Dissertation title:

An adaptive theory for human belief systems.

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ABSTRACT:

The thesis expounds a unifying theory, which draws from many scholarly disciplines to build an argument that human belief systems are adaptive, resulting from memetic-genetic co-evolution. The term 'belief systems' is intended to describe collections of beliefs within human minds that belong to different classes of belief and in different proportions, with the result that each belief system elicits particular behaviours. It is the range in elicited behaviours between individuals that natural selection acts on and which, therefore, has affected our species' evolutionary direction.

Key assumptions and predictions from the general hypothesis were tested in a series of questionnaires. The first hypothesis, that there are three main types of belief – epistemic (empirical), prosagogic (supernatural) & efevresic (societal) – was supported by the first questionnaire. The latter also supported the prediction that there is an antagonistic relationship between epistemic and prosagogic beliefs, and that efevresic beliefs are distinct from, and orthogonal to, the other two, as they are hypothesized to belong to a separate scale.

Cluster analysis of responses to two distinct questionnaires, one with national and the other global reach, indicated that people fell into three main groups, the largest consisting of participants with strong responses related to social conformity, religious tolerance and spiritual beliefs unconnected to mainstream religion. This group was quite separate from two other clusters: those with strong traditional religious beliefs and those with strong secular superstitions. The religious cluster, thanks to the larger sample size of the pan-global questionnaire (n=5,000), was shown to consist of two distinct clusters: those who strongly accept all superstition and those who accept religious but reject secular superstitions.

It is suggested that, in human prehistory, pre-religious superstitions allowed an 'intentional stance' that placed inexplicable events within a coherent world view. This, genetically underpinned, way of thinking was then susceptible to more elaborate memes, the (memetically) coevolved groupings of which constitute today's religions. However, I propose that it is the same fundamental cognitive architecture that supports both religious and secular superstitions, the balance of power within minds varying in response to upbringing and social pressures.

Dedications:

I would like to dedicate this dissertation to my wife Sarah,
and our three sons, George, Hardie and Johnnie.

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This PhD project would not have been possible without the supervision of Prof. Innes Cuthill and funding from Dr. Jonathan Milner of the Evolution Education Trust. Colin Davies was also instrumental in computer coding to turn the concept for the Phase 3 questionnaire into a working application.

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated, by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED [redacted] DATE: 29th March 2019.

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Introduction.

The subject area for this PhD project is human behavioural ecology. It presents and investigates an adaptive theory for human belief systems. Although humans exhibit seemingly infinite and random variety in their belief systems, the theory offers a means of simplifying our understanding of belief system structure worldwide, so that diagnostic patterns in trait distribution can be detected as evidence of an adaptive mechanism. Belief systems affect fitness by prompting varying behaviours in individuals upon which natural selection acts and so alters the gene pool. Thus, populations have adapted, and adapt, due to changes in the genetic belief inclinations of previous generations and changes in the environment, which includes both environment and sociocultural selective factors.

On the matter of belief in supernatural phenomena, the theory proposes an explanation for their origin and their subsequent involvement as part of the adaptive mechanism. In so doing, it provides a logical and scientific function for them, which consequently encloses them entirely within the human imagination, making their 'existence' superfluous to requirements.

Chapter One expounds the theory in its entirely, by drawing on various disciplines in order to demonstrate its component hypotheses by example and cogent argument. Chapters Two, Three and Four describe three phases of questionnaire development, deployment and analysis to explore the ways in which beliefs, religious and secular, interact. Chapter Five overviews and discusses the research evidence in relation to the theory and reaches some conclusions.

Chapter One.
Expounding the theory and identifying methodologies.

Abstract.

This chapter outlines the many and various hypotheses that comprise the overarching theory for this research, that belief systems are adaptive, and it pinpoints the parts of the theory that are suitable for running worthwhile experiments. It is necessary to describe the components of the theory in order to put the methodology into context for the reader and to provide a linear understanding of events, as the entire evolutionary story is lengthy, multifaceted, interwoven and ongoing. The consistent thread though, is that different beliefs cause different behaviours that selection acts on differently, so that level of biological fitness varies between individuals. Selection itself has duality however, as it involves natural selection and sociocultural selection due to coevolution between genes and memes. Despite this apparent complexity the selective mechanism emerges as a relatively simple one, but it is determined by environmental specifics that differ and change between and within human societies. Without adequate explanation and expoundment this serves to obscure the adaptive process to the uninitiated, which is why it had been hidden in plain sight prior to this work. Just as natural environments vary, so do sociocultural environments along with the beliefs and behaviours that determine relative likelihood of survival and reproduction. Common to all human populations, however, is the supernatural meme which, it is postulated, has exploited sociocultural selection to such an extent that it has altered human belief psychology to its benefit and so perpetuated its own survival by maintaining sociocultural environments that favour inclinations towards supernatural beliefs and superstitious behaviours over alternative beliefs and behaviours. Thus, the methodology investigates this reasoning as its core theme.

1.1.0. Defining 'belief'.

Here, the notion of 'belief' refers to what the mind accepts as its version of reality: i.e. the interpretation of information that a given mind has accepted as truth, The same information may be interpreted differently by another mind, which is why we have varying belief systems.
The epistemological view is that human knowledge of everything and anything is always incomplete, so *belief* is the default platform by which the mind deals with the problem of assembling a model of the world in order to effect appropriate interactions with the environment. In epistemology this is described as *justified belief* (Goldman, 1979), as the mind has to find a way of justifying its acceptance that something is true in order to form a belief. A belief system is therefore a collection of beliefs that contribute to the internal model of reality

and facilitates responses to the environment. A universal structure for belief systems is hypothesized in 1.11.0 and successfully tested for in Chapter Two.

Justification doesn't mean 'deciding' what to believe, because the mind either believes something or does not, so the process of justification describes the process of reaction that the mind has to information. There is no dualism, as once a belief is justified it is formed. That isn't to say though, that a belief cannot be modified in reaction to new information, but that the mind cannot 'float' between different beliefs (contradictory beliefs must be internally reconciled; Festinger, 1957).

Research using Transcranial Magnetic Stimulation (TMS) has shown that it is possible to externally control people's decisions (Oliviera et al., 2010), yet people 'believe' they have made choices themselves. A facet of reality perception that the brain thinks it is in control, that we have free will over our belief systems, and this is plausibly an evolved trait. If we were aware that there were elements of our decisions beyond our control then I argue that it would probably erode functional efficiency, which is why 'conviction' evolved as part of the brain's operation. Conviction is embedded in the decision process, so the brain naturally assumes that it has made its decisions entirely autonomously.

Émile Durkheim thought of religious belief as a way to bridge the gap between the known and the unknown (Durkheim, 1912). The 'known' was the world of *ordinary* and everyday experiences that had accessible explanation, and the 'unknown' was the world of *extraordinary* experience that had inaccessible explanation, such as chance events, sickness and death. Thus, beliefs might be described as conceptual models, by which the mind constructs its subjective understanding of the world around it. This is the working definition for the dissertation, as it embraces all kinds of belief with parity, regardless of theme and content.

Also, by employing this definition it becomes apparent that there is no such thing as a correct or definitive description of the world. Each human has its unique perspective, because sensory representations are filtered versions of reality and their interpretation is also determined by belief system (Kahneman & Miller, 1986). As this interface between sensory perception and cognitive interpretation is the means by which human consciousness connects with the environment, I propose that all human minds conceive the world through the same mechanism but, as conceptions of the same information can differ, so the mechanism must vary in some way between individuals as a matter of logic.

If the definition of a belief is a conceptual model as described, then one is bound to ask why the human brain evolved a mechanism to construct such models in the first place. For example: it might have simply evolved a set of reflexes to respond directly to environmental stimuli, as seen in less advanced organisms. It may be that sapient intelligence only evolved because cognition-based-on-believing came about, and is therefore a prerequisite for sapient intelligence. The term

'sapient intelligence' is used here to distinguish between human intelligence and that of other sentient species. The defining ontological differences, apart from the machinery (relative brain size: Deaner et al., 2007), are the capacity for existential enquiry, self-awareness, complex communication and imagination (Renfrew et al., 2008). Mental modelling itself is a well-researched field in cognitive psychology, so there is no need to expand further (Gentner & Stevens, 2014; Johnson-Laird, 1983).

It is likely the hypothesized mechanism's naissance and subsequent development afforded our ancestral species a fitness advantage, plausibly because it made cognition more efficient and behaviour more effective. So, the process of filtering information, by accepting or rejecting it, and then constructing conceptual models offered an advantageous state of mind that natural selection acted on and, I suggest, continues to act on. Thus, the belief mechanism became a diagnostic characteristic of the human design, through the ecological function it fulfils.

1.1.1. Bayesian decision-making.

Bayes' Theorem allows one to calculate the probability of a hypothesis given data, from the probability of the data given a hypothesis, and the prior probability of that hypothesis before the data became available (Bayes, 1763; Jeffreys, 1973). It allows the optimal combination of prior knowledge with new information to create a posterior distribution of the likely turn of events, which can, in turn, be used, for decision-making (Jeffreys, 1973). A Bayesian view of the hypothesized belief mechanism can offer an explanation for the dynamic that results in the brain accepting or rejecting information and ideas; this is the foundation for forming beliefs. The premise is that people vary in measure between two diametrically opposed cognitive platforms: either, a tendency to treat newly observed data as plastic and making it correspond to strong prior expectations: or, a tendency to treat the data as hard or fixed and modifying expectations flexibly to accommodate them.

The general view in cognitive psychology (Beck et al., 2008) is that the brain makes its belief decisions according to the principle of Bayes' Theorem because nature has found it to be the most cost-effective solution. New information is combined with a 'prior' (belief) in an optimal way, and decisions based on the resulting posterior distribution.

Bayes' Theorem calculates the probability that an event was generated by particular conditions (or 'hypothesis' about the state of the world) given an observed event (the data) and prior beliefs about the conditions/state of the world. For example, to an atheist the chances of an event being attributable to the actions of a god are zero (their prior), so the event must have a rational explanation even if that explanation is extremely unlikely or, as yet unknown. To a theist, their prior is that a god exists, so an unlikely event is more likely to be attributed to the actions of a

god, rather than accepting a rational explanation or that a rational explanation must be responsible even if unknown.

1.1.2 The role of the prior.

To illustrate the role of the prior, let us consider the two tosses of a coin. Multiple tosses of a coin provide a data record of heads and tails that, if the sequence is long, will expose the true odds of 50:50. But here we consider two tosses, and the first has landed heads. Someone naïve to what coins do when tossed, and coin ballistics, will not possess the prior knowledge that a subsequent coin toss has odds of 50:50 of being heads or tails, independent of the previous toss; instead they will have to rely on the data. They have information that a head is possible, none concerning the likelihood of a tail. A rational bet might well be heads for the second toss. Conversely, another person might have a prior (a belief) that expects harmony in the universe, or that the tosser of the coin is a confidence trickster, and so, if the first toss is heads, the second is likely to be tails. Thus, there is a difference between a person with a prior and someone without a prior, and between people with different priors, in terms of the way they are likely to behave in predicting the outcome.

We can now consider the cognitive processing that a brain runs through in forming its beliefs. The starting point is to consider what would happen if the brain had no capacity to form a prior and therefore had to perpetually interpret new information as and when it arrived, rather than updating a prior belief to form a posterior. In the case of simpler organisms, the role of the prior has been played by evolutionary history (Dall et al., 2015), biasing the response to new information by innate tendencies and perceptual filters. Likewise, beliefs may be thought of as adaptive biases – i.e. 'memories of adaptive behaviour past' that have been filtered and processed because they had survival value. Awareness is unnecessary to the process of Bayesian integration of old and new information, but it is important in humans because it enables the conscious comparison of beliefs with incoming information and judge the relative merits of different situations more accurately. Levels of animal awareness, or consciousness, in other animals are a matter of debate, but there is general agreement that awareness increases with neural complexity, until self-awareness emerges (Tannenbaum, 2009; Griffin, 1992).

Akin to 'genetic memories' are instincts, which are really heritable fixed memories (Gould, 1977). Both are memories that have been retained because of their survival value, which is essentially what I propose that beliefs are. Thus, by understanding that there are analogies of beliefs in even the simplest organism - parcels of useful stored information that bias the response to new sensory information - it becomes apparent that human beliefs must be fundamentally similar, even though they can often make little or no reference to things in the real world.

Thus, it is hypothesized that whatever form beliefs take, they all serve the same purpose unconsciously, which is to generate behaviours that bias the response to new information in such

a way as to maximise survival and reproduction. Sometimes the relationships between belief, behaviour and level of fitness are direct and obvious, at other times the relationships are indirect and obscure, but the same process is in action all the same.

Understanding this disconnect between many human beliefs and elements in the physical world is fundamental to the apprehending the role of beliefs as ecological drivers when such beliefs have no immediately apparent role in affecting human evolution. It is therefore central to the research in this thesis, both theoretically and methodologically. Much of Chapter 1 explains the hypothesized connection by example and the experiments are designed to reveal the connection by catalysing reactions to questions to obtain relevant data.

1.1.3 Comparing frequentist reasoning with Bayesian reasoning.

The inclusion of the prior imposes a Bayesian regime on the way the brain conducts its reasoning about the likelihood that a chosen strategy will be successful in relation to other possible strategies. The brain already has a model upon which to base its reasoning and, with the addition of new information, it increases its efficacy with strategy. Without the prior, or the ability to form a prior, the brain uses frequentist reasoning, because it has no model to work with, so it is reliant on the new data in making its strategic decisions.

If we translate this into a situation where two organisms are deciding on a strategy that has direct bearing on survival, then it becomes clear that having an informative prior is likely to result in greater fitness. Of course, the larger the dataset available to the individual without the prior, then the more likely they will be able to choose the same strategy as the individual with the prior, but that would require them to have survived similar situations many times before in order to have the necessary information; which, in itself, is unlikely. So, we can see that the ability to form a prior is statistically advantageous and that the advantage increases with the ability to modify the prior (this event's posterior becomes the next event's prior).

When it comes to tossing a coin there is clearly no need to modify the prior, because the odds are fixed, but in most scenarios there will be many changing variables that make reasoning far more flexible. The ability to form and modify the prior therefore steers cognition in favour of Bayesian, over frequentist, reasoning. As organisms become more complex, with longer lives and wider experience of variation in space and time, then the Bayesian strategy has obvious advantages (McNamara et al., 2006; McNamara & Dall, 2010). Although the quality of data can blur the divide between frequentist and Bayesian reasoning, as a general evolutionary rule, frequentism abdicates to Bayesianism as organisms become more complex and reasoning strategy becomes more critical to their survival.

Looking at humans, there can be relatively few real circumstances where frequentist reasoning is a match for Bayesian reasoning; i.e. due to a situation being encountered about which no prior information is available. One can see that infants would be more likely to encounter such situations, having not had the opportunity to establish priors other than instincts and maternal effects ('intergenerational memories', as it were), which is why they readily turn to adults, who usually have appropriate priors to deploy on their behalf (Jaswal, 2010).

That isn't to say though, that the parent's priors have anything to do with veracity; only that they are more likely to result in appropriate reactions in a given environment, precisely because they have survived in that environment (McNamara & Dall, 2011; Dall et al., 2015). Research has shown children developing their priors by comparing their own experience of the world against accurate and inaccurate information provided by adults (Nurmsoo & Robinson, 2008), but belief memes are different because comparisons cannot be made with real experiences, so they are more fluidly passed to new generations regardless of their content. Children err on the side of trust when uncertain. This can sometimes cause parent-offspring conflict, when the parent insists on instilling the priors that were useful during his or her life, but the offspring judges, or asserts, that "the world has changed" and so those priors are no longer appropriate.

As acquiring data incurs cost, then the greater the cost the more inclined the person will be to fall back on beliefs, because it either represents past cost to that individual by forming a prior, or it represents past cost to their genes via forebears having formed their priors and bequeathed them. One can see then, that instincts are related to beliefs in terms of their function. Although instincts are not beliefs as such, because the person isn't aware of them, they serve the same purpose, in the sense that they equip the person with a way of fast-tracking behaviours, which saves on the cost of acquiring and processing relevant data, and reduces the potential cost of delayed, inappropriate or absent reactions. Our instincts are prior investments that the same genes have made in prehistory. Evolution has found a way to perpetuate those investments, by making them built-in, data-free, behaviours.

It is apparent that some consciously appreciated beliefs operate in a similar, data-free, way to enable the brain to skip the effort of processing new information. Chauvinism, bigotry and prejudice are examples, as they are priors that the mind has either formed itself or adopted from proximate minds, and is subsequently reluctant to modify, because they do the job in the given environment, so there is nothing to be gained from modifying them. In fact, modifying them might even have a negative outcome in the given environment. It is more efficient for the mind to stick with its prior, unless the environment changes sufficiently to warrant modification, but even then it may still be more efficient to keep the prior and feign modification.

An example is seen in intransigence with adopting political correctness in older members of society. It is not worth their while adjusting their prior in the company of younger people,

because they spend most of their time in the company of their own generation, where their existing prior is appropriate. Conversely, younger people readily invest in updating their prior because they spend most of their time in the company of their own generation, where keeping up with political correctness is perceived as important because it assimilates them socially, which translates into greater fitness.

It is also possible for people to arbitrarily settle on prior variants because there is little difference to the outcome for them whichever one they choose and the same level of cost is required in forming either prior or modifying either prior. This explains why essentially similar belief systems can vary so much in their exact details. Furthermore, it makes little difference in selective terms, because fitness enhancing behaviours will be more-or-less similar.

1.1.4. When Bayesian reasoning goes awry.

Returning again to the toss of the coin; it is also possible for an individual to have knowledge of the model (that the odds are 50:50) but to misapprehend the model and still allow the new information to corrupt their prediction of outcome: i.e. the 'gamblers' fallacy'. In the case of tossing a coin, past data are not relevant to the next toss, but the Bayesian inclination is to try and incorporate that information into the calculation. Thus, the mind is led by the past data to create false bias in prediction. In fact, it essentially becomes a frequentist calculation. If this were translated into a 'real life' situation it could clearly lead to a miscalculation in appropriate behaviour. In effect, it amounts to worsening one's prospects by thinking one is improving them.

Another way of looking at this is to think of irrelevant or superfluous incoming information as 'noise'. For organisms to detect the signal within this noise (isolate the useful information), evolution has found different strategies. For simpler organisms, the noise level is likely to be low, because they only have the ability and requirement to collect immediately useful information, through a limited number and types of sense organ (at the lower limit, for a bacterium, a cell-surface receptor for a particular molecule). As organisms become more complex, more information is received but more noise has to be dealt with (Clark & Dukas, 2002; Jerison & Barlow, 1985; Dusenbery, 1992). This means that it becomes advantageous to be able to remember things, so that it becomes easier to recognise and dismiss irrelevant information by comparison to the platform of learnt experience in the nervous system. That platform, in less complex species, is the prototype for the belief system. It is an integral component of the evolving brain, becoming more refined and sophisticated as the brain increases its requirement to filter useful information from noise.

In the case of evolving humans, there was an exponential increase in functional demand because humans developed the ability to communicate in ways that were, and still are, unique among the Earth's fauna (Greenspan & Shanker, 2005). This meant that the rate of information receipt was

amplified significantly which, in turn, meant that noise was amplified significantly too. However, an important point to realize is that the definition of 'noise' changes. Belief system function has become removed, to varying degrees, from the straightforward matter of dealing with the natural environment. Instead, sociocultural environments increasingly dominate what information is likely to be useful and, therefore, what information is noise (Alberti et al., 2003). Given that the human has to interpret and navigate the sociocultural environment, rather than directly knowing what information is useful and what is noise, then the differences in experience inevitably results in variability between individuals. Thus, one human's noise is another human's useful information, and vice versa. Consequently, humans express a peculiar interplay between what they regard as useful/noise information in the natural environmental context and what they regard as useful/noise information in the sociocultural environmental context.

1.2.0. Unempirical beliefs.

Having provided a general definition for *beliefs* in section 1.1.0, we turn to examine those beliefs that are variously described as supernatural, paranormal and so on. They are of particular interest because they contain ideas about phenomena (energies, entities and events) that are not supported by empirical evidence and would require forces and laws currently unknown to science in order to exist *and* would contravene the forces and laws already known to science. As such, the origin and subsequent ubiquity of these beliefs would seem illogical and irrational from the scientific standpoint, unless they serve a covert purpose beneficial to biological fitness.

Science investigates these beliefs from the standpoint that they have no foundation in truth, due to the absence of empirical proof, so the rationale is that *behaviours* resulting from such beliefs must be the key to understanding their conception and continuing presence, as behaviours are the point of contact between the mind and the environment. There is a presumption of function, rather than any notion that supernatural beliefs simply occur for no particular reason, because they are very widespread and established (Boyer, 2003), and some appear costly, so it would seem unlikely for humanity to devote so much effort into them unless there were a return on the investment, in evolutionary terms.

When we think of the inordinate levels of human time and effort invested in supernatural beliefs, spanning time from the prehistoric to the present, it represents an expenditure of resources that would be inexplicably wasteful for the individual performing them unless there were hidden yield in improved fitness. This becomes especially evident when we consider the work put into ancient megalithic monuments and earthworks (Atkinson, 1961; Brown, 1980), such as Stonehenge (Renfrew, 1973; Allen, 2014) and Carnac (Mohen & Baker, 1999), at a time when usable hours and energy would have been at a high premium and seemingly far better spent in pursuit of food, materials and other resources for furnishing everyday survival and reproduction.

Clearly, the ecological return must have been significant enough to outweigh the enormous losses incurred, so my objective is to hypothesize what that return might have been.

The salient point here is, that Neolithic peoples would not have been aware of the ecological implications of their behaviour, as is generally true with modern people too. Natural selection had acted on the genes of past generations because those innately inclined to donate time and effort into such apparently arbitrary tasks must have been relatively better at survival and reproduction than others. Furthermore, it seems unlikely to have been the actual building of stone monuments that brought ecological benefit, as their forebears didn't build them, so it surely relates to diagnostic behaviours that natural selection favours and that can be expressed via different modes of activity, past and present: i.e. many different human projects, tasks and activities relating to supernatural beliefs must have been affiliated with behavioural benefits.

Of course, it is the concerted effort with building places of worship and burial that is most conspicuous, because those structures largely still remain in the landscape as reminders of past supernatural investment, even when cultures and civilizations have since died out or subsequently evolved. As well as prehistoric henges, monoliths and temples, this includes historical structures, such as sepulchres, tombs, shrines, chapels, churches, abbeys, monasteries, mausolea, cathedrals, tumuli, pyramids, ziggurats, barrows and cists. Thus, they represent incalculable numbers of man-hours and meals that might apparently have been put to more logical ecological use. It follows that for every one of those structures there must have been innumerable further man-hours invested in worship, ceremony, ritual and so on. So clearly, humans have been engaged in the business of expending their attention and efforts in this curious way since the dawn of human prehistory until the present day.

Science tells us that no other species is wasteful of resources to no apparent end, as whenever it may seem that way, there is always an underlying ecological explanation related to the behaviour improving fitness in one way or another (Bekoff & Alan, 1998; Enquist & Leimar, 1987). This is because natural selection would not allow resource inefficiency without compensatory gain. Very occasionally the human cost is the whole point, as with the 'potlatch' ceremonies of West Coast Native Americans, where the destruction of resources is a demonstration of access to more resources (Handicap Principle: Zahavi, 1975), but this is an unusual exception to the rule and does not apply to typical human behaviour.

Although there is also relevant argument that sociocultural environments have increasingly conferred surplus in resources - *White's Law* (White, 1943) - so enabling humans to focus time and effort on nonessential occupations with reduced ecological impact (Parisi, 1997; White, 1949; Weisdorf, 2005), we can conclude that the same ecological underpinning of behaviour has always been present. Humans were certainly not exempt from the same rule of nature to begin with and a disproportionate amount of time and effort has clearly gone into the trappings of

supernatural belief. Indeed, religion has also propagated a good deal of resource loss through associated stress, warfare, crusades, famine, suffering, disease and death on an inestimable scale.

A leading question, then, might be '*why didn't humans dismiss their supernatural beliefs and activities altogether and simply utilize the resource surplus generated by society for culturally progressive means alone?*' Clearly there has to have been a very good covert reason why they instead diverted much of that resource surplus into behaviour that generated no immediately obvious advantage and often seems to have incurred costs.

As supernatural beliefs are commonplace in human societies across the globe (Beck & Forstmeier, 2007) then we can also assume that they are not delusions resulting from psychological illnesses. There are people who suffer from such psychiatric delusions, but they represent only a very small fraction of any given population (Tepper et al., 2001). The same applies to people who exhibit brain dysfunction; such as memory loss, learning difficulty and other cognitive processing problems. In point of fact, as the data will show, supernatural beliefs are so much part of the general human condition that everyone betrays at least some level of inclination towards them regardless of the public stance they may take or the principles they may uphold. This, then, tells us something important about their role in the way human brains have evolved to perceive the world and the way they manage their interactions as dictated by their personal interpretations of reality.

If we define a supernatural belief as a belief with the inclusion of any content that cannot be supported by empirical evidence, then we find that there is a broad-ranging list to choose from, even in societies where empiricism is the dominant cultural precept. Supernatural beliefs thus include religions (monotheistic, polytheistic, paganistic, etc.) the occult (paranormal entities and powers, etc.), superstitions and notions of destiny, fate, purpose, reason and luck. It is worth pointing out that people don't necessarily acknowledge, or indeed realize, that part of their belief system has a supernatural basis. This is partly because they have never analysed their beliefs in that way, but also because their beliefs, by definition, are what they believe to be true, so they are accepted as axioms.

The title for this section is 'unempirical beliefs' rather than 'supernatural beliefs' because the latter are not the only beliefs that are not supported by empirical evidence. There are many other human beliefs that qualify as constructs, because they don't attempt to describe elements of the real world. They are often affiliated with supernatural beliefs, but they don't contain supernatural content and can be separated into a discrete category. They include morals, ethics, philosophies, politics, laws, rights, principles, etiquette, codes and rules. It is hypothesized that their function is to allow societies to operate effectively, as without them it would not be possible to establish and maintain the predictability of behaviour necessary for societies to work. Holding such beliefs can be described as degrees of adherence to social norms (Haidt & Joseph, 2004).

As an example, the Highway Code can be viewed as a societal belief system in microcosm. By believing in the code and behaving according to the rules, both road users and pedestrians can be fairly certain that nothing untoward is likely to happen to them. Thus, society functions well as long as most people adhere to the prescribed norms. However, people's adherence to these societal beliefs has nothing whatever to do with their supernatural or religious beliefs, which can vary in the extreme without affecting highway safety: i.e. their societal beliefs. If we entertain the fanciful idea of a Highway Code based on supernatural beliefs instead, then it would be an unmitigated disaster, because people would behave in wildly conflicting and unpredictable ways, making our roads and pavements extremely dangerous places to be. Imagine traffic lights where green signals go to atheists, but red signals go to theists, and amber signals go to agnostics! There would be chaos and carnage. It becomes clear then, that societal beliefs have a discrete and important purpose. They try to generate and maintain societal accord and harmony by behavioural uniformity, regardless of other beliefs people may have.

Unempirical societal beliefs are often affiliated with unempirical supernatural beliefs, which can be misleading. For example, the Ten Commandments of Christianity and Judaism, include four unempirical *supernatural* beliefs relating to their god (1-4) and six unempirical *societal* beliefs relating to ethics (5-10). The latter are discrete, because they can apply to secular thinking as a well as religious thinking: i.e. honouring parents, not killing, not committing adultery, not stealing, not telling lies and not coveting others' possessions. Their intention is instructional in order to maintain peaceful and functional society, indicating that people will cross such behavioural boundaries if they are not policed. In other words, the very concepts of right and wrong behaviour don't come naturally because they are human constructs, so people require educating in such matters, and then reminding, for society to work.

Clearly society itself is a construct too, which is why a framework of behavioural rules has to be maintained by deploying unempirical societal beliefs. In the case of the Ten Commandments, the first four (supernatural) reinforce the others (societal) by imposing a powerful psychological message that their god will always be in judgement of their behaviour even if their misconduct is not discovered by family, friends and the society around them: i.e. there is no escape from punishment.

This begs the question '*how might one govern people's behaviour in order to maintain societal accord in the true absence of religion*?' Western culture is still underpinned by the legacy of commandments even though many people think of themselves as secular. Moreover, it might be argued that secularism is a privileged mind-set that can only exist within the traditional framework of religiosity, because it is the religion that has imbued society with the moral and ethical codes to keep it functional.

One might speculate that a truly secular society would therefore require some kind of 'secular bible' with equivalent secular commandments and accompanying belief system to keep people in obeyance. But, how would one manage to strike the equivalent to fear of a god (superstition) into secular people as part of the obeyance mechanism? This suggests that a secular ambition might be impracticable because there would be no means of securing an effective psychological hold on a population in the same way as superstition. If one thinks of despotic communism and fascist dictatorship as experimental models that have historically attempted secularism, then clearly those forms of psychological control are not effective in the long term. They have not succeeded in erasing religiosity, but made it covert, only to re-emerge when the opportunity arose.

This is important in our search for function in supernatural beliefs, because it demonstrates that other unempirical beliefs have function and suggests that the human mind does not invest in any beliefs without good reason. What-is-more, the investment in this other type of unempirical belief can be seen to benefit individuals in evolutionary terms, because the societal lifestyle confers advantages, in terms of individual fitness, over the non-societal lifestyle (O'Gorman et al., 2008; Krebs & Janicki, 2004).

In point of fact, people are *so* accepting of societal beliefs that they are generally regarded as normal and expected, albeit with some variation, whilst the extent to which people hold with supernatural beliefs can vary more considerably and generate greater contention. For example; scientific minds tend to be openly dismissive of supernatural beliefs, yet they have no problem with societal beliefs, even though they are equally unfounded in scientific principles.

It is a useful point of reference for the scientific mind in apprehending just how normally supernatural beliefs are perceived in the minds of those who believe in them. It also helps in explaining why people, who otherwise think of themselves as scientifically minded, can fail to notice their own belief in 'lesser' supernatural beliefs, such as destiny, fate, luck, purpose and wishing, because they are very similar to the societal beliefs they readily form. They contain no overt supernatural content and have simple structure, and so are sequestered into the subconscious.

The salient point is that societal beliefs are readily formed among all societies, because they are part of the definition of 'society' (Blumer, 1994). Thus, social compliance is a diagnostic of the human type specimen, regardless of sociocultural setting (Kerr & Levine, 2008). After all, the very notions of *antisocial*, *unsociable* and *sociophobic* behaviour only exist because we instinctively judge people's behaviour against a backdrop defined by the parameters imposed by society: i.e. we are attuned to the idea that *sociability* is the benchmark of normal behaviour. This is because it is perceived as the measure of the cooperation required for society to keep working properly (Argyle, 2013). We don't condemn people for being *prosocial*, *sociable* or *sociophilic*.

The ‘ecology’ of humans combines both natural environmental factors and societal environmental factors. The distinction between ‘natural’ and ‘artificial’ or sociocultural ecology is nicely illustrated by the phenomenon of incest, which has been documented in human society from the ancient to the modern and from the primitive to the advanced (Read, 2014). The reason why incest is such a good exemplar is that both types of ecological driver become antagonistic, thereby demonstrating their distinction. Incest, in this context, is not about erotic attraction, but the preservation of power and wealth through family lineage to maintain sociocultural fitness (Bixler, 1982). As status enables survival and reproduction in individuals who are less biologically fit, then the genetic aberrations resulting from inbreeding (Bittles & Neel, 1994) can be tolerated for the sake of lineage preservation, but only to a certain point: i.e. the biological driver eventually takes over, because incest corrupts the genetic lineage to such an extent that it becomes necessary to outbreed. This switch between endogamy and exogamy marks the boundary between the sociocultural ecological driver and the biological ecological driver, and therefore provides a model for understanding the difference (Van Den Berghe, 1980; Livingstone, 1969; Slater, 1959). The agents behind the two antagonistic drivers are different, because the factors that determine relative fitness are disparate.

Another important element in the role of unempirical societal beliefs is their control of natural or ‘primal’ desires in maintaining sociocultural frameworks. For example, monogamy may not be a natural human strategy, but it brings societal advantages that outweigh polygamy, by maintaining community stability and order (Alexander, 1987; Clarke, 1968; Masao et al, 2016).

In the modern era many people seem to have become confused about societal rules, not least because modern societies often comprise many subcultures that work by different rules. Thus, there is an erosion of societal control. One can see then, that society attempts to impose behavioural codes in order to police people who might otherwise behave in all manner of ‘non-conformist’ ways that are injurious to societal stability. Moral and ethical beliefs are central to this mechanism, but they require a means of imposing and reminding all members of society on a frequent basis, which is why their affiliation with religion has worked so well, as religion functions as both the conduit and the means of policing beliefs and behaviours via superstition.

When religious people talk of deep ‘spiritual connection’ or ‘inner peace’, they are essentially expressing the effect of, what I argue is, a supernatural meme that imbues them with societal accountability. They, of course, cannot see this, as they genuinely believe in the supernatural realm, but therein lies the trick of the meme. It mediates their societal actions, reactions and interactions so that their behaviour is societally appropriate. Of course, some secular minds claim to manage this without religion, but I hypothesize that without a secular equivalent to superstition this is not sustainable across a population.

1.2.1 Hypothesized function for supernatural beliefs.

Various other scholars have made inroads into the adaptive nature of religion. It is self-evident that religion affects the society and culture in which it sits, so it follows that the behaviour of the members of a given society will affect their chances of survival and reproduction depending on their level of adherence to doctrine in the assessment of one another (Wilson, 2010; Foster & Kokko, 2009).

The hypothesis here is that supernatural beliefs have a function that works on two levels: i. They cause the individual to behave in particular ways that result from having those beliefs. ii. They have the effect of convincing the mind of their veracity (*conviction function*), which maintains their hold within the belief system of the individual, thereby generating a 'feedback loop' that makes beliefs and solicited behaviours consistent – a necessary arrangement for their hypothesized involvement with natural selection.

1.2.2 Conviction function.

We now need to explore just how there could be any evolutionary advantage in supernatural beliefs convincing the human mind that they are true, without any corroboration from empirical evidence. I propose that the key lies in the epistemological view, that beliefs result from the mind dealing with incomplete information. When the believer is not privy to the empirical explanation, or where the empirical explanation is complex or conflicts with other evidence, making a decision based on conviction, rather than an assessment of the evidence, will be rapid and entail no processing costs. As long as the conviction (prior, in Bayesian terms) does not lead to very costly erroneous behaviour, it will have an advantage. Having convictions that are internally consistent, as part of a 'world view' or belief system, will bring further efficiency gains.

