



# ***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**

*As humans, we value our capacity for self-awareness highly; we even see it as something which differentiates us from most other animals. But what do we mean when we say we are self-aware? How does a self determine that it is aware of itself; what is the self aware of when it is self-aware; and how and why did our particular type of self-awareness arise in our species?*

*This paper attempts to answer these questions by looking at our self-awareness as a product of our highly socialised and highly communicative culture. It proposes that our peculiar self-awareness is a product of a relatively ancient capacity to model relationships between other members of our social group, and a relatively recent capacity to share those models.*

*In section 2, the paper gives an overview of awareness, showing that it has many levels: it represents a continuum of mind-body relationships throughout nature, from the internal-external differentiation of amoebae through to the self-analysis of humanity. Section 3 examines the primate capacity to model relationships between other members of their groups, and discusses the type of cognition, known as Machiavellian Intelligence, that this modelling requires. The particular self-awareness of humans is then examined in detail in section 4: 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 a capacity to model a "myself" as if it were a "themselves". The way this capacity emerges from the sharing of social models is addressed.*

*Finally, section 5 looks at the significance of modelled selfhood in terms of how it defines us as a species. It considers the effect that awareness of selfness has on cognition and communication, showing that the range of messages transmissible grows exponentially when communicants have the capacity to model themselves as communicants. It also reviews the role of recursion in language origins, arguing that, while it is certainly a key marker for human language, it is not a precursor but an emergent feature, a product of pre-existing language-like behaviour linked to the development of awareness of selfness.*

**Key words:** Language origins, Protolanguage, Self-awareness, Social communication, Primate communication, Cognitive modelling

## **1. 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 only defines types of consciousness, not types of minds. 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 reified into the substance, consciousness. The different commentators then unpack this substance in different ways.

The same problem applies to what we mean by 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 illusory? With self-awareness we have to define two processes, doing awareness and doing selfness, instead of the one process of doing consciousness; and we must then subsume those two processes into three separate states, being a self, being aware, and being self-aware. Defining self-awareness is more, not less, difficult than defining consciousness.

This paper will therefore attempt to delimit its meaning of self-awareness 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.

## **2. The Beginning**

It would seem to be pointless to look for any kind of awareness, of self or other, 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 “selfish” in the traditional meaning of the term, it is “self-ish” in that it cannot avoid using limited resources at the expense of other genes.

If we wish to look 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), and this awareness of similar may be the route by which multi-cellularity evolved.

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: identification of parents by offspring (and vice versa), and friend-foe differentiation. 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, among others. 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 awareness improvements in the mammalian clade 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 group 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 eusocial insects classify friends and foes by type, most mammals are able to recognise and classify friends and foes at the individual level. Where individuals, rather than just types, can be recognised, co-operation can be intentional: 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. This assumption was challenged, however, by Gallup's mirror test (1970), which demonstrated that some chimpanzees have the capacity to recognise that the image in a mirror is self and not other. Recognition of self, therefore, is not a purely human capacity; and subsequent experiments on other species have shown that it is not even limited to the great ape (Hominidae) clade. To date, all the great apes (bonobos, chimpanzees, gorillas, orang-utans and humans) have been shown to pass the mirror 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, often at the expense of those others. This type of thinking, using another animal's rational thought against them, was named Machiavellian Intelligence by de Waal (1982). Byrne (1995, ch13) showed that it is a capacity which chimpanzees definitely possess, and which may also 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. It does not, however, model actual knowledge states. As Call & Tomasello (2008) show, chimpanzees have problems attributing false beliefs to others: they can predict another's actions based on what that other is likely to know, 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 not as advanced, therefore, as the Theory of Mind that humans use to model each other (Malle, 2003). 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 (Fowler & Christakis, 2009) – our Theory of Mind supports co-operation more than competition (Burkart et al, 2009).

The ubiquity of Machiavellian Intelligence in the great ape clade 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: we can model false beliefs, and the beliefs that others have about the beliefs of third parties (Dunbar, 2004, ch3). Humans also have an additional 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 dynamic cognitive feedback loop (Hofstadter, 2007, ch6). It allows both the modelling of other as self (what would you do if you were me?), and the 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 – as predicted by the Hauser, Chomsky & Fitch (2002) model. Unlike the Hauser, Chomsky & Fitch model, however, recursion is not identified as the cause of complexity in language; instead, it is an emergent feature of the sharing of modelled relationships (Edwardes, 2010, ch7). Being able to model minds (both of others and of self) increases the range of what is cognitively possible, and it has identifiable fitness values which recursion by itself does not have. Mind-modelling is likely, therefore, to be a more fundamental feature than recursion in what make us human.

