

Awareness of self and awareness of selfness: why the capacity to self-model represents a novel level of cognition in humans

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Abstract

Being self-aware is often seen as a binary state: you either are, or you aren't. However, this dichotomy subsumes a whole range of awareness states. There is the issue of sleep and coma – when awareness is low, what happens to the self? There are the questions of whether the self determines awareness of itself, and what the self is aware of when it is self-aware. And there is the question of what kind of self-awareness arose in humans, and what it enabled humans to do that they could not do before.

This paper gives an overview of self-awareness, showing that it has many levels: from the internal-external differentiation of amoebae through to the self-analysis of humanity, self-awareness represents a continuum of mind-body relationships. The paper also looks in detail at the particular self-awareness of humans: while not always in this state, we do have the capacity to step outside of ourselves and model ourselves as if we were other people. As well as an awareness of self as an entity, we have an awareness of selfness, which give us this capacity to model ourself.

The paper considers the side-effects of awareness of selfness for cognition and for communication, showing that the range of messages transmissible grows exponentially when communicants have the capacity to model themselves as communicants. It reviews the language capacity in terms of the minimalist requirement of recursion, arguing that it is certainly a key marker for language; but that recursion is an emergent feature of pre-existing language-like behaviour and the development of awareness of selfness, rather than the touchstone for language. The paper also looks briefly at the likely evolutionary timescale for the emergence of awareness of selfness, and what made it possible.

The Big Problem

When it comes to defining terms, the cognitive sciences are remarkably lax. We have, for instance, been able to conduct a decades-long debate on the nature of consciousness without ever properly agreeing on what we mean by “consciousness”. For Damasio (2010) it is “mind with a twist” – although he then goes on to discuss how mysterious the mind is. Nonetheless, for Damasio there are human minds, which have consciousness, and non-human minds, which do not. Edelman (2004) separates perceptual consciousness from higher-order consciousness; but, as he seems to define consciousness as something that probably only humans do, this separation is more administrative than definitive. Dennett (1991) sees consciousness as a property of a range of species, but reserves a particular form, linguistic consciousness, for humans. Even Metzinger (2009), who takes the view that consciousness of self is an illusion, still reserves the illusion for humans. Dennett sees consciousness as a discontinuous process, Edelman sees it as continuous; Baars (1997) sees consciousness as mostly existential, Metzinger sees it as mostly illusory. Important everyday definitional issues – what does sleep do to consciousness, what is a dream, what is inebriation – remain largely unaddressed: the process of doing consciousness is subsumed into the state of being conscious, and then into the reified substance, consciousness. The different commentators then unpack this substance in different ways.

The same definitional problem applies to the meaning of self-awareness, which is often seen as a subset of the consciousness definition. Here however, the definitional problem is multiplied: what is the self of which there is awareness; what is the awareness that this self has of itself; is that awareness truly self-referential; and, Metzinger’s view again, is the self real or illusional? We now have to define two processes, doing awareness and doing selfness, instead of the one process of doing consciousness; and we then subsume those two processes into three separate states, being a self, being aware, and being self-aware. The definitional problem is more, not less, difficult.

This paper will therefore attempt to define its meanings more closely by looking at selfness and awareness separately, in terms of continua. To do this we need to look at the different ways of doing selfness and awareness, in nonhuman species as well as in humans; and we need to consider the types of selfness and awareness likely to have been available at different stages in our evolution.

The Beginning

It would seem to be pointless to look for any kind of awareness of self in single-celled animals: awareness would seem to require a brain which is capable of having a mind; and that can only happen at the multi-cellular level. Looking for selfness, however is a different matter: the very existence of, say, an amoeba is an act of doing selfness. For the amoeba, the world is divided into self and non-self at its cell membrane: everything inside the membrane is about the “ends”, or purpose, of existence; everything outside is the “means” to bring about those ends. Feeding is about converting means into ends, and reproduction is about cultivating those ends (Cordingley & Trzyna, 2008). Obviously there is no cognition in this definition of selfness, but there is what Dawkins (1989) refers to as genetic selfishness. At the genetic level, the survival of genes that enhance the survival of the animal translates into doing selfness: the gene is not traditionally “selfish”, it is “self-ish” in that it cannot avoid using limited resources at the expense of other genes.