Science can be hard work for some people and fail to deliver satisfactory answers, while supernatural beliefs are digestible and *do* deliver satisfaction in those who believe them. Supernatural ideas suit the human mind, because the human mind only had science and empiricism as an alternative way to interpret the world relatively recently. Instead, in prehistory and in less technologically progressive extant societies, is a prototype form of scientific thinking that is often described as 'natural philosophy' (Bronowski, 1977). It contains scientific intent, in that it attempts to base ideas and theories on observation, experience, experiment and shared information, but it lacks empirical vigour. A result is that pseudoscience emerges and blurs the boundary between scientific thinking and supernatural thinking. In mimicking scientific thinking it evidently lends pseudoscientific beliefs legitimacy because they seem to be part-and-parcel of the scientific description of the physical world, making them all the more convincing. In fact, pseudoscience has significant lure to some, because it caters for a human need for explanation both on the logical-rational level and on the emotional-existential level (Weightman, 1998). This

seems especially true in the absence of real science to offer a counter explanation or when the real science is complex and specialized.

Astrology is a good case in point, because it cloaks itself in jargon and terminology that lends it a beguiling similarity to astronomy, so that many people fail to acknowledge the difference, and therefore believe it is true. Indeed, the science of astronomy is rather awe-inspiring and incredible anyway, so a magical version in the form of astrology isn't so far removed in terms of credibility. Both belong to a realm beyond everyday human experience and both evoke the human imagination, so a pseudoscience that provides added meaning and personal relevance is attractive, especially when interpretation is ambiguous and self–verifying. In psychology this behaviour is known as the Barnum, or Forer, effect and is part of the phenomenon of 'subjective validation' (Marks & Kammann, 1980). A companion process is known as 'self-deception', where the subject dismisses evidence to the contrary.

Furthermore, astrology has existed for far longer than astronomy, and began as a kind of quasi-science, before anyone attempted a scientific approach or even realized that the sky was a physically three-dimensional environment. Therefore, the real science had to emerge from a long tradition of mystical reading of the sky as a two-dimensional (albeit concave) surface. The fact that many people persist in believing astrological ideas based on the earthly view of the cosmos, even though they now know that the view would be different from another vantage point, is indicative of the hold that supernatural beliefs can have on the human psyche. Mystical attribution is, it seems, a very powerful attractant to many human minds, even when the science demonstrates a pragmatic truth, because astrology is self-indulgent. Some psychologists call this 'true-believer syndrome' as it describes a psychological state where no amount of counter evidence can shift the condition of belief (Keene, 1976).

Another area that confuses pseudoscience with real science is homeopathic medicine. Homeopathy is similar to astrology, in that it predates the scientific alternative, in varying traditional guises, so empirical medicine has had a hard time superimposing itself on medicinal practices that are based on superstition, tradition, familiarity and trust, rather than development through scientific understanding and evidence.

There seem to be a number of reasons why these homeopathic medicines can appear to work and therefore perpetuate the beliefs associated with them.: coincidental recovery, placebo effect, subjective diagnosis, imaginary illness, nocebo effect and so on. (Colquhoun 2007; Teixeira et al., 2010, Ernst, 2008; Shang et al., 2005; Benson, 1997; Benedetti et al., 2007), Above all, on the scientific level, homeopathy uses no clear empirical distinction between the parameters that define 'normal health' and the parameters that define 'disease and illness', which obviously leaves the way open for all kinds of misinterpretation, distortion and misapprehension. Thus,

there is a belief system and culture surrounding homeopathic medicine that ignores the science, in favour of anecdote, hearsay, delusion, and sub-sample data.

In history there have been many similar pseudoscientific ideas that have since fallen by the wayside because they have been sufficiently refuted by scientific evidence, so that belief in them has discontinued. They include phlogiston, perpetual motion, phrenology, spontaneous human combustion, alchemy and group selection. Unlike astrology and homeopathy, they were not about the self and they were not, either, incorporated into an enveloping belief system, so the science eventually won the argument.

1.2.3. The cost of abandoning beliefs

Why is the human brain reluctant to abandon beliefs it has invested in; or rather, to replace them with new beliefs? Thought experiments such as Maxwell's demon - that appears to be able to break the second law of thermal dynamics, by reversing entropy (Knott, 1911) – show that the storage and deletion of information involves energy (Paninski, 2002). The brain constantly reanalyses the statistical relationships between old and new bits of information, so that frequency of co-occurrence and re-occurrence inform what the brain memorizes, and in which way (Gallistel & King, 2010; Kitamura et al., 2017).

This serves as empirical proof that thinking and believing incur energy costs, not just in terms of maintaining the brain, but also in terms of storing (memorizing) information, deleting (forgetting) information and recalling (remembering) information. If a brain is asked to alter its belief system then firstly, it has to delete existing beliefs and store new beliefs, but secondly, it has to remember why the deleted information *should not* be believed and why the new information *should* be believed: i.e. it has to process and store even more information.

Thus, we can see that a good deal of cognitive activity is required, so humans naturally resist the effort of adjusting their belief systems because the mind prefers to remain in a low entropic (ordered) state rather than experience a high entropic (chaotic) episode. Unless the change in belief state results in a behavioural outcome that outweighs the processing costs, natural selection will favour belief system stasis. This is an instance of the more general principle that flexibility has informational costs (Dall & Cuthill, 1997; Johnstone & Dall 2002; Schmidt et al., 2010).

Current research has shown that consciousness, and therefore brain functionality, relies on entropy in the thermodynamics of the brain (Guevara Erra et al., 2017). In other words, an optimum number of brain network interactions is facilitated by an entropic state, thereby enabling the mind to think lucidly, decisively and consistently. The inference is that effective consciousness requires the organization of brain matter, so that the resulting equilibrium allows

thought pathways to be travelled with the highest efficiency. Furthermore, other research has shown that the mind stores information in the form of 'memory representations': i.e. static code (bits) that is reactivated when memory retrieval is prompted, in much the same way that writing is static code until the eye and brain uses the code to process and release the information (Tanaka et al., 2014; Josselyn, 2017). Entropy thus facilitates the flow of electrical pathways throughout the brain during this process. It may be that dreaming is the brain latently processing data is the absence of sensory input and output, in an effort to reduce the costs of maintaining entropy, which is why we need restorative sleep to function (Siclari et al., 2017; Rechtschaffen & Bergmann, 2002).

1.2.4 Superstition.

Superstition is the mechanism associated with supernatural beliefs that causes the conviction function to work consistently, because it evokes emotionally orientated actions and reactions in the believer, so level or strength of belief translates into degree of impetus to perform rituals and to interpret outcomes according to the notion of supernatural judgement (Foster & Kokko, 2009; Matute, 1995). i.e. superstition is the behavioural expression of supernatural belief. It also transfers ultimate responsibility for events in life onto a supernatural power, as if the believer were a childlike figure and the supernatural power were a parental figure. Thus '*praise and blame*' psychology causes the believer to be locked into a perpetuating cycle of superstitious behaviour, known as general attribution (Gray & Wegner, 2009: Spilka et al., 1985).

A similar behaviour seems to be expressed in the condition OCD (obsessive compulsive disorder) in modern environments where supernatural beliefs do not predominate. It suggests that those with particularly strong inclination towards superstitious behaviour find themselves expressing repetitive behaviour in substitution for superstitious ritual. (Fiske & Haslam, 1997) Examples of OCD behaviour include ritualized ablution and domestic routines that seem to be linked with transfer of psychological control. That is to say; the behaviour is prompted and initiated by stress in areas of life upon which the sufferer has little or no control, so their attention is transferred towards things that *are* within their control (Moulding & Kyrios, 2006). In effect it becomes a behavioural placebo that must be conducted in an exacting and specific way to alleviate feelings of anxiety. Similar arguments are advanced for stereotypies in animals, such as repetitive pacing (Clubb & Mason 2007). As such, it is very similar to superstitious ritual and suggests that those people are genetically prone to that kind of behaviour, regardless of the culture they are raised in, because it is the conspicuous redirection of an evolved trait that is beneficial in its normal context.

The superstitious cycle of behaviour is common to all supernatural belief systems whether categorized as paganisms, occults or religions, as they all involve the concept of supernatural powers or entities that exist within a supernatural realm and are believed to have influence or

potency over the lives of their believers, whether merely spirits or grandiose gods or *a* god (Rossano, 2010). So they all generate conviction, for the reason already outlined. As we shall see, later in the dissertation, this commonality is to be expected, because all of these belief systems are hypothesized to be variants of the same meme. In other words, the supernatural meme manifests itself in many and various forms, from the grand and obvious, such as religions, to the small and obscure, such as belief in purpose.

If we look at some examples of the conviction function in action then it becomes easier to appreciate the potency of this arrangement in locking people into a behavioural cycle, thus demonstrating why natural selection might have favoured such inclinations. In so doing, we will also examine the resulting behaviours that may have served the proposed ecological function by affecting fitness level, both indirectly and directly.

Assuming a similarity between contemporary human tribal societies and those of our ancestors for the purpose of modelling ideas on behaviour and beliefs obviously runs the risk of mismatch, to one extent or another (Barrett et al, 2002; Lloyd et al, 2011), so it is inevitably an educated judgement. Mismatch can also include adaptations that have become maladaptive due to environmental changes. We cannot know for sure that natural and sociocultural environmental factors are exactly comparable, nor can we know to what extent modern humans are similar to prehistoric humans, but we can certainly conclude a reasonable approximation. Thus, in the absence of alternatives I feel that current ethnographic examples serve as very good tools in demonstrating human patterns of belief and behaviour that are likely to have been present in the past. Ultimately, modern humans are the product of that past, so it makes sense that their intrinsic beliefs and behaviours can have altered little if at all, simply because they sit on the same evolved platform.

A pertinent example is seen with the Naskapi, a Native American people, grouped among the Algonkin or Algonquin nation of languages that formerly inhabited the areas of Quebec and Labrador in modern Canada. An early twentieth-century ethnography (Speck, 1939) describes a superstitious ritual performed by the Naskapi in preparation for hunting trips, called 'scapulimancy', in which the scapula bone of a caribou was burned in a fire. The burnt surface of the bone was subsequently examined and interpreted as a map, showing the huntsmen where they should focus their efforts, as determined by supernatural forces.

In 1957 Omar Khayyam Moore wrote an article, *Divination – A New Perspective* (Moore, 1957), for the journal *American Anthropologist*. In his article he postulated an adaptive function for the scapulimancy ritual; suggesting that it randomized Naskapi hunting and so improved their prospects of making a kill. The notion was that humans are creatures of habit and repetition, so the Naskapi would naturally be inclined to revisit the places where they had previously had hunting success were it not for the ritual, which effectively led them to try new locations or

places they hadn't been for some time, where game stock would theoretically be higher. Moore concluded that this behaviour conferred a selective advantage because the Naskapi were more likely to be successful by scattering the frequency of their hunting activity over their territory.

Detractors, Vollweiler and Sanchez, in their 1983 article *Divination – "Adaptive" From Whose Perspective?* (Vollweiler & Sanchez, 1983), pointed out that the Naskapi were perfectly able to override their inclination to revisit previous hunting grounds without using a supernatural ritual and that scapulimancy did not randomise hunting, but was instead used intentionally as a means of re-establishing harmony and accord between tribe members and the supernatural realm during times of ecological stress. Dale Slaughter makes much the same case in his 1981 article *The Shoulder-Blade Path Revisited: A Belated Response to Omar Khayyam Moore* (Slaughter, 1981), by questioning how randomizing locations would improve hunting prospects.

Either way, it can be shown that Moore was correct in his hypothesis that supernatural belief resulted in behaviour that was ecologically advantageous, because both interpretations translate into selective advantage. Both are adaptive, whether the Naskapi are viewed as behaving unconsciously or consciously. The conviction function is simply that the Naskapi practice the ritual because they believe they are appeasing supernatural forces, regardless of whether they are aware of intentions or not. They are, therefore, locked into the behavioural cycle because they believe that supernatural forces exist and hold sway over their fortunes. Furthermore, this belief is reinforced by the results of their behaviour, whether negative, neutral or positive, thereby perpetuating the cycle; i.e. they are psychologically bound to interpret outcomes as either: supernatural punishment, indifference or reward respectively.

The ecological function, however, has potential for expression in various ways, I propose. Even if scapulimancy did not strictly randomize hunting, it still imposed a general regime of conscious variation in hunting locations and access routes that were more likely to yield results, simply because game animals tend to distribute themselves fairly evenly in the landscape territorially. In addition, there are other behavioural effects that supernatural belief and ritual would have had on Naskapi effectiveness at hunting when game was located. It is these effects that are of particular importance, because they are proposed here to have pan-human distribution and explain the intimate relationship between supernatural beliefs and human evolution. They are hypothesized to be 'behavioural cohesion' and 'behavioural alignment'.

1.2.5 Defining behavioural cohesion and behavioural alignment.

The concepts of behavioural cohesion and behavioural alignment are defined here as follows: Behavioural cohesion is the expression of the collective identity that people feel when they share similar belief systems, so that they display positive prejudice towards like-minded people and negative prejudice towards unlike-minded people (Piper et al., 1983; Brewer, 1999; Rossano,

2012). In the case of the Naskapi, the consequence of behavioural cohesion is that similarly superstitious tribal members have camaraderie and work well as a team, thereby optimizing their chances of hunting success by cooperating and communicating more effectively than those who are dissimilar (Beal et al., 2003). In the vernacular it is 'teamwork'.

Behavioural alignment might be described as optimizing efficiency in mental and physical preparedness for specific tasks, routines, moves, actions, etc. (Damisch et al., 2010; Rudski & Edwards, 2007). In the case of the Naskapi, following superstitious rituals and sharing ceremonials would have had a beneficial effect on mental and physical behaviour during the build-up to a hunt and during the heat of the moment, so that individuals had the confidence to think and move with decisiveness and coordination once committed to the pursuit and attack. In the vernacular it is 'focus'.

In both cases, these behaviours can be seen paralleled in modern sports and games, which might be thought of as activities that imitate primal occupations (Birrell, 1981; Wright & Erdal, 2008). Indeed, it may be that sports and games have their ubiquitous appeal precisely because they satisfy innate requirements that are otherwise missing in modern environments, so their apparent lack of purpose is actually underpinned by a substitutional function. Behavioural cohesion is seen in the way the members of sports teams rally one another to perform as units (Carron et al., 2002). Behavioural alignment is seen in the way they are compelled to perform rituals in preparation for the performance. Pundits often comment on the importance of psychology in sport for these reasons (Young & Pain, 1999).

1.3.0 Distinction between systemic details and lore.

Systemic details are the particular ideas that comprise the doctrine of a belief system, such as the minimalism of Protestantism and the maximalism of Catholicism, or Christianity having one god and Hinduism having many gods. It has been proposed that the theological detail of particular belief systems might have something to do with their ecological role or function (Burhenn, 1997; Hultkrantz, 1966; Jost et al., 2014).

This may be so, to some extent, as the hypothesis is that belief memes evolve into new variants, due to adjustments occurring through the processes of communication and reinterpretation from one person or group to the next over time and space, and the success of the supernatural meme is that it promotes adaptive behaviour in diverse contexts (Doebell & Ispolatov, 2010; Wiebe, 2013; Brodie. 1996). For example, there are many Abrahamic religions, so-called because they have a shared point of origin (the biblical tribal patriarch Abraham), but are quite different in terms of their specific beliefs and practices: their systemic details. What matters is that supernatural ideas affect behaviour via superstition in one way or another. I describe this as the ICA (Imagined Causative Agent).

Whilst systemic details are involved, I propose that lore is far more significant, because it imposes traditions of beliefs and associated behaviours upon which natural selection acts more directly. In other words, it is those elements that require believers to act or behave in certain ways, as this is what must affect success with survival and reproduction in some way relative to others. A good demonstration of this can be seen in religious taboo. For example, a number of religions have a cultural restriction against eating pork, including Coptic Christianity, Druzism, Islam, Judaism, Mandaeism, Zoroastrianism and various Middle Eastern sects (Lobban, 1994).

These belief systems clearly vary in their *systemic detail* due to memetic speciation (i.e. they are distinctly different religions), yet the *lore* that forbids pork consumption is common ground and so affects behaviour in the context of ecological fitness in a similar and identifiable way.

Eating pork can result in trichinosis (worm infection) there is a trade-off between the risk of eating pork and the ecological benefit of rearing pigs in different types climate and terrain. As the presence of the worm (*Trichinella spiralis)* is not immediately obvious and the disease takes time to develop, it makes better sense for caution to be enshrined in lore as a blanket ban among populations at high risk of the disease. That way there is no need to keep reminding the population, as the taboo does the job from one generation to the next (Djurkovic-Djakovic et al., 2013; Lobban, 1994; Harris, 2012; Blumer, 1939; Harris, 1974; Diener et al., 1978),

One can see that it helps to have prudent advice bound into religious lore in this way. If substances are poisonous or toxic, such as plant berries and fungi, then the consequences of eating them are likely to be immediately obvious, so lore is not particularly useful or necessary in reminding people to avoid ingestion, because those rules will be readily and frequently communicated culturally. In the case of pork, where the consequences of trichinosis parasitization are fatal and pernicious but take some time to incubate and emerge (and the actual cause is essentially mysterious), then religious lore prevents the uninformed from eating pork and it also prevents the informed from taking a chance that the meat will be safe.

The mechanism I hypothesize to link beliefs with natural selection is therefore quite simple in its operation, but it is also subtle in its effect and obscured by a good deal of cultural 'noise'. Thus, there is no need to look for more complex explanations, such as beliefs directly affecting function and development in the brain (Sosis & Alcorta, 2003). Here, I propose that natural selection simply acts on the differences in expressed behaviours to determine fitness level, but they can be very slight and difficult to identify between individuals; especially in modern environments that are a blend of many and various sociocultural elements.

More specifically, the transition from natural to sociocultural environments has resulted in a confusion of beliefs and adaptive behaviours, some of which are common between different

peoples and some of which are very different between peoples, but serve the same adaptive end. Therefore, it is necessary to fully grasp the *modus operandi* of the mechanism in order to realize why belief systems and their corresponding behaviours are adaptive, no matter what degree of familiarity or exoticism they may possess in relation to our own belief systems and behaviours. The mechanism has been hiding in plain sight all along; not because it is mysterious and esoteric, but simply because anthropologists have been focussed on the details of beliefs and behaviours rather than the pervading effects and consequences of the behaviours in the context of each given environment.

In the case of pork taboo, this process relates primarily to human ecological interaction with the natural environment. There are other instances when taboo relates primarily to interaction with sociocultural environments: i.e. taboo can be interpreted as a kind of sociocultural test, by prompting people to assess one another's behaviour and thereby gauge relative level of commitment to superstition, which translates into level of social acceptability and therefore determines relative fitness within the sociocultural habitat.

On the island of Madagascar there is a complex tradition of taboo culture, known as *fady*, which is an evolving regime of superstitious lore, relating to many areas of everyday life; i.e. not just foods, but manners, customs and etiquette (Ruud, 1960; Lambek, 1992; Walsh, 2002; Tyson, 2013). That is to say, the cultural elements considered to be taboo often differ between regional populations and many also frequently change by the decree of certain members of society. This is in marked contrast with the pork taboo, which is common to different cultures and belief systems, and has remained unchanged because it has a common and consistent ecological foundation.

I propose an underlying ecological driver for *fady,* and one that works differently to the example of pork taboo. Here, my hypothesis is that the evolving *fady* lore works as a selective filter, because members of a society are required to keep up to date with the lore in order to be accepted and not shunned. If they fail to observe the current lore then the implication is that they have either been absent from that society for some reason, they don't have the wherewithal to remember and observe the lore, or they are disinclined to bother complying. In addition, they may be an imposter to that society and therefore uniformed of the lore. *Fady* thus serves to maintain behavioural cohesion by discriminating against those who are unable, or unwilling, to observe and adapt to the most recent taboo culture.

Furthermore, as some *fady* taboos are more constant and also common to adjacent societies, the hypothesis is that the overall behavioural profile results in a more accurate assessment of an individual's likely relatedness across the metapopulation, as well as their underlying superstitious inclinations. Therefore, the level of acceptance they receive is calibrated and continually monitored, and the same applies to all other members of the same Malagasy society.

Fady can therefore be seen as a rather sophisticated ecological mechanism by which the supernatural meme causes the ongoing selection of the superstitious inclinations required for its own survival, by exploiting social selection.

In both cases – pork taboo and *fady* – the participants are naturally unaware of the underlying ecological drivers, because there are belief system layers above that engage and convince the mind otherwise. This assists the supernatural meme, as awareness of the ecological driver might cause the participants to consciously change their behaviour, however it would be very unlikely as the power of superstition is considerable. So, the participants remain unaware that their thoughts and behaviours are being managed by an agent: the supernatural meme. Thus, they have the sensation of freewill, yet their minds are actually being controlled.

1.3.1 Sacrifice and cannibalism.

Another example of adaptive lore is seen in human sacrifice and cannibalism, which has been recorded in association with a number of religions or paganisms, albeit historically (Harris, 1978; Vargas, 1985). Those who practiced human sacrifice typically believed that they were appeasing spirits or gods and they believed that they were absorbing the life-forces of those whose flesh they ate, so there were clear superstitiously motivated benefits to be had from their actions as far as they were concerned.

If we consider these supernatural beliefs and behaviours from an ecological perspective, there are selective advantages that may have initiated and perpetuated them. The most obvious one is a form of genocide, so that other populations are kept in check, thereby reducing competition for resources. In tribal situations, such as in Papua New Guinea, there would also have been the added benefits of removing male competition, so that more females could be accessed and fertilized, along with supplementation of nutrition (Dornstreich & Morren, 1973). Thus, improved survival and reproduction were both addressed under the guise of superstitious belief.

In situations where organized agriculture was present, as with the Aztec (Harner, 1977), then human sacrifice and cannibalism may have served to address variation in crop success and subsequent food availability. During times of famine it would have been necessary to appease supernatural powers by sacrificing humans – the worse the famine the more sacrifices required. This, of course, would have lowered the population in correlation with hardship level, thereby making the shortage of food less stressful. With the addition of cannibalism, more food was made available too, so these behaviours became a win-win strategy, though still masked by superstitious belief. The Aztec had a very high population concentration in Tenochtitlan, which was situated on an island within a lake, so variations in surrounding crop success would have had a marked impact on resource availability, which is probably why these behaviours evolved as part of their version of civilization (Mundy, 2015).

It seems that some scholars have been reluctant to propose or accept ecological explanations for cannibalism because it implies that all humans are capable of it, given the right (or wrong) circumstances, so it somehow jars with their idealized model of humanity. They would therefore rather not believe it, so their preference has been for theories that make cannibalism the result of either degenerate behaviour, as with serial killers such as Albert Fish (Heimer, 1971) and Jeffrey Dahmer (Tithecott, 1997), or extreme circumstances, as was the case with the Franklin expedition (1845) (Keenleyside et al., 1997), the Donner Party wagon train (1846) (Grayson, 1990) and the Andes air disaster (1972) (Read, 1974). It is interesting to note that the survivors of the latter were extremely reluctant to resort to cannibalism, but desperation meant that they ultimately adapted their Catholic faith to justify their actions and once they had broken the taboo it then became normalised and routine behaviour for the remainder of their ordeal (Read, 1974). The evidence suggests that similar events unfolded with the other two cases as well: desperation led to reluctant cannibalism, led to justification, led to normalization.

Thus, rather than arguing against an ecological root, these models actually demonstrate just how cannibalism might have become cultural in other prehistoric and historic settings, following initiating events of ecological stress, and then perpetuated by being ensconced in lore even when other food sources subsequently became more readily available. Effectively, this is an ecological backup system already set in place, so that subsequent starvation events don't require the population to overcome any innate reluctance to consume human flesh all over again.

The salient point here is that, in isolation, human populations are capable of adopting idiosyncratic behaviours because they become the norm within those populations: i.e. relativism is not present, so there is no 'voice of reason' as we might term it, especially when the idiosyncratic behaviour becomes entwined in the belief system as lore. That is, different populations work to different ethical and moral codes that determine what they regard as acceptable and unacceptable behaviour. This means that the range in beliefs relating to morals and ethics will be specific to different cultures, thereby providing a cultural signature. Thus the notion of sinning, for example, is a construct, as one needs to be informed specific to a particular sociocultural environment to know that one's behaviour or thoughts are sins. The same goes for superstitions, as one needs to know that the number thirteen, for example, is unlucky to believe it is unlucky, thereby making all superstition implausible in truth which, of course, includes all notions of interaction with a supernatural realm.

A pertinent example of idiosyncratically accepted behaviour is funerary cannibalism, as recorded among the Fore tribes of Papua New Guinea (Matthews et al., 1968; Steadman & Merbs, 1982). At some point in prehistory, probably as an extension to their existing exocannibalistic habit (eating strangers), it became lore to consume the mortal remains of deceased family members (endocannibalism), including brain and spinal tissue; the accommodating thought process being

that surviving relatives then had an intimate sharing of bonds with their late kin: i.e. the deceased became part of the living. In the 20th century it was noticed, by outsiders, that this had led to an unfortunate epidemic of the prionic disease *kuru*, which is a type of spongiform encephalopathy, similar to CJD (Creutzfeldt-Jakob disease). The tribesmen hadn't linked their cannibalism with the disease because the incubation period for the disease is 5-50+ years (Collinge et al., 2006).

However, the cannibalistic practice saw its cessation when Western missionaries and anthropologists intervened in the 1950s by educating them and explaining the connection, thereby advertently introducing a new ecological driver to alter Fore tribe lore and behaviour (Lindenbaum, 2008). Effectively, the original lore had supported community vigour via behavioural cohesion and by supplementing diet, until *kuru* appeared, when the newly introduced lore supported community vigour via prolonged life expectancy and by removing the burden of palliative care. The introduction of Christianity played its part in ensuring the necessary change in habitual behaviour, by making cannibalism a sin, so that Fore superstition swung from finding it acceptable to finding it unacceptable by this shift in lore.

1.3.2 The case of the Spiti Bhutia.

Population control can be interpreted the ecological driver underlying the religious lore of the Tibetan/Indian Bhutia community of the Spiti Valley (Francke, 1914). Traditionally, when families had more than one son, the eldest son inherited while other sons were invested into the local Buddhist monastery. From an ecological perspective, my interpretation is that this meant that the family wealth wasn't divided and there was no sibling rivalry either. In addition, it checked the population size in an environment where finite resources presented a very real restriction, by preventing the additional sons from procreating and spreading resources too thinly. It is better to share finite resources between a smaller population than to spread them too thinly among a larger population. The monastery population was supported by community donations and formed the spiritual hub of society, because the monks were family members whose prayers were believed to bring good fortune by appeasing supernatural powers. So, the whole setup was ecologically motivated, yet superstitious beliefs drove the behavioural regime. Incidentally, the eldest daughter inherited a dowry of jewellery to assist in finding a husband, but younger daughters were largely left to fend for themselves, often remaining unmarried and earning their keep by assisting the reproductive part of the family.

We have seen, then, how supernatural beliefs can result in superstitious lore driven by ecological benefit to those human populations. The extent to which those populations are aware or oblivious to the ecological mechanism is open to argument, but the point is that they are locked into a cycle of behaviour regardless, because their superstition prevents them from breaking the

cycle. Therefore, their evolved superstitious inclinations are part of an adaptive cycle, whereby the resulting behaviours are acted on by natural selection and the gene pool is duly influenced.

When referring to 'genes' I am not supposing that a particular zone in the genome is responsible for specific belief inclinations. Instead, I am using the term in the sense Richard Dawkins uses it (Dawkins, 1976), to refer to the heritable component that affects trait differences. Those genetic factors will be many and scattered across the genome, and they will also be both directly and indirectly involved, so any notion that a specific part of the genome controls belief inclinations would be erroneous.

In addition, 'meme' in this context refers to supernatural ideas or concepts that are hypothesized to have been initiated by human minds in prehistory and have perpetuated, developed and diversified by means of variation in interpretation, imitation and replication due to their intimate interaction with human behaviour and the natural selection of associated genes (Dawkins, 1982; Blackmore, 1999). So, I hypothesise that it is this particular and ongoing marriage – coevolution - between memes and genes that has made belief in the supernatural a diagnostic part of what we might call the *human condition*, as the behaviours have continued to confer relative fitness.

If we suppose that humanity might have evolved without conjuring the supernatural realm and subsequently been manipulated by its meme, then it becomes apparent that our belief systems and accompanying behaviours would be quite different. However, it seems that the attainment of sapient intelligence meant an inescapable inevitability, because the sapient mind intuitively asked existential questions and therefore had to invent the supernatural realm as a means of making sense of unanswered questions and unanswerable questions.

1.3.3 Gift exchange.

Various cultures have developed systems of political gift exchange, again with underlying ecological benefits driven by supernatural beliefs that induce the behaviour. Early anthropologists found themselves confused, because the concept of ecological underpinning was as yet unrealized, so the behaviour was interpreted as a curious form of ritualized pseudo-barter (Malinowski, 1922). In the case of Kula exchange among the Trobriand Islands of Papua New Guinea, genuine barter also took place, alongside gift exchange, which served to confuse the matter further by creating the impression that the Kula gifts were being used as a form of currency, which was illogical because the items were made from common natural materials that could be easily gathered, and therefore had no intrinsic value. Eventually, it was realized that the islanders treated barter and Kula exchange as quite different activities, but they happened to conduct them simultaneously because they were making the most of their infrequent visits, which involved arduous and dangerous canoe journeys between the islands, sometimes over hundreds of miles (Mauss, 1970; Damon, 1980; Weiner, 1992).

Eventually, modern anthropologists realized that Kula exchange is based on exchange of obligations (Mauss, 1990). The gifts are therefore symbolic tokens (reminders) that denote obligations between the giver and the receiver. In fact, gifting is the culmination of negotiation between the important members of each society, rather like signing treaties agreed at summit meetings in the Western world. Outwardly and consciously, the motives for forming these obligations are all about future strategy. By forming allegiances and obligations it means that potential conflict and competition are avoided via communication and contact, and it also means that favours can be asked for and indebted. This also occurs over generations, so that a son may renew an obligation made by his late father, for example. In our terms, my observation is that the obligations are 'I owe you' notes for any support that may be required, be it resources, manpower, alliance, or other kinds of help. In other words, it generates a spirit of reciprocity and redistribution of resources and support. Gifts effectively still belong to givers, so the receivers are custodians, which enhances gift powers. Inevitably, the gifting and barter trips also mean opportunities to reconnoitre for prospective mates for young men and women too. For the Trobriand islanders this is another opportunity for forming advantageous political connections and bonds, as well as opportunities for reproduction, but in ecological terms it maintains gene flow by exogamy and reduces gene deletion through conflict.

Scholars now define 'gift economies' and 'barter economies' as discrete concepts. The latter is a straightforward swap of commodities or resources of equal value (where money is involved, then the money represents that value), while the former is more open ended, as obligations may never be settled or, conversely, they may be over settled due to a more lax assessment of value. Most importantly, gift exchange self-sustains due to the ongoing overlap, while barter exchange happens only in the moment (Kranton, 1996).

Thus, I propose that the Kula exchange system is perpetuated by the belief system of the Trobriand islanders because the behaviour offers a range of ecological benefits that maintain viability and fitness, without the need to resort to destructive strategies of bellicosity and anthropophagy, which have been mentioned as other evolved cultural outcomes. Living on an island means that a neighbouring island may very well have a resource one lacks, or vice versa. Or the other island may offer a suitable mate, so it pays to have a peaceful diplomatic behavioural setup dictated by superstition.

Although anthropologists are wont to analyse societal behaviours in terms of altruism, kinship lineage, kin selection, and so on, the bottom line is: that all of these exotic behavioural systems are seen to be underscored by natural and sociocultural ecological drivers, and the vested interest of the supernatural meme in optimizing its own survival by ensuring that the most superstitious procreate with higher frequency. In any case, they are not quite as exotic as we may like to think, because we can see similar behaviours in ourselves. After all, it is always

strategically advantageous to form friendships and allegiances by holding and attending social functions. Most humans are motivated to 'put on the act': i.e. pretending to like people and cultivating affectations for the sake of fitting in and enjoying prosperous lives.

To connect is strategically better than to disconnect, because we are a social species, which is why we bother with christenings, marriages, graduations, funerals, dinner parties, birthday parties, seasonal get-togethers, work-dos, and the rest of it. It is also why we bother with swapping tokens, cards, presents and gifts in association with many of the above. It is our diluted version of the exchange systems described, so we are expressing a vestige of a belief/behaviour system that was once diagnostic, because it still has some adaptive relevance. It still demonstrates an ability and willingness to 'play the game', and therefore elicits a response that translates into improved fitness, which also radiates into the view taken of kin. It is why we have the phrase '*it's the thought that counts*' because gift exchange is not the same thing as trade exchange, so the material cost or value of a gift is not a consideration. *Tact* is the word we use for negotiating social politics, and gift exchange is part of the strategy. In the most basic terms, my view is that *exchange behaviour* of any kind is all about humans trying to make social existence work, because the dynamic is one of perpetually attempting to maintain accord between individuals or groups of individuals in order to avoid conflict. We may all know that it is fakery and hyperbole, but our belief system says that compliance is still expected, thus is does mutually affect our relative level of fitness.

1.4.0 Empirical beliefs.

Despite the general definition of 'belief' in section 1.1.0, it may seem contradictory to describe an empirically supported idea as a belief, because it purports to be proven 'true'. However, the first principle of science is that nothing is ever properly proven, so theories and hypotheses remain open to revision should new evidence emerge; even if it is deemed extremely unlikely. Therefore, they are beliefs, as they are accepted as true but they may not be. Indeed, we often trust the word of experts or learned papers, by 'believing' the information, but we also accept that new and convincing information may duly appear and alter or revise our view. Empirical beliefs differ though, from unempirical beliefs, in attempting to describe and explain elements of the physical world around us by utilizing knowledge gleaned from communication, observation, experiment and experience in reality.