### ***3. 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 the minds of others and Theory of Mind are synonymous: Theory of Mind is an emergent, and therefore dependent, property of the ability to model the minds of others. This means that 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 ancient.

The capacity to model our own minds, on the other hand, does seem to be much newer (Carruthers, 2009), 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 been huge advantages for humans in taking a dispassionate approach to ourselves: 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 (1999, ch8) describes this commitment to the group as reverse-dominance: not only do we suppress our own tendency to dominate, we co-operate to suppress alpha behaviour in our whole group. 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, this dispassionate approach creates a major headache for plotting the evolution of our species: how did we get from a Machiavellian society, in which genetic selfishness is paramount, to a peculiarly human culture, where consensus and group-defined priorities prevail, without the early co-operators being exploited to the point of extinction?

According to Nowak (2006) there are five evolutionary mechanisms which tend to lead to an increase in individual co-operation.

- Kin selection shows that helping your relatives is helping your shared genes 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.

- With direct reciprocity you co-operate with individuals until they no longer co-operate with you; so, in the long term, you end up co-operating only with co-operators. It is, however, an unforgiving strategy which may eventually leave nobody co-operating.
- 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. However, network reciprocity can only explain how co-operation can prosper once it has reached a critical mass in the group; it does not say how that critical mass can be achieved.
- 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 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 have been a later development than language.
- 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 evolved from a Machiavellian society, in which coercion is a normal strategy, to a highly co-operative human culture, in which negotiation and persuasion are the norm. 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 which are central to being human – alloparenting, food-sharing, co-operative food gathering, care of the sick, mutual protection, dominance suppression, role specialism, and so on – and any one of these could have been the important first strategy in our path to pseudo-eusociality. Whichever it was, though, Nowak's five evolutionary mechanisms 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 Machiavellian coercion to co-operative negotiation and persuasion is, however, unlikely to have been achieved in a single step. It probably involved at least four stages of other-modelling: initially, internal modelling was used to bias the behaviours of others to favour the self; then it was used to anticipate the needs of others to benefit both self and other; then the communication and sharing of models enhanced group cohesion; and finally internal modelling was 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 an early, simplified form of language, or protolanguage, would have been the mechanism by which that communication was achieved.

So how did we evolve from a culture of competitive Machiavellianism, where the highest level of co-operation is the ad hoc hunting party, to a highly co-operative pseudo-eusocial culture, with economic specialism, trade, nation states and rule of law? Archaeology 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. How we got to be such good co-operators is unknown – perhaps reproductive co-operation was needed (Burkart et al, 2009), or perhaps a vocal grooming mechanism (Dunbar, 1996); and when we got our awareness of selfness is probably unknowable. However, how we became aware of our selfness, and the effect it had on us, is more certain.

#### ***4. 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 we 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), making them more similar to the common ancestor than humans. Modelling of others would 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. We should, though, take a little time to describe how a brain would have to work to produce, store and compute models which can record relationships between others.

A brain capable of effective social modelling would first need to recognise others as entities, so that conspecific A can be distinguished from, and modelled separately to, conspecific B. Second, 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 simple A-relationship-B form has a noteworthy similarity to the two argument subject-verb-object form of language. However, the components in the internal social grammar are not just combined in simple, stand-alone triads, they form a network of nodes (entities) and links (relationships), and this nodes-and-links model 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; it can be produced by pre-existing primate brain architecture.

There is, however, a difficulty in fitness terms, which 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 involving a communication system complex enough to support the co-operation. Sharing A-Relationship-B social models requires group stability and long-term relationships to be pre-existing.

There is currently no mechanism to explain how the sharing of models could have happened, but the pre-existence of a system of segmented and differentiated signals is certainly possible. Keenan et al (2013) identify such a system in the calls of Campbell's monkeys (*Cercopithecus campbelli*); and 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 internal 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. It is certainly less extraordinary than Chomsky's (2002, pp146-151) proposal that language was created by a single macromutation; and, unlike Chomsky's proposal, it is supported by examples of segmented and differentiated signalling in other primate species (e.g. Keenan et al (2013); Arnold & Zuberbühler, 2006).

