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"What's HIDD'n in the HADD?"[1]

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Abstract
The consensus in the cognitive science of religion is that some sort of hyperactive agency detection in the human mind is responsible for the origin and spread of beliefs in superhuman agents such as gods, spirits and ancestors among human populations. While it is expressed differently in different authors, they all agree that some sort of hyperactive agency detection is a basic function of human cognition. Most well known perhaps is the formulation of this by Justin Barrett as the Hyperactive Agency Detection Device or HADD. Problems, however, arise when we begin to consider the neural basis of this: It doesn't add up, or more precisely the HADD does not work that way. Like the magician pulling rabbits from the hat this explanation may be a "self"-conjuring trick, only for us the hat is a HADD and the rabbits are superhuman agents (no reference to were-rabbits intended). This paper will try to point to a more parsimonious explanation.

Keywords
Agency, evolutionary psychology, hyperactive agency detection, intentionality, superhuman agents

The basic line of argumentation for a lot of research in cognition and culture can be paraphrased thus: Cultural representations are widespread in human cultures because they are transmitted often. What gets transmitted depends on how well it fits the human cognitive system (e.g., Sperber and Hirschfeld, 2004). The human cognitive system is evolved through natural selection, so that adaptive cognitive functions have provided humans with selective advantages.[2] This explanatory strategy has also been used to a large extent in the cognitive science of religion to explain why religion is widespread in human

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[2] The argument has been spelled out more in more detail by John Tooby, Leda Cosmides, Dan Sperber and others (Barkow *et al*. 1995; Bloch and Sperber 2002; Sperber and Hirschfeld 2004)

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cultures (Boyer, 2001; Atran, 2002; Atran and Norenzayan, 2004). A central feature of this endeavour has been to explain the ubiquity in human cultures of belief in superhuman agents (Boyer and Ramble, 2001; Atran and Norenzayan, 2004; Barrett, 2004). This has in most cases been done with recourse to a stipulated hyper active agency detection function, what Justin L. Barrett has termed the Hyperactive Agency Detection Device or HADD. In this article I will consider whether the widespread belief in superhuman agents (gods, ghosts and ancestors) can be adequately explained by the HADD theory.

Explaining Cognitive Functions by Evolutionary Psychology

The ultimate explanation of hyperactive agency detection is made with recourse to evolutionary psychology. Evolutionary psychology's strategy is to explain universal cognitive phenomena by evolved psychological functions. Let us consider this strategy as it is presented by John Tooby and Leda Cosmides. Any given cognitive function is stipulated to have had a selective advantage in the human ancestral environment thereby accounting for its present existence; as the slogan goes: "Our modern skulls house a stone age mind". The function may be triggered in other contexts than that for which it was selected. It is then a by-product of the original function.[3]

But a couple of quite basic points need to be emphasised before we begin: First cognitive functions are *not* inherited; only genes are. Second, cognitive functions do *not* have any selective advantages, only behaviour does. Third, cognitive functions cannot be observed, only inferred from behaviour. Likewise only the scantiest evidence exists of any connection between a given gene and a cognitive function. Add to this the hypothetical function in a largely unknown environment (the Stone Age), and we end up with quite a mixture of "what ifs", "maybes" and "probablies". That, of course, is the nature of science. But the nature of science is also to use all available evidence in the investigation, and not introduce more hypotheses than are needed.

For a cognitive function F to have been adaptive, it is necessary that a gene produces a neural structure S which reliably produces the cognitive function F. F leads to behaviour B under certain conditions, which has been adaptive in an ancestral environment. Empirically we only have access to B and S.[4] B is

[3] For a short and accessible introduction presenting these thoughts confer the primer on the web-site for the Center for Evolutionary Psychology (http://www.psych.ucsb.edu/research/cep/primer.html (9 January 2006))

[4] The different levels: behaviour, cognitive function and neural structure is based on the classic distinction between levels of analysis in cognitive science made by David Marr (Marr, 1982).

observed in psychological experiments as the dependent variable, and S can be observed through a number of techniques, such as various scanning techniques, lesion studies, single cell recordings, brain surgery and autopsies. Evolutionary psychology has almost exclusively focussed on B (e.g., Cosmides and Tooby 2005). This is not a wise move in an environment with so many hypotheticals.