Of course, that knowledge may be inaccurate, distorted or incomplete, so that a belief perceived to be empirical is actually incorrect, especially in sociocultural environments where there is an absence of proper scientific enquiry and methodology, or where experimental manipulation is difficult to conduct. But the point is: that empirical beliefs don't resort to supernatural or philosophical content in order to satisfy a human desire or need for rounded explanations. So, in proximate terms, one may believe in a scientific theory because the scientist 'says so', but the

underlying belief is based on one's trust that a true causal relationship has been demonstrated, based on scientific laws, and that this can be independently verified.

There are occasions when supposed empirical beliefs *do* resort to supernatural or philosophical content, because their champions reach an impasse with evidence or motive. The anthropic principle (Carr & Rees, 1979) is an example of this. The notion that biological evolution has purposefully led to humanity by way of explaining the unlikeliness of our very presence to think about higher things is, at best a tautological misapprehension of the natural selection mechanism as teleonomic, at worst an anthropocentric pseudoscientific belief in the guise of empiricism (Dawkins, 2006).

If one thinks about it impassively, there is no reason to have such a theory in the first place, because there is actually nothing to explain, so both enquiry and solution are superfluous constructs. Indeed, it might be thought of as a kind of get-out clause for empiricists who still cannot help but look for reasons and for whom their own existence to ponder the workings of the universe therefore seems too incredible not to have a reason behind it. For some 'atheists' it offers the next best thing to a sensation of divinity, without actually believing in a god, by placing humanity (if not themselves) at the metaphorical centre of the universe instead – a proxy god.

When philosophical argument becomes involved, things become self-consuming, especially in the view of those not used to the style of analysis. René Descarte famously managed to use philosophical argument to convince himself of the certain existence of a god in his *Meditations of First Philosophy* (1641). British scholar Benjamin Heath did the same in his *The Essay Towards a Demonstrative Proof of the Divine Existence*, in 1740, yet Richard Dawkins managed the exact opposite in his *The God Delusion* (Dawkins, 2006). Dawkins necessarily builds his arguments using the structure and logic of a philosophical approach, because he is attempting to disprove a negative (i.e. provide evidence of absence), which is not possible with beliefs, leading him to use an approach which is polarizing and counter-productive in any attempt to dissuade theists.

Even supposing it were possible, the trouble with philosophical argument, to empirical scientists, is that it, again, appears to operate within the same domain as empirical scientific analysis, yet it is only requisite in the absence of empirical evidence, so one's inclinations towards one philosophical position or another pilot one's argument: i.e. appeals to a particular philosophical position take on inadvertent 'a priori' bias. Philosophy is included among the hypothesised 'unempirical societal' beliefs, so such arguments are already regarded as discrete from empiricism, because philosophy is simply not required where data are available. Therefore one would be attempting to take an unempirical stance to make an empirical argument, which inevitably has questionable logic. Here, instead, I am offering a scientific explanation for the conjuring of supernatural beliefs as part of a mechanism, alongside all other beliefs, so that philosophy is not used.

It is worth adding though that, as empirical scientists, we are necessarily more likely to side with Dawkins, simply because there would appear to be absolutely no initiating empirical evidence at all to justify the conjuring of the idea of a god in the first place, so there is no requirement to provide *evidence of absence* and one must hypothesize that the idea originates from naïve human imaginings in prehistory - as a primal ontological solution. The burden of proof is always on the shoulders of those who claim belief in anything that is not empirically evident to all, whether the belief has supposed supernatural or natural foundation, by definition of empiricism. Besides, if one can offer a viable ecological explanation and genesis for the notion of a god then that is the nearest one *can* get, and the nearest one *needs* to get, to propounding empirical disproof of the existence of a god, simply because the god function, as a purely human construct, becomes clear and satisfies scientific enquiry. Actually, the *only* way to deconstruct the god construct is by inversion using tenable function in this way.

The matter of whether god exists or not is an unnecessary debate here anyway, as the idea of a god is really just an arbitrary branch of the overall supernatural concept. That is, superstition works both with a god and without a god, as long as the supernatural concept is present, so we are far more interested in the human adaptive journey and the mechanism that controls the interface between memes and genes, via beliefs and behaviours. As the mechanism is able to function without the god concept, then it demonstrates that the god concept is superfluous to requirements and this point, therefore, serves as valid dismissal of the existence of a god. However, I look at the possibility of the god concept acting as an amplified stimulus (supernormal stimulus) in the second part of my methodology: Chapter 3.

The superstitious brain simply has to believe that something external – a god, force, spirit, power, energy, whatever the term adopted - holds sway over its life for superstitious behaviour to be elicited, so 'god' is merely one of many labels for communicating the idea of the supernatural meme from one person to another. The meme can manifest, in the believer's mind, as anything from a humble and mundane (minimal) influence to a grandiose and overblown (maximal) fantasy, but it only requires a name for the purpose of communication. It is the process of communication that has caused, or allowed, the former to become the latter. They are the same '*imagined causative agent*' conceived in different ways. Thus, whilst one cannot provide evidence of absence, one can provide evidence that there is nothing to disprove.

There are plenty of empirical beliefs, of a mundane nature, that have questionable supportive evidence, *but* are generally accepted because they do the job well enough. These are the models and analogies we use in understanding the physical world. They exist precisely because we find it difficult to apprehend and describe many esoteric scientific phenomena, so we find ways of simplifying and visualizing them. As a consequence, we accept or believe those models and analogies as if they are the truth, because alternatives are less comprehensible to us. Examples

include the atom as mini solar system, electricity behaving like a fluid, time passing as a constant, sound moving like ocean waves, light illuminating what we see and the presentation of evolution in diagrams as if teleonomic or purposeful in direction. Although empirical evidence supports the science, we are drawn to believe in models and analogies in order to grasp the science conceptually in everyday life, even though they may be quite misleading and removed from the scientific point of view (Caramazza, 1981).

Gravity is a good example. We believe in models and analogies in order to grasp the concept, yet the concept itself is a belief too, because we know that the Newtonian theory is wrong. Einstein has clearly demonstrated that gravity is not a force of attraction between objects (Fritzsch, 1994) but his explanation, that mass bends space-time, is counterintuitive and difficult to understand, while Newton's theory is intuitive because it concurs with our everyday experiences. So, we believe in Newtonian physics despite its scientific nullification. It is still empirical however, because experiments fit perfectly well with Newton's law of gravitation in most circumstances. So, Newton's model describes the behaviour of the physical world in a way we can relate to, whilst Einstein's explanation does not, even if its is more scientifically correct.

1.4.1 Evolutionary theory acceptance.

People will often choose to believe ideas with no empirical support if it is more convenient for them, especially if it ties in with other aspects of their belief system. The classic example of this is biological evolution. Despite the overwhelming weight of evidence in favour of biological evolution, amassed over more than 150 years of research and experimentation, there is still considerable resistance to the theory. Part of the problem is that demonstrations of evolution in action, although convincing to biologists, often concern organisms (bacteria, viruses) or processes (metabolic reactions) that are not part of everyday, macroscopic experience (Elena & Lenski, 2003). Of course, we ourselves are part of the ongoing evolutionary experiment, but trying to demonstrate it happening in front of the eyes of the sceptical is problematic.

Aside from this irony, the diagnostic reasons for disbelief in biological evolution seem to be threefold in my view. Firstly, if belief systems include supernatural beliefs that use the model of creationism then there is already an intuitive explanation in place for the existence of animals and plants. Secondly, biological evolution is counterintuitive because (at least in macro-organisms) it is not an easily observable or experimentable process, often taking place on timescales beyond regular human experience, so people naturally resist the cognitive effort of swapping the intuitive for the counterintuitive. Thirdly, if someone's supernatural belief system has no capacity to embrace biological evolution over creationism then superstition prevents the mind from considering or accepting the alternative explanation.

Interestingly, other types of evolving or processional science, such as geology and cosmology, are met with less resistance because there is plenty of hard evidence, which is difficult to refute, ignore or dismiss. The aggregate result is a clear demonstration that the entire universe is in continuous change and that stasis, which creationism imposes, simply does not fit with the observable evidence and model, therefore making creationism an implausible idea for science. But biological evolution seems to be more emotive in the reactions it provokes even when evidence is presented: e.g. fossils, gene sequences, cladistic mapping, taxonomic classification, atavism and vestigial traits, to name a few.

Another important factor is that humans, themselves, are 'explained' scientifically by evolution, so the implications jar with religious models, which were not originally conceived to accommodate any process of change, and which give humans a central role in the universe, and are often based on powers or forces with supposed human form. Therefore, the idea that animals, including humans, have evolved from more primitive origins, and are not 'special', requires revamping most of the original explanatory model. In fact, it becomes easier for those with that doxastic attitude to debunk biological evolution and either ignore it or invest effort into trying to counter the scientific evidence by distorting empirical principles, by applying pseudoscience or by simply claiming that the evidence is supernaturally planted.

This applies particularly to people with a rigid religious model already ensconced in the mind. It seems reasonable to hypothesize that minds naïve to such religious models would be more accepting of evolution and would find it difficult to accommodate creationism in a reverse scenario. The Bayesian view supports this notion that the prior has a normalizing effect such that new information, unless decisive, influences opinion (the posterior) with varying degrees of effect, depending on the genetic inclinations in the individual and sociocultural environmental factors. One might pause, at this juncture, to imagine how a religious belief system might have developed with prior knowledge of biological evolution.

The notion of an omnipotent god, in charge of everything including evolution, is certainly not precluded, so perhaps that is an appropriate way to accommodate both, as modern Christianity does. To some extent this is a compromise, as there are belief components that inevitably contradict one another, but it works because the sum of the parts satisfies different cognitive requirements. This feat of mental prowess is known as cognitive dissonance (Festinger, 1962), and it is an ability of which all humans are capable to one extent or another because it is a fundamental tool in adapting the mind to make sense of the deluge of information received, which would otherwise be overwhelmingly chaotic and result in dysfunction (Cherniak, 1983).

The tenet is, that it is better to have a belief system than not, or rather, it is better to have a stable belief system than an unstable one. That isn't to say that the belief system cannot be flexible and adapt, but that a state of uncertainty or instability in belief is not good for generating decisive

behaviour (Bandura, 1982). From the ecological perspective, cognitive dissonance fits very well, because it caters for the Bayesian decision-making process by allowing minds to accommodate ideas contrary to the prior, to varying degrees, thereby producing a spectrum of belief systems, which translates into a spectrum of behaviours upon which natural selection acts.

In the context of societal acceptance of evolutionary theory, of which the scientific community has a vested interest, the hypothesis is that isolated first exposure is important, so that the evolution prior is planted and germinated in the minds of children. This would be largely impracticable though, as many children are already exposed to creationist religious doctrine before their schooling begins, so the window of opportunity has closed.

1.4.2 Sample of one, conspiracy theory and misinformation mythology.

Another problem with empiricism is that distorted interpretations of the discipline often lead to people employing anecdotal and poorly-sampled evidence. People either think, or pretend, they are making evidence-based argumentation, but their data are actually inaccurate, incomplete, insufficient or entirely wrong. This may be honest misapprehension of the scientific way, or it may be the result of motive. Either way, the result is that lay understanding of scientific argument is kept several degrees away from the true definition.

Typical cases are what I describe by the phrase "*sample of one"*: i.e. where people base their view on a single case, or very few cases, as their evidence. Alternatively, they simply believe a commonly reported idea or hearsay because they prefer not to resist the weight of consensus or because it suits a rudimentary logic in the absence of counter evidence. This is sometimes described as *communal reinforcement* or *collective reinforcement* as an oft-repeated belief or piece of information within a community convinces the individual that it must be true, regardless of a lack of empirical proof (Sewell, 2001). Of course, the media can also play their part in this phenomenon too, by surrounding the mind with pervading reinforcement (Carroll, 2011).

A relative of the urban myth is the conspiracy theory. Again, such belief systems are largely born out of ignorance of the science, or misapprehension of the science. However, they are also reinforced by the notion that much of the evidence is either being concealed or distorted by the conspirators. Therefore, this gives the believer license to reinterpret by adjusting and tailoring the evidence to suit their preferred 'truth'. Of course, this scenario is also tempered by the knowledge that some real conspiracies do occur. The result is that believers give themselves free rein to imagine that anything is possible, rather than acknowledging that reality is still bound by scientific and logical frameworks: i.e. that even if a conspiracy were in action, the conspirators would still have to adhere to those frameworks. Thus, in most cases it comes down to a rational calculation of what is the more likely by considering the gamut of factors in a logical and sequential manner.

Intriguingly, belief in governments concealing information about visiting aliens presents a phenomenon that is very similar to belief in religious ideas, because the 'alien beings' effectively become divine entities with supernatural powers, as opposed to biological organisms with mundane ecological requirements, having simply evolved on other worlds. If we consider that we would be the aliens if we had occasion to visit another living planet, then it immediately becomes obvious how biologically vulnerable any visiting alien life forms would be here. Such beliefs possess a quasi-religious cachet through the notion, in the believer, that they are being held at arms' length from the truth and so introducing an enticement to keep searching, in the same way that religious people pursue pure faith. (Wood et al., 2012; Swami & Coles, 2010).

This brings up an important point; that conspiracy theories may function as substitutes for religious beliefs in people who fall into a similar type as those who suffer from OCD (Darwin et al., 2011). Thus, the conspiracy theory provides something for the mind to engage with and obsess over. Indeed, any scientific and logical counterview may then only serve to reinforce the belief, rather than negate the belief, because it triggers a determination to avoid adjusting the prior: i.e. altering the established mind set.

Akin to the conspiracy theory is the misinformation myth. In this context I refer to incorrect information that is passed from one person to the next as if a 'pearl of wisdom' so that the meme perpetuates. In addition, anyone who questions the myth has also to contend with a consensus of lay opinion, which, although incorrect, represents a collective prior meme that is culturally ensconced and remarkably difficult to shift.

An example is the myth that 'bumblebees shouldn't be able to fly'. In itself, there is clearly no logic to the belief, because bumblebees *can* fly, so it comes down to apprehending the dynamics of their particular style of flight. The interesting thing about the bumblebee myth, is that its point of origin can be traced exactly, to a book published in 1932, titled *The flight of insects* (*Le vol des insects*) (Magnan 1932; Magnan, 1934) and written by Antoine Magnan, who was a French aeronautical engineer and zoologist combined: a biomimetic engineer. He came to the conclusion because he didn't understand how bumblebees fly, as the theory of flight was insufficiently understood at that time. Subsequently, it was realized that bumblebees paddle the air to generate lift force, which is sufficiently amplified by very rapid wing beating (Zeng et al., 2001; Bomphrey et al., 2009). Despite this development, Magnan's myth had become ensconced in popular culture as a 'pearl of wisdom', and so it perpetuates to this day.

That isn't to say though, that all myths are born from ignorance. A common myth generally believed among the scientific community is the 'long path' or 'equal transit time' explanation for the aforementioned lift force: i.e. that low or negative pressure is created above the wing because passing air molecules have farther to travel: i.e. a misinterpretation of the Bernoulli principle (Liu et al., 2015). The reason why it doesn't apply is that not all aerofoils have an appropriate

profile; for example, some are flat and others have equal dimensions above and below. Another incorrect myth is that lift results from air molecules hitting the bottom of an angled wing, as that dismisses the presence and behaviour of the air molecules above the wing.

In fact, lift force is created by a phenomenon known as 'stream tubing'. As the air hits the front of a wing its flow is turned both upwards and downwards to create invisible stream tubes above and below. Both stream tubes contain the same mass of air and are the same length, but the stream tube above is more compact. Therefore, the air has to travel faster, which generates lower pressure above the wing (Jameson et al., 1998; Anderson & Eberhardt, 1999).

The point is, that the lift force myths are more intuitive than the correct explanation, because they offer simple and constant models whilst stream tubes are counterintuitive. As a result, the myths are often offered as explanations even in reference books, with no mention of stream tubes, so the student acquires an erroneous understanding of lift force. .

On the everyday level, clearly many people are inclined to accept unfounded beliefs, or at least not challenge them, if it means that they are seen to conform, because such behaviour is all about acquiring heightened sociocultural fitness. Indeed, one can even imagine a case of farcical irony, where no one actually believes a myth, yet people are still inclined to say they believe because they think everyone else does and therefore fear the consequences of expressing scepticism (as in "The Emperor's New Clothes" by Hans Christian Andersen; Andersen 1837). Of course, there are more basic forms of myth too, such as believing that dreams are premonitions and that coincidences have meaning. It seems that the human brain is inclined to make connections of this kind, even when there are none. In basic terms, the brain is intuitively correlating sets of data, even when the data are sparse, because that is how it functions (Beitman, 2009).

The phenomenon whereby humans have a tendency to look for, or realize, patterns in data, is generally known by the term 'apophenia' – which comes from the Greek 'to reveal from': *apo-phainien* (Conrad, 1958; Brugger, 2001). In essence, the human brain seeks order in the data (information} it receives because genuine patterns often *do* exist, of course, which are useful (if not essential) in assessing appropriate actions, reactions and interactions and therefore improving fitness. Thus, the brain operates on the basis that it is better to search for patterns than not, which accordingly results in some error where patterns are not present.

A more prosaic example is where the human eye perceives or imagines faces in the scatter of leaves and branches in undergrowth and foliage – clearly an evolved precautionary instinct against attack from other hominins and stereoscopic predators. This visual form of apophenia has been described as 'patternicity' (Shermer, 2008; Shermer, 2011). It extends, of course, to people seeing faces and images in the random patterns on arbitrary surfaces, such as the clouds in the sky, the graining on wood and even the browning on slices of toast. When faces are perceived, it is more specifically a type of apophenia called 'facial pareidolia'. This happens

because the data required to trigger face detector neurones in the visual cortex are minimal and the response is very rapid (165 ms; Hadjikhani et al., 2007); think of the actual data content in an 'emoticon' or a 'smiley'.

In ecological terms, such errors (the aforementioned false positives and myths) are not likely to lead to significantly deleterious outcomes in humans, so they persist and, crucially, generate a pervading and essentially inert 'background radiation' of sub-sample data beliefs that exist partly due to the relaying of memes and partly due to the nature of brain function.

Therefore, more significant empirically-unsupported beliefs - i.e. religious beliefs - that generate more consequential behaviours, have their suitable backdrop upon which to hang without being conspicuous and thus are more readily accepted by the human brain as rational and logical, or true. Consequently the human brain is beguiled, because the perceived patterns act as agents – thus we have the apophenia subcategory 'agenticity' too (Shermer, 2009). To use an analogy, a cryptic moth is only camouflaged against the right background – so I hypothesise that supernatural beliefs benefit from this background of sub-sample data beliefs, because they seemingly merge: i.e. it provides the 'right background'.

The aforementioned '*sample of one*' beliefs might be better explained as people using insufficient data to make supposedly scientific assessments. It is a frequent and commonplace phenomenon in society simply because it doesn't require the additional effort of truly scientific enquiry. Such unscientific conclusions usually relate to minor aspects of life, so there is little or no impact on fitness level, but there is certainly the potential for more significant outcomes when people in positions of influence use unscientific conclusions to sway the opinions of their audience: e.g. as propaganda to stir up societal tensions. It works in this way because humans are naturally inclined to simplify their perception of the world by compartmentalizing data. It therefore suits the brain to believe such unscientific conclusions because it is rapid, minimises cognitive effort and can benefit fitness level in other ways too.

Forms of prejudice, such as racism and xenophobia, are good examples of this as, on the ecological/adaptive level, there is limited usefulness in the brain using additional memory capacity in appreciating that the different members of another race or tribe have different personalities, or even *have* personalities. In prehistory the brain would have found it more useful to compartmentalize, so that it made more immediate decisions in response to potential enemies (by treating them as one and the same), so the inclinations towards those cognitive habits would have been selectively favoured through increased chances of survival and reproduction. As an evolved strategy, we can see then, that belief in compartmentalized data (generalizations) can be beneficial.

Of course, we have a vested ethical and political interest in suppressing such thought processes and behaviours in the modern 'global village' era, but they have clear adaptive origin in all of

humanity, due to past competition for resources and resulting bellicosity (Henson, 2006). Despite this, the instinct for bellicosity is still frequently and ubiquitously expressed to our children in themes that we instil in them from an early age via comics, books, television programmes, films and computer games, which are obsessed with tackling enemies and adversaries and the fight between good and evil, goodies and baddies, us and them. It seems that we cannot help ourselves.

In everyday life, people often generalize their view of other people, so that they can categorize them as 'types'. This is a commonplace example of compartmentalization or stereotype formation. When they have personal encounters with those other people, however, they are forced to revise their generalized beliefs because the increased level of information means that those compartments no longer work so well. Thus, intimate knowledge of their family and friends results in either an absence of compartmentalization or the use of increasingly incremental subdivisions. We can see then, that the human brain has evolved to strategically compartmentalize others relative to available information: i.e. the level of information correlates with level of intimacy which, in turn, correlates with worthwhile level of investment in expressing sympathy and empathy for the sake of optimizing its own biological fitness in the sociocultural context.

Conceptualization, compartmentalization and categorization are areas that have been investigated by other scholars as they form the basis of human apprehension of environment. That is, they enable the human mind to give structure and simplicity to information that might otherwise be rather chaotic and complex. Thus, without this ability the human brain would cease to function efficiently despite its high intelligence level. This is because there is a paradox in having high intelligence, as it results in an awareness of so much information that it becomes confusing to interpret. Therefore the brain has to find a means of ordering the information into manageable units by way of defining concepts in which to file the information (Neisser, 1989; Pothos et al, 2011).

A simple experimental brainteaser, known as the 'bat and ball puzzle', demonstrates this tendency towards compartmentalization rather neatly (Jarvilehto, 2015): If we are told that a bat and ball cost a total of £1.10p, and we are given the information that the bat costs £1 more than the ball, and then asked how much the items cost individually; we are inclined to conclude that the bat and ball cost £1 and 10p respectively, when the correct values are actually £1.05p and 5p respectively. This illustrates that the brain is content to settle on a solution that requires minimal processing effort, so it uses the compartmental units already provided rather than generating new ones. The brain is instinctively behaving to optimise efficiency, even though it arrives at the wrong answer. This is because, in the evolved context, the difference between the outcome of many wrong answers and right answers is allowable to a certain level of tolerance.

With survival decision-making, there is inevitably a trade-off between the speed of processing a decision and the accuracy of the assessment. The allowable time for processing a decision will be constrained by circumstance and relative urgency, but a wrong decision might be deleterious. Therefore, fast processing in combination with large cognitive capacity will result in decisions that are both speedy and accurate. Humans have advanced processing and capacity, making their speed and accuracy in decision making acute. A number of scholars have investigated relative decision speed-accuracy trade-off among various species. (Chittka et al, 2009; Chittka & Niven, 2009). In general a bigger brain requires more resource investment, but speed-accuracy is improved to justify the investment (Trimmer et al, 2008). This can also have significance when faced with decision-making in uncertain situations – when prior information and incoming information are insufficient, so that an estimated decision has to be made (Trimmer et al, 2011).

In social research the acceptance of using generalization in data is determined by level of 'external validity', which is an approximation of the truth of conclusions drawn from generalizations, which is done by comparing sample size against reliability of the chosen criteria (Mitchell & Jolley, 1988). In effect, the human brain does this quite naturally and for similar reasons: i.e. it simplifies the factors being analysed and, similarly, there is a cut-off point, where generalization is calculated to be the less effective strategy. In psychology 'compartmentalization' is seen as the counterpart to 'cognitive dissonance', because the simplification of information into categories means that the mind finds it easier to construct its belief system without accommodating high levels of contradiction in data (Leary & Tangney, 2002). Thus, the process of generalizing or compartmentalizing facilitates efficiency in thought and behaviour, which translates into greater relative fitness, and converting those generalizations into beliefs serves to fix them in order to avoid reprocessing data.

A similar form of cognitive processing is seen in the calculations of Wald's *maximin-minimax model* for game theory, which works on the basis of ranking possible outcomes, rather than using mathematical probability (Sniedovich, 2016). For example, the brain should naturally calculate that it is better to carry a raincoat in uncertain weather because the inconvenience of carrying the coat when it doesn't rain is outweighed by the risks associated with not having a raincoat if it does rain: i.e. getting wet and possibly ill. This is known as a 'best worst payoff' calculation and is a form of *information-gap decision-making*.

Abraham Wald was interested in the idea that it should be possible to make reasonable or functional behavioural calculations in the absence of complete information by a process of logic. During World War II he read that additional armour was being fitted to allied bombers on the basis of the frequency of damage recorded on the planes returning from raids. Wald reasoned that a counterintuitive solution was better, by considering instead the aircraft that failed to return. Thus, the evidence seen on the returning bombers should be interpreted in reverse, as they had clearly survived being hit in those locations. He wrote a paper on his theory in 1943,

which has become a seminal work in the field of applied logic (Wald, 1943; Mangel & Samaniego, 1984).

Wald's work has relevance here, because it is really about persuading the mind to opt for one belief over another, based on logical likelihood rather than proof, as the decisive evidence is either missing or unavailable. In the case of taking a raincoat, most people will make the most sensible belief calculation themselves, but in the case of bomber armour it was necessary for an innovator to take the lead in order to counter the erroneous popular logic. It demonstrates that logic can be very persuasive in shifting beliefs if it is presented in such a way that it offers a hermetically sealed argument.

In contrast, many people display deferential behaviour, which can be seen to play a significant role in belief psychology. It seems that a significant percentage of people defer to authoritative data and, in so doing, abdicate responsibility for their own behaviour (Tyler, 2001). In ecological terms, this seems to be a product of social learning, whereby deference is essentially taking advantage of other people's investment in experimentation and autonomy, but at the measured expense of failing to rely on one's own cognition and data processing (Dall et al., 2005).

An example of this can be seen in 'use-by dates' on packaged foods. Prior to their introduction, many people managed to poison themselves by consuming rotten foods, because they lacked the wherewithal to make their own judgement and because societal change had meant that such wisdom was missing. However, having been introduced, many people now strictly defer to the advice even when foods are still safe, because they still lack the wherewithal and societal wisdom to make subjective judgements. This tells us a great deal about the human preference for deference, as relatively few people have the inclinations and confidence to decide their own strategies. For a socially evolved species it can make better sense to display compliant and cohesive behaviour than 'go it alone', even if it means the abandonment of common sense.

Some biologists consider this type of behaviour to be a *eusocial* development, because many individuals have, in essence, lost the ability to behave wholly autonomously, and thus defer to others who have retained the ability to behave autonomously (Gintis, 2012; Wilson, 2012). It isn't as pronounced as the eusocial behaviour seen in Hymenopteran insects, for example, but it serves the same purpose by causing behavioural dependence. Indeed, it might be argued that co-dependence is in evidence too, as both types of human (autonomous leaders and non-autonomous followers) may require something from the other that they don't possess themselves, in promoting their own biological fitness. To that extent, the eusocial argument comes very close to extoling the idea of group selection as, in this context, we are no longer considering the fitness of the individual in ethological isolation.

Fundamentally, the same deferential behaviour is hypothesized here to be behind all manner of collective supernatural beliefs, because it is an expression of the same socially evolved strategy.

It is what psychologists describe as 'herd instinct' as it is a characteristic tendency to follow the herd: i.e. to align behaviour through local interaction, and typically in the absence of centralized coordination (Raafat et al., 2009). Thus, if an individual is innately inclined to adopt religious beliefs, then they are far more likely to adopt the supernatural meme variant (religious denomination) that characterizes their immediate sociocultural environment, because it is strategically optimal. It is, in effect, an extension of a behaviour that evolved for more basic ecological reasons, but has been hijacked by the supernatural meme.

There are many examples of human herd, or mob, behaviour, such as rioting, bullying, gang rape, vandalism, looting, demonstration, intimidation, fan tribalism and so on, where the members of the ensemble are incited to behave in a collective manner due to this tendency to mimic (Raafat et al., 2009). Individually, they would be unlikely to exhibit the same behaviour, but the presence of others elicits a combination of desire to impress, a feeling of camaraderie and notions of consent, safety and strength in numbers, so that those present get carried away by a feedback loop of actions and reactions, until their behaviour escalates into an 'unthinking' euphoric state. In essence, the very same thing happens with religious worship, as there is an inclusive environment in which fervour and excitement are given license to ferment, so that worshippers behave in exaggerated ways that are atypical of their normal condition. Consequently, this sense of emotional abandon and dependent security feels good because it functions as a kind of hypnosis or meditation, where the worshiper is able to forget about their daily concerns and anxieties for the duration and also induce the release of oxytocin and endorphins (Dunbar, 2008; Sasaki et al., 2011; Holbrook et al., 2015; Cappellen et al., 2016; Sasaki et al., 2015).

Further to the above, a recent study, using MRI (magnetic resonance imaging) scans, has demonstrated that religious thoughts, in the religious (Mormons, in this case), induce brain activity similar to those induced by affection and drug induced euphoria (Ferguson et al., 2016). Significant amounts of dopamine are released when religious people think about religious ideas, suggesting a cognitive feedback mechanism in operation, whereby the brain experiences a sense of release from existential concerns by giving itself license to enter into those thoughts: i.e. it is a self-providing cycle. Dopamine is a neurotransmitter associated with reward motivated behaviour, so the brain enters a loop where the more it thinks about religiosity the more dopamine it releases, so the mind is inevitably convinced by its own religious thoughts because they feel pleasant, so it continues those thoughts (Ferguson et al., 2016; Ano & Vasconelles, 2004). In the researchers' words; '*reward, salience, and attentional networks are activated by religious experience*'. Yet, conversely, rationality networks must evidently be deactivated to facilitate the trick; i.e. the mind is seduced by a sense of euphoria, into abandoning rational analysis of what it is believing in. Thus, the god becomes salient (foremost in the mind) and all countering logic is suppressed.

Dopamine, endorphins, oxytocin and serotonin are all associated with physiologically pleasant feelings that translate into psychologically positive moods (Benarroch, 2012). They work in different neurochemical ways. Speaking in the vernacular: dopamine is the 'feel good' hormone, which is released when we do something we enjoy, thereby generating affirming emotions and emphasizing the importance of that activity; endorphins are the 'pain killer' hormones, which allow us to overcome stress and fear, and thereby empower us; oxytocin is the 'love inducing' hormone, which helps us form emotional and attachment bonds and to empathize; serotonin is the 'ego feeding' hormone, which makes us feel important and successful in relation to other people, so that we experience healthy self-esteem. Collectively they might be thought of as four chemical pillars of contentment or happiness, and they evidently play important roles in belief system psychology. Other work has demonstrated that endorphin and oxytocin release is associated with social behaviour and promotes social attachment (Machin & Dunbar, 2011). There is, therefore a vested interest in the social cohesion that comes with associated religious activity (on both primitive and organized levels), because it promotes the sensation of togetherness, through congregation, ritual and so on, that catalyses natural opiate release (Johnson & Dunbar, 2016).

Another study has shown that the neuropeptide *oxytocin* results in different endocrine and behavioural outcomes in relation to levels of social interaction in mammals (Carter et al., 2008). Oxytocin has been termed the 'love hormone' because it facilitates prosocial behaviour: i.e. trust and attachment to other individuals (Van Cappellen et al., 2016). Oxytocin also modulates feelings of anxiety and fear, and it seems that social isolation results in depression in those who are more innately social, perhaps because they are more inclined to internalize their thoughts, because there is no social stimulus. When people are in an internalized state, they typically take some time to adapt to group social situations, because they have a desire to first off-load their concerns on a one-to-one basis, but once the oxytocin has balanced their mental state they forget about their worries and become socially cohesive (Theodoridou et al., 2013). It seems that the steroid hormone *cortisol* is antagonistic to *oxytocin*, causing psychological stress and clinical depression when social individuals are deprived of social interaction (Burke et al., 2005; Atran & Henrich, 2010). Thus, sociality and religiosity are associated due to the commonality in the hormonal responses they elicit.

1.5.0 Renouncement and deleterious behaviour.

When someone renounces, rejects or abandons their faith (apostasy), this might be seen as evidence that humans are not controlled by their inclinations, as this behaviour outwardly seems to exhibit freedom of choice. However, I propose that claiming renunciation can be interpreted in reverse: i.e. as an overt grand gesture, equivalent to turning one's back, as a statement of disappointment or anger that their faith has let them down in some way. After all, one would need to have significant belief in something to be motivated to renounce it in the first place,

indicating that the belief has merely become covert, as a kind of punishment to the faith. In other situations, it may be that the person genuinely loses faith because environmental factors change, or events occur, that renders alternative behaviour adaptive. In other instances, it may be that a person is exposed to the scientific explanation for the first time, having previously only been privy to the supernatural explanation. In both cases, we can interpret this as the posterior being so shifted from the original prior (because the strength of the data is overwhelming) that the new prior (which is what the posterior has become) is qualitatively different from the old. The conscious manifestation of this is a loss of faith (which is, implicitly, adoption of a new belief).

As for conversion from one religion to another; this does nothing to counter the ecological theory, because it is hypothesized here that all religions are variants of the same meme. Therefore, conversion is simply changing allegiance from one version of the supernatural meme to another. It depends on the specific circumstances however, as to whether the behaviour might be interpreted as either strategically beneficial or strategically injurious (Paloutzian et al., 2001).

Christian missionaries lack acuity in this regard, by thinking their religion and associated lifestyle is superior, and not realizing that indigenous tribes already have versions of the same supernatural meme that are appropriate to their lifestyles and settings. As a result, they proselytize, acculturate and then abandon tribes, no longer able to flourish in their own natural environments because their knowledge, skills and rituals - their cultures - have been suppressed and lost with the hollow promise of a better and godly life (Threlfall, 2014). Organized religions belong only to organized society, because they don't accommodate the need to be attuned with, and incorporated into, one's natural habitat in order to survive; which is why those tribes are still deemed to be in a "primitive" state in the first place. Lifestyle and belief system need to match.

One of the counter arguments for ecological function in beliefs is that people occasionally exhibit anomalous behaviour that seems to contradict arguments in favour of ecological function: i.e. they are apparently maladaptive behaviours. However, it must be remembered that it is perfectly feasible for supernatural memes to produce anomalous behaviour once in a while, such as mass suicides in religious cults (Mancinelli et al., 2011).

This is because memes speciate and occasionally produce unviable variants, which become 'dead ends' and delete themselves from the 'meme pool' (Tyler, 201; Bouissac, 1992). These aberrant memes are not selectively favoured over generations, but arise and persist only in the short term as the result of one or a few individuals propagating them, who then kill themselves, but more usually because they lose interest, change faith or simply die, so that the meme variant dies too. So injurious behaviour related to belief systems can therefore be viewed as evidence of meme mutation/speciation, as would be expected as part of the ecological argument.