The grammatical system required for the sharing of social models does bear some resemblance to Bickerton's (1990) suggested protolanguage, in that it is more complex than other segmented and differentiated natural signals while being much less complex than full modern language. Unlike Bickerton, though, the assumption made here is that the change from protolanguage to full language was, as Heine & Kuteva (2007) suggest, steady and incremental, rather than a single step.

Assuming that the initial fitness problems are overcome, and a signalling mechanism for social modelling appears, it would still have lacked one important feature of modern language: the arguments in the social grammar all represent third parties (other individuals). There is no need for "I" or "you" in the grammar when it is inside one brain; and there would have been no immediate way of incorporating them into utterances when the grammar was shared. This is not how we use language nowadays: many of our utterances use self-reference ("I" and "me"), or refer to the immediate receiver ("you"); in fact, the word "I" is the 24<sup>th</sup> most commonly used in English, and the word "you" is 8<sup>th</sup> most common (from <http://oxforddictionaries.com/words/the-oec-facts-about-the-language>). However, referring to self and other using first- and second-person forms is not something we are born knowing, we have to learn it alongside language (Oshima-Takane et al, 1999), and it seems to have its own separate schedule (Dobrova, 1999).

There is also no need for an explicit "I" or "you" when signalling agonistically, or in mating rituals or territorial displays, or when making food-related signals or alarm calls. If the sharer needs to express their own relationships with another ([my]-relationship-[you]) then they can use simple indexical signals. The first- and second-person do not need to be represented in the signal because they are constants; and the relationship between self and other is a real emotion, not a representation of an emotion. Why say "I am hungry" when I can beg, or "I am scared of you" when I can whimper, scream, or run away? I don't need to tell you my state, I can be it. This is what chimpanzees do, they express their current feelings without inhibition (Arcadi, 2000). They have no need for the explicit expression of "me-ness" or "you-ness" in their communication system.

So where did the need for first and second person come from? This question is best answered by posing a different, but related, 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. However, one of them is also the receiver of the model, so the act of sharing a social model about A with A creates the explicit role of "you" as a specific case of third party reference. Explicit expression of "you-ness" is therefore simply an emergent feature of the sharing of social grammar models.

The emergence of the explicit expression of "me-ness" is more complex. When

I am presented with an A-relationship-B construct in which A 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 third-party 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 (and self-sacrifice) is not an inexplicable non-Darwinian capacity, it is an emergent and necessary effect of the sharing of our social modelling.

## ***5. Beyond Awareness of Selfness***

Through the sharing of cognitive models of third-party A-relationship-B constructs, 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 therefore 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 strong positive effects: the everyday modelling of the self as a better, future self – a process we know as aspiration or ambition – has been an effective 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 actually be possible: Metzinger (2009) is not alone when he argues that there is no contiguous, indivisible self to be aware of (e.g. Hood, 2012). 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 “themself”. However, the model that others have of me is as much a model as is 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 probably became 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 cognitive model, A-relationship-B-by-C, is needed to encode the new information: hierarchy becomes necessary in our cognitive modelling. 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 our cognitive modelling.

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 co-operative sharing of simple social models through a simple protolanguage, and the sharing of complex models of reality and irreality 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, ch4), or cognitively construct one (Edelman & Tononi, 2000, ch15) 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 indicate 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. There seems to be only one species where awareness of selfness has had a significant effect on both the nature of the individual and the social culture in which the individual exists.

## ***6. Conclusion***

For humans, awareness of selfness has proved to be an incredibly useful side-effect of the sharing of social models. Before the sharing of models, there would have been no need for explicit first and second persons in signalling, very little personal aspiration, and no need for self-effacement; after self-modelling, there would have been an increase in trust built on reputation, increasing intra-group co-operation and inter-group rivalry, an increasing need for negotiation to meaning, and increasingly complex communication systems. In terms of the development of language, the sharing of social models would have introduced the need for a simple structural grammar into a pre-existing signalling system; and awareness of selfness, a product of the social-model sharing, would have done the rest.

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