If we are looking at how the “awareness” part of self-awareness developed, then it is awareness of others that seems to drive development of this capacity. A single-celled asexual animal needs no greater awareness of other than that the other exists, so that the means that otherness represents can be converted into the ends of selfness. However, this does not mean that single-celled animals are incapable of greater awarenesses: for instance, the amoeba that recognises and does not eat its sister-cells will do better in fitness terms than one that eats anything. Awareness of “similar” is therefore an effective survival trait, one which relies on nothing more complex than simple chemosensory mechanisms. Some single-celled animals, such as slime moulds, have even developed co-operative communities which behave in many ways like multi-celled animals (Hudson *et al*, 2002).

Multi-cellularity greatly increases the opportunities to recognise and react to others, and we do not need to go very far along the cladistic development of multi-celled life before encountering all kinds of social behaviours. Sex, with the inevitable need for inter-individual co-operation in reproduction, evolved over four billion years ago (Stearns, 1985); and this co-operation in reproduction, or mate recognition, led to two other important recognitions of othernesses: parent-offspring differentiation, and friend-foe identification. These recognitions in turn allowed the development of more sophisticated co-operative behaviours, which created new othernesses: us-them recognition, nest sharing, co-operative brood care, and group hierarchy. From these, full eusociality evolved in insects over 100 million years ago, long before the first primitive primates appeared (Nowak *et al*, 2010).

Mammals have been able to improve on these simple awarenesses of others, but not significantly add to them. While our awareness improvements have all been related to our improved cognitive machinery, or larger brains, it is humbling to know that the key components for humanity’s great trick, the evolution of complex societies, seem to be present in animals with brains of less than a million neurons. Nonetheless, large brains have given mammals some useful cognitive machinery, perhaps the most powerful of which is the collection of recording and interpreting mechanisms we call memory. Memory allows us to remember our encounters with other individuals, building complex cognitive representations of our relationships with those others. Where social insects classify friends and foes by type, most mammals are able to recognise and classify individuals as friends and foes. Where individuals, rather than just types, can be recognised, co-operation can be provisional: individuals who co-operate consistently with each other can establish effective and directed relationships; and co-operation can be withdrawn from individuals who are not themselves co-operating (Milinski & Wedekind, 1998).

One important addition to our repertoire of awarenesses is recognition of self, a capacity which for a long time was believed to be available only to humans. It was also believed to be an indivisible faculty – you either have it or you don’t. Both of these assumptions were challenged by Gallup’s mirror test (1970), which demonstrated that chimpanzees have the capacity to recognise that the image in a mirror is self and not other. Recognition of self, therefore, was not a purely human capacity; and subsequent experiments on other species have shown that it is not even limited to the Hominidae (great ape) clade. To date, all the great apes (bonobos, chimpanzees, gorillas, orang-utans) have been shown to pass the test; and non-primates such as bottlenose dolphins, orcas, elephants and European magpies have also passed. This range of species is so varied that it

argues for mirror self-recognition to be an emergent capacity of cleverness, rather than directly genetic. Asendorpf *et al* (1996) have also shown that humans younger than 18 months tend to fail the mirror test, so there may be a maturational, or even learned, component to mirror self-recognition (Meltzoff, 1990).

Another capacity that was once believed to be solely human is Theory of Mind. This is, basically, the ability to recognise that others have beliefs and intentions. Theory of Mind allows you to predict the likely actions of friends and foes (and of prey) based on your knowledge of how their mind works. By predicting their likely reactions you can enhance your own existence, possibly at the expense of those others. This type of thinking, using another animal's rational thought against them, was named Machiavellian Intelligence by Byrne (1995, ch13). He showed that it is a capacity which chimpanzees definitely possess, and it may be partially present in some of the other primates, such as baboons (e.g. *Papio ursinus*).