1.6.0 Argument for non-ecological function in beliefs.

Thus far, we have discussed both ecological function for supernatural beliefs and absence of ecological function for supernatural beliefs: i.e. that they just occur for no particular reason, as a by-product of complex cognitive machinery. A third argument is that supernatural beliefs are merely a by-product of the evolved usefulness of the belief mechanism in general.

There are examples of evolutionary compromise, where natural selection has had to work with existing traits that effectively stand in the way of globally optimizing design because the evolutionary process cannot backtrack. Examples include the route of the aorta around the mammalian windpipe (Muster et al., 2001), the circuitous route of the mammalian recurrent laryngeal nerve from the brain to the larynx (Dawkins, 2009) and various other evolutionary 'errors' listed by Ainsworth & Le Page (2007).

Natural selection only acts on what is available, but evolution is sequential, so there is no rewind to a 'better' starting point. It is possible to think of supernatural beliefs in this way: as superfluous to requirements but existing because the brain is so adept at containing beliefs that it sometimes adopts beliefs that spontaneously appear from the imagination. The idea is that supernatural memes behave as self-serving entities that parasitize human minds (Dawkins, 1991), as it were, and then persist as they happen to cause behaviours that natural selection favours. Alternatively they might 'hitch a ride' by being passed from one generation to the next without affecting behaviour, or rather, *because* they don't affect behaviour; i.e. they are neutral memes that persist for as long as people relay them to more people, and for no apparent reason but to make conversation.

Although there might seem to be some credence to this non-adaptive belief argument, as it may seem to be relevant to certain details of belief systems, in fact there can be no such thing as a truly neutral or inert belief, by definition, because any belief must occupy storage space in the brain and thus consume energy (Atwell & Laughlin, 2001), and, when consciously recalled, exclude other thoughts from occupying attention, Also, no matter how insignificantly, simply by being a part of the belief system, it affects behaviour.

1.7.0 The influence of neoteny.

I hypothesise a link between supernatural beliefs and human neoteny. As children are frequently encouraged to believe in unempirical ideas by adults who often do not believe, there is some indication that there is a perceived hierarchy in supernatural beliefs and that some are considered 'neutral', such as Santa Claus, fairies, elves and pixies, because they don't typically persist into adulthood. This is true regardless of religious leaning and, therefore, childhood fantasies have no bearing on sociocultural outcomes, but serve to seed or prime juvenile imaginations until children reach an age where they realize the truth (Prentice et al., 1978). As

such they are also used as a social gauge of normal development in children, as they are expected to reach that stage following infancy (Shtulman & Yoo, 2015; Woolley & Ghossainy, 2013).

Intriguingly, it is considered amusing if children's belief in such ideas persists beyond that point for a short while, but it is considered aberrant if the beliefs persist into later childhood, adolescence and adulthood. This is apparently because there is an expected transition from gullibility to astuteness, which translates into having capable cognition. It is intriguing, of course, because the same rule is not applied to other supernatural beliefs that are considered part of the adult mind-set, but are equally unfounded in empirical terms. This is presumably because most adults are aware that they possess such inclinations to one extent or another, even if this is not outwardly expressed, so they avoid self-denigration (Woolley, 2006). Also, there is often a respect for religions and the religious in the unreligious, which aligns with the liberal socio-political view that defends the right to freedom of speech even if there is disagreement. There may also be a respect for tradition and for those with strong convictions (an interesting manifestation of the belief meme, perhaps, that having strong beliefs can be viewed as better than having none).

The theory of humans as neotenous apes is that natural selection favoured a larger brain but met a compromise due to the size of the lumen (birth canal) through the pelvis, which could not expand further without impeding ability to walk. The solution was for human babies to be born prematurely, so that they would still pass through the lumen and continue cranial growth following birth. One consequence of human neoteny was a prolonged period of childhood development resulting from the requirement to give birth prematurely as a physical compromise between cranial size and passage through the pelvis (Gould, 1977; Walter, 2013; Bogin, 1997). Thus, the prolonged childhood provides the incubation period for the supernatural meme to establish itself in the mind more successfully, as described.

1.7.1. Priming for the supernormal stimulus.

My hypothesised link, therefore, is that these 'juvenile' supernatural beliefs function as a priming stimulus (Barrett, 2010) before the instillation of the 'adult' idea of the omnipotent god (the supernormal stimulus), which is too intimidating and grand a concept for the young mind. As such, the infant mind has a prior version of the meme put in place by adults who are typically unaware that they are being covertly influenced by the same meme in its adult guise. The meme achieves this by stealth due to the aforementioned perception that these beliefs are neutral, and by veiling them with entertainment value in relation to development. Adults often express approval when childhood play exhibits imagination with phrases like 'lost in their own little world' – this seems to be because it effectively serves as a learning 'environment' away from genuine risks and challenges in the physical world, so agents that encourage play are met with encouragement (Fisher, 1992). With the supernormal stimulus in place, the child is primed and

more likely to be receptive to further supernatural beliefs than it might otherwise be by having been signalled that it is acceptable to adopt unempirical ideas, so the meme perpetuates its own selection via resulting behaviour.

The more significant link to neoteny though is hypothesized, by me, to lie at the very origin of 'the supernatural': i.e. where such ideas came from in the first place and why. When the protohuman mind transitioned from sentience to sapience it began to wonder about its place in the world and how the world works. This coincided with the brain's increase in capacity, which is, of course, why neoteny was favoured. So, we need to consider the effect of the sentience-sapience transition in combination with the juvenilization of the human chronospecies.

Studies have shown that infant human minds are often inclined to spontaneously impose personality upon things that are not alive (toys), living things that are not human (pets) and on imaginary companions (Taylor et al., 2004; Newman & Newman, 2006). This has been interpreted as the vestige of the way the human brain develops and is tuned to comprehend the actions of others (Dennett's "intentional stance"(1989; 2011). It is known generally as attachment theory (Bretherton, 1992). If we extend this to the prototype human brain trying to understand life and death for the first time, then it makes sense that the chronospecies would have realized life as an entity or force that inhabits an object to make it alive, so that death comes with the departure of that life-force.

1.7.2. The invention of the supernatural realm.

The aforementioned concept of the 'life force' makes life a transferable phenomenon, so that life-forces (spirits, ghosts, entities, angels, etc.) continue to exist somewhere out of view. We can see then, that this is the very naissance of the supernatural concept, because the chronospecies would have naturally conjured the supernatural realm in parallel with the natural realm as a place for those life-forces to reside (Siegel, 1980). Psychologists sometimes talk of the *phenomenal self* and the *epistemic self*, in their attempt to distinguish between states of consciousness (Dainton, 2008). Thus, the phenomenal self describes our ability to dream and daydream; i.e. the mind can occupy a different place from the body in terms of its awareness. So, the epistemic self is when mind and body are in the same place; i.e. when we are awake and paying attention. It accordingly creates the erroneous ontological impression that the 'self' is a standalone phenomenon that can come and go from the body, as if it is not a product of biological processes in the brain. Of course, that is delusory in scientific terms, but it contributes greatly to the intuitive notion of the life-force.

Furthermore, as a social animal, the chronospecies would undoubtedly have conceived of the supernatural realm as hierarchically organized, so that life-forces took their place according to their own familiarity with tribal or troop structure (Swatos, 1998). Thus, a whole supernatural

community populated the imagined supernatural realm and required someone to be in charge - a chief - so the god concept emerges. I look at the possibility of the god concept acting as an amplified stimulus (supernormal stimulus) in the second part of my methodology: Chapter 3.

As an extension of this, the concept of reincarnation, or rebirth, of some kind is fairly commonplace among belief systems (TenDam, 1990; Pospisil, 1963; Beidelman, 1971; Califano, 1986). This fits a logical corollary, because it makes sense to have a turnover of life forces, so that both the natural realm and the supernatural realm avoid becoming overcrowded.

The belief system of the Tiwi Aborigines, of the Bathurst and Melville islands off the coast of northeast Australia, is an example of the way such concepts of 'parallel' supernatural and natural realms affect evolution (Hart et al., 1960; Goodale, 1974). Their belief system involves three stages of existence: pre-life (unborn), life (living) and afterlife (dead). More specifically their concept of pre-life has nothing to do with biological conception, but rather that a child comes into existence in another realm once the father has dreamt about them. Thus they can 'exist' for years before gestation, which is seen as the child transcending from one realm to another by emerging inside the mother and only triggered by the act of sex, rather than biologically conceived.

The pertinent detail here is the way this belief system affects Tiwi reproductive behaviour. All females are married from birth. These marriages are arranged by their fathers and are wed to men in positions of esteem, wealth and stability: i.e. tribal elders. Conversely, the young men are only able to marry the elderly women, who have lost their husbands and are not valued by the tribal elders, because they have lost fertility. On the face of it, this arrangement seems to counter any ecologically effective reproductive strategy, because the young and virile men don't have the opportunity to pass on their genes. However, the system is actually more complex. In order for Tiwi men to acquire esteem, they need to learn life skills and undertake the tradition of *Walkabout*, which means they are not available to father any children for some years, so marrying elder women gives them license to be absent. It also establishes a way to develop tribal allegiances, so they are socially connected in readiness for their eventual maturity and reproductive potential.

In addition, there is an unusual cultural tolerance of infidelity. The young women are inevitably attracted to the young men, so they often have coitus when the young men are in the village. However, going back to their belief system, they don't believe that having sex produces babies, but only initiates transcendence. Therefore, the father of any baby is believed to be the husband of the women and not the lover, because he is responsible for having dreamt the baby into existence. Thus, there is a behavioural mechanism that allows the offspring of the most virile young men to be born into stable family environments.

If a young Tiwi man is caught 'in the act', then he has to undergo a rite of passage, which is to stand in the centre of the village and allow the husband to strike him with a spear. If he is skilled, and brave to-boot, then he manoeuvres himself so that the spear hits a relatively favourable part of the body, such as a leg or arm, as a miss only allows the husband to throw again. So, the objective is to take a flesh wound, but avoid a mortal injury. The rite of passage is therefore, in itself, part of the process of cultivating esteem, with an eye on future reproductive strategy, for the resulting scar is a badge of honour. The spear ritual is a test, as those who are too cowardly to even entertain the idea are outcast from the tribe, while those who orchestrate it badly have a genuine risk of death or disability. Thus, both behavioural cohesion and behavioural alignment are clearly demonstrated by this example.

Thus, the Tiwi socioculture is ecologically driven on various levels. The most eligible young men, both physically and mentally, are sexually selected and their offspring are born into nurturing environments. The mindset also serves to eliminate social tensions that would otherwise arise through jealousies and rivalries that might result in the demise of the fittest men at an early age due to aggression and violence. There is also the social alignment and cohesion that results from playing, and being seen to play, the cultural game, as dictated by taboo, superstition and ritual.

The interplay between natural selection and sociocultural selection has been considered and investigated by many other scholars under the general banner of 'gene-culture coevolution'. In this context a 'culture' is defined as a set of socially transmitted pieces of information that can evolve in a Darwinian manner (Boyd & Richerson, 1988; Feldman & Leland, 1996; Laland, 2003). Dawkins invented the term 'meme' to describe such pieces of information. If we consider that memes affect the behaviour of those belonging to a particular culture, then we can see that their genes will be influenced and that this, in turn, will affect the memes. They are mutually inductive. Therefore, gene-culture, or gene-meme, coevolution is an integral part of the evolutionary process in any species that has some form of culture. In the case of humans, culture is a more complex phenomenon than in other species, often comprising specialized components of ritual, ceremony, communication, custom, belief and behaviour that have no direct or obvious bearing on survival and influence on the genetics of participants (Laland et al, 1995; Gifford, et al, 2008).

An important observation to make, therefore, is; that we can far more easily identify the adaptive effects of belief systems when we look at ethnographic studies because all members of the society are signed-up to the same regime of behavioural convention in tribal settings, which simplifies matters. When we look at modern societies, on the other hand, there is such a mishmash of cultures and variation in belief systems that it becomes all but impossible to identify any adaptive effects due to the lack of uniformity (Flannery, 1972) and the rapidly changing environment (particularly social).

Indeed, there may be no significant adaptive effect, precisely because belief system uniformity is a prerequisite. Or, it may be that different adaptive effects are going on sub-culturally, as if they are many and various unique ethnographic scenarios playing out side by side. Fellow scholars should have a better understanding by examining the evidence from the ethnographic examples described in this dissertation therefore. It is a matter of appreciating that modern society simply throws too many variables into the mix for the adaptive mechanism to be apparent in the same way. We can presume therefore, that humans continue to evolve in this respect, both in singular sociocultures and multiple sociocultures, as the adaptive mechanism is always present but varies in its visibility.

1.7.3 Proto-superstition: the missing link.

I now ask whether sociocultural factors are selective, or even exist, in other primate species, in a search for a possible point of origin in humanity. The answer is undoubtedly *yes* to both questions, although restricted to behaviours that cannot be communicated by language. For example, hierarchy in primate groups is determined by deferential and conformist behaviours that are specific to the sociocultural environment within a given group. Every group leader has an idiosyncratic personality, so this affects the kind of sociocultural behaviours that work (secure social advantage) for those lower in rank (Uher et al., 2008). Therefore the sociocultural environment will vary between groups of the same primate species, so it follows that differences in behaviour determine relative selective advantage and disadvantage. They may be very subtle differences from our point of view, but they are still differences.

Social learning in animals, particularly transgenerational learning, can be seen as the root of culture (Heyes & Galef, 1996), even if the extent to which this is culture is debated (Laland & Hoppitt, 2003). Recent work has suggested that behavioural imitation, in learning appropriate sociocultural behaviour, seems to have laid the foundation for superstitious behaviour when the human chronospecies evolved the ability to both communicate abstract ideas and have existential (sapient) thoughts: i.e. *phenomenal consciousness* (Nichols & Grantham, 2000). West African chimpanzees have recently been recorded displaying an imitative habit of throwing stones at tree trunks and into tree cavities (Kühl et al., 2016): i.e. a stone throwing ritual with (apparently) no practical purpose. It seems that the animals copy this behaviour from one another because they witness its inclusion in behaviours that work within the hierarchy, so the behaviour is perpetuated as a ritual – a behavioural meme.

I hypothesize that the chimpanzees essentially 'believe', in the most rudimentary way, that the stone throwing is what they should do to gain status even though it has no functional purpose. One can see then, that if all the chimpanzees 'believe' this then sociocultural selection translates the behavior into a measure of fitness. Although such behavior is still a long way from having supernatural beliefs, one can also see that it would only require the inclusion of sapient

imagination and communication for the sociocultural consequence of conforming, or not conforming, with the behavior to be attributed to supernatural forces. Thus, the supernatural meme had a readymade platform on which to appear and begin evolving in our chronospecies when it's brain developed higher intelligence. Only then did it signal the start of religiosity or spirituality.

If one wished to identify a model for a formative *missing link*, then this is it, as it explains the naissance of superstitious behaviour in humanity once appropriate levels of enquiry, imagination and communication had come about to introduce supernatural content. Thus, the supernatural content becomes the *Imagined Causative Agent* (ICA) that prompts the ritualized behaviour to become superstitious behaviour.

Presuming the hypothesis is correct, then it is revealing to think that this simple self-reinforcing mechanism seen in chimpanzee behaviour has, in humans, expanded into a phenomenon that preoccupies and dominates people to such an extent that they are prepared to live, to die and to kill for the beliefs it has conjured in their minds. And yet, as implausible as it may seem, it is clearly diagnostic of the human condition; we are all in varying states of delusion by the meme, as will be revealed by the methodology.

So, all supernatural ideas were born out of this event in our evolution: the beginning of what might be termed the 'sapient horizon'. With the mechanism already in place, all it took was an evolved increase in cognition (phenomenal consciousness) for the meme to germinate and grow from a simple causative-consequential observation in the pithecine brain into a complex communicable fantasy in the sapient brain.

Self-deception, deceit and delusion are not to be regarded as faults or failings however, as belief is not about the veracity or truth of information but, rather, it is about believing in information that has the most beneficial outcome to the believer in a given context. For example; supernatural ideas have no veracity as they do not stand up to scientific scrutiny, but once they are incorporated into a collective belief system the individual is better off believing, as the consequential behaviour is accepted so the individual is more likely to propagate their genes. Similarly, it can be advantageous to have evolved misbelief about concepts that do have scientific veracity. For example; not believing in evolution is a good strategy in a society where such ideas are considered blasphemous (Trivers, 2011). Some work has shown that sociocultural factors generate stress and proneness to misbelieve, even when the individual is naturally inclined towards rationality, such is the evolved benefit of sociocultural conformity in humans (Keefe, 2011; Norenzayan et al, 2009; McKay & Dennett, 2009).

It has been postulated by others that ritual was, itself, an important driver for the selection of higher cognition in the human chronospecies (Rossano, 2009). Rituals are likely to have become

more elaborate during the transition to sapience, perhaps because the more intelligent and imaginative individuals of the species would have been responsible for those elaborations.

Chimpanzees are well known for their genuine rudimentary tool use too, which is also invented by individuals and imitated by other members of social groups. These include dental grooming with sticks (McGrew & Tutin, 1973), honey and termite extraction with twigs (Fay & Carroll, 1994), breaking nuts with stone hammers and anvils (Inoue-Nakamura & Matsuzawa, 1997; Mercador et al., 2002; Biro et al., 2003) and chewing wood fibres to collect water (Boesch & Boesch, 1990). These have genuine ecological purpose, compared with the stone throwing ritual, but their transmission and selective effect work in a similar way. That is, there is a sociocultural effect at play here too, because being seen to comply with expected tool use behaviour may have social benefits, in addition to improving access to resources, because it displays competence and compliance, which may be attractive to a mate. That sociocultural as well as ecological benefits exist is a hypothesis that field primatologists could usefully investigate. Indeed, the sociocultural effect might be, or become, more beneficialthan the initial ecological effect in some instances of tool use, thereby creating quasi-ritualistic behaviours.

Social grooming in primates is an example of this transition from ecological to sociocultural benefit in ritualized behaviour (Dunbar, 1991). Robin Dunbar analyzed the grooming behaviour of 44 primate species and concluded that the function of grooming has become a social device over hygienic service. Thus primates often faux-groom to please their social superiors, because it feels good and is expected. Thus, grooming is a ritual with some ecological purpose (cleaning fur and removing parasites), and origin, but which now confers greater usefulness in securing social advantage by mutual obligation and approval, thereby favouring the genes of those more inclined to groom and, indeed, to *be* groomed.

With grooming the sociocultural benefit is obvious because it involves *direct* reactions from the social group. With stone throwing the sociocultural benefits are *indirect* reactions from the social group, which is why attribution is primed to stray into supernatural territory once the primate brain has evolved the ability to conceive of it. One might observe that it may have been possible for humanity to evolve without the supernatural meme if the chronospecies hadn't been a social animal, due to the absence of the sociocultural effect, but it seems that there would also have been an absence of selective drive toward increased cognition without the presence of evolving ritual. Thus, I hypothesize that the one cannot have evolved without the other.

On the matter of human cognitive innovation in the social domain, there may be a role for mirror neurons. These are cerebral neurons that fire when a physical action is conducted by the owner of the brain *or* when the same brain observes another individual conducting an action (Gallese & Goldman, 1998). It is thought that this characteristic has been vital in the evolution of advanced human cognition (Del Guidice et al., 2008). It may also explain the mechanism underlying the

stone throwing ritual in chimpanzees, because they find themselves compelled to copy observed behaviour so that the brain can experience the behaviour for itself and therefore learn something new. Thus, mirror neurons may have been fundamental to the attainment of sapient intelligence by providing the neural interface that drove the generation and selection of imitative behaviours.

It may also be that mirror neurons are behind empathy, as their signals might relate to physical, mental and emotional interactions collectively; i.e. they might enable us to connect and communicate at the human level via interpretation of the complex information received by our senses (Iacoboni, 2009; Williams, 2008; Oberman et al., 2005). Thus, mirror neurons may have been a prerequisite to our evolving into humans, because they provide the cognitive platform upon which sapience is mounted. By extension, it may be advancement of neural mirroring that resulted in the evolving hominin brain requiring explanations in order to complete networks, so that it resorted to the invention of supernatural solutions for those circuits to connect.

1.8.0 Case studies in behavioural cohesion and behavioural alignment.

I propose that *behavioural cohesion* and *behavioural alignment* result from superstitious beliefs interacting with human lifestyles. As humans evolved and societies developed, for many people natural selective factors would have been largely replaced by sociocultural selective factors in their environments. For the ancestors of modern civilizations, superstitious belief systems were evolving into more organized forms of religion, so the emphasis turned to socially consequential forms of these behaviours. That is: the degree of social acceptance and rejection became underpinned by a play-off between the individual and the population, so that the behaviours of both parties determined relative fitness. Thus, cohesion and alignment were initially unconscious behaviours, but people became increasingly conscious of them and deliberate in their actions, ultimately making them official behavioural policy as dictated by church or government.

Thinking of the aforementioned Naskapi we can regard their lifestyles as likely approximations of our own sociocultural beginnings, before agrarianism and civilization came about. They were hunter-gatherers, as those were their two modes of securing food resources. We can imagine then, that there would have been competition for resources between early hunter-gatherer groups. Therefore, natural selection would have acted on traits that optimized cooperation, teamwork and focus: i.e. behavioural cohesion and alignment. Furthermore, this would have become the platform for the supernatural meme to exploit. We therefore need to analyse the relationship between competition and behavioural cohesion/alignment.

Competition, in its most basic interpretation, is the contest for ecological resources necessary to survive and reproduce, which can occur between different species or within a single species. Our chronospecies would have been a social species and lived in social groups, so there would have been competition between groups and within groups, as well as with other species (Dunbar,

2014). This means that complex socially competitive interactions would have occurred, in addition to the environmental interactions, involving hierarchy, altruism, relatedness, cooperation and so on.

So, for our chronospecies there would have been competition relating to physical resources (food, water, materials, shelter, living space and so on) and competition relating to social resources (mates, allegiances, inclusion, status, and so on). One can appreciate, therefore, that both conscious and unconscious behaviours would have been important in determining relative outcomes with regard to survival and reproduction.

As the chronospecies evolved sapient intelligence and the associated ability to communicate information and ideas, so belief memes began to infiltrate, inform and instruct those behaviours (Tomasello, 2000). This was largely because intelligence and communication resulted in shared belief systems to satisfy shared existential enquiry, which resulted in shared behaviours (Hermann et al., 2007). The supernatural belief meme encouraged individuals to think and behave collectively as if one organism by using superstition.

In effect, the supernatural meme gives individuals a common cause. When this translates into competition between social groups then it becomes apparent that behavioural cohesion and alignment can be significant factors in determining conflict outcomes and perpetuating the interplay between gene and meme. The proposition is that competition and conflict between members of the chronospecies' gene pool was a primary driver for natural selection in this regard. The following hunter-gatherer case studies should shed further light on the ecological consequences of this process.

1.8.1. The Yanomami.

The Yanomami are a South American (Venezuelan) native people, ethnographically documented by a number of anthropologists (Chagnon, 1968; Lizot, 1985; Borofsky et al., 2005), with particular interest in the reciprocal violence between tribes that characterizes their culture. When conflicts occur, the outcome is surprisingly aggressive. The men and offspring of the defending tribe are often killed and the women raped and claimed.

From the ecological perspective it is evident that these actions benefit individuals in the aggressor tribe by reducing competition for resources, increasing access to mates and deletion of competing genes. In addition, there may be outbreeding benefits; at the very least, a consequence is that it generates gene flow among the various tribes and peoples: i.e. exogamy. So, there are underlying behavioural drivers for conflict, provided the costs don't outweigh the benefits. In addition, the belief system of the Yanomami provides both the incentive for aggression and psychological acceptance of death necessary to normalize the behaviour. The incentive comes

from superstitious belief that it is necessary for males to avenge their dead relatives and to display machismo to females. The acceptance comes from their belief that the natural and supernatural realms are closely interlinked, so that the soul of a victim is merely freed from the body and continues to exist in perpetuity.

So, their particular version of the supernatural meme ensures its survival because those Yanomami who display the stronger behavioural cohesion and alignment are more likely to be the victors in conflict and therefore pass on their genetic inclinations towards superstitious belief with higher frequency than those with weaker behavioural cohesion and alignment. The meme therefore keeps the Yanomami constantly honed to its requirements.

I therefore argue that the behavioural cohesion is expressed in solidarity of intent by the aggressor tribe having performed rituals in preparation for a raid, and their behavioural alignment comes from the psychological and physical preparation during those rituals. This example provides a good model as it demonstrates that relative strength in behavioural cohesion and alignment resulting from superstitious belief will always have been selectively favoured, whether the people in question were in competition with other tribes of the same race, with other races or even with different hominin sub-species or species as may have been the case at certain points in prehistory. Furthermore, the supernatural meme will have adapted and evolved to take on a diverse range of specific beliefs without altering the mechanism. That isn't to say that violence, warfare and bellicosity are diagnostic of the human condition, although they certainly seem to have been commonplace in our chronospecies (Diamond, 1991; Pinker, 2011; Goméz et al., 2016). It can be speculated that warfare would not have characterized the Yanomami had their supernatural lore found a different way to optimise fitness, but natural selection only acts on what is made available – genes, memes and behaviours combined.

As we have seen with the Naskapi, behavioural cohesion and alignment also apply to natural environmental interactions, and it seems that conflict only becomes a worthwhile strategy when environmental resources cannot satisfy demand. Indeed, it seems likely that agrarian and trade economies began because farming and permanent habitation offered a way to avoid conflict by increasing availability of foodstuffs per capita and to barter for material resources found in locations no longer part of a wider territory (Chapman, 1980) – think of the aforementioned gift exchange culture.

1.8.2 The Semai.

The Semai, a Malay people (Montagu, 1978), are noted for having had a semi-sedentary, semi hunter-gatherer lifestyle and for exhibiting a cultural absence of aggression, in marked contrast with the Yanomami and, indeed, typical sedentary populations. The Semai settled disputes

peaceably by means of negotiation and compensation and regarded any form of retribution or violence as abhorrent.

This points to the Semai having attained a level of ecological balance that did not require the memetic creation of lore to promote warlike behaviour. It suggests that they represented an intermediate phase in human development. That is: in becoming semi-sedentary, semi-hunter-gather, their environment and available resources seem to have removed any selective pressure to act in favour of warlike behaviour. It was apparent that traits leading to aggression, such as jealousy, envy and rivalry, had been selected out of the Semai population through sociocultural marginalization in prehistory, so that the resulting population was disinclined to be aggressive and was self-policing due to belief lore.

Intriguingly, it is also known that the Semai were quite capable of violence when required, so they weren't innately passive as a race. During the Malayan war of independence, known by the colonialists as the 'Malayan Emergency' (1948—60), the Semai were required to take up arms and fight (Knox Dentan, 1968). They readily killed the enemy and subsequently returned to their non-violent lifestyle without noticeable effect on their normal behaviour. Clearly this implies that all human races do indeed have the potential to be warlike, but their belief systems hold sway over what might be regarded as standard cultural expression in this regard, via their specific lore. One might suppose that the same applies to other key human behavioural characteristics too.

So, we have violence as an adaptive strategy in the Yanomami and peacefulness as an adaptive strategy in the Semai, yet both are underscored by the same supernatural meme, demonstrating that it is not the specific behaviour that counts but the expression of behavioural cohesion and alignment.

1.8.3. The Cargo Cults.

It is worth considering also, the evidence to be had from what happens to belief systems when modern cultures and 'primitive' cultures meet. A good example of this is seen in a phenomenon known as the Cargo Cults (Worsley, 1957; Stanner, 1958; McDowell, 1988). During the course of World War II (1939—45), several South Pacific Melanesian archipelagos were occupied by Japanese forces and then by US forces, as the balance of power shifted. So the native populations had sudden exposure to modern culture, having only encountered outsiders infrequently in the past. In particular, they observed the occupying forces receiving cargos of goods from aeroplanes and ships, which were technologies they had never seen before, and interpreted them as magical supernatural machines bringing wondrous provisions.

When the Americans departed, following the end of the war, the natives had grown accustomed to having luxury goods either as gifts or trade items, so their response was to imitate the actions

of the Americans they had seen at the airfields and ports, with the aim of enticing aeroplanes and ships to come again. In other words, they had presumed that the Americans, by clearing the land for runways, building jetties for moorings had been enacting mystical rituals because their own way of understanding the world was through superstition. The Cargo Cults lasted until the natives became informed sufficiently to realize their misapprehension.

The interesting thing is that post-war anthropologists who became interested in studying the indigenous peoples, and missionaries who were interested in bringing Christianity, actually perpetuated the Cargo Cults by their own arrival in aeroplanes and ships – it served as affirmation to the natives that their mimicking rituals were working, as the anthropologists and missionaries also brought desirable commodities. So, for a while the natives adapted their belief systems as an ecological strategy, demonstrating that human belief systems are adaptive and can adapt very quickly in response to perceived environmental changes. The Cargo Cults seem to facilitate the provision of new resources due to scholarly and ecclesiastical interest in them, so those who believed in them continued to believe.

This example illustrates the adaptive nature of belief systems, because it is reasonable to presume that the South Pacific natives would have adopted the Cargo Cult meme as lore for longer had they not ultimately lost their naïveté and had the rarefied environment also perpetuated, because it brought ecological benefit in resources, which would have translated into increased fitness in the long term, relative to those natives who were not so inclined to participate.

A similar cult began in 1940 on the island of Tanna, in the New Hebrides (Vanuatu), called the John Frum Movement (Guiart, 1952; Guiart, 1956). John Frum seems to have been a spiritualized representation of the generic European, as Tanna had been visited frequently since 1774, when Captain Cook first arrived. The John Frum Movement still persists on Tanna, because its emphasis is slightly different from the Cargo Cults. The movement is modelled on Christianity and the lore is largely about maintaining contact with the infrastructure of the outside world. It seems that it began during WWII because the Tanna natives perceived a threat to their established cultural ties.

The Cargo Cults and the John Frum Movement are particularly useful specimen cases here, because the phenomena demonstrate the memetic-evolutionary process of ecological adaptation in action in 'real time' scenarios. We see the point of origin and the way the supernatural meme and resulting behaviour are altered. Thus, the reciprocal dynamic between memetic evolution and biological evolution is illustrated. There is a state of mutual induction between genes and memes, via mechanisms that allow their interaction.

As hunter-gatherer and nomadic peoples still exist in some places over the world, it demonstrates that humans have no incentive to settle if ecological pressures remain agreeable to an itinerant or migratory lifestyle. It seems that European ancestral stock was ecologically encouraged to abandon its own 'natural career' several thousand years ago due to burgeoning population. Even so, it clearly only alleviated the ecological pressure for a limited period, as there is evidence for frequent warlike behaviour in later pre-history and history (Keeley, 1996; Gat, 2006).

As sociocultural environments became characterized by sedentary, rather than wandering, lifestyles it seems that the supernatural meme took on a new mantle, in part due to the removal or moderation of many natural environmental factors in people's daily experience, but also because society was more structured with people remaining in the same place, doing specific tasks, cooperating with neighbours and experiencing a new set of challenges caused by this shift in ecological emphasis, from the wild or natural to the manmade or artificial.

This new mantle saw the superstitious and ritualized elements of the supernatural meme become more contained, as religions became organized and instructive, with designated places and times of congregation and worship, along with faith leaders and sacred symbols, images, relics and texts. Societies were being increasingly manipulated and controlled by the supernatural meme, because they were psychologically captive within communities and wont to compare themselves with one another in trivial detail. It is the cultural-evolutionary start of the phenomenon sometimes known as 'keeping up with the Joneses': i.e. social aspiration. The result was duality in behavioural cohesion: intra-societal behavioural cohesion, where members of a common society assessed one another in terms of social acceptability, and inter-societal behavioural cohesion, where societies found differences between themselves and other societies.

1.8.4 Hybrid religions.

The New World is noted for the evolution of mélange religions, which are hybrids of Christianity and indigenous beliefs. *Candomblé* and *Umbanda* are blends of African, South American and Roman Catholic beliefs and practices, which developed in Brazil (Da Silva, 2005). *Tarahumara* is a blend of Mesoamerican and Roman Catholic beliefs and practices, which developed in Mexico (Arrieta, 1992). There are many similar examples across the globe, resulting from the empirical colonization and religious indoctrination of indigenous populations begun in the days of European exploration and conquest.

They are of interest here, because they are examples of the supernatural meme having speciated in prehistory, when human populations disseminated over the globe, and then recombined to produce further variants in modern times. They readily combine, demonstrating that they are fundamentally similar, having the same point of memetic origin as hypothesized. Thus, they

recombine religions in different states of evolution: i.e. primitive paganism and organized religion. Thus, those who practice mélange religions have taken the belief elements that best suit their current sociocultural circumstances in the modern world.

The salient point is that these religions still generate the same behavioural cohesion and behavioural alignment that their parent belief systems propagate, because they are yet more variants of the same supernatural meme. Moreover, the believers still have the genetic inclinations of their ancestral populations, so they perpetuate the selection of those genes via the new supernatural meme variants they have evolved.

1.8.5 The modern world.

On the matter of the concept of the supernatural meme itself, it would be relevant to look for evidence of its influence in modern society, to demonstrate that it is still active even in sociocultural environments that purport to be secular, or at least agnostic. Two studies (Edgell et al., 2006; Ritter & Preston, 2011) have provided such evidence by examining the social acceptance of atheists by theists in the USA. The study shows that religious diversity is being accepted increasingly by religious Americans, yet atheism is being increasingly marginalized. This fits with hypothesis, as it demonstrates that different religions are variants of the one supernatural meme, so the meme is causing selective bias against those disinclined to believe at all, rather than promoting conflict between different versions of itself.

However, when not faced with a common enemy, religions can and do turn on one another, as is seen between Christians and Muslims (different religions), or Protestants and Catholics (similar religions) for example. From the ecological view, these might be regarded as up-scaled versions of intertribal conflict, as with the Yanomami, so that the outcome selectively favours those with stronger belief inclinations and it selectively favours the variant of the supernatural meme that exerts greater influence.

