]] R. Carter. Mapping the Mind. University of California Press. 2000.

[C89]] L. Cosmides, The Logic of Social Exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. Cognition, 31:187–276, 1989.

[[D97]] S. Dehaene (1997). The Number Sense. Penguin, London.

[[E02]] Earthlore Gothic Dreams: Cathedral Architecture Glossary Study Reference. http://www.elore.com/Gothic/Glossary/components.htm

[[E92]] G. Edelman. Bright Air, Brilliant Fire: Nn the Matter of the Mind. BasicBooks. 1992. (described in [[S97]])

[[G83]] H. Gardner. Frames of Mind: The Theory of Multiple Intelligences. New York: Basic Books. 1983.

[[G93]] H. Gardner. Multiple Intelligences: The Theory in Practice. NY: Basic Books. 1993.

[[H90]] A. Howes and S. Payne (1990). Display-based competence: towards user models for menu-driven interfaces. Int. J. of Man-Machine Studies, 33:637-655.

[[H90b]] E. Hutchins (1990), The Technology of team navigation. In Intellectual teamwork: social and technical bases of collaborative work. Gallagher, J., Kraut, R. and Egido, C., (eds.), Lawrence Erlbaum.

[[K92]] A. Karmiloff-Smith. Beyond Modularity. MIT Press. 1992. (described in [[M96]])

[[M00]] K. Manktelow (2000). Reasoning and Thinking, Psychology Press, Taylor and Francis.

[[M96]] S. Mithin. The Prehistory of theMind. Thames and Hudson. 1996.

[[TC97]] Tooby, J. and L. Cosmides. Evolutionary Psychology: a primer. 1997. on-line at: www.psych.ucsb.edu/research/cep/primer.html

[[S97]] J. Searle. The Mystery of Consciousness. Grant. 1997.

[[S94]] D. Sperber. The modularity of thought and the epidemiology of representations. In Mapping the Mind: Dimain Specificity in Cognition and Culture. L. Hirscgfeld and S. Gelma (eds.). Cambridge Univ Press. 1994. (described in [[M96]])

[[S87]] L. Suchman (1987). Plans and Situated Actions: The problem of human–machine communication. Cambridge University Press,.