Machiavellian Intelligence is clearly a type of Theory of Mind: it models the intentions of others in order to exploit them. However, as Call & Tomasello (2008) show, chimpanzees have problems attributing false beliefs to others: they can predict another's actions based on their model of that other's knowledge, but they cannot predict based on what that other does not know, or what they know falsely. The Theory of Mind that chimpanzees have is clearly not as advanced, therefore, as the Theory of Mind that humans use to model each other. Additionally, while we are certainly capable of using our knowledge of others' minds against them, humans mostly use Theory of Mind to adjust our own behaviour to accommodate others.

Machiavellian Intelligence means that we are able to model the minds of others in the same way as other apes; but the human capacity to model those other minds is more sophisticated than that of other apes. Humans, however, have yet another modelling trick: somehow, we have been able to realise that our own mind is itself just a mind, and it can be modelled in the same way as other minds. Not only do we have an awareness of self as the beneficiary of the actions of others, we have an awareness of our own selfness. We have not just a "self-as-object" (recognition of the self as a physical body) we have a "self-as-knower" (recognition of the self as a modeller of others), and a "self-as-witness" (recognition of the self as a modeller of the self) (Damasio, 2010, pp7-13).

This linkage of the modelling of other minds and our own mind provides a powerful cognitive feedback loop. It allows both the modelling of other as self (what would you do if you were me?), and the more powerful modelling of self as other (what would I do if I were you?). The nesting of these two models (e.g. my model of you reacting to my model of me reacting to my model of you ...) means that we need cognitive mechanisms to handle iteration and, to a limited extent, recursion. Unlike the Hauser, Chomsky & Fitch model (2002), however, this does not identify recursion as the cause of complexity in language; instead, it is an emergent feature of modelled relationships. Modelling the minds of others is a powerful tool, but modelling our own mind increases the range of what is cognitively possible. It is likely, therefore, to be more fundamental than recursion, a key component of the suite of features that make us the particular animals we are.

Where Does Modelling Come from?

The term Theory of Mind (and its subset, Machiavellian Intelligence) has been expressed above in terms of a capacity to make models of others. Clearly Theory of Mind is reliant on this ability: I cannot predict the likely outcomes of your cognition unless I have a model of your cognition to test my predictions against. This does not mean, however, that modelling of others and Theory of Mind are synonymous. Theory of Mind is an emergent property of the ability to model the minds of others, so the fundamental question about Theory of Mind (and Machiavellian Intelligence) has to be, where does modelling come from?

The capacity to model the minds of others is likely to have pre-dated the evolution of *Homo sapiens*. Call & Tomasello (2008) give two definitions of Theory of Mind: a broad construal which does not include the ability to model false beliefs, and a narrow construal which does. Under the broad construal, chimpanzees can be shown to have a Theory of Mind; under the narrow construal they do not; but, even under the broad construal, they must possess the capacity to model the minds of others. To model the minds of others you must first know that others do have minds; and, to gain from that knowledge, you need to be able to use their beliefs and intentions to predict their possible actions. There is some evidence that this predictive capacity is not a binary all-or-nothing but a continuum, and that aspects of Theory of Mind are therefore present in animals outside the Hominidae clade (Horowitz, 2011). If this is so, then the modelling of other minds is, as far as this paper is concerned, ancient.