1.9.0 Cognitive perceptual variation.

Here, I suggest there is an argument that perceptual differences in belief can exist between human populations, because their sociocultures have led them to cognitively apprehend the world in different ways. For example, modern cultures think of colours according to scientific precepts: primary, secondary and tertiary, or similarity: yellows, blues, reds, greens, etc. As is discussed below, in other cultures, the understanding and role of colours can be markedly different. By extension, it means that their way of believing and disbelieving might also be different from our way.

Research comparing colour perception between the Himba, of Namibia, and Western participants has shown that the Himba struggle to distinguish between green and blue colours, yet they are far more perceptive of different tones (Roberson et al., 2005). It seems that the hunter-gatherer lifestyle of the Himba has attuned their eyes and brains to their natural environment, so that tonal perception is more important than hue perception. A further study has demonstrated that colour vocabulary tends to suit sociocultural perception of colours, to such an extent that people find it more difficult to distinguish between colours if their language only uses a single encompassing term (Goldstein et al., 2009).

In the case of the Himba, they have just four terms for describing colours: *zuzu* describes colours seen at dusk – dark shades of blue, green, red and purple; *vapa* describes colours that glare in sunlight – whites and yellows; *buru* describes bright greens and blues when looking upwards in daylight; *dambu* describes earthy colours when looking downwards in daylight – greens, reds and browns. Thus, the Himba have no individual words for blue or green, as they are included together in both *zuzu* and *buru*. But they *do* distinguish between levels of brightness in colour, as they are critical to hunting success and general daily routine: i.e. they are more informative in their setting, not least because colours do vary, depending on time of day, passing clouds, changing angle and so on.

Taking the Himba view on colour; one can see that the psychology of a population can be conditioned to comprehend the world in a different way by the socioculture that evolves, or rather, they both interrelate due to environmental factors. Therefore, it may be that the distinctions we make between beliefs do not exist within other sociocultures, because they employ concepts that encompass ideas that we treat separately or, conversely, they may subdivide ideas that we treat as one. Thus, cognitive dissonance may be necessary with beliefs in one culture, but not in another culture, because they use different templates.

1.9.1 Tiered behavioural cohesion.

It is hypothesised that behavioural cohesion can be expressed on different levels. Unconscious behavioural cohesion is where the people involved are unaware of their behaviour in this regard. Conscious behavioural cohesion is where the people involved are aware of their behaviour to varying degrees and are proactive. Orchestrated behavioural cohesion is where spiritual leaders exploit the phenomenon by issuing protocol for dealing with those of no faith, lax faith, altered faith or different faith.

An example of orchestrated behavioural cohesion is the historic disallowance of abortion under Catholicism. Interestingly, the ecological consequence – increased population – is veiled in superstitious lore, stating that it is ethically wrong to prevent new life. Consequently, fear of divine retribution motivates spiritual leaders to instruct and spiritual followers to obey, with

neither party aware of the ecological undercurrent. Those followers most inclined to adhere to the lore are the ones who pass on their genes with greater frequency.

One can speculate that the lore became cemented at a time when supposedly celibate Catholic priests abused their position by impregnating females in their confessional trust, so they had a vested interest and the power of superstition on their side to see that they passed their genes on to the next generation (Werner, 2010; Sipe, 1995). Indeed, by employing this hemi-parasitic strategy, a priest may very well have procreated with considerably greater fecundity than other males in society and without parental resource investment. In effect, a human version of the cuckoo, facilitated by the cachet that acting as a conduit to a supernatural belief system brought. Incidentally, the Roman Catholic church introduced the law of celibacy in 1139 C.E, because it was having problems policing sexual misconduct in its bishops, deacons and priests, which was considered unholy, thereby only forcing promiscuity underground rather than cleansing the church: i.e. out of sight, out of mind (Plante, 1999).

We have seen then, that behavioural cohesion and alignment have undergone various phases, just as the supernatural meme has diversified into many versions, but I propose that the mechanism has remained unchanged, in that the modus operandi is simply to favour those with the greater inclinations to believe in the supernatural meme, thereby perpetuating the gene:meme interaction. It is an adaptive model for supernatural belief function.

This tendency towards behavioural cohesion is also seen expressed in related areas of behaviour, such as classism, racism, nationalism and other perceptions of difference. Biologists see this as an evolved mechanism, because perceived similarity in appearance and behaviour equates to trustworthiness: i.e. that the other person is less likely to present a threat (Cassidy & Gutchess, 2015). By extension, it also translates into a higher likelihood of relatedness on the genetic level (Dawkins, 1976). Therefore, humans are inadvertently programmed to be initially suspicious or fearful of difference in other humans, because natural selection has determined that such behaviour is (or has been) generally beneficial. The supernatural meme is thus assisted by other mechanisms in its tendency to promote behavioural cohesion.

1.9.2 Maladaptive arguments.

It has been postulated by Mathijs Pelkmans that 'doubt' is the psychological factor that drives speciation in societal belief systems, because it forces a cognitive camber, so that the mind becomes inclined towards either belief or disbelief (Pelkmans, 2013). In other words, doubt is not a resting state for the mind, so the mind is forced to search for a resting state by finding a belief system that satisfies its requirements. Therefore, there is an inevitable process of exchange and invention, so that new belief variants are conjured as solutions. This means that belief systems are always in flux within sociocultural environments, which is why speciation occurs. An

analogy might be made with Brownian motion, so that the belief systems of all the individuals within a society are perpetually readjusting and affecting those in contact due to 'seeds of doubt'. Thus the aggregate effect is a mechanism for an ongoing and arbitrary process of change, which occasionally produces maladaptive variants.

Looking at the bigger picture, it might also be argued that maladaptive variants of established religions sometimes occur because they are formed by fanatics who are dysfunctional within the environment of the established religion. So the supernatural meme has extracted them from the mainstream population, where it finds more effective behavioural cohesion and alignment. That is to say, believing too little is selectively unfavourable, but believing too much can also be selectively unfavourable.

There is also an argument that while the model *is* adaptive, the modern environment is making it potentially maladaptive. This is due to the 'global village' phenomenon, tied in with the advent of technologies that can cause mass destruction. The mechanism has us ecologically channelled to look for differences in readiness for conflict, because that strategy has worked prehistorically and historically, but it is no longer appropriate for the present. This argument has its place as it seems reasonable to hypothesize that human belief systems would merely take a different evolutionary direction if we became the authors of a significant environmental shift due to global warfare over belief differences. One might speculate that a retrograde step is most likely, so that surviving pockets of humanity would revert to belief in more primitive versions of the supernatural meme appropriate to their ecological circumstances.

An additional variant is seen in the advent of modern migration and communication technologies. People can now live in environments different from their familial and ethnic sociocultural and religious background, but use smartphones, computers and the internet to mentally occupy a virtual society, where they are able to interact with similarly minded people; i.e. with similar moral and ethical codes and beliefs. They can express behavioural cohesion and alignment via modern technologies and, depending on their version of the supernatural meme, may choose to assimilate or alienate themselves with regard to the real society around them. Indeed, individuals may even identify with particular sub-cultures via such media, yet have no real contact or communication, because they believe they are doing so by spiritual conduit, so they develop virtual bonds and allegiances. Thus, the supernatural meme has metamorphosed into the World Wide Web, where it uses the Internet to migrate between human minds.

In some circumstances there has been a cultural widening due to the real society being more progressive, in its laws and beliefs, than the virtual society, and this has inevitably caused polarity within the members of the virtual society. Also, there seems to be a process of ghettoization rather than assimilation, due to the increasing contrast between conservatism and liberalism expressed generally by different belief systems.

It remains to be seen in which ways this phenomenon will affect behaviours with regard to the selective process overall. One must be careful to distinguish between the consequences of extreme behaviour and the consequences of general behaviour, as the latter will have the more telling effect on ecological adaptation. The point is; that the genes with the highest frequency will be most telling and the hypothesis is that high or low inclination towards supernatural beliefs is the same regardless of the specific religion, because they are expressions of the same supernatural meme as different variants.

This process is though, rather clouded by the effect of the sociocultural environment largely replacing ecologically selective pressures with artificially selective pressures in modern environments (Rogers & Ehrlich, 2008; Schatzki, 2001; Langton, 1979). That is to say, most humans are relatively removed from many of the selective agents that might have removed them in the wild or natural state, due to their inclusion in modern sociocultural environments, so they may be more readily able to survive and reproduce now than they would have been in prehistory.

The consequence of this phenomenon is that the human gene pool is becoming less honed to 'wild' ecological survival, because deleterious genes are not being selected out of the gene pool by ecological pressures. In fact, the sociocultural environment does its best to perpetuate aberrations in physical and mental design, because it is part of modern human behaviour to accommodate difference: to empathize. Indeed, as long as modern sociocultural environments persist then this ethos for compassion can operate because there is the technology, infrastructure and social attitude necessary to create an artificial ecology within which a wide variety of traits are not subjected to the ruthless selection process that persists in nature.

This, of course, applies to any human traits that would otherwise cause compromise to survival and reproduction in a natural setting, whether they relate to physiology, physicality, mentality, sexuality and any other areas of functionality or viability as organisms. In the context of belief traits there is a similar situation, in that their basic function to elicit behaviours more directly related to ecological survival and reproduction have been largely superseded by a requirement for belief traits and behaviours relating to sociocultural survival and reproduction.

Humans have progressively become a product of their own making, by introducing their own selective factors and removing natural selective factors. The result is a human species in part evolved due to the effects of artificial factors, but also genetically heterogeneous due to the absence of ecological factors to keep the gene pool honed – in short, modern society enables a wider range in human variation to survive and reproduce than primitive society. It follows that this phenomenon must vary between human populations, depending on the degree and duration of immersion into artificial settings and extraction from ecological settings.

A physical example of this relates to neoteny, where birth canal size has become compromised by evolution. In modern society caesarean section is frequently used to allow the birth of infants whose heads are too large or, conversely, where their mothers' pelvises are too small. The result is that the infants pass the deleterious genes to the next generation and the mothers survive to produce further offspring who also carry the deleterious genes. Therefore, the overall effect is for those genes to propagate within the gene pool of the population to which they belong. However, in primitive societies caesarean section is not an option, so natural selection deletes those genes and keeps the gene pool honed for natural birth. Therefore, the former gene pool is becoming increasingly reliant on the artificial environment, while the latter gene pool is still honed to the natural environment (Liston, 2003; Walsh, 2008).

All societies counter natural selection to some extent, by enabling aberrations to survive and reproduce in one way or another, because that is part of the effect society *has*, so the phenomenon is exponential, from the primitive society to the modern society and all variations in between. Put simply, society undoes much of the good that natural selection does in keeping our species adaptable in the context of the natural environment beyond society.

In the context of human belief psychology, it is clear that the situation is rather complex, with different human populations having a slightly different genetic holotype (theoretical typical or mean example), depending on their specific interplay between natural and artificial selective factors. Added to this, there is the effect of gene pools having merged or isolated at different times as well as idiosyncratic variations in the artificial selective factors that different societies may have introduced. The belief holotype of any population will be a mean reading that is ultimately dependant on genetic inclinations, sociocultural influence and expressed behaviours, so there are three tiers to the mechanism, in addition to the many other factors involved.

1.10.0 Intentional awareness.

One of the bedfellows of evolving intelligence is an increase in conscious awareness with regard to an organism's ability to react when conditions change or events occur that may have some bearing on its survival and reproduction. If an organism is aware that an agent (A) has caused an event (B) then it can make a calculation about how to react (C). However, if the organism is aware that (A) intended to cause (B), then (C) may be a different calculation. This is because intention is something that comes from another organism's brain, making the situation more complex. (A) may also be aware of intention in the organism when it responds to (B) in calculating (C). (Dennett, 1989).

Thus, for cognitively advanced animals there is a complex interplay of awareness and intention between organisms, whether the scenario is predator encountering prey, male courting female,

and so on. If one organism has a reasonable idea of how the other organism will react to different behavioural options then it has a better chance of choosing the right strategy. So, awareness of intention enables an organism to read the situation (Gallagher et al., 2002).

A useful analogy is the mental combat that occurs betwixt chess players between physical moves on the chessboard. Both parties need to project several moves ahead in their minds in order to optimize their chances of winning. When a player moves they inevitably betray intention and the other player adjusts their projected game. Thus, there is a toing and froing of intentional tells, both in terms of the moves and in terms of body language – gesture, posture, micro-expressions, etc. Essentially winning is all about outwitting the opponent by disguising true intention with false intention.

In scientific terms this dynamic is known as the *intentional stance* (Dennett, 1989). The first organism attempts to read the intentions of the second organism by assembling what it already knows (prior) with the data it is sensing in real time, plus an awareness that the second organism is likely to know or be able to read something about its own intentions. Needless to say, at the human level these calculations can involve a complexity of pathways in interpreting data and predicting potential outcomes.

If we translate this cognitive exercise in terms of beliefs, then we can see that intentional stance must have significant purchase with regard to the concept of a god or gods. This is because believers believe that their gods are omnipresent, so they are privy to every thought and intention in the believers' minds. The relationship between a believer and their god is rather one-sided therefore, as the god is entirely aware of intention in the believer, while the believer has to interpret intention in the god by reading arbitrary 'tells' from outcomes and occurrences. As the god is also believed to be omnipotent, then the believer is in the tortuous situation of having to constantly police their thoughts and behaviour for fear of retribution.

To use an analogy, it is rather like the Victorian *truck system*. The employee was paid in tokens by the employer, who owned the shop where the tokens had to be spent (Hilton, 1957). The believer (employee) perceives fluctuations in payment from the god (employer) according to judgement of their own conduct and perpetually tries to maintain payment so that they can purchase a contented and happy existence. It is a contract of commitment to please the god on a frequent basis, in an effort to keep the cost of those commodities affordable.

Given a simple scenario, such as a human encountering a predator, the ecological basis of the intentional stance is evident, simply because reading the situation well can mean the difference between life and death. It is also relevant to belief, because the human relies, in part, on prior knowledge, which is a collection of beliefs in their most fundamental form. It comes back to the Bayesian calculation, where the mind is combining prior data with current data, but processing it

with the added dimension of awareness of intention in both parties – its own mind and that of the predator.

This is why it is hypothesized that the human mind's ability to modify its belief system is governed by circumstance. Such calculations need to be made quickly, in order to optimise survival chances, so it makes evolutionary sense to lock into a fixed prior in the heat of the moment (up time). However, it also makes evolutionary sense to modify the prior with new information having survived, so that the chances of favourable outcomes from future encounters are optimized, thus the modification is undertaken when the heat is off (down time). If we examine modern human behaviour, then we can see this in action as a commonplace and familiar phenomenon, in ourselves and others. An associated phenomenon is 'thinking disposition' – the apparent tendency for certain circumstances to trigger different ways or modes of thinking (Norris, 1992).

When people are expressing their point of view and feel stressed, they often become blinkered and maintain their perspective even when the evidence indicates they are wrong: this is known as *belief perseverance* due to *confirmation bias* (Ross & Anderson, 1982; Nickerson, 1998). They are unable to modify their belief system during the argument, because their mind is treating the situation as strategically critical, so it switches to survival mode. In fact, their view can become more extreme in light of the evidence, which is called *attitude polarization* due to their *belief bias*, as determined by their prior (Lord et al., 1979; Evans & Pollard, 1990). Only after the confrontation, when things have calmed down, do they find themselves unstressed and able to absorb the new information and adjust their point of view – update and reset their prior belief system.

1.10.1 Positive and negative empathy.

Dennett's 'intentional stance' is part of the general *Theory of Mind*, which is centred on the ability of one mind to comprehend another mind (Premack & Woodruff, 1978). A precursor of a full-blown theory of mind (a model of someone else's way of thinking) is the phenomenon we call empathy: the ability to project psychologically to presume to understand and share the feelings and emotions of another mind. Interestingly, we tend to use the term empathy only as a positive and beneficial quality, because it is usually associated with kindness, altruism and helping others, within a shared sociocultural environment (Calloway-Thomas, 2010).

In fact, it is a human characteristic that varies between individuals, is subject to regulation and can be employed ruthlessly, as described by Peter Bazalgette (2017). To illustrate *variability in empathy*, think of the way different people vary in their skill at giving directions. This is because they have varying ability to imagine what it would be like for a naïve mind to take the journey they are describing. To illustrate *regulation in empathy*, think of medics dealing with injured

patients. They need sufficient empathy to care for their patients' wellbeing, but they also need to be able to attenuate their empathy in order to supress their emotions and get on with their job. To illustrate *ruthlessness in empathy*, think of people who abuse, punish and torture other human beings. They need empathy to imagine the most effective ways of going about their unsavoury deeds, but they also need to switch their positive empathy off in order to be effective and efficient (Bazalgette, 2017). Some scholars use the terms emotional empathy and cognitive empathy, in place of positive empathy and negative empathy. However, an inference that negative empathy does not involve emotions would be inaccurate in my view.

Studies indicate that positive empathy tends to be expressed with greater frequency between familiar individuals, and that negative empathy tends to be more prevalent as individuals become less familiar (De Waal, 2009; Bazalgette, 2017). Furthermore, humans are highly susceptible to 'emotional contagion': i.e. they readily adopt the empathic view of those around them, because it is an evolved strategy. Empathy therefore functions as a cognitive mechanism that enables the mind to switch from one kind of behaviour to another behaviour, or to express two kinds of behaviour concurrently.

This explains why people are capable of surprising belief and behavioural extremes that seem to contradict our preferred view of humanity. Put plainly, we have evolved to express love, affection and tenderness to our allies, yet express hatred, violence and cruelty to our enemies, because both behaviours are adaptive: i.e. those with this dual ability express higher fitness, because both increase the chances of survival and reproduction in different ways. Clearly, shared belief systems are implicated strongly here, as they aid us in determining whom we should regard as friend or foe, when other indicators are not immediately obvious.

1.10.2 The two faces of humanity.

In 1963, Stanley Milgram published a paper titled '*Behavioural study of obedience*' (Milgram, 1963). He described the first of many experiments he conducted in order to study human obedience when faced with an opportunity to inflict suffering on other individuals – a range of electric shocks. Milgram discovered that a significant proportion of his participants were willing to deliver the maximum electric shock and they exhibited an array of intriguing behavioural dynamics in response to the reactions and protestations of the victim – who was actually acting the part. 14 of the participants could not overcome their positive empathy and broke off the experiment before reaching the maximum shock, but 26 switched to negative empathy and reached the maximum shock. They exhibited signs of elation, excitement, and hysteria in reaction to their own believed acts of cruelty.

Milgram had shown that humans have a 'dark side' to their nature to varying degrees, which caused a sensation at the time and prompted other scholars to focus their research in this area of

behaviour (Mehrabian & Epstein, 1972). This was the beginning of the journey towards the realization that humans possess evolved 'primal' traits that have been prehistorically favoured by natural selection because they conferred biological fitness. In particular, there was the aforementioned duality in empathy. To some extent negative empathy is justified in the minds of the perpetrators by a desire to be obedient – following orders – but there is also a pleasure response to inflicting pain that enables the mind to lock out conflicting thoughts.

A recent re-run of Milgram's experiment has produced results more or less similar to those of the original, demonstrating that it was not a temporal cultural result – i.e. of its time – but a genuine betrayal of innate evolved human behaviour (Doliński et al., 2015). The logical corollary would be to test for positive/negative empathy, by seeing whether the same participants were so willing to inflict pain and suffering on friends and relatives, rather than strangers. Hypothesis says they would not, due to the evolved duality of the behavioural mechanism: i.e. both types of empathy are adaptive in context.

1.11.0 A proposed scientific taxonomy for beliefs.

In order to avoid problems with ambiguity in scientific definition, here are alternative terms for describing empirical, supernatural and societal beliefs based on Greek etymology:

- Epistemic in place of empirical; derived from *episteme* (ἐπιστήμη) and translates as 'knowledge from science'.
- Prosagogic in place of supernatural; derived from *prosagógé* (προσαγωγή), which translates as 'to bring spiritual access'.
- Efevresic in place of societal; derived from *efevresi* (εφεύρεση), which translates as 'inventions'.

An **epistemic (empirical) belief** is any belief that attempts to describe or explain an element, phenomenon or event by the application of empirical scientific principles or by lay scientific principles – observation, experiment and experience – but always without the inclusion of any supernatural or unscientific content.

A **prosagogic (unempirical – supernatural) belief** is any belief that attempts to describe or explain an element, phenomenon or event by including supernatural or unscientific solutions – these beliefs range from religious notions of a god or gods, to lesser superstitious notions of fate, destiny and luck.

An **efevresic (unempirical – societal) belief** is any belief that is a constructed and structured way of thinking about and conducting life, which is invented by the mind but has no supernatural

content – these beliefs include philosophies, politics, ethics, morals, principles, policy, protocol, laws, conduct codes, etiquette and rules.

By honing beliefs to just three types it means that the sociocultural details of beliefs are pared away, enabling comparison between any two people, no matter what their specific beliefs happen to be or the environment in which they have formed those beliefs. The apparently infinite variety in human beliefs is thereby greatly simplified, I propose, to only three measurable factors.

The definitions provided for the three types of belief make them discrete according to the parameters described, but it can be argued that some beliefs are not discrete in themselves: i.e. they might be regarded as straddling more than one definition. Also, it might be argued that societal beliefs are not 'beliefs' in the sense that they have no 'object of belief' but are instead focused on thought and behavioural concepts. Nevertheless, I argue that they *are* beliefs, because they are centred on thoughts and behavioural concepts that the owner believes are appropriate or inappropriate, and to varying degrees of strength, in the same way as the other two belief types. Thus, the majority of beliefs can be refined by empirical evaluation using the outlined system. So, it is considered precise enough for collecting and analysing valid data.

The first hypothesis is that epistemic and prosagogic beliefs have an inverse proportional relationship, so that each human mind has a particular ratio of each and can therefore be placed on a spectrum. The second hypothesis is that efevresic beliefs have an indirect relationship with the other two, and have a relatively constant reading across that spectrum, because they enable human minds to behave functionally in a societal context. In other words, the prediction is that people can be classified along two, more or less orthogonal (independent) vectors: an epistemic-prosagogic vector and an efevresic vector. Thus, the three belief types are hypothesized to have particular roles that relate to level of biological fitness, via natural selection acting on the behaviours they generate.

The first methodology (Chapter Two) was designed to test this theory by measuring percentile levels of response to polarizing questions. Thus, it was possible to show that epistemic and prosagogic beliefs are antagonistic to one another, and that efevresic beliefs are independent of the other two belief types. Moreover, it was revealed that people possess highly contrasting epistemic-prosagogic views, yet their efevresic views tend to be more moderate and consistent across the sample. This was taken to indicate that genetic inclinations towards social behaviours have been favoured in the society from which the sample was taken (British) because societal accord aligns with enhanced fitness.

With regard to the other belief types; despite the higher variability it was revealed that every subject expressed at least some level of supernatural belief. Given that many British people proclaim atheism, or at least agnosticism, the data were taken to indicate that the gene pool

betrays a strong vestige of selection for prosagogic beliefs due to the sociocultural advantages of the expressed behaviours. Thus, many British people outwardly side with epistemic beliefs due to nurture in the current sociocultural environment, but their innate beliefs are more accurately described by the data.

1.12.0 A note on logic, reason and rationality.

At this juncture it is worth noting that that beliefs cannot be defined by logic, reason or rationality, because these would be subjective, rather than objective, measurements. The point being that all beliefs that comprise a belief system are logical, reasonable and rational in the view of the owner of that belief system, by definition, otherwise they would not be believed. Of course, there is some room for uncertainty and adjustment in belief system due to the involvement of cognitive dissonance, but this can apply to any beliefs from all three categories. We all think that what we believe makes perfect sense, because we are all governed by the same belief mechanism, but what is rational to one mind might be irrational to another, and vice versa.

From the scientific point of view, however, the opinion is that any supernatural content in beliefs is irrational, because there is no empirical support for any such beliefs, so this is the necessary stance taken in the methodology. The assumption is that people forego or ignore the process of true rationality in their thinking in order to accommodate supernatural ideas as if they are rational ideas in their minds, because the human brain has evolved the ability to do this due to the effect of natural selection in collusion with the supernatural meme, via the resulting behaviours. Thus, the brain allows empirical and supernatural beliefs to coexist because it is beguiled into thinking they are both rational and therefore sanctionable.

The Dunning-Kruger effect (Kruger & Dunning, 1999) may play a role in people's assertion or confidence that irrational beliefs are true. The effect relates to people's subjective and objective judgment in terms of their cognitive competence, which is not the same as intelligence but, rather, common sense and self-awareness. It varies between people from all cohorts of intelligence and might therefore explain why bright individuals can hold with beliefs that one would expect them to dismiss on the grounds of rationality and logic, and vice versa. For example, members of the clergy are usually quite intelligent, but readily accepting of supernatural beliefs.

The Dunning-Kruger effect demonstrates that people with low cognitive competence are generally lacking in objectivity and that this results in delusory confidence in their judgement and abilities, because they don't compare their competence with others and lack the ability to detect their own failings: i.e. they are 'blinkered'. Conversely, those with high competence tend to assume that other people find things as easy as they do, because they are overly objective, resulting in an underestimation of their own judgement and ability, which is exemplified by

'imposter syndrome' (Clance & Imes, 1978). Thus, the competent suffer from self-doubt, while the incompetent suffer from self-surety.

A better definition of 'cognitive competence' might be a general ability to successfully compare internal information with external information without allowing emotional desires and needs to cloud their judgement. If we consider this effect in light of beliefs, then people with lower cognitive competence are more likely to believe in irrational beliefs because they are less susceptible to self-criticism, or generally less likely to notice or consider counter views in the first place. In other words, the Dunning-Kruger effect locks them into an intransigent mind-set because they are convinced they must be right, so it would be absurd to even consider their own ignorance of alternatives.

An example of this is the inept auditionees seen on television talent shows, who are clearly incompetent at their proclaimed talent, yet are incredulous and indignant when the judges tell them the truth. They typically have a marked lack of embarrassment too, because that comes with the territory; their lack of objectivity is the reason why they are deluded about their own level of competence in the first place. This is known scientifically as anosognosia (Vuilleumier, 2004; Heilman et al., 1998). Anosognosia study tends to be associated with brain injuries, disease and defects, because these examples are more pronounced, but the evidence suggests that it is an evolved natural state of the human mind: i.e. a variable trait.

For example, there are many everyday people who have occupations, interests or pastimes that are perceived as very singular or inappropriate, and open to ridicule by society as a whole, but their anosognosia enables them to block any sense of self-awareness and embarrassment. Among those people are the ones labelled as nerds, geeks, dweebs, dorks, anoraks, squares, eggheads, swots, spods and superfans. Indeed, these terms exist precisely because these people are seen to exhibit levels of anosognosia that make their behaviour seem odd to the masses. One might observe that intellectuals and scholars are often included, along with anyone with an unusual job in rarefied environments so that collective anosognosia prevails. Then there are the poseurs, show-offs and exhibitionists who employ their anosognosia in feeling pride in boastfulness, rather than humility.

It seems though, that anosognosia is varyingly present in all humans as a prerequisite to societal integration: i.e. it enables one's brain to cope with being amidst other brains, by assimilating with the few and by blocking out the many. This implies that sociality is not the natural state for the human brain even now, and that anosognosia is a coping mechanism.

The case of anosognosia that prompted Dunning and Kruger to conduct their investigation was that of a man who committed two robberies in 1995. When confronted with CCTV footage of his crimes he was completely incredulous, to the point of arrogance, that the police could possibly

know it was him, because he had coated his face in lemon juice and believed it would render him invisible to the cameras. He had been told of a schoolboy trick of using lemon juice as invisible ink and his level of incompetence had led him to believe that the lemon juice would make him invisible too. The investigating officers were astounded, both by his incompetence and by his utter disbelief that the lemon juice had failed to work (Fuocco, 1996). In fact, McArthur wasn't nearly as stupid as he sounds, for it turned out that he had been clever enough to test his theory with a Polaroid camera, which duly failed to reveal his image (presumably because the film was defective or he had used the camera incorrectly), so he believed what he perceived as evidence even though common sense would have told him otherwise. The point is, that he wanted to believe it, so he allowed his desire to take precedence over logic, and any thought that the experiment must have given a dud result was either absent or dismissed.

The implication is that believers in supernatural ideas are fundamentally behaving in the same way, especially when they live in modern environments where empirical alternatives are conspicuously available but ignored or disregarded. Degrees of anosognosia are therefore in evidence, depending on the intensity of supernatural belief. This explains the self-assurance often reported in the devoutly religious, as their anosognosia has led them into a state of complete denial that secular alternative viewpoints might be considered. So, secular people struggle with existential concerns because they lack the anosognosia to beguile their minds into the state of equanimity that religious people achieve through belief that they are being guided and protected by a parental god. It may seem peculiar to compare belief in a god with belief in the vanishing property of lemon juice, but the comparison is entirely appropriate, as both are the medium that facilitates the delusion due to anosognosia.

Although examples such as the *lemon juice heists* and those associated with brain malfunction (Pia et al., 2004; Kortte et al., 2003) create the impression that anosognosia is an undesirable and defective form of cognition, it is clearly not so in its more general manifestation. In fact, the evidence suggests that it is a diagnostic and variable trait in human brain function, as those with clinical anosognosia either deny, or are unaware of, their deficiency in the same way as those with the Dunning-Kruger effect (Vuilleumier, 2004). So, in basic terms, everyday anosognosia is what we mean when we use the term 'denial', as it is characterized by mental blinkering, so that contradictory information and thoughts are denied access to the mind. Thus, it is something of which all humans are capable, because it plays a role in facilitating survival and reproduction.

There seems also to be a connection between anosognosia and hypnosis, or trance. The mechanism behind hypnosis is; that the mind becomes rendered into a disassociated state by relaxation, so that thoughts are channelled into a single point of attention, rather than having the more general distribution in the typical or normal aware state (Ludwig, 1983). The benefit of hypnosis, as seen in tribal dance rituals, is a form of heightened social cohesion, whereby the participants share the same focussed attention on supernatural beliefs in a euphoric or placebo

condition. The practice of trance therefore serves to reaffirm supernatural beliefs on a collective level and elicit the general behaviours that improve fitness, both in the natural and sociocultural environmental settings.

By extension, it seems that anosognosia is a workaday version of hypnosis, that has the same effect of channelling or trancing the mind into a reassured mode, but still allows the mind to operate in an outwardly functional way (Kihlstrom & Tobias, 1991). Just as people vary in their susceptibility to hypnosis, they also vary in anosognosia, because it is a trait with varying expression. The implication is that religious people are in a perpetual state of mild hypnosis, brought about by the effect of their beliefs – a comfort blanket for the mind.

1.12.1. Cognitive dissonance.

Leon Festinger first proposed cognitive dissonance as a psychological phenomenon in humans in 1957 (Brehm & Cohen, 1962; Festinger, 1962). He noticed that people are able to accommodate conflicting – dissonant – ideas as a truth avoidance strategy to excuse themselves from behaviours that are unbeneficial. He used the example of smoking, by pointing out that people will say things like 'the damage is already done' despite the evidence that stopping smoking at any time will benefit one's health, so that they can justify a continuance of the habit. Cognitive dissonance can be seen in many areas of human behaviour, including (perhaps particularly) beliefs, because it is a fundamental mechanism, having evolved to enable the human brain to deal with the influx of, often conflicting, data.

The Bayesian stance is to settle on a prior and combine new data with the prior as and when it arrives, to form a posterior distribution (that in turn acts as the new prior) (Gopnik & Tenenbaum, 2007). However, if the new data so contradict the prior as to suggest they are irrelevant (or part of a 'different distribution'), then cognitive dissonance is one mechanism by which the brain can accommodate modification. In the case of smoking, the scientific evidence that the habit is bad for health is fairly conclusive, but it is tempered by the element of chance, so this acts as a 'get out clause' in the mind of the addicted smoker, because is allows the mind to believe that they will be one of the lucky ones and therefore avoid having to adjust the prior and associated behaviour. This is not wholly irrational: new data may be unreliable and too rapid an adjustment to new data may be costly if the new data are subsequently found to be in error. The brain has taken the path of least resistance for the time being. When the balance tips the other way, due to a health scare perhaps or old age, then the same mind may revise its stance and adjust its behaviour, even becoming evangelical in its opposition to smoking.

In addition to cognitive dissonance, there is 'self–affirmation theory' (Steele, 1988; Sherman & Cohen, 2006), which contends that people manage their stress levels when confronted by new and contradictory information by reflecting on the values that are relevant to them. In the

context of beliefs this is the equivalent of reverting to the prior, when new ideas are confronted, because it represents the most stable part of the belief system. So the individual is naturally reluctant to abandon the prior and does everything possible to spin information to suit rather than adjust the prior, in order to avoid a sense of stress or threat, or vulnerability, that would come from disassembling and then reassembling their belief system.

1.12.2 Nature, nurture and their measure.

When we talk of environmental factors and innate factors we are, of course, alluding to nurture and nature. The theory is; that people each belong on a genetic spectrum, which determines their general inclination towards epistemic-prosagogic beliefs, but environmental factors determine their exact position on the expressed spectrum (and, of course, culture and upbringing determine how those beliefs are manifested). So, we need to compare the contributory value of nature (genes) and nurture (environment).

There have been various experiments conducted, comparing sets of monozygotic (identical) twins and dizygotic (non-identical) twins, both reared together and reared apart, in efforts to determine the extents to which nature and nurture influence human personality and susceptibility to illnesses, conditions, disorders and so on (Boomsma et al., 2002). From our point of view, this type of research has potential significance because belief systems can be considered part of personality, and even to underpin other aspects of personality, so the comparative datasets might be informative.

The largest and most relevant of these studies is the '*Minnesota Study of Twins Reared Apart*', which began in 1979 (Tellegen et al., 1988; Bouchard et al., 1990). More than 100 separately reared sets of identical twins and triplets were scrutinized and their data compared with data from identical twins and triplets reared together. The study found that about 70% of measure of Intelligence Quotient (IQ) can be associated with genetics – with the remaining 30% associated with environment during upbringing.

On the matter of personality in general, multiple measures were taken by looking at aspects of temperament, interests and attitudes. The conclusion was that identical twins reared apart seem to be about as similar as identical twins reared together. Taking into account the general measures of difference and that there were still many elements of commonality in the upbringing of the isolated twins (being from the same overall US culture) the conclusion is that nature and nurture are roughly equally accountable. Range in heritability was measured at 0.39—0.58 (midrange 0.485).