So, before we start to look for an extra hypothesis concerning the environment of evolutionary adaptation for any uniquely human cognitive function F we should expect to find:

1) A neural structure, S, reliably producing the stipulated cognitive function, F, under certain input conditions causing a range of behaviours B1..Bn.
2) S should be unique to humans
3) All instances of B1..Bn should be caused by S through F

The first point is the causal nexus explaining the existence of any given evolved cognitive function. Usually evolutionary psychology is testing B in psychological experiments; a difference in cognitive function is inferred from differences in behaviour. Tooby and Cosmides found that subjects performed differently in the "Wason selection task", when the problem was framed as a social problem (Cosmides and Tooby, 2005, p. 597).

The second point naturally only goes for behaviours specific to humans. Behaviours we share with animals would not include this clause.

The third point is trickier. It amounts to distinguishing homology from analogy. It is possible that two apparently identical behaviours have different neural substructures, in which case they are analogous. This is the case for example of ritualised behaviour, which is similar to OCD and normal routine behaviour. While routine behaviour is analogous to ritualised behaviour, OCD seems to be homologous (Boyer and Lienard, 2006, p. 606). They are then analogical features and need two different explanations. The evolutionary psychology account has to make sure that the features are homological, or must assume that they are. For example doing the "Wason selection task" in terms of a social problem, must be homological, or assumed to be homological, with actual social problem solving tasks in real life.

What does the HADD do? Examples

While a number of scholars have used some sort of hyperactive agency detection in explaining religion, I will focus on only two examples namely Scott Atran and Ara Norenzayan's and Justin L. Barrett's work. Let me just shortly

mention those left out: Stewart Guthrie's account is the first, but he does not think of agency detection as a cognitive function, but as a perceptual function (Guthrie, 1980, 1993, 2001, 2004). Pascal Boyer does not explain the function with recourse to agency detection per se, but instead with reference to an inbuilt search for relevance and agentive concepts can produce more inferences than non-agentive. The explanation is thus made more with recourse to a cost/benefit algorithm working as a system property of the mind, rather than to hyperactivity (Boyer, 1996, 2001; Boyer and Ramble, 2001).

Let us presently consider how hyperactive agency detection works according to Barrett. According to Justin Barrett: "Part of the reason people believe in gods, ghosts and, goblins also comes from the way in which our minds, particularly our agency detection device (ADD) functions. Our ADD suffers from some hyperactivity, making it prone to find agents around us, including supernatural ones, given fairly modest evidence of their presence. This tendency encourages the generation and spread of god concepts" (Barrett, 2004, p. 31). This is what he terms the Hyperactive Agency Detection Device or HADD. Examples of when the HADD is activated include: Hearing a bump in the night (31), perception of geometric objects moving by themselves (32), perception of a wispy form (33), a computer malfunctioning (33), perception of crop circles (37). To this we might add all representations of "gods, ghosts and goblins". I do want to add that Barrett does not say that the HADD is the whole story, he actually has several chapters explaining other important factors, but he does say that it is the central function for the development of religion.

According to Scott Atran and Ara Norenzayan: "Widespread counterfactual and counterintuitive beliefs in supernatural agents can be explained by the fact that they "(..)trigger our naturally selected agency-detection system, which is trip-wired to respond to fragmentary information, inciting perception of figures lurking in shadows and emotions of dread and awe" (Atran and Norenzayan, 2004, p. 714). While they call it the agency-detection system, it is basically the same explanation as Barrett gives for the HADD. Examples of when this system is activated include: Dots moving on a screen, voices in the wind, faces in the clouds, any complex design, Mother Theresa in a cinnamon bun, the virgin of Guadeloupe in a melted ice cream on the pavement, the Virgin in windows, curtains and television afterimages, the face of the Evil-One in the smoke of the World Trade Centre (719), sudden movement of an object stirred by the wind and representing ghosts or gods (720).

These summaries cannot do justice to the details of the argument of neither Barrett nor Atran and Norenzayan, but should suffice to show the general outline of their argumentation.

What does the HADD do? A Benchmark

Since belief in superhuman agents by these accounts qualify as uniquely human, all three points mentioned above must apply to the HADD. Religion is considered a by-product of human cognitive functions. According to Barrett and Atran and Norenzayan the proper function[5] of the HADD was to detect and evade predators, the by-product is a susceptibility to infer superhuman beings. Let me highlight four representative examples of situations in which the HADD is stipulated to be activated as a sort of benchmark:[6]

> B1: the sudden movement of a twig in the forest leads to the inference of ghosts, which can be seen in subsequent caution, sacrifice or stories relating the event.
>
> B2: the perception of crop-circles leads to the inference of aliens, which can be seen in stories about the aliens communicating their far advanced technologies to us.
>
> B3: prayer activating the inference of a god listening, which can be seen from the communicative behaviour in a context where there is no one to communicate with.
>
> B4: Reading the book of Genesis in the Bible, which leads to talk about the design of nature.