The capacity to model our own minds, on the other hand, does seem to be much newer, and the advantages it gives are much harder to identify. In terms of Darwinian fitness, there is a considerable problem: to model your own mind you have to treat it in the same way as your models of other minds; you have to see yourself dispassionately, as an object rather than the prime subject. Where, though, is the fitness advantage in being dispassionate about yourself when all around you are being passionately Machiavellian in their interpersonal dealings? (Edwardes 2010, ch8). There have clearly been huge advantages for humans in sharing a dispassionate approach to ourselves and each other: our complex culture of specialist roles relies on a common commitment to the group rather than the individual, and this in turn has led to the invention of cultural tools for even greater social integration and co-operation, such as law, money and religion (Sober & Wilson, 1999). Boehm describes this commitment to the group as reverse-dominance: not only do we suppress our own tendencies to dominate, we co-operate to suppress alpha behaviour in our whole group (Boehm 1999, ch8). Our dispassionate approach to our selves has enabled us to reach levels of co-operation even greater than those achieved by eusocial animals such as the hymenoptera and isoptera. However, our dispassionate approach creates a major headache for our evolution: how did we get from a distrusting Machiavellian society to the peculiarly co-operative human culture without the early co-operators being exploited mercilessly?

According to Nowak (2006) there are five evolutionary mechanisms which increase co-operation.

1. Kin selection means that helping your relatives is helping the genes you share to survive. It is therefore worth co-operating with kin even if it is to your detriment. However, while this is mathematically rational, kin selection explains only a small part of the co-operation we see in nature, and it is a particularly poor model of the way humans co-operate.

2. With direct reciprocity you co-operate with individuals until they no longer co-operate with you; in the long term, you end up co-operating only with co-operators. It is, however, an unforgiving strategy, and may eventually leave you with nobody to co-operate with.
3. Network reciprocity is an extension of direct reciprocity: co-operators form a network of mutual support which excludes non-co-operators. Non-co-operators, forced to the margins of their social groups, are eventually out-reproduced by the co-operators.
4. Indirect reciprocity relies on reputation. Co-operative individuals become known as reliable co-operators by others not involved in the co-operation. This mechanism works best when individuals share their experiences of others with others, so it relies heavily on a complex communication system which can exchange descriptions of co-operation. As human language is the only such system known, indirect reciprocity is likely to be a recent mechanism in great ape evolution.
5. Group selection is the most controversial of the mechanisms, and it only works in species where individuals are highly reliant on the group for survival. Although non-co-operators do better than co-operators as individuals, groups with majorities of co-operators succeed, and those with majorities of non-co-operators fail.

These mechanisms do not solve the problem of how we got from a distrusting Machiavellian society to the high levels of co-operation evident in human culture. They do explain, though, the ways in which co-operation can flourish once it has become established. Humans have a wide range of co-operative strategies, (alloparenting, food-sharing, co-operative food gathering, care of the sick, mutual protection, dominance suppression, and so on) and any one of these could have been the important first strategy. Whichever it was, though, it would have facilitated the other strategies in a steadily incrementing stream.

The capacity to model others is necessary for both chimpanzee Machiavellian Intelligence and human co-operation, it is a common factor in the behaviours of both species. The process of change from one behaviour to the other probably involves at least four stages of other-modelling: initially, internal modelling is used to bias the behaviours of others to favour the self; then it is used to anticipate the needs of others to benefit both self and other; then the communication and sharing of models enhances group cohesion; and finally internal modelling is used to anticipate the behaviours of others to benefit the group, and therefore the individual. The socio-cultural context is transmuted from a competitive environment where an individual's fitness is compromised by the sharing of internal models of others, to one where communication of those models enhances an individual's fitness in a co-operative and dependent environment. Communication is paramount in this process, and a simple form of language, or proto-language, would have been the mechanism by which that communication was achieved.

So how did we change from a competitive Machiavellian species to a highly co-operative pseudo-social species? Archeology has identified a series of artefactually-defined behaviours and skills involved in this process (such as tool-making, fire-making, dietary indicators, and art); palaeontology has identified a series of morphologically-defined behaviours (upright stance, running, skull size and shape, gracilism, etc); ethology and anthropology have given us clues as to what the physical indicators may represent; and neurophysiology and genetics have helped us to understand the processes of change; but, to date, no definitive single story of evolution in the Hominini clade (Pan, Australopithecus and Homo) has been produced.