Other work on personality looks at the evolved benefits of personality difference as trait variation, so that different behavioural actions and reaction to the same stimuli result in a range

of outcomes, upon which natural selection acts. Thus, there appears to be a genotype-phenotype mechanism in place that counters natural selection's tendency to narrow the genetic spectrum. Thus, differences in personality are seen to equate with differences in behaviour as the psychological equivalent to physical and physiological trait variation (Nettle, 2006; Nettle & Penke, 2010; Buss & Hawley, 2010).

As belief systems are an integral component of personality, then this work is clearly relevant and useful in assessing the extent to which belief systems might affect behaviour, which is what natural selection is hypothesized to act on. The inference is that an approximately equal combination of nature (genetic predisposition to beliefs) and nurture (exposure to beliefs) will shape a belief system and the behaviours expressed by the person. Thus, that person's belief/behaviour level of fitness is determined by the sociocultural environment around them, which comprises the beliefs and behaviours of everyone else in their society. Selection is then determined solely by relative fecundity.

Polyphenism – the possibility of two or more phenotypes from a genotype – is recognized as an important adaptive mechanism in human evolution, as it can prevent a population from channelling its behavioural options too narrowly. Furthermore, if there is phenotype overlap with another genotype then it can enhance gene flow by encouraging individuals from differing genotypes to reproduce (Nijhout, 2003; Gluckman et al, 2005).

1.13.0 Putting some of the theory into practice. Deciding which components of the theory were testable and how to test them.

Most of Chapter One is devoted to explaining the theory of how the phenomenon of believing evolved in our ancestral brain as an ecologically advantageous platform and why the ancestral brain subsequently invented the supernatural realm as a solution to understanding its environment in response to increasing intelligence accompanied by existential enquiry and ability for complex communication. The theory goes on to explain how the supernatural meme then effectively took control of the protohuman mind by causing natural selection and sociocultural selection to favour behaviours associated with belief in the meme. An important component of the theory is that the resulting superstitions and behaviours (lore) are context specific, explaining why there are so many sociocultural variations recorded in humanity, yet all share commonality in their underlying selective process. This is because all supernatural belief systems are hypothesized to be merely differently expressed versions of the same supernatural meme acting on different human populations. Thus, the apparent complexity in human beliefs, as demonstrated by the worldwide demographic examples, is nothing more than a beguiling distraction to anthropologists that has served to conceal a simple and uniform mechanism all along.

Therein lies the objective of the set of methodologies for this research: to attempt at finding ways of yielding data that might support some areas of the theory. The problem is, that most of the theory cannot be tested for at all, simply because one cannot turn back the clock to investigate the various stages in our evolution, even supposing one might think of ways of investigating in the first place. Instead, one can only search for vestigial evidence that lies within the brains and minds of living humans, and in the expressed behaviours in relation to their belief systems. So, the challenge is to think of experiments and analysis that may be worthwhile. It should then be feasible to make predictions and run experiments to assess for degrees of agreement/disagreement with hypothesis.

It was first necessary to provide a universal framework for understanding what we mean by 'belief system'. Rather than being an amorphous and vague concept, it had to have meaningful structure (defined components with measurable dimensions and parameters) otherwise it would be impossible to gather meaningful and comparative information between subjects, and therefore impossible to detect any distribution patterns across a data sample. This is how the tripartite foundation for belief systems was realized.

Methodology One (Chapter 2) was a test for this hypothesized belief system structure, by assessing the level of alignment between data and the predictions outlined in Chapter One (1.11.0). The predictions are; firstly, that epistemic (scientific) and prosagogic (supernatural) beliefs belong to a common spectrum and are therefore inversely proportional to one another; secondly, that efevresic (societal) belief belong to a separate and orthogonal spectrum; thirdly, that efevresic beliefs will be more moderate and consistent in their measurement than the other two beliefs, because they are an indication of social functionality, regardless of other beliefs.

So, supportive results would sanction the execution of Methodologies Two and Three (Chapters 3 & 4) as a negative result would have presented an impasse. As it was, Methodology One indicated that the hypothesized structure was defensible as a model to work with.

Although this technique merely provides relative reading of epistemic and prosagogic beliefs rather than the associated behaviours upon which selection is postulated to act, a level of cross-reference is to be had from the data relating to societal (efevresic) beliefs, which imply levels of conformity in behaviour.

Methodology Two (Chapter 3) was an extension of Methodology One, focussing particularly on supernatural (prosagogic) beliefs. This was done by sub-dividing the category into two types: secular superstitious (absence of god) and religious superstitious (including god). The aim was to test for the inclusion of god as a 'supernormal stimulus': a stimulus that has a more pronounced effect than a normal stimulus. Therefore, the central prediction was; that people are more likely to believe in the whole range of supernatural beliefs, the more they believe in a god, thereby

demonstrating that the god concept is a device exploited by the supernatural meme as it creates supernatural belief bias. The origin and latent function of the god concept are discussed in Chapter One: 1.4.0 & 1.7.2. It is hypothesized that the god concept emerged as a communicable idea of governance in the supernatural realm because it provided a logical paternal and anthropomorphic model in naïve minds. Thus, it had considerable purchase to the believer, which is why it acquired added potency as a supernatural belief stimulus: i.e. god became the overarching reason or explanation, thereby rendering anything supernatural a possibility.

Methodology 3 (Chapter 4) took a different experimental approach. The results from the other two methodologies betrayed the possibility of two or more 'belief phenotypes' involved, exhibiting diagnostic variation in cognitive flexibility and rigidity. Thus, the third methodology was designed to test a prediction that a distribution structure exists with regard to beliefs and behaviours, which is hypothesized to mitigate the narrowing effect of the supernatural meme by promoting belief and behavioural variation, thus enabling populations to remain adaptable when presented with environmental changes – both natural and sociocultural. The hypothesized presence of phenotypes is outlined in Chapter One: 1.1.1, 1.1.2 & 1.1.3. The fundamental premise is that a Bayesian dynamic is involved, so that people belong in two camps: those with cognitive plasticity adapt their beliefs to fit new information, while those with cognitive rigidity attempt to adapt the new information to suit their fixed belief system.

The data for the three described phases of methodology were collected with the use of questionnaires. These were designed, prototyped and tested for legibility of questioning, uniformity of question comprehension, neutrality of intent, and so on, to ensure that the experimental data would be unbiased and impartial. A good deal of work has been done by other scholars regarding ways in which questionnaire data might be affected by biases, so I was mindful of this when refining the questionnaires ready for deployment (Choi & Pack, 2005). Certain agents of potential bias can be beyond adequate control however, so these need to be recognized and factored in as part of the assessment of analysis of data. These might include 'participant acquiescence' (a participants reluctance to provide truthful data) or alternatively an eagerness to please (Schriesham & Hill, 1981), and 'sociocultural bias' (a participants Pavlovian tendency to answer questions in the way they think they should, rather than expressing their genuine thoughts) (Van de Mortel, 2008). To some extent the promise of anonymity will assist in these biases, but one can never know for sure that participants have been entirely truthful. Indeed, they may not even be aware that they are expressing bias. The method of questionnaire distribution, the styling of the questions and its physical form might also affect data, as it might encourage certain cohorts and discourage other cohorts, so that a dataset is not a fair representation of society (Choi & Pack, 2005; Bowling, 2005). It becomes clear then, that it would be impracticable to eliminate all potential elements of bias, as one cannot know either way, despite considering them. Therefore, the use of questionnaires is never an exact science, as it relies on self-report from voluntary samples of participants, but it is a convenient and resource

efficient way of collecting data. Thus, the caveat is always to acknowledge the degrees of potential bias and inaccuracy.

In that light, a further methodology would be to design an experiment that elicits real behaviours in subjects, either as physical reactions or physiological responses to stimuli (+ve and –ve) relating to their beliefs. This would go further by directly testing for connections between particular belief system types and particular expressed types of behaviour. Such an experiment would thus be useful in measuring levels of emotional motivation associated with presumed belief phenotypes, but it would require considerable resources in terms of facilities and funding. For the time being, the methodologies deployed here set a foundation upon which further investigations can be built.

A further study might be genetic, to determine the relationship between belief phenotypes and genotypes. There is evidence of two general phenotypes with further sub-division, so it would be interesting to see whether there are two genotypes with phenotypic overlap.

Although the evidence presented here is not fully demonstrative it is not wholly circumstantial either, as the methodologies were designed to reveal underlying beliefs and behaviours in subjects. Also, multivariate analysis of the data is designed to reveal associations and correlations between belief system types and responses that are too diagnostic and consistent to be considered coincidence or happenstance. Therefore a reasonable Waldian calculation can be made that the various hypotheses are the most likely explanations for the results (Efron, 1982).

There is something to be said for intuition too, as that is the starting point for any scientific investigation that proposes to adjust a received paradigm: i.e. the idea has to come from somewhere to start with. In this instance, there is innate logic to the presumption that beliefs about ideas unsupported by empiricism must, in themselves, have purpose in empirical terms to explain their very existence.

Chapter Two.

Methodology One: Testing the tripartite hypothesis for belief systems.

Abstract.

The objective with the first questionnaire was to see whether participants' belief systems concur with the hypothesized tripartite structure, outlined in Chapter One. This was essential to the continuation of the research, as it would provide the platform upon which the rest of the methodology would rest. The overriding notion is that all human belief systems comprise only the three belief types, but in varying ratios of strength, so supporting evidence of this would open the door to a way of analysing the belief systems of people from anywhere in the world with a standard technique. The methodological reasoning was that both epistemic (scientific) beliefs and prosagogic (supernatural) beliefs belong to a common spectrum, as they are diametrically opposed in concept, and that efevresic (societal) beliefs have their own orthogonal spectrum, as they are concepts that determine thoughts and behaviours relating to levels of social conformity. Multivariate analysis of the data agreed with hypothesis, by demonstrating the two spectrums. It also showed that the sample had generally moderate and uniform readings for the latter spectrum whilst having more extreme variation and lack of uniformity in the former spectrum, demonstrating that efevresic beliefs and associated behaviours serve to regulate the running of society, even though other beliefs and behaviours can be irregular.

Introduction.

The theory described in Chapter One is centred on the overarching hypothesis that human belief systems are adaptive: i.e. they affect biological fitness via behaviours upon which natural selection has acted and possibly still acts. In Chapter One I proposed that there are three fundamental belief types: prosagogic (non-empirical supernatural), epistemic (empirical) and efevresic (non-empirical societal). One goal of using these three categories was to be able to assess any human belief system within the same framework, rather than more typical systems of classification by religious or secular sub-type, such as pagan, monotheistic, polytheistic, agnostic and atheistic, which emphasises differences rather than commonalities. The tripartite classification, if valid, would provide a way of evaluating underlying belief systems both within populations and between populations, stripped of the obvious culturally imposed variation through which those *ways of thinking* are expressed. The goal of the research presented in this chapter was to determine whether beliefs do indeed cluster into three categories similar to those proposed. The method chosen was a questionnaire based survey, deployed to draw from a broad demographic (although still UK based, a limitation avoided in Chapter 4). The rationale that the best way to find out what people think or believe is to ask them by '*developing adequate measurements of abstract constructs*'. (Hinkin,1998).

2.1.0 Methods.

I initially 'brainstormed' as many questions as I could, by applying the three belief categories to everyday scenarios. This resulted in about 300 questions in total. I then honed the number of questions down by eliminating any repetition in intent, until the overall number became more workable, bearing in mind that there is an inevitable trade-off between breadth of scope and the likelihood that someone will volunteer to fill-out the questionnaire (Herzog & Bachman, 1981).

The resulting 48 questions were allotted thus: prosagogic 24, epistemic 12, efevresic 12. The prosagogic category was allotted twice the number of questions because non-empirical supernatural beliefs required a greater diversity of questions to cover their range. The order of questions was then fully randomized.

There then followed a prototyping process, where trial questionnaires were deployed and tested amongst associates in order to ascertain appropriate use of vocabulary, sentence structure, punctuation and so on, to make sure that the questions read clearly and their intent was understood across a broad demographic (particularly with regard to educational background and age). Thus, the grammar and structuring of the questions was honed, but the overall structure of the questionnaire remained the same.

Next, the response measure and the physical format were considered. I opted not to use Likert-type scales (Baron, 2011; Likert, 1932) for answering the questions because the small number of response options (typically a 5 or 7 point scale) causes clumping of answers and lacks discrimination. In psychology they are known as ipsative scales or 'forced choice' measures, because the subject is asked to make a decision between options. Similarly, continuous sliding scales were disregarded because this creates a different form of bias, because people grow reluctant to repeatedly drag a marker from a starting position, whether it is initially placed at either end or in the middle of the scale (Funke, 2016).

It was decided that a percentage scale with no slider to move would be best. The continuous scale minimizes clumping and bias, as there is no starting position that could (subconsciously) be treated as a default choice, and more subtle variation can be captured as choice isn't forced into a small number of options (Grant et al., 1999). Although scores were ultimately still discrete, at 1% intervals, to the user the percentage scale functioned in the manner of a visual analogue scale (VAS), because the increments were too small to be perceived.

I wanted a questionnaire that would be functional both as a paper (hard copy) document and an electronic document, so that it could be emailed as an attachment or downloaded from a dedicated link website. The solution was to design the questionnaire as an interactive PDF file, so

that it could be filled out in electronic form or filled out in paper form as a printout. I didn't use an online form, because available 'off the shelf' formats were not suitable.

The PDF percentage scale utilizes a series of 102 (0-100, plus default) invisible 'radio buttons' that span the scale from zero to a hundred. PDF files also offer the advantage of revealing the numerical reading, in Adobe Acrobat Pro - Adobe Systems, 1993 - edit mode, that corresponds with the marked position on the scale, which was not visibly numbered on the questionnaire in order to avoid leading the subject. The final page of the questionnaire was designed to collect demographic data for cross-referencing against the question data (see Appendix 1). It included ethnicity, gender, age, childhood locale, education type, education level, and so on. Question data and demographic data were ultimately stored separately and given connecting codes to preserve anonymity. The survey was approved by the University of Bristol Faculty of Science Research Ethics Committee.

On the matter of scientific legitimacy in collecting data with questionnaires: the *independent variable* is the different questions asked of the participants, the *dependent variable* is the different scores recorded for each answer, and the *control variable* is the standardized formatting of the questions and method of recording scores. Thus, questionnaires are entirely valid scientific tools when designed with due diligence.

For the data to have validity, we needed to obtain, if not truly random, at least a representative sample with a wide geographical scatter (in terms of subject location) and a good variation in age, education and the other demographic details. A number of approaches were used to achieve this, including the use of social media websites, online email directories, posting fliers and asking contacts to disseminate the information. The sole criterion was that volunteers had to be aged 16 years or above, in order to satisfy the requirements of the ethics approval.

All 48 questions are listed in Appendix 1. Here are the first 4 questions by way of example:

Q1. To what extent do you think it has always been a matter of sense to you that a spiritual world exists alongside our own world?

Q2. To what extent do you think that society can only work if people think and behave according to the same moral and ethical codes of right and wrong?

Q3. To what extent do you think that certain things can bring good or bad luck in life, including numbers, animals, omens, charms, curses and jinxes?

Q4. To what extent do you think that only science can explain the way everything works in the world, even though scientists have yet to find all of the answers?

Probably because the questionnaire comprised a fairly high number of questions asking for information about what some may regard as personal or emotionally charged, issues and on a voluntary basis, the response rate was relatively low, at <1%. However I got a good sample of

subjects with regard to their geographical distribution, age range and other demographics. I ran the campaign for 6 months until we had 300 questionnaires, which was deemed a sufficient number to run cogent analysis. A widely used criterion in Factor Analysis, which was the primary method initially applied to the data, is for the ratio of subject-to-variables to be no lower than 5 (Bryant & Yarnold, 1995; MacCallum et al., 1999). So, with 48 questions, 240 responses would have been the minimum requirement.

The 300 datasets satisfied our criterion for representative sampling as they covered 56 counties of origin within England, Scotland, Wales and Northern Ireland. There were also a few from elsewhere in Western Europe or of Western European ancestry. The sample also satisfactorily covered the other demographics (see below). There were only a few subjects who were not Caucasian and so there was no prospect of making fair inferences about effects of ethnicity; hence their data were not included in the sample of 300. Therefore the conclusions apply only to the Caucasian Western Europeans of largely British residency.

2.1.1 Demographic statistics.

Age Band									
Band	1	2	3	4	5	6	7	8	9
Ages	16-25	26-35	36-45	46-55	56-65	66-75	76-85	86-95	96-105
Count	19	25	47	93	68	31	16	1	0
%	6.6	8.6	16.2	32.1	23.4	10.7	5.3	0.3	0.0

Gender		
Type	Male	Female
Count	179	121
%	59.7	40.3

Schooling			
Type	State	Scholarship	Private
Count	221	23	56
%	73.6	7.7	18.7

Qualification							
Level	None	Secondary	6th Form	College	1st Degree	2nd Degree	3rd Degree
Count	5	29	38	24	112	67	25
%	1.7	9.7	12.7	8	37.3	22.3	8.3

Childhood Home						
Type	Rent Council Flat/House	Rent Private Flat/House	Private Own Flat	Private Own Terrace	Private Own Semi-D	Private Own Detached
Count	20	16	7	34	113	110
%	6.7	5.3	2.3	11.3	37.7	36.7

Origin					
Type	W European	English	Scottish	Welsh	N Irish
Count	17	252	14	11	6
%	5.7	84	4.7	3.7	2

Table. 2.1. Demographic statistics.

R Analysis.
Analyses were carried out in R version 3.2.2 (R Core Team 2015). Additional packages used were: psych (Revelle, 2015) for Factor Analysis, NbClust (Charrad et al., 2014) for cluster analysis, lmodel2 (Legendre, 2014) for Reduced Major Axis Regression, PMCMR (Pohlert, 2014) for Kruskal-Wallis non-parametric one-way ANOVA and, for graphics, ellipse (Murdoch & Chiao, 2013) and RColorBrewer (Neuwirth, 2014).

2.1.2 Variation in response to questions.

An important initial consideration was whether the questions produced useful variation in responses; any questions where everyone answered similarly (e.g. all disagree or agree strongly, or all very similar in the middle) would not be useful for examination of variation in beliefs and so could be dropped from the analysis. Calculating the distribution of the per-question variances

across the entire data pool, there is a broad range of values (Fig. 2.1.0). But, importantly, no variance was so low that it indicated relative uniformity in response between subjects (Fig. 2.1.1) and so all questions could be used in the analysis.

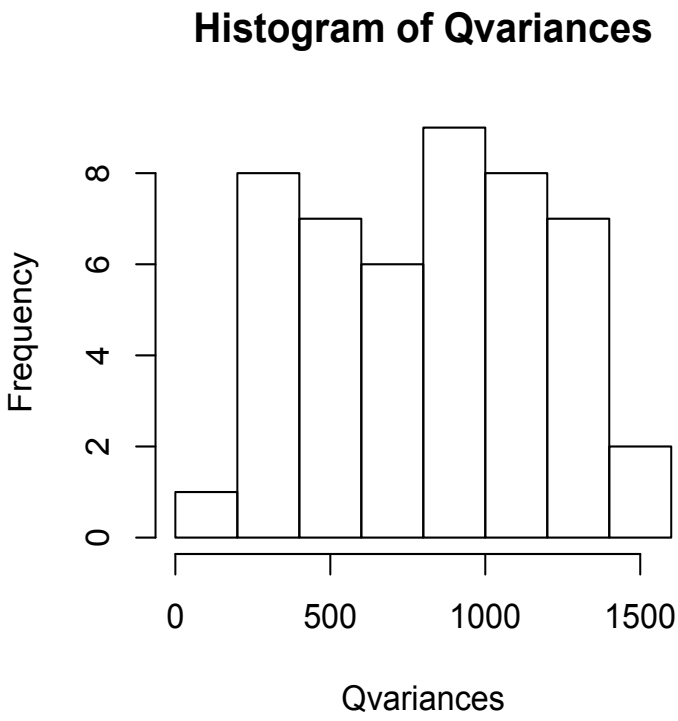


Figure. 2.1.0. Histogram of the frequencies of question variances (N=48). The variance for each question was calculated from the 300 responses (each response being on a percentage scale).

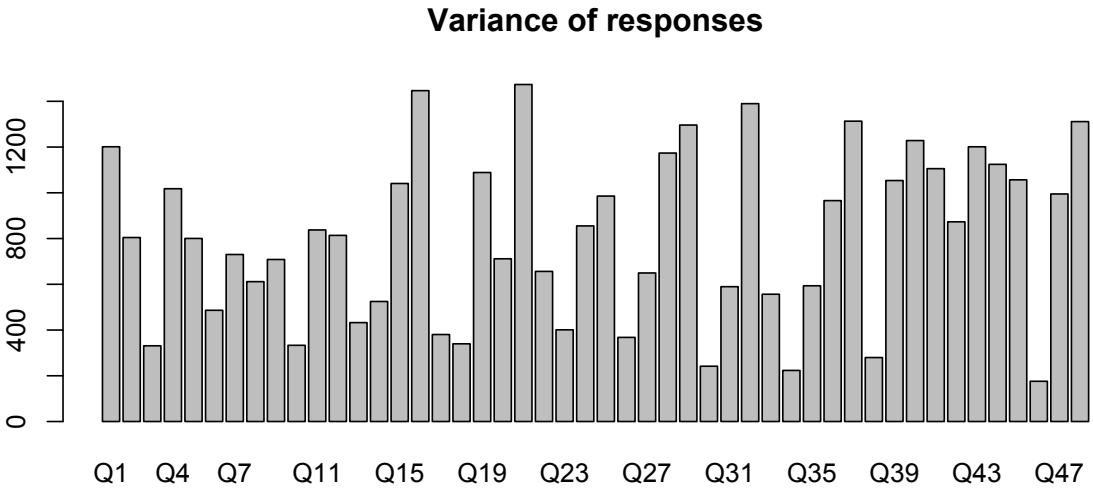


Figure. 2.1.1. Bar plot (discrete data) of question variances.

Taking the questions with the lowest variance (Q46: 175.9) we can see, in Fig. 2.1.2 (left panel), that the data are skewed to one side, because subject responses are generally in agreement, but there is still enough variance for inclusion. For comparison, the middle panel of Fig. 2.1.2 shows that the question with the highest variance (Q21: 1473.4) has data that are highly divided left and right, because subject responses are in disagreement – hence the high variance. Conversely, looking at an example of medium variance (Q22: 656.3; right panel of Fig. 2.1.2), we can see that the data spread is more even across the scale, because the subject responses are neither singular nor divided.

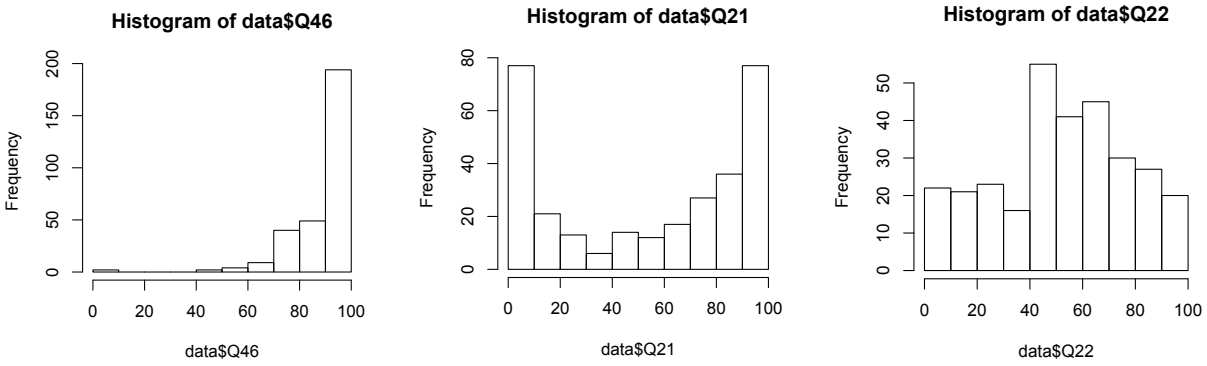


Figure. 2.1.2. Histograms for Q46, Q21 and Q22, illustrating different types of distribution of responses, left to right: skewed and in broad agreement (Q46), divided in opinion (Q21) and with a central tendency but highly variable (Q22).

Comparing the grouped means and their variances for each of the question types (Fig. 2.1.3) we can see that the question responses broadly agree with the theory. The efevresic means are higher, while the efevresic variances are lower than the other two question types, as expected, because we predict that efevresic belief values should be relatively high and constant in order for society to function, while prosagogic and epistemic belief means and variances will be relatively inconstant because they have an inverse relationship (see later). That isn't to say that efevresic values are 'constant' though – only 'relatively constant'. In fact, they still have a significant range, which reflects the variation that one would expect to see in a sample: i.e. there are both antisocial and hypersocial subjects as extremes among the sample distribution.

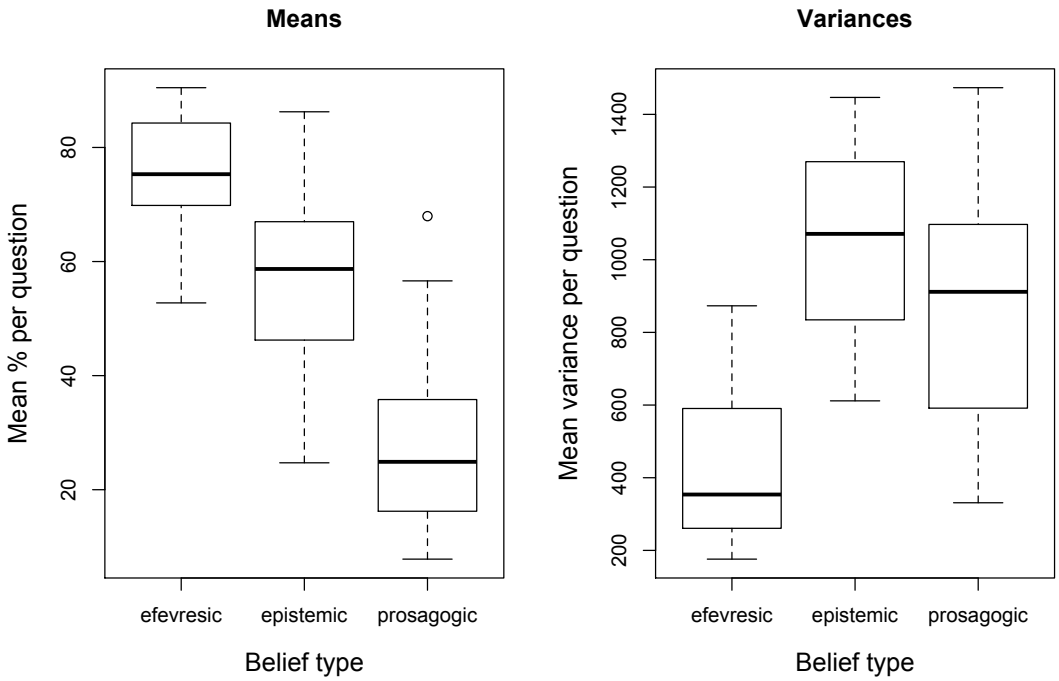


Figure. 2.1.3. Boxplots comparing the grouped means (left panel) and their variances (right panel) for each of the question types: efevresic, epistemic and prosagogic. Efevresic means are higher and with a smaller range than the other two. Efevresic variances are lower and with a smaller range than the other two. Both results agree with hypothesis.

2.1.3 Correlation Analysis.

I generated correlation matrices for the responses to the 48 questions in order to understand their relationships with one another. The purpose of this analysis was to investigate relationships both for questions within belief categories and for questions between belief categories. The focus here is not statistical significance (with N=300 even a Spearman's rank-order correlation of 0.1 is significant at p< 0,05) so much as the pattern of relationships. The plotcorr function in the *ellipse* package (Murdoch & Chow 2013) in R generates a stylized plot, using ellipse shaped glyphs on a Pythagorean table. The ellipses elongate with strength of correlation, and they change direction and colour to indicate +ve or –ve correlations: red/left (-ve) to blue/right (+ve). Low correlations are indicated by paler hues and shortened ellipses, until zero correlations are indicated by white circles.

Firstly, I correlated the questions within the three belief categories against themselves. The expectation was a predominance of high +ve correlation (blue ellipses), as the question sets enquire about related themes and the questions were expected to be alike in orientation of response. Fig. 2.1.4 shows the results for these three correlations: left panel; prosagogic:prosagogic, middle panel; epistemic:epistemic, right panel; efevresic:efevresic.

Question 36: *To what extent do you think that spiritual ideas can feel farfetched, but you still have them anyway, because they give you something extra that you need as a person?* has noticeable –ve correlation with several other questions within its category. This seems to be because it allows the subject to express a need for prosagogic beliefs even though they feel farfetched within the realm of epistemic enquiry.

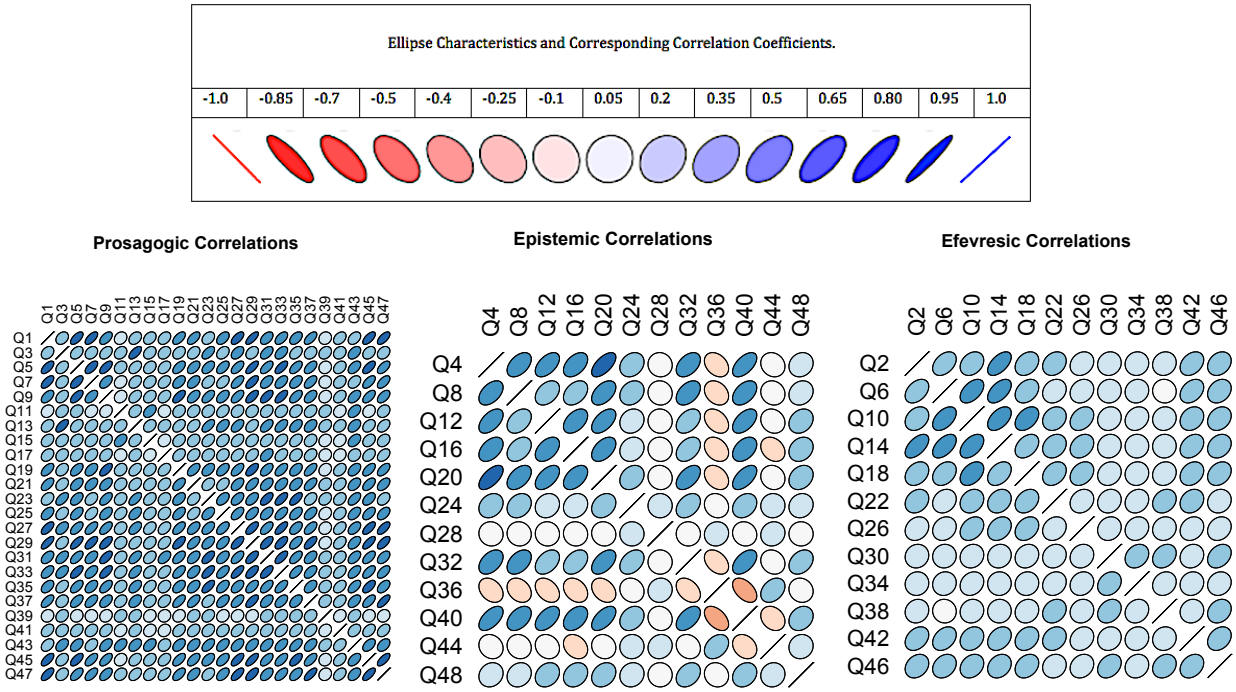


Figure. 2.1.4. Results for the three question categories correlated against themselves: prosagogic:prosagogic, epistemic:epistemic and efevresic:efevresic (left to right).

Using a correlation coefficient threshold value of >0.7 as indicative of a 'strong' effect, I identified three notable pairings. They were all prosagogic:prosagogic pairings - Q1:Q29 (r=0.72), Q5:Q29 (r=0.71) and Q29:Q45 (r=0.70). Q1 was "To what extent do you think it has always been a matter of common sense to you that a spiritual world exists alongside our own world?"; Q5 was "To what extent do you think that humans have high intelligence to make it possible to connect and communicate with the spiritual or supernatural world?" and Q 29 was "To what extent do you think that humans have life forces that continue to exist after death in the form of supernatural entities, such as souls, spirits and ghosts?"

These pairings were then scatter plotted (Fig. 2.1.5), with Reduced Major Axis (using R package lmodel2; Legendre 2014) regression lines as a guide for the eye, in order to see whether the high +ve correlations resulted from a few outliers, or polarised distributions (e.g. everyone actually had answered at 0% or 100% - binary response). Each has a relatively right-skewed distribution but with a broad spread of answers, demonstrating that while there is consistency in responses to these questions (i.e. the positive correlations) there is plenty of variation. Question 29 is

common to each of these pairings. It asks whether subjects believe that humans have life forces that exist after death. A majority of people in the sample don't strongly (there are lots of scores near 0) but, interestingly, most people didn't answer exactly 0; there is residual belief that there might be life after death or, equivalently, some doubt that there isn't. The same is true of the other two 'spirituality' questions but notice also two other revealing things about these data.

First, those that do have some leanings toward a belief in the existence of a spiritual world (Q1), having been imbued with the power to communicate with it (Q5) and believing that we have life after death (Q29), do not all show complete faith in these notions: the data are not binary (clumps in the bottom left and top right of the graphs).

Second, the responses to the questions are not trivially correlated; i.e. because they essentially ask the same question in a different way. The points are spread throughout the square frames of the scatter plots: someone may have a 100% belief in life after death but have anything between 0 and 100% belief in our power to communicate with the spirit world and, despite it seeming logical that belief in life after death would imply a spirit world, people with high levels of belief in life after death show quite variable degrees of belief in the existence of a spirit world.

The point here is not to place special emphasis on these three questions but, because these three questions showed the highest correlations, and yet none were trivially correlated because they asked "the same question", this gives us confidence that our 48 questions were indeed exploring different aspects of belief.