These four examples are, or lead to, behaviours involving superhuman agents. We, thus, have four distinct behaviours B1-B4, which are the explananda. Either the HADD is activated in B1-B4 or it is not the most parsimonious explanation. Now let me jump to the first point, the neural structure. We should expect to find a neural structure which reliably produces hyperactive agency detection, and, which is specific to humans.

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[5] I am using the notion of proper function in the sense given by the American philosopher Ruth Garrett Millikan (Millikan, 1984: pp. 28–33). Millikan has a longer philosophical justification for the term.

[6] I will term them B1–B4 because the empirical measure is some sort of behaviour. In some of the examples the behaviour is a product of something perceptual (B1, B2 and B4) while B3 does not include anything perceptual. B1 includes movement while this is not the case in the others. These examples have been chosen to represent the breadth of the claims about the conditions under which the HADD is stipulated to be activated.

Neural Basis – A Review of Possible Candidates for the HADD

Superior Temporal Sulcus

The classic example of hyperactive agency detection, mentioned by Barrett and Atran and Norenzayan, is Michotte's experiments (Michotte, 1963). Michotte had subjects watch a screen on which dots were moving. When they were moving freely, apparently self-propelled, and reacted to other dots, subjects were inclined to infer mental states such as chasing, helping etc. This obviously suggests some sort of hyper active agency detection. A good portion of neurological research has been dedicated to this function (Decety and Grezes, 1999; Blakemore *et al.*, 2001; Frith and Frith, 2001; Grezes *et al.*, 2001). It is usually referred to as detection of biological movement and the neural structure responsible activated by this function is the superior temporal sulcus, or STS. While most studies have focussed on its activation by visual stimuli, a recent fMRI study has showed that part of the STS was also activated by auditory stimuli (Bidet-Caulet *et al.*, 2005). There are lateral specialisations in the STS (Blakemore *et al.* 2001) and also some sub-structures serving specific sub-functions (Goodale and Milner, 1992; Grezes *et al.*, 2001; Bidet-Caulet *et al.*, 2005).

Indeed this neural structure would account for B1, where something is moving, but not B2-4, where nothing is moving. Thus, it cannot be the S of the HADD. There is also another problem, namely, that it is not unique to humans.

Mirror Neurons

Another possibility is that the, so called, mirror neurons are responsible for the hyperactive agency detection. Mirror neurons were found in the ventral pre-motor cortex in macaque monkeys (Gallese *et al.*, 1996). They have the special property that they are activated both by the perception of a movement and the execution of a movement. This has been seen as the basis of mentalizing or empathy (Gallese, 2001).[7] Comparable findings have been reported in homologous areas in humans, most notably the ventral pre-motor are (PMv). These areas were found to be active during perception of a movement, execution of the movement, but also in the imagination of the movement (Jeannerod, 1999). Thus mirror neurons could enable us to simulate a non-present agent. This would account for B3 and B4, where some sort of simulation of an agent takes place, but it would not explain B1. Mirror neurons are not either very hyperactive, and

[7] For recent criticism of this, see Jacob and Jeannerod (2005).

they seem to function at a low level and boring level of mere movements. Another problem is, as mentioned, they are found also in monkeys, even macaques. Consequently, the mirror neuron circuit cannot either be the S of the HADD.

A Combination

We could then stipulate that the STS and PMv together formed a distributed neurological instantiation of the HADD. There are two objections to this: First, the mirror neuron circuit is not hyperactive at all; at least not in the sense stipulated by Barrett.[8] It is also a pretty pedestrian movement centred system that does not care much about the mental states, or long term goals of the perceived agent. Second, this system is not in any obvious way unique to humans.

Summary

We have not been able to find an S which reliably produces hyperactive agency detection leading to behaviours B1-B4.

While there is ample evidence of hyperactive agency detection, the HADD is not the most parsimonious explanation of why the belief in superhuman agents and their associated behaviours are widespread among humans. In short, the HADD as explaining belief in superhuman agents is an illusion. We may be conjuring ourselves to think that we have explained what we wanted to. Like the magician pulling rabbits from the hat, the HADD does not contain all the rabbits, only for us the hat is a HADD and the rabbits are superhuman agents.

Another Trick?

Any skilled entertainer knows you must always have another trick ready if the first one fails. So my trick for know will be a guessing game combined with a riddle posed by the title "What's [actually] HIDD'n in the HADD?"