What follows, therefore, is necessarily speculative. When we got our awareness of selfness is probably unknowable; but how we got it, and the effect it had on us, is more certain.

Awareness of Selfness

Although the process of moving from social Machiavellianism to pseudo-eusociality may be unknowable in any detail, the starting and ending positions are more certain. We can take modern humans as the definitive exemplar for the final state, because they *are* the final state; and we can less certainly take modern chimpanzees as the exemplar for the common ancestor, because they appear to have had fewer *alu* duplication mutations in their genetic lineage than humans (Prüfer *et al*, 2012). Modelling of others is likely to have been a capacity available to the hominini common ancestor – it is required for Theory of Mind, which we know is possessed by chimps and bonobos as well as humans (e.g. Melis *et al* 2011; Savage-Rumbaugh *et al*, 2005) – so we can take this as a given. Is it, though, sufficient to explain the modelling of relationships between others? How would a brain have to work to produce, store and compute models which record those relationships between others?

Clearly there has to be recognition of others as entities, so that conspecific A can be distinguished from, and modelled separately to, conspecific B; and there has to be a mechanism for recognising and modelling the relationship between A and B. This gives us our basic two components for cognitive modelling, and it also gives us a basic grammar for the combination of those components: the basic A-relationship-B form has a noteworthy correspondence with the two argument subject-verb-object form of language. However, the components in the social grammar are not just combined in simple, stand-alone triads, they form a network of nodes (entities) and links (relationships). It is a system which maps well to the neural network model that best explains how vertebrate brains work (O'Connell & Hofmann, 2012). This social grammar, therefore, does not rely on novel cognitive mechanisms.

The difficulty, in fitness terms, comes with the sharing of these cognitive models. If I have knowledge of how fellow group-members work together, knowledge I can use to my advantage, why would I give it to you, thereby diluting or nullifying my advantage? And if you offer me information about other group members, information which disadvantages you if it is true and disadvantages me if it is false, why should I believe you? In order to share these models, therefore, there already has to be a high level of co-operation between you and me, probably supported by a reasonably sophisticated communication system. Sharing these models requires group stability and long-term relationships to be pre-existing.

There is currently no mechanism to explain how this sharing of models happened. Somehow a signalling system was generated which permitted the sharing of segmented and differentiated signals. This is a less extraordinary proposal than that of Chomsky (2002, pp146-151), who proposed the appearance of the whole of language with a single macromutation; and, unlike Chomsky's proposal, it is supported by some examples of segmented and differentiated signalling systems in other species (e.g. Arnold & Zuberbühler, 2006). The proto-language system proposed here bears some resemblance to Bickerton's (1990) proposed protolanguage: it is more complex than other segmented and differentiated natural signals, but it is much less complex than the communication revolution proposed by Chomsky. Scott-Phillips *et al* (2009) have shown that, given

no starting conditions other than our own ingenuity, modern humans are capable of generating effective communication systems in very short periods of time. In the circumstance described here, both parties would have had a pre-existing cognitive grammar of A-relationship-B, so the appearance of a communication system which maps this cognitive grammar onto a signal is not a completely outlandish idea.

Assuming that the initial fitness problems are overcome, and a signalling mechanism appears, the communication of social models leads to an intriguing question: what happens when an A-relationship-B model is shared with A or B? For the person sharing the models, the entities in the models are all third parties. If there is cognitive modelling by the sharer of the sharer's relationships with others then it requires a very different mechanism to the A-relationship-B model being shared: the self does not need to be represented cognitively, and the relationship between self and other is a real emotion, not a representation of an emotion. This own-relationship modelling is unlikely to have been shared representationally (chimpanzees share it indexically), so there would be no need for a concept of "me-ness" in the communication system. However, when I am presented with an A-relationship-B construct in which A or B is me, I need a new representation: if I wish to utilise the information in the signal, I have to model myself as an entity node in my own cognitive social network. In other words, I need to produce a model of myself which is equivalent to my models of other individuals – and to do this, I need to be dispassionate about my model of myself. From this we can see that dispassionate self-modelling is not an inexplicable non-Darwinian capacity, it is an emergent and necessary effect of the sharing of our other modelling.