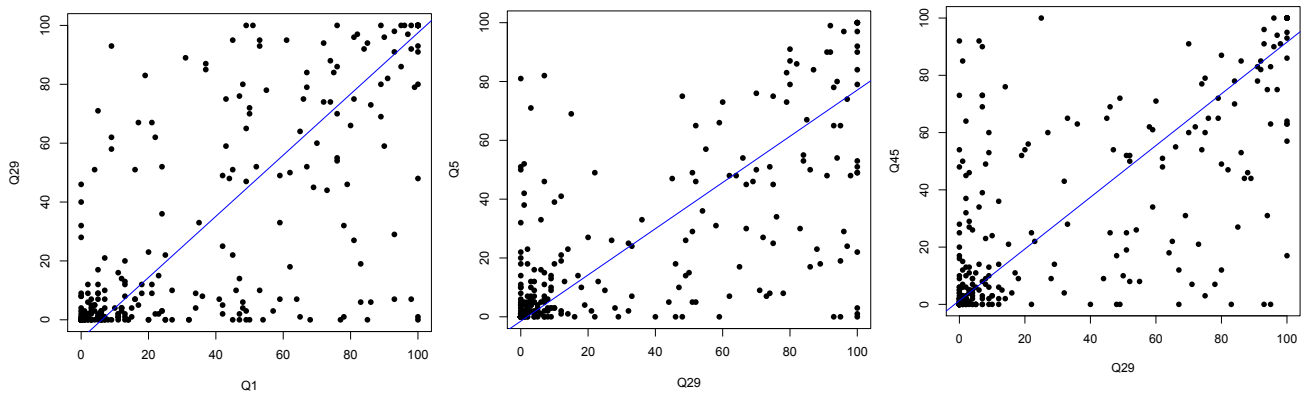


Figure. 2.1.5. Scatter plots for the three highest +ve correlation question pairings: Q1:Q29 (r = 0.72), Q5:Q29 (r = 0.71) and Q29:Q45 (r = 0.7) – left to right.

My prediction was that the prosagogic and epistemic questions would be diametrically opposed in theme, so a predominance of –ve correlations (red ellipses) is to be expected. Some pairings have +ve correlations (blue ellipses). Particularly those associated with the aforementioned Q36 and Q44: *To what extent do you think that spiritual and paranormal ideas are unlikely to be true,*

but they must still be considered because science cannot disprove them? evidently because they compromise empirical rationality.

Looking at the pairing with the highest –ve correlation (dark red ellipse: correlation coefficient: -0.74) Q8 asks about belief in evolution and Q17 asks about belief in creation. This strong negative relationship is as expected, with a full acceptance of evolution being incompatible with a belief in special creation. As efevresic themes are hypothesized to have no direct relationship with either epistemic or prosagogic themes, then the prediction is low correlations (pale/white ellipses/circles). This is what we see, consistent with the hypothesis that belief in social norms that help society function should be orthogonal to the degree of belief in the other two.

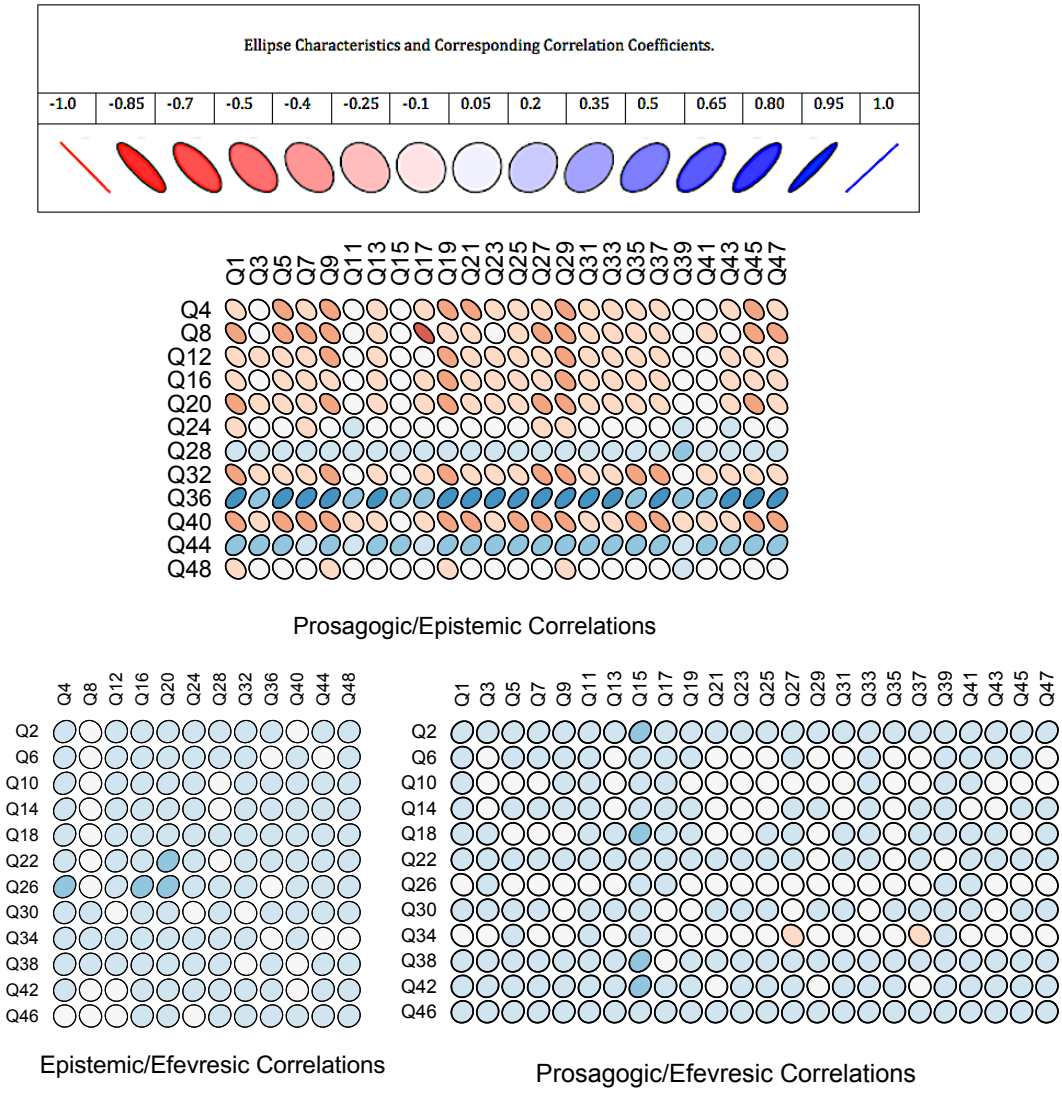


Figure. 2.1.6. Results for the three question categories correlated against one another: prosagogic:epistemic (top), epistemic:efevresic (bottom-left) and efevresic:prosagogic (bottom-right).

2.1.4 PCA (Principal Component Analysis). Principal Component Analysis, invented by Karl Pearson in 1901 (Pearson, 1901), was used to find out whether the measured variables can be transformed, and reduced, to a smaller set of new variables that capture the most important information about data relationships. (PCA is epitomized by R.A. Fisher's classic example: using 'length' and 'width' data of iris petals to generate new 'size' and 'shape' axes, which more clearly delineate species differences; Fisher, 1936). Thus, correlated single-variable measures are converted into multivariate measures or principal components, which best explain the variance in the data. In this instance we have 48 variables: the question responses. By using the correlation of these data, I ran PCA to reveal the principal components that suggest the way people process their belief thoughts, which equates to the 'shape' of their thinking.

Fig. 2.1.7 shows a scree plot of the resulting principal components: the variance 'captured' by the successive principal components. PCA, being a mathematical transformation rather than a statistical analysis, doesn't give a criterion for how many components capture 'enough' variation, but it is clear that the first component captures ('explains') by far the greatest amount of variation in the original question responses and, after the second component, additional components only contain small incremental amounts of variation.

Components 1 and 2 were used as new X and Y vectors to generate a biplot (Fig. 2.1.8), which superimposes, on a scatter plot of the first versus second principal components, a set of vectors that represent the magnitude and direction of the loadings of the two components on the original variables, in order to identify the nature of those vectors; i.e. what they express. The black numbers mark the positions of the mean data responses of the 300 subjects relative to the principle component axes. The red arrows indicate the trends of the data for each of the 48 questions relative to the same axes, radiating from 0:0. The intersection of blue lines represents the mean expression in both axes.

By analysing this information, we can conclude that the X axis approximates to a scale of superstition—rationality, taking the scientific stance that superstitious beliefs are 'irrational'. We can also conclude that the Y axis approximates to a scale of conformity—dissent. Thus, the 'shape' of people's thinking is characterized by these two vectors.

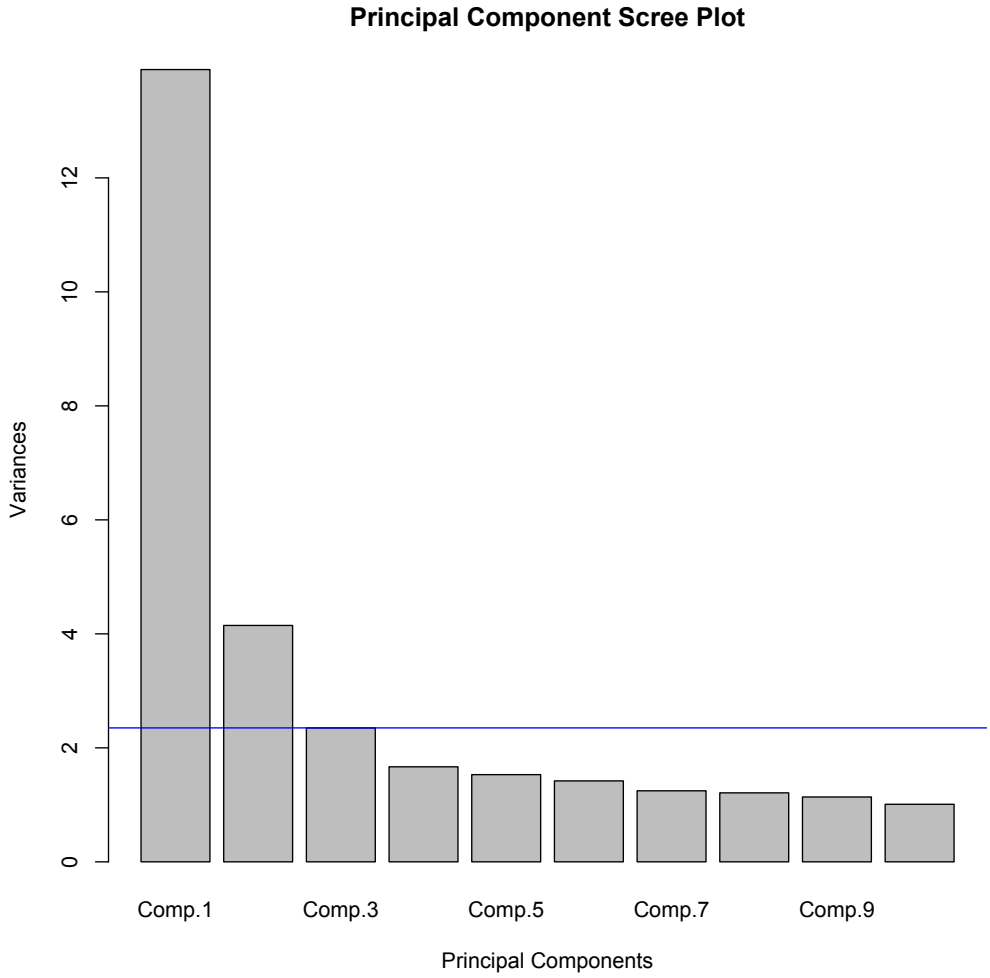


Figure. 2.1.7. Scree plot showing the variance (Eigenvalue) of successive principal components (Eigenvectors).

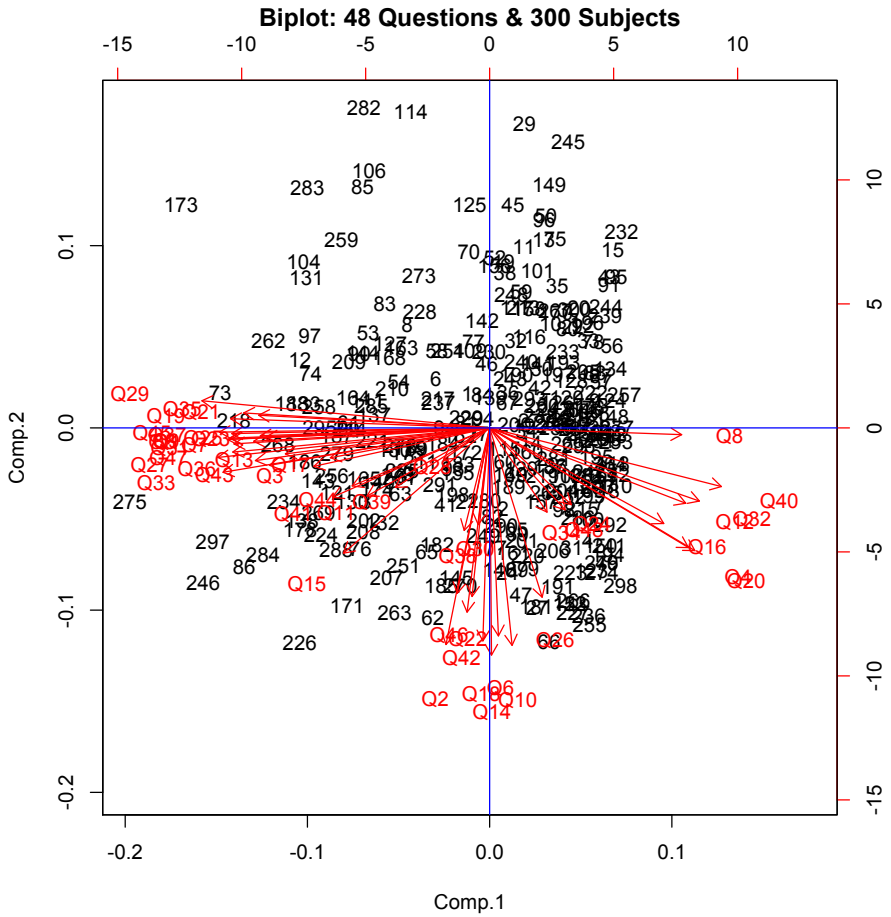


Figure. 2.1.8. Biplot showing mean subject expression and trends of question responses, relative to the Principal Components 1 and 2 used as axis vectors. For example, component 1 is strongly positively correlated with positive answers to Q8: *To what extent do you think that the idea of evolution is better than the idea of creation at explaining how so many different plants and animals came to exist on earth?* and is strongly negatively correlated with positive answers to Q29: *To what extent do you think that humans have life forces that continue to exist after death in the form of supernatural entities, such as souls, spirits and ghosts?*. People with high positive scores on PC1 are therefore people with a strong belief in evolution but a strong disbelief in life after death. People with high negative scores on PC1 show the opposite responses to these two questions.

2.1.5 Factor Analysis.

Factor analysis (FA) differs from PCA in presuming that there may be hidden, or latent, variables involved, which may have not been identified but are assumed to covertly play their part in influencing outcomes. Factor Analysis is therefore a more appropriate analytical tool than PCA for the hypothesis in this dissertation that there is an underlying 'belief spectrum' on which people lie. Instead of 'principal components' we have 'factors' (Spearman, 1904).

An important difference is that principal components have fixed values, regardless of the number of components one decides to use, while factors are potentially changeable depending upon the

number one chooses to extract. This is because their values are calculated in relation to an unknown variable or variables, which influences the derived variables (the factors). More technically, PCA is based on the whole correlation matrix, whereas FA chooses the new factor vector axes so as to maximise the correlation of the original variables with these factors (Bryant & Yarnold, 1995).

Running FA, I found that Factors 1 and 2 presented a 0.95 (95%) combined value, while Factor 3 added only 2% in explanatory value, indicating that Factors 1 and 2 are sufficient to explain most of the variation in question responses. I then compared the question loadings for Principal Components 1 and 2 with the question loadings for Factors 1 and 2, in order to see whether the axis vectors were alike. Fig. 2.1.9 shows the plots for these PCA and FA loadings.

We can see that the relative positioning of the questions is very similar in each plot, indicating strong agreement that the two axes approximate to superstition—rationality and dissent—conformity, respectively. Most importantly, this also points to the choice of two factors for the FA not having biased the results (PCA gives the same answer) and any additional belief dimensions having had little role in shaping the responses to the questionnaire. The major conclusion is that the two hypothesized primary belief axes are correctly identified. Note, that these plots are in 180º rotation with the biplot in Fig. 2.1.8 (this difference is unimportant to the interpretation of the axes

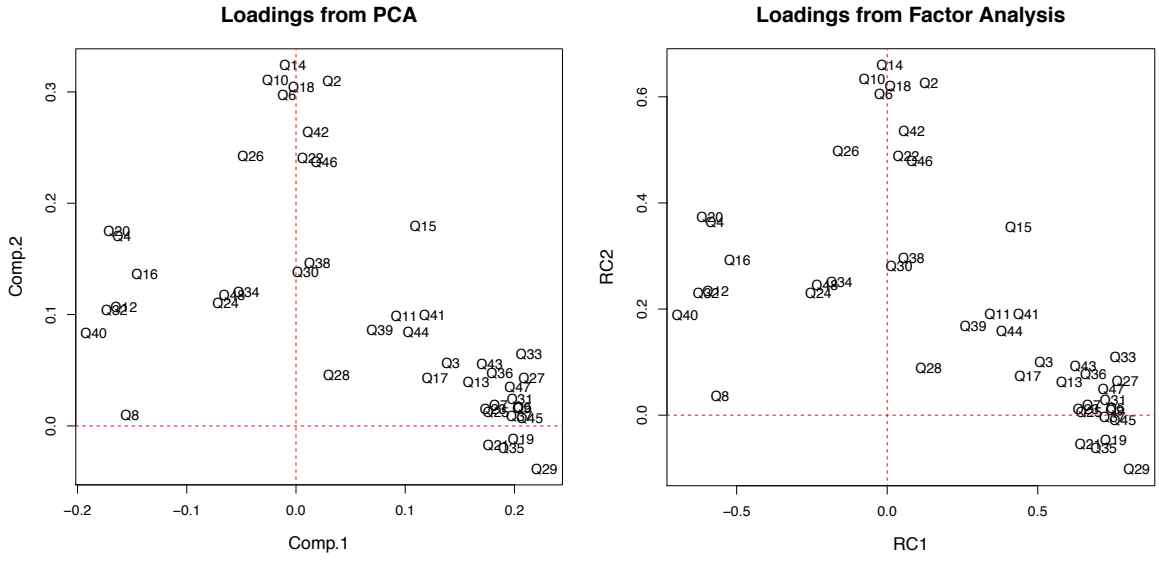


Figure. 2.1.9. PCA and FA plots of the questions loadings, using Principal Components 1 and 2 (left panel) and Factors 1 and 2 (right panel), respectively, as the X and Y axis vectors for comparison.

2.1.6 Cluster Analysis.

I used Cluster Analysis to understand the relationship between the thinking of the 300 subjects, by analysing levels of similarity and dissimilarity in their responses to the 48 questions, and also the similarity of the questions in the responses they generated. The latter is considered first.

Firstly, I calculated a pair-wise distance matrix for the 48 questions using the R function *pdist*. If the response of each participant to each question is considered an axis, the distance between any two questions is the Euclidean distance in this 300-dimensional space. The points were then clustered, based on their distances, in a hierarchical agglomerative fashion (the closest two points are joined first, then the next two closest points or clusters of points, and so on until all pints are linked). There are many metrics for joining clusters of points (the average distance, the shortest distance, the median distance, etc.), but I used Ward's method as implemented with the Ward.d2 argument for the R function *hclust* (Murtagh and Legendre, 2014). Ward's method groups clusters so as to minimise the within-cluster variance and so achieves compact, spherical clusters rather than, say, the nearest-neighbour method where long chains can result, with distant cluster members not particularly similar (Everitt & Hothorn, 2011). In practice, other clustering methods produced similar results. The resulting cluster dendrogram of the relatedness pattern for the 48 questions' responses (Fig. 2.2.0) shows that the 48 questions, although designed around three hypothesized belief types, fall into two main response categories, echoing the two axis vectors expressed by PCA and FA analyses.

Secondly, I generated a cluster dendrogram of the relatedness pattern of the 300 subjects' responses. The approach was identical to that for clustering questions, but performed on the transposed matrix of question responses. That is, if the response to each question is considered an axis, the distance between any two participants is the Euclidean distance in this 48-dimensional space. Fig. 2.2.1 shows that the 300 subjects also fall into two response categories. Although the presence of two main clusters is, by eye, obvious, we can confirm this more quantitatively. k-means clustering is a widely used technique in machine learning, which assigns data (here, questionnaire respondents) to clusters such that the within-cluster sums-of-squares of Euclidean distance are minimised (Lantz, 2013). If we plot these sums-of-squares against the number of clusters, we get a metric of the 'natural' number of clusters in the data. Data can always be divided into ever-smaller clusters (at the limit, one datum each), but there are diminishing returns, as can be seen in Fig. 2.2.2. The most common rule of thumb is to look for a 'natural break' where the slope levels off (Lantz 2013); here, there appears to be one at two clusters. More formal metrics can be applied and there are many. Fortunately, the R package NbClust (Charrad et al., 2014) applies 30 metrics that have been proposed in the literature and supplies the consensus. Using NbClust, 15 metrics proposed two as the best number of clusters, six proposed three clusters, one proposed 6, one 13 and one 14. There is therefore strong support for there being two main types of people in terms of their responses to the belief questionnaire.

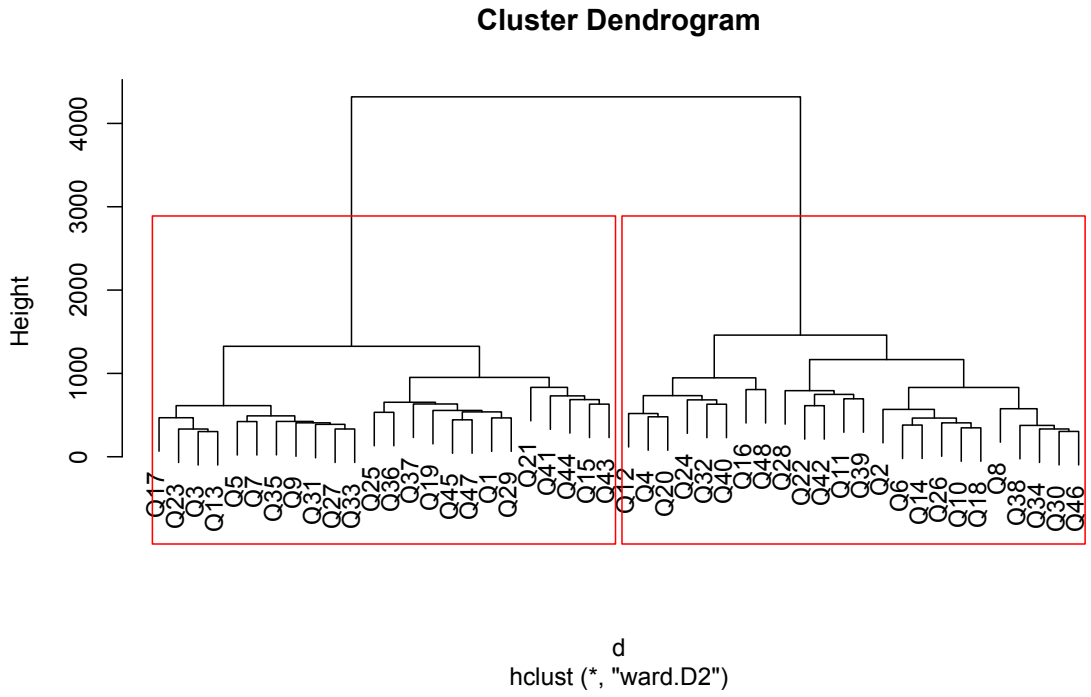


Figure. 2.2.0. Cluster dendrogram of the relatedness pattern for the 48 questions' responses, with red boxes to indicate the two main clusters.

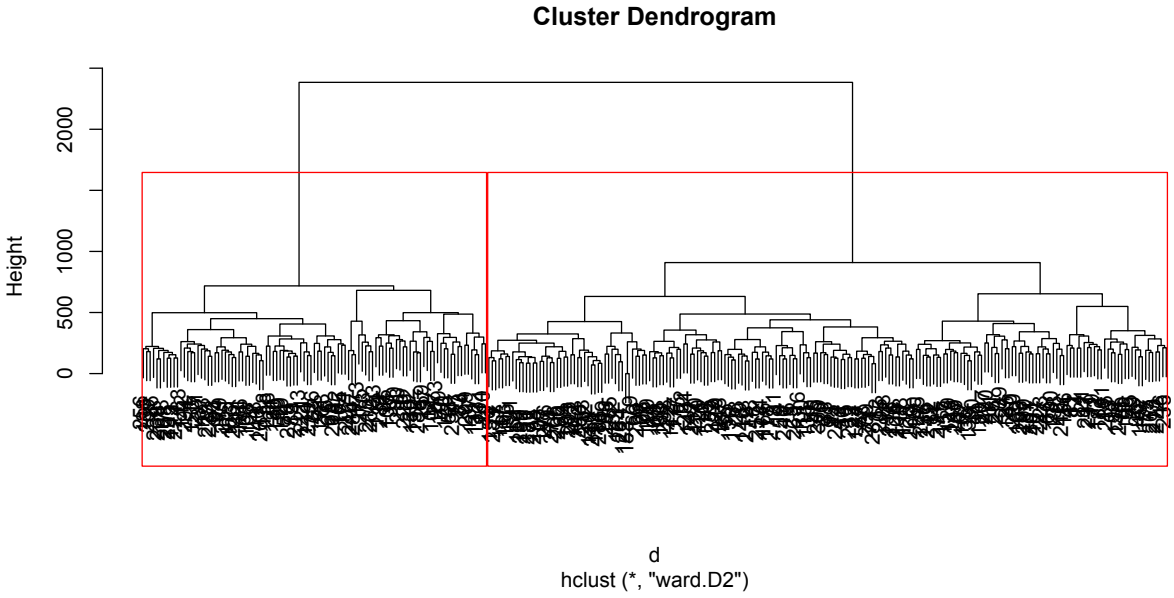


Figure. 2.2.1. Cluster dendrogram showing the relatedness pattern of the 300 subjects' responses. There are two main clusters (red boxes). The left-hand side represents superstition and the right-hand side represents rationality (taking the scientific view that superstition is irrational).

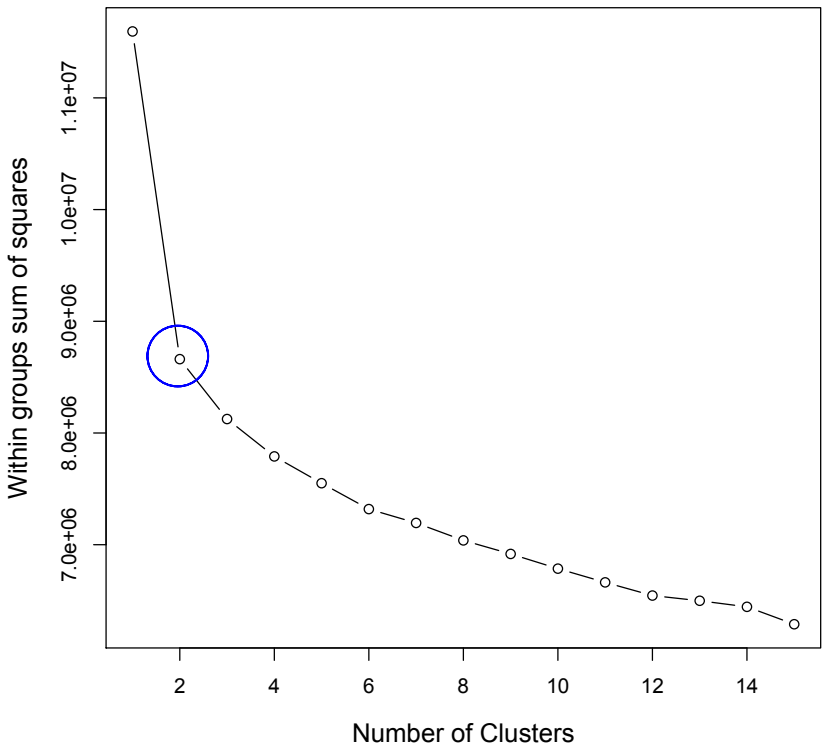


Figure. 2.2.2. Plot of the within-group sum of squares against the number of clusters, based on k-means cluster analysis of the questionnaire responses (48 questions). There is a 'natural break' at two clusters (blue circle), where the slope levels off.

I next examined the differences and/or similarities between the two subject groups from Fig. 2.2.1, in the context of the two component/factor vectors generated by PCA and FA. Fig. 2.2.3 shows boxplots corresponding to Principal Components 1 and 2, and Factors 1 and 2, respectively, as measured against vector 1 (superstition—rationality) and vector 2 (conformity—dissent). We can see that in both instances, there is disparity on vector 1 (Mann-Whitney-Wilcoxon test on PC1, $W = 19933$, $p < 0.0001$; M-W-W test on factor 1, $W= 19920$, $p < 0.0001$) and parity on vector 2 (M-W-W test on PC2, $W = 9509$, $p = 0.4469$; M-W-W test on factor 2,$W = 9248$, $p = 0.2593$). This agrees with the hypothesis that expression in efevresic beliefs is likely to be relatively constant, as compared with prosagogic and epistemic beliefs, because societal functionality is seen as a prerequisite, regardless of variation in other aspects of belief. For those who have little efevresic belief then it has similar irrelevance compared with the other two.

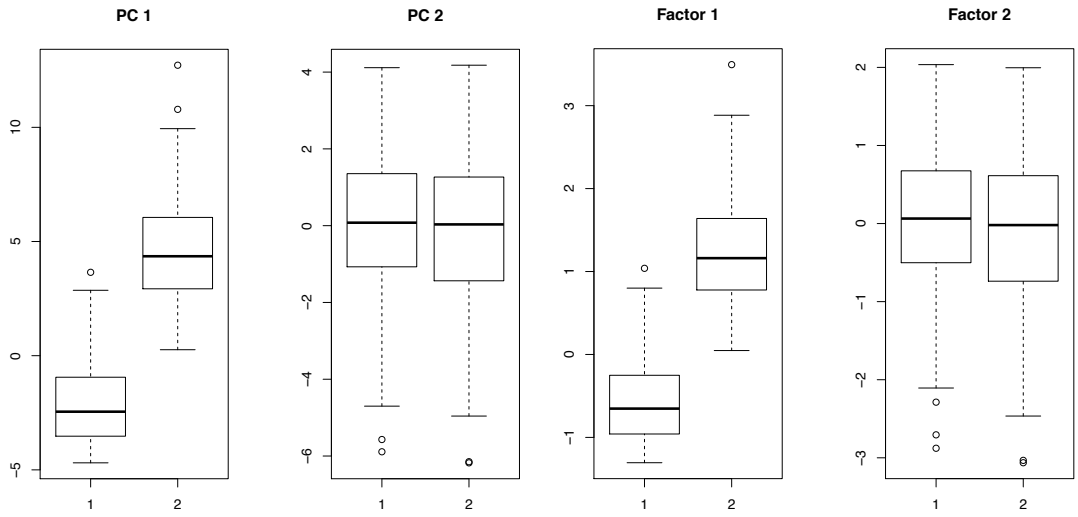


Figure. 2.2.3. Boxplots comparing the two subject groups against the two vectors identified by PCA and FA respectively. Disparity is seen in PC 1 and Factor 1, parity is seen in Pc 2 and Factor 2.

We can understand this relationship in more depth if we use the belief types as vectors and plot the sums of the scores for all the questions in each belief type category against each other, with the two types of people as clusters. Fig. 2.2.3 shows scatter plots of the 300 subjects (comprising the two groups) by using these sums-of-belief-type-score pairings as axes: epistemic:prosagogic (left panel), efevresic:prosagogic (middle panel), evefresic: epistemic (right panel). We can see that the first pairing, representative of a superstition—rationality scale, expresses a strong negative correlation. The other two pairings express low correlations because efevresic beliefs are held (to varying degrees) irrespective of the superstition-rationality dimension.

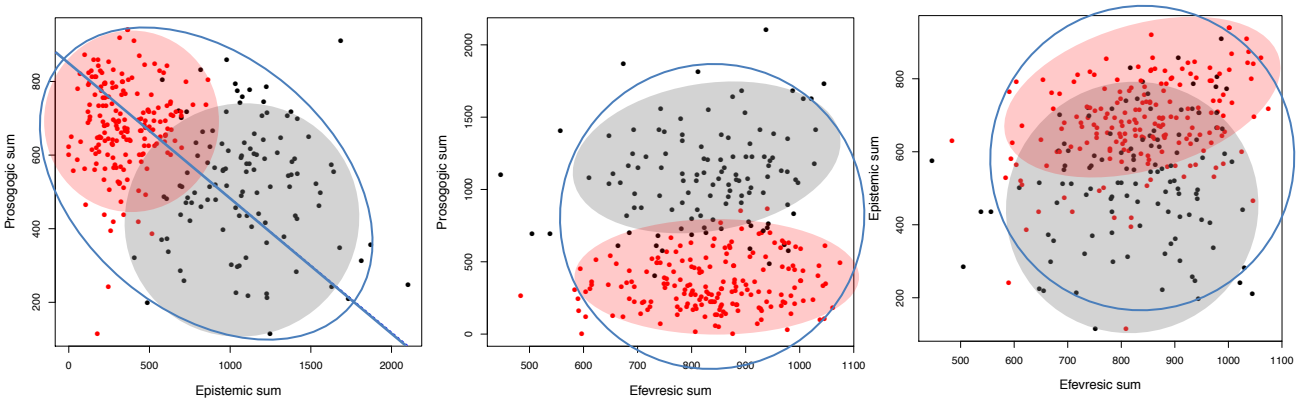


Figure. 2.2.4. Scatter plots using belief type pairings as axis vectors to plot the positions of the two subject types (red points, the left-hand cluster, black points the right-hand cluster, in Fig. 2.2.1). The epistemic:prosagogic pairing (left panel) shows clear –ve correlation of the two clusters, whilst the other two show no correlation. The blue line in the left-hand panel is the Reduced Major Axis regression line (Legendre 2014) that visualises the correlation ($r = -0.41$, d.f. = 298, $p < 0.0001$).

2.1.7 Demographic analysis.

I now used Factors 1 and 2, from the Factor Analysis, to see whether our demographic variables demonstrated any patterns relating to the corresponding vectors: superstition—rationality and dissent—conformity.