A possible way out of the problem would be to focus on the central function before we eagerly make up some evolutionary scenario. I submit that what we really want to know is why humans have a tendency to interact with physical entities as if they were intentional or related to a hidden intentionality. This central function is most precisely put by Daniel Dennett, who calls

[8] Although some sort of hyperactivity has been detected: activity in left PMv was detected in subjects viewing tools, and implied movement (Chao and Martin, 2000), but these are more commonly interpreted as being simulations of the affordances of the object at hand. Further, these are not strictly speaking mirror neurons, but so called "canonical neurons". This would not explain B2 and B3.

this "taking the intentional stance": "first you decide to treat the object whose behaviour is to be predicted as a rational agent; then you figure out what beliefs the agent ought to have, given its place in the world and its purpose. Then you figure out what desires it ought to have on the same considerations and finally you predict this rational agent would act to further its goals in the light of its beliefs" (Dennett, 1987, p. 17).[9] This indeed seems to be a hyperactive function, that is, a function with many false positives, as Dennett already pointed out in the seventies.[10] We should then instead talk of a hyperactive intentionality detection device, or HIDD, if we want to continue in that vernacular. Let us see if this move will fare better than the HADD.

Neural Basis of the HIDD

Anterior Paracingulate Cortex (PCC)

In a series of fMRI studies Helen Gallagher, Chris Frith and colleagues have tried to find out what happens neurologically, when people took the intentional stance (Gallagher *et al*., 2000, 2002). Previous studies had shown a discrete system involved in mentalizing tasks, but all of them were off-line, that is, reflective like narrative comprehension tasks. To isolate the intentional stance in on-line processing, they asked subjects to play a computerised version of the children's game rock, paper, scissors. One group was told that they were playing against an experimenter, another that they were playing against a computer using a predetermined rule-based strategy, while a third was told they were playing against a random sequence. The first group was, thus, prompted to take the intentional stance toward the game, reflecting quite accurately what takes place in much religion. What the participants did not know was that all three groups were in fact playing against a random sequence. Therefore the only difference between the groups was the stance taken towards the task. The results showed just increased activation in just one area, which had also been activated in all other mentalizing studies: the anterior paracingulate gyrus (PCC) (Gallagher *et al*., 2002).

Now let us consider whether the stipulated neural structure could be activated in all instances of the behaviours we wished to explain:

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[9] I think a more contemporary reading of the quote would substitute rational with intentional.

[10] The article in which Dennett presented the idea of the intentional stance, "True Believers: The intentional Strategy and Why it Works" republished in *The Intentional Stance*, was from 1979 (Dennett, 1987, p. 13).

B1 the sudden movement of a twig in the forest leads to the inference of ghosts, which can be seen in subsequent caution, sacrifice or stories relating the event.

This would amount to biological movement, since this is characterized by being movement by and of itself. Castelli and colleagues used animations of two characters, a blue triangle and a red triangle, to investigate the neural activation in ToM tasks (Castelli *et al.*, 2000). In some animations the triangles were interacting intentionally like dancing together, chasing each other or imitating each other, while in others they were bouncing off the walls like billiard balls (Castelli *et al.*, 2000, p. 316). This showed strong activation, among other places, in the PCC (Castelli *et al.*, 2000, p. 319).[11]

B2 the perception of crop-circles leads to the inference of aliens, which can be seen in stories about the aliens communicating their far advanced technologies to us.

Crop circles are traces of agency, or have evidence of design, as Barrett calls it, that is, they seem non-random. One study by Gallagher and colleagues might show something similar (Gallagher *et al.*, 2000). They used cartoons without any text. This is perceptually similar in that you have straight lines and order. They showed that these cartoons also activated the PCC, but other cartoons did not (Gallagher *et al.*, 2000, p. 19). That indicates that we probably have another variable here that needs further investigation.

B3 prayer activating the inference of a god listening, which can be seen from the communicative behaviour in a context where there is no one to communicate with.

Prayer is the same as interacting with non-present agents. This was shown in the already mentioned study of Gallagher *et al.* (2000), where a game of rock, paper scissors was played with a non-present agent. Something similar was also shown by a study of McCabe and colleagues, where subjects were told they were playing a game against another person (McCabe *et al.*, 2001). This study also showed increased activity in activation of the PCC.[12]

[11] The study mentions the medial prefrontal cortex, but the PCC is a sub-part of that area.
[12] Also here the designation is medial prefrontal cortex (cf. previous note)

B4: Reading the Book of Genesis in the Bible, which Leads to Talk About the Design of Nature.