Beyond Awareness of Selfness

From the cognitive modelling of third-party A-relationship-B constructs, through the sharing of those models, humans would have reached a point where the capacity to model the self dispassionately as a third party becomes necessary; and this need to model myself is what would have given me my awareness of selfness. Interestingly, the self that I am aware of is a model of my real self, and it is subject to all the distortions that can occur in model-making: body dysmorphia and dissociative disorder are two extreme cases where the model of the self catastrophically does not correspond to the actual self. These, however, are extreme negative examples, self-modelling also has powerful positive effects: the everyday modelling of the self as a better future self – a process we know as aspiration or ambition – has been a powerful driver for achievement throughout the history of modern humans.

So awareness of selfness does not directly give us self-awareness in the usual definition of the term. Indeed, that type of self-awareness may not be possible: Metzinger (2009) is not alone when he argues that there is not actually a contiguous, indivisible self to be aware of. Whether this is true or not, awareness of selfness does give us the impression that there should be a myself to be aware of, because others are aware of me as a "themselves". However, the model that others have of me is as much a model as my own model of me: the existence of a second model cannot prove the reality of the first model.

A dispassionate view of the self would seem to enhance group selection at the expense of individual fitness. In evolutionary terms, it shouldn't work – but it does. Alone among the non-eusocial species, humans are willing to sacrifice themselves for their group; and not just for the

physical entity of a group but for the concept of a group. Awareness of selfness is a powerful mechanism for ensuring the survival of the self's cultural group; but it is also a terrible tool in the hands of those who do not play by the dispassionate rules underlying this cultural system. As van Vugt & Ahuja (2010) show, humans are remarkably good at following.

Once models of selfness are being exchanged, the communication system becomes complex relatively quickly. When I am given an A-relationship-B model in which I am A, I am able to assess the offered relationship model against my actual relationship with B. This makes the identity of the sharer of the model significant. If C has a different view of my relationship with B than I do, then a new three-argument model, A-relationship-B-by-C, is needed to encode the new information; hierarchy becomes necessary in the cognitive model. If this second-hand information is then shared as an A-relationship-B-by-C model, it needs to be encoded in the cognitive model of the receiver as A-relationship-B-by-C-by-D; limited recursion becomes necessary in the cognitive model.

Once we began to share our cognitive calculus of social interactions, we opened the way for an awareness of selfness; and once we were aware of our selfness, we opened the way for more complex communication of social models. Awareness of selfness is both a product of our sharing of social models, and the producer of more complex social modelling. It sits at the cusp between cooperative sharing of simple social models through proto-language, and the sharing of complex models of reality through language; it is the product of the first and motivates the development of the second. Language allows us to negotiate a self (Bruner, 1986), or cognitively construct one (Edelman & Tononi, 2000) from our awareness of our selfness.

Awareness of selfness is a very unusual attribute in nature, and may be limited to *Homo sapiens*. It is possible that the signature whistles of dolphins has created a similar self-recognition mechanism in that species (Cook *et al*, 2004), but this has not yet been specifically explored. There is also some evidence that awareness of selfness is present in great apes who have been "inducted" into human social systems through exposure to language (e.g. Savage-Rumbaugh *et al*, 2005); but it does not seem to be present in wild populations. For humans it has proved to be an incredibly useful side-effect of the sharing of social models, probably made possible by pre-existing widespread cooperation and the need for a vocal grooming mechanism (Dunbar, 1996). In terms of the development of language, the sharing of social models would have introduced a simple structural grammar into a pre-existing communication system; and awareness of selfness would have done the rest.

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