Reading the Bible like any other book is a matter of story comprehension. A couple of studies have shown that the PCC is activated in such tasks (Fletcher *et al.*, 1995; Gallagher *et al.*, 2000). There might of course be differences in neural activation in reading the Bible, but what concerns us here is that reading the bible will activate the PCC.

In conclusion we can say that the stipulated neural structure responsible for our cognitive function, the HIDD, is indeed activated in the different behaviours we wished to explain. The key here is that there are different ways of activating this function. Earlier it has been assumed more or less tacitly that agency detection was stimuli driven, but the above mentioned studies indicate that it can just as well be context driven.

But how far is this uniquely human? The anterior cingulate cortex, of which the PCC is considered to be part, is an ancient structure belonging to the limbic lobe. This would indicate that the neural area is not even specific to primates. This looks like a setback for the theory. However, an unusual type of projection neuron (spindle cell) is found here, and it is found only in higher primates. There is even evidence that in humans this structure has undergone further evolution from the primates (Gallagher and Frith, 2003, p. 80). This is consistent with a uniquely human structure. Second, this type of neuron is not present at birth in human children. It does not appear until around 4 months of age, which could give some clues to the delayed development of mentalizing capabilities in infants (*cf.*, Meltzoff and Prinz, 2003).

Conclusion

This investigation has shown that supplying an evolutionary explanation about how a stipulated cognitive function would have been adaptive is sometimes detrimental to understanding the phenomenon at hand. Because of the eagerness and easiness with which an adaptive function was supplied, reflection on the phenomenon seized. Further reflection and research into philosophy and neuroscience would have revealed the insufficiency of the argument, and led to what I have presented here. In short, we should be wary of supplying ultimate explanations for phenomena whose proximate explanations are not sufficiently worked out.

The proposed HIDD, or just taking the intentional stance, fits all the criteria stipulated in the beginning: it has a well defined neural structure (PCC),

which reliably produces the cognitive function (intentionality detection); it is uniquely human, which can be seen neurologically from recent mutation after the phylogenetic departure from the great apes; all instances of the behaviours B1-4 was found to be consistent with activation of the neural structure. The proposed explanation of the widespread belief in superhuman agents, dare I say the origin of religion, is thus more parsimoniously explained by a HIDD than a HADD.

But this is not the end point of the investigation. It is just the starting point. The next problem is the activation of the HIDD in all the different contexts in religion. As we saw there are many different ways of activating the HIDD. We need to understand the input conditions. In order to do this we need to understand the neural connections. I have here compiled a sketch (Fig. 1), which highlights some of the most important areas and their most important interconnections.

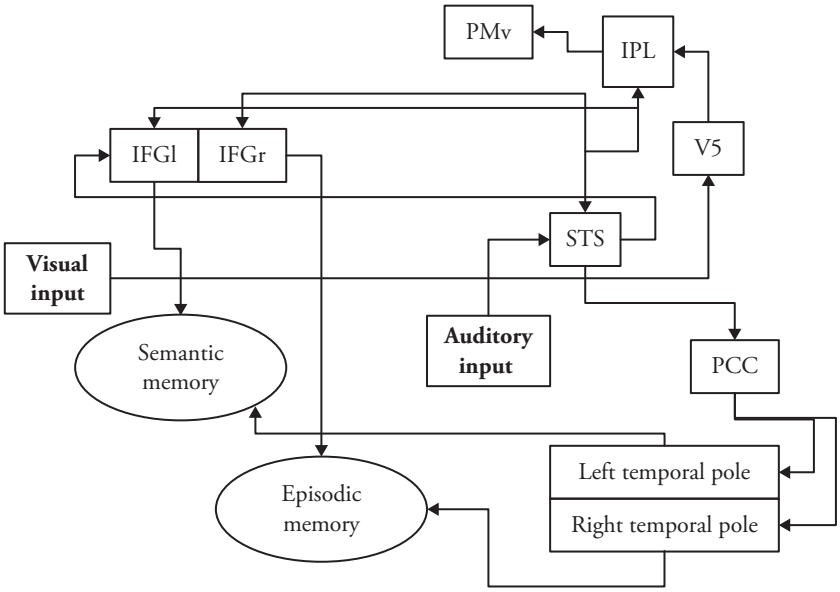

Figure 1. Sketch of the neural components related to the Hyperactive Intentionality Detection Device.

I hope to have shown that the functions needed to explain the hyperactive intentionality detection are much more complicated than previously assumed and that we need to integrate all the knowledge we have from a wide variety of disciplines to begin to solve the riddle.

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