Age band

I found that there was no significant relationship between subject age and Factor 1 (level of superstition), as shown in Fig. 2.2.5. (linear regression on log(1.5 + x) transformed scores, to normalize residuals: slope = 0.027, t = 0.923, d.f. = 298, p = 0.357).

It is tempting, from Fig. 2.2.5, to think that superstition level rises with age band 76—85. It may be that anticipation of death, particularly through illness, health decline and seeing others die, causes people to become more prosagogic in their thoughts, either because they prefer the idea of going to some kind of afterlife rather than an absolute end, or as a behavioural expression of the game theory found in Pascal's wager (Richerson & Boyd, 1989; Connot, 2006). However, the sample size is small for this age band and so we should not read to much into this pattern.

With Factor 2 (level of conformity) I found a significant positive correlation with age (Fig. 2.2.6; linear regression on untransformed scores, which gave normal residuals: slope = 0.082, t = 2.055, d.f. = 298, p = 0.041).

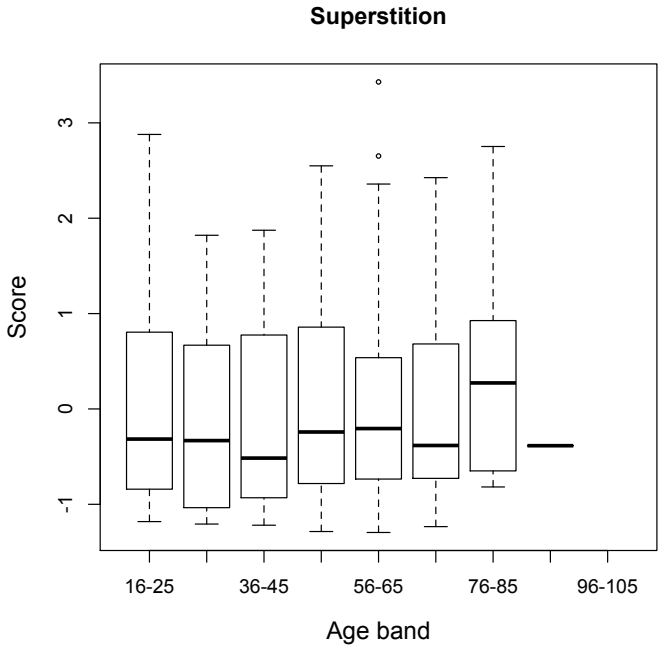


Figure. 2.2.5. Boxplot, comparing age bands with Factor 1 (level of superstition). There is no apparent change with age.

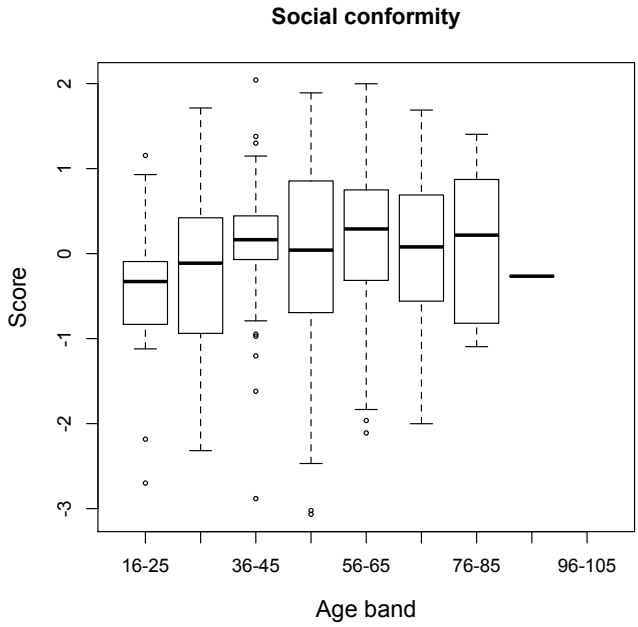


Figure. 2.2.6. Boxplot, comparing age bands with Factor 2 (level of social conformity). Note: significant increase in social conformity with age. The blue line plots the regression slope.

Gender.

Comparing genders, I found that females have a higher Factor 1 (superstition) score than males (Fig. 2.2.7, left panel.; log(1.5 + x) transformed scores: t = -3.01, d.f. = 258), p = 0.003; male mean 0.062, female mean 0.312). For Factor 2 (conformity), no significant difference was seen between genders (Fig. 2.2.7, right panel; untransformed scores: t = 0.67, d.f. = 261, p = 0.505; male mean 0.032, female mean 0.047).

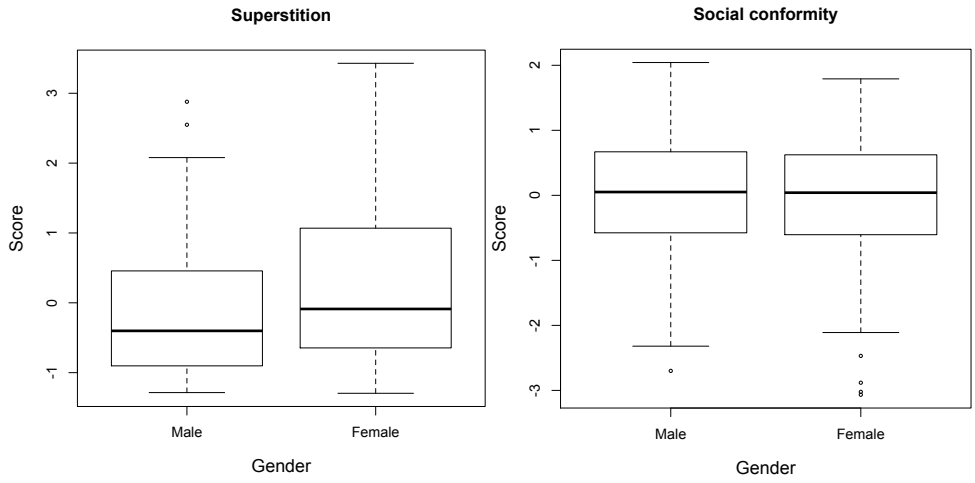


Figure. 2.2.7. Boxplots, comparing genders with Factor 1 (level of superstition), left panel, and Factor 2 (level of social conformity, right panel. Males have a lower mean score for Factor 1.

I ran further analysis with regard to gender distribution among the clusters expressed in the dendrogram from Fig. 2.2.1, to see whether the results concurred with the t-tests above. I generated a cross-tabulation of gender by group (Fig.7.2. top table; $X^2 = 7.139$, d.f. = 1, p = 0.008]. Group 1 is the cluster weighted towards superstition, Group 2 is the cluster weighted towards rationality. The middle table shows the tallies converted into proportions, and the lower table shows the superstition:rationality ratios of the two genders. We can see that Group 1 has exact parity in gender representation, while Group 2 is two-thirds male, one-third female. In terms of ratio, males are quite biased towards the rational, while females are fairly balanced between the superstitious and the rational.

Tallies of gender by group.

	Group 1 Superstitious	Group 2 Rational
Male	57	122
Female	57	64

Gender proportions per group.

	Group 1 Superstitious	Group 2 Rational
Male	0.5	0.656
Female	0.5	0.344

Superstitious:Rational ratios for genders.

Male	32:68
Female	47:53

Figure. 2.2.8. Cross tabulation of gender by groups, taken from dendrogram in Fig. 2.2.1.

Schooling type.

Comparing the three types of schooling with respect to Factor 1 (superstition) (K-W X^2 = 3.958, d.f. = 2), p = 0.138) and Factor 2 (social conformity) (K-W X^2 = 1.405, d.f. = 2, p = 0.495) there is no evidence for a difference between state, scholarship and private schooling (Fig. 2.2.9, left and right panel respectively).

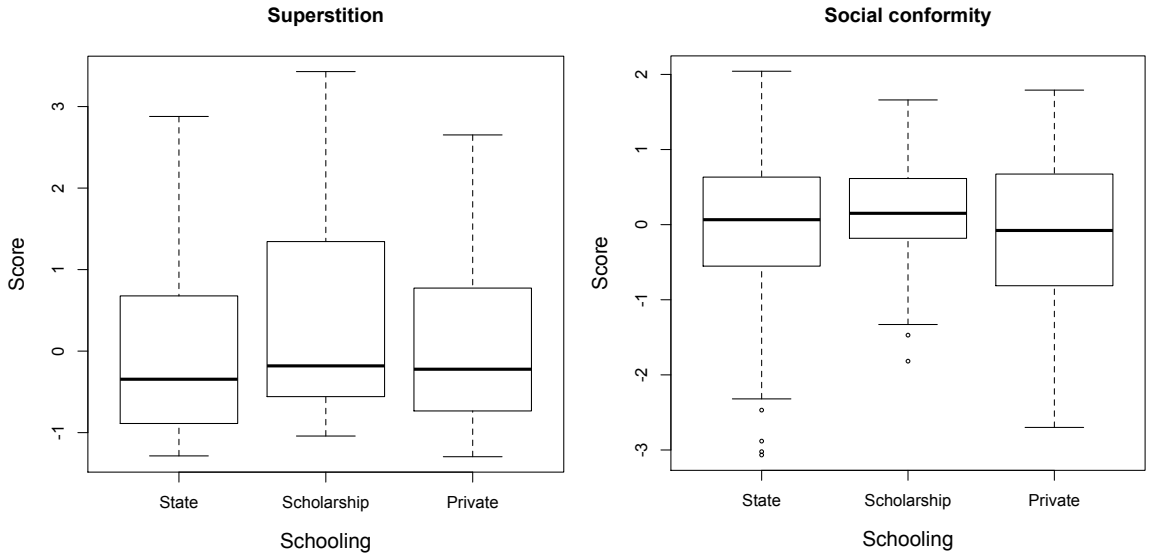


Figure. 2.2.9. Boxplots, comparing schooling type with Factor 1 (superstition; left panel) and Factor 2 (conformity; right panel). No trends were revealed.

Qualification level.

One can consider the level of qualification to be an ordinal predictor, even if the actual value of the slope has little meaning because the intervals between each level of attainment are not equal. In linear regression, there was a significant negative relationship with educational qualifications for both factors: i.e. the higher the qualification the lower the levels of superstition and social conformity (Fig. 2.3.0; Factor 1 (superstition) log(1.5 + x) transformed: t = -2.840, d.f. = 298, p = 0.005; Fig. 2.3.1; Factor 2 (social conformity): t = -3.611, d.f. = 298, p < 0.001. Slope τ = -0.153].

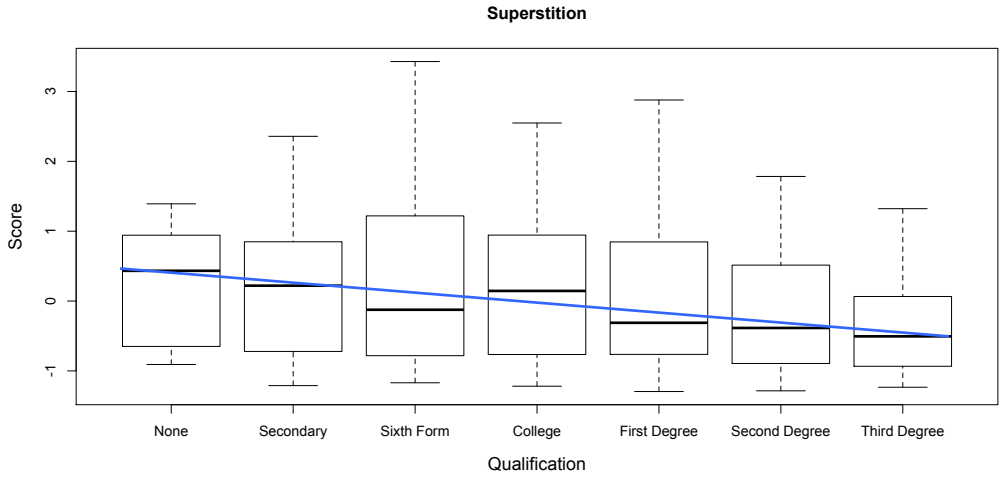


Figure. 2.3.0. Boxplot, comparing qualification level with Factor 1 (level of superstition). Note: significant negative relationship. The blue line plots the regression slope.

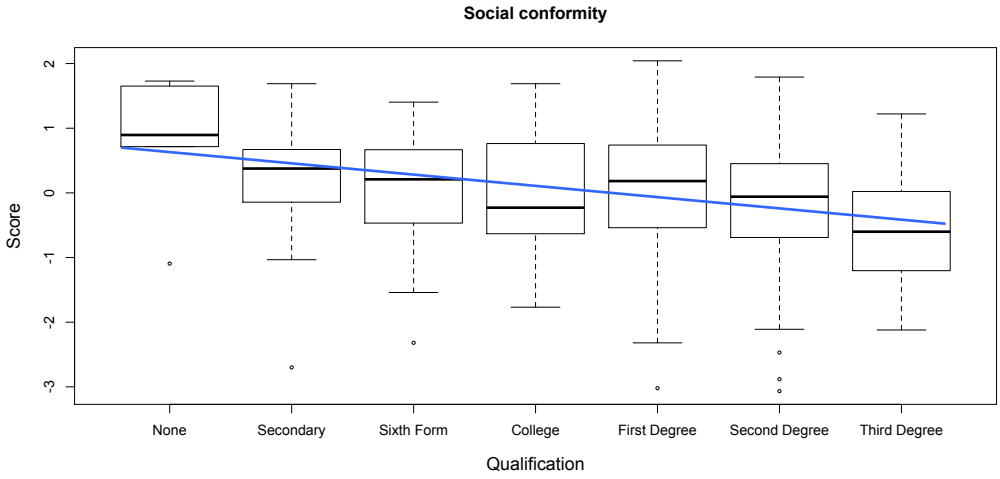


Figure. 2.3.1. Boxplot, comparing qualification level with Factor 2 (level of social conformity). Note: significant negative relationship. The blue line plots the regression slope.

Home type.

Comparing Factor 1 (superstition) and Factor 2 (conformity) with respect to childhood home type, there were significant differences for Factor 1 (Fig. 2.3.2; log(1.5 + x) transformed values: $F = 2.382$, d.f. = 5, 294, $p = 0.039$) but not Factor 2 (Fig. 2.3.3; $F = 1.196$, d.f. = 5, 294, $p = 0.311$). Post hoc pairwise comparisons for Factor 1 showed no significant differences (using the False Discovery Rate method of controlling Type I errors; Benjamini & Hochberg 1995). However, the original intention was that 'home type' could be an index of wealth or socio-economic class. This involves treating home type as a continuously increasing variable rather than categorical. Performing a linear regression of log(1.5 + x) transformed Factor 1 scores on Home Type as an ordinal predictor from 'poor' to 'wealthy' showed a weak, but significant, positive relationship (slope 0.062, $t = 2.162$, d.f. = 298, $p = 0.031$). There are higher levels of superstition in wealthier people as assessed by property ownership status.

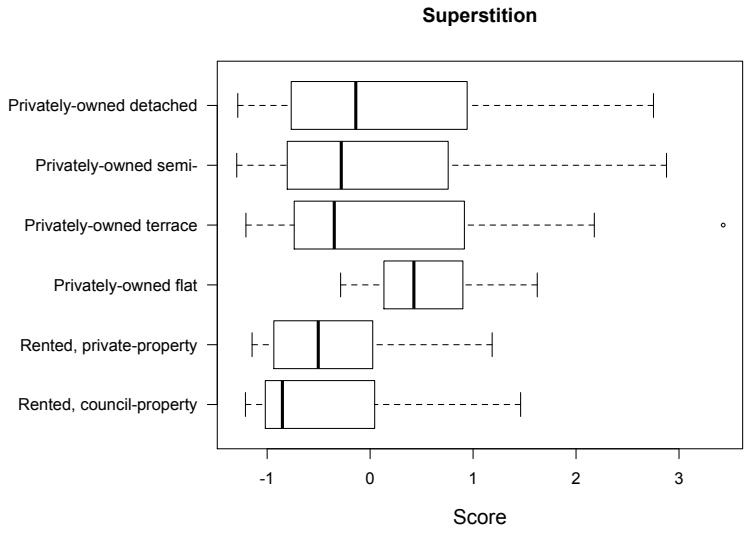


Figure. 2.3.2. Boxplot, comparing home type differences in Factor 1 (level of superstition). Although the privately owned flat group appears to be an outlier, the sample size for this group is fairly small.

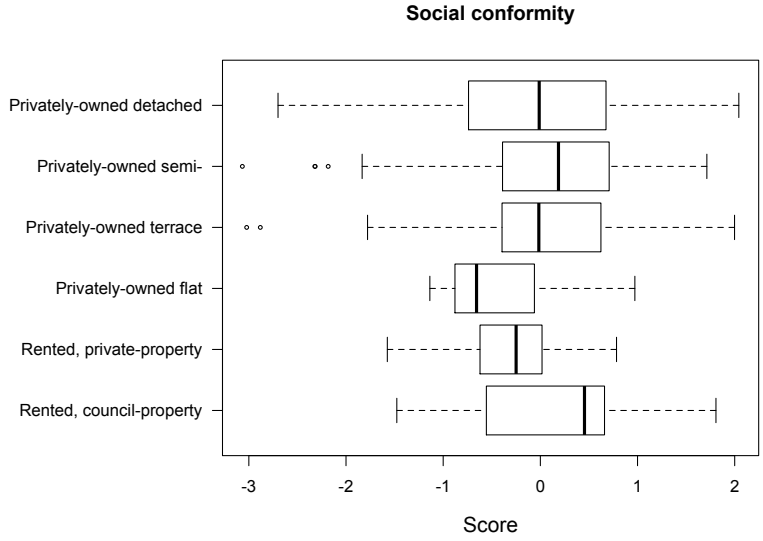


Figure. 2.3.3. Boxplot, comparing home type with Factor 2 (level of social conformity).

Interactions.

Whilst it might seem natural to enter all predictors and their interactions into one General Linear Model, the number of predictors and their interactions is large (five demographic predictors, so five main effects, 10 two-way interactions, 10 three-way interactions, five four-way interactions and one five-way interaction, so 31 terms), the sample size modest (300 individuals), and so the potential for Type I errors (false positives) large. Therefore, a more focused approach was used, considering only the interactions between predictors that were significant in the single-term analyses above.

Note: The same applies in Chapter 3, which has a smaller sample size (140). However, in Chapter 4, with a sample size of 5000+, machine-learning methods are applied to explore the full range of possible interactions.

The only two predictors reliably affecting the same response variable are gender and qualification level affecting Factor 1 (superstition). So, I looked for a possible interaction between the variables by entering both into the same General Linear Model, with log(1.5 + x) transformed Factor 1 as the response. There was, formally, no significant interaction ($F_{1,297}$ = 3.321, p = 0.069), the trend being for the negative relationship between Factor 1 (superstition) and educational qualification level to be steeper in females than males (Fig. 2.3.4). the main effects are the same as in the univariate analyses (superstition is higher in females, superstition declines with educational qualifications), whether or not one includes the interaction in the model (with interaction: gender $F_{1,297}$ = 9.375, p=0.002, education $F_{1,297}$=8.206, p=0.004; without interaction: gender $F_{1,297}$ = 9.302, p=0.002, education $F_{1,297}$=8.142, p=0.005).

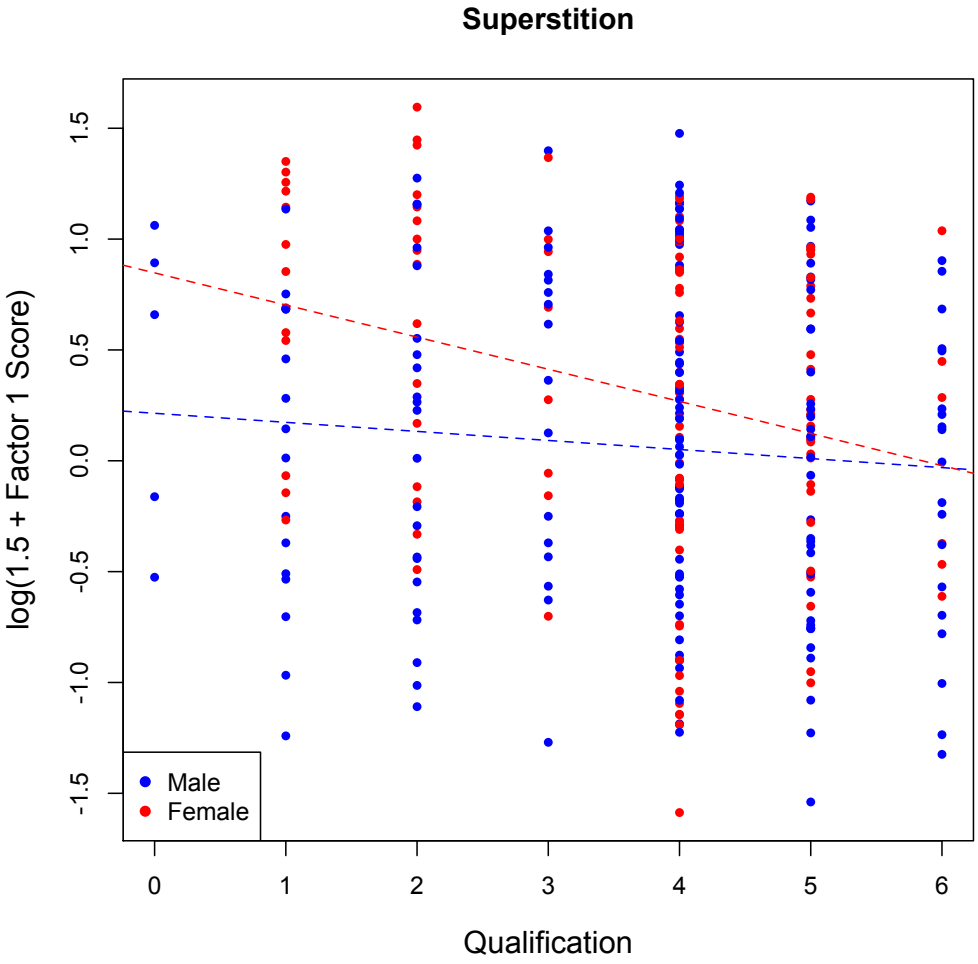


Figure. 2.3.4. Combined effects of gender and qualification level (increasing from 0 to 6) on Factor 1 (superstition). The blue and red points and lines are for males and females respectively, both showing a negative relationship between qualification level and superstition. The gender*qualification interaction is not in fact significant (p = 0.069) so there is no statistical evidence that the lines are anything other than parallel in real terms.

2.1.8 Conclusions.

The multivariate analysis of the main dataset indicates that the hypothesized scheme of three belief types (prosagogic, epistemic and efevresic) is appropriate as a taxonomy of beliefs, as the PCA and FA both produced the same derived variables as their PCs 1 and 2 and Factors 1 and 2, respectively: i.e. vectors superstitious—rational and dissent—conformity. The former vector relating to the hypothesized trade-off between prosagogic and epistemic beliefs and the latter vector relating to the hypothesized discrete prerequisite for relatively high efevresic belief scores that are orthogonal to an individual's degree of superstition/rationality. The cluster analysis suggests that, although there are certainly intermediates, there are two clear clusters, separating on the superstitious—rational axis.

We can tentatively suggest here that this lends support to one aspect of the hypothesised foundation for belief systems. That is, it seems that we are seeing evidence of two phenotypes, although there is overlap in the middle to create what would seem, were it not for the resolution of the data and the power of the analysis, an uninterrupted single spectrum. This is not to say that there are two belief mechanisms (related perhaps to differences in brain wiring and thus how information is processed); these data are also consistent with a single mechanism that with polar outcomes depending on starting conditions (e.g. social environment in which someone is raised). This is explored further in the next two chapters. If further research supports the premise that there are two phenotypes it would certainly be consistent with a hypothesized Bayesian process, involving two phenotypes with distinct priors, which generate the spectrum of belief systems and associated behaviours which, it is proposed, have been brought about by natural selection and, again it is proposed, upon which it may currently still act.

With regard to the modus operandi of the mechanism, the data are consistent with two main possibilities: (i) That there are two main genotypes, one of them with the brain wired to process information (experience from birth onwards) in a 'rational' way, wi no assumptions about causes unless observed or deduced from data, and the other wired to interpret events as caused by unseen agencies. (ii) That there is a single genotype in terms of interpreting causes of events, but that some cultures/upbringings equate 'causes' with the unobserved agency of supernatural forces and other cultures/upbringings equate causes with the agencies deduced by science (still, for most people, unobserved and so taken on faith). In either (i) or (ii), there is still variation around the main type or types, and society still dictates exactly what 'flavour' of superstitions or rational models are adopted by individuals. The data in this chapter don't allow one to differentiate between (i) and (ii), but they argue against arbitrary continuous variation in types of beliefs.

In either model, understanding phenotypic plasticity (DeWitt et al., 1998; Price et al., 2003) is key to understanding the wide variation in beliefs we see across humanity. An analogy is the way a tree will adopt an asymmetric canopy shape when subjected to prevailing wind direction. So, just as the same tree has potentially different forms depending on where it is planted, so a person has potentially different belief systems depending on where they are raised, but within parameters set by their natural inclinations. Thus, two individuals with fairly different innate inclinations can theoretically arrive at similar belief systems and behaviours, due to the environments in which they are brought up. The converse would also apply. The overall effect is a three-way interplay between natural (genetic) inclinations, the derived belief system and the expressed behaviour.

Analysis of the relationships between Factors 1 and 2 and the demographic dataset indicates the presence of some patterns, and the absence of others, that are consistent with the hypotheses. These are discussed in turn.

On the matter of age band, there is no real evidence that levels of superstition change with age, suggesting that they are well established in early adulthood and then remain relatively constant during the span of reproductive life. Becoming more or less superstitious would require significant environmental or experiential input, which is unlikely to occur (at least not in any consistent direction across people), and I hypothesize that the mechanism has become designed to maintain stability in a social group. It also makes sense that social conformity rises with age because people have a longer history of following a particular behavioural strategy, within their particular social group, and it being successful. They have more information about the set of legal and moral codes that are acceptable, and 'work', in that society, and so there is less value is changing these types of belief (efevresic). An alternative interpretation, that this is a cohort who retain values from early life that are different from those born later cannot be discounted with these data, which are a snapshot in time. A longitudinal cohort analysis would be required: i.e. tracking through life.

On the matter of gender, the higher superstition level in females may be attributed to either environmental or innate factors, or a combination of the two. As is often the case, it is also appropriate to consider the converse, i.e. why males have a lower superstition level. As males and females are in almost exact parity with levels of social conformity, as one would expect, it suggest that the different levels of superstition is not a false positive: i.e. that natural or sexual selection favours this disparity for a combination of reasons. There is also the very real possibility of a cultural influence in questionnaire response: i.e. males are culturally conditioned to associate the rational stance with masculinity, which generates a response bias in their date, thereby creating the impression of gender disparity when there is none. Another way of interpreting the analyses is: are somewhat more superstitious people (cluster 1) more likely to be male or female? The answer is that it is pretty even. Conversely, if we ask whether very rational people (cluster 2) are more likely to be male or female, the answer is that they are almost twice as likely to be male. This may sound different from the interpretation of the sex difference in Factor 1 earlier, but it is not. Factor 1 is RELATIVE superstition-vs-rationality, so saying 'women are more superstitious' is the same as 'women are less rational'. It would actually be more accurate to say 'women tend to include people who are slightly more inclined to hold superstitious beliefs than men'. Indeed let's be careful to put this in perspective: if we look at the medians of the responses to Q29 ("belief in souls, spirits and ghosts?), the median for males is 3% and females 8%. So while it's correct to say that, from these data, that females "are more superstitious than males", it is also true that neither sex believe, for the most part, in spirits & ghosts.

On the matter of schooling, one is unlikely to see any significant trend in levels of superstition or social conformity because there is no reason to suppose that there are consistent factors that determine the filtering of people into state, scholarship or private schooling that would correlate with their expressions relating to Factors 1 and 2. That is to say, they each comprise an approximately random mix of subject types, and there are too many variables involved for any trend to exist. It should be noted that scholarship children are chosen for a variety of reasons, rather than simply a measure of one characteristic: i.e. intelligence. In any case, intelligence cannot be regarded as a single variable as there are many 'types' of intelligence (Furnham & Petrides, 2007) Similarly, there are many 'types' of state and private school and various reasons why parents make their choices, relating to school performance, geography, convenience, subject interests, ambition, aspiration, politics, culture, wealth, familiarity, normalization and so on.

On the matter of qualification, it makes sense that there is a correlation with levels of superstition and social conformity, because qualification level is an approximation with intellect and other intelligence levels. Although some of the sample will attain higher qualifications in time, none will move down the ranking and most, one would hope, will have reached their educational potential. The correlations are both negative, but for different reasons. In the case of superstition, it is logical that higher intelligence renders subjects better able to attribute phenomena to scientific causes by rationalizing their view of the world (Kahneman, 2011), or that with more education their exposure to scientific ways of thinking is greater. In the case of social conformity, it is logical that higher qualifications give subjects greater autonomy and societal freedom, and higher intelligence brings generally higher self-esteem from outcomes, so the cumulative effect is that subjects become less concerned about conformity and the consequences of nonconformity diminish (Bernheim, 1994; Whiten & Byrne, 1997).

On the matter of home type; although this category may be loosely interpreted as an approximation of wealth and social status, there is no reason to suppose, anyway, that there are consistent factors that determine the filtering of people into home types that would correlate with their expressions relating to Factors 1 and 2. While there are higher levels of superstition in wealthier people, as assessed by property ownership status, the statistical significance is marginal ($p = 0.031$) and the effect size weak ($R2 = 1.2\%$; only just over 1% of the variation in Factor 1 is explained by the regression on home type). However, it may be that superstition rises with home type because it correlates more significantly with level of responsibility and risk (i.e. the more to lose, the more superstitious), thereby rendering people more inclined to feel that their actions might affect their luck and fortune. Remembering though, that this is the childhood home, so any such feeling would need to have been conveyed from their parents.

The patterns revealed in this survey are explored further in Chapter 3, where I follow up particular individuals with more in-depth questions that seek to establish the relationship between individual beliefs and actual behaviours**.**

Chapter Three.

Methodology Two: Comparing general supernatural beliefs with the concept of a god.

Abstract:
Having established a tripartite structure for belief systems in Chapter Two, the second methodology was designed to explore the possibility that the concept of a god and religion have a supernormal stimulus effect over other supernatural beliefs, which might be thought of as non-religious; thereby demonstrating a basic hierarchy in the potency of supernatural beliefs in terms of their ability to convince the human mind of their credibility and so induce belief in them. The phenomenon of supernormal stimulus is well established in animal behaviour, so it was hypothesized to be plausible that the notion of a god happens to have heightened stimulus on the human mind due to the essentially anthropomorphic concept. Evidence of supernormal stimulus would therefore help to explain why theistic religions have become so well established, ensconced and ubiquitous. A second hypothesis is that a 'background radiation' of non-religious supernatural beliefs serves as mutual reinforcement of the plausibility of religious beliefs. Cross-analysis showed that the hypotheses are plausible, particularly in irrational people. However, those with high rationality with regard to non-religious supernatural beliefs are still quite likely to be stimulated into believing religious concepts, essentially treating both discretely. This finding suggested the possibility of two, or more, belief phenotypes comprising the sample, and thus piloted the direction of the third methodology, described in Chapter Four.

Introduction.

What participants report about themselves and how they actually behave might be quite different. This chapter attempts to address this potential shortfall by harvesting data that can tell us more about the beliefs of those subjects who volunteered to continue with their participation in the project. One aspect that I am particularly interested in investigating is whether belief in a god functions as a supernormal stimulus: i.e. that, with a god ensconced in the belief system, it renders the mind more willing to accommodate other supernatural ideas. In order to achieve this investigation a new 2 questionnaire was deployed that was designed to evoke both advertent and inadvertent readings in prosagogic (non-empirical supernatural) beliefs, so that any contrasts can be measured.

The new questions are also designed to reveal more about the relationship between beliefs and behaviours. The hypothesis is that humans are born with belief inclinations and their belief systems develops according to the influence of environmental and experiential factors acting on those inclinations. Belief systems then translate into outward behaviours, which natural selection

acts upon. Therefore, there are two phases of separation from the original inclinations, so gauging the potential extent of the second phase of separation is a valuable exercise.

3.1.0 Methods.

In completing the questionnaire analysed in Chapter 2, participants were asked whether they wished to be involved up in follow-up research. Those that did were emailed an interactive pdf of the new questionnaire with similar 0-100% response options for each question (see Chapter 2 for how this was achieved). Participants were invited to email or post a hardcopy of the completed questionnaire as they wished. All identity information was stripped from the completed questionnaires before analysis. The survey was approved by the University of Bristol Faculty of Science Research Ethics Committee.

Of the 300 subjects who participated in the survey analysed in Chapter 2, 140 consented to continue with the study. There is no evidence that this sub-sample of the original 300 is biased with respect to belief phenotype; the ratio of superstitious:rational participants in the original questionnaire was 101:199 (33.7%:66.3%) and in the sub-sample of 140 it was 52:88 (37.1%:62.9%), a non-significant difference (chi-squared contingency test: chi-squared = 0.37, d.f. = 1, p = 0.545). My second questionnaire was designed to harvest more specific data relating to sub-categories of prosagogic beliefs. One aim was to investigate the comparative role of different supernatural memes in eliciting supernatural beliefs in general. Thus, the questionnaire (Appendix 2) comprised a mix of 15 religious supernatural belief questions (R) and 27 non-religious supernatural belief questions (NR) – taking the view that the subjects might subconsciously treat them as different concepts and betray informative data patterns. There were also a subset of 6 questions relating to social tolerance, which function as a kind of control, orthogonal to superstition versus rationality, being more closely aligned to efevresic beliefs as discussed in Chapters 1 and 2.

The religious supernatural belief questions (R) included any reference to god, religion, places of worship, religious figures and so on. The non-religious supernatural belief questions (NR) included any reference to superstition, fate, luck, paranormal phenomena and so on. In concept, the one type of supernatural belief can exist without the other, as discussed in Chapter 1. The general theory proposed in Chapter 1 hypothesizes that the latter concept (NR) would have evolved before the former (R). This is because non-religious supernatural beliefs are essentially more primitive in concept and simple in structure (there is no overarching framework), and thus would have frequented the mind of the human chronospecies before more advanced religious concepts took hold.

All 48 questions are listed in Appendix 2. Here are the first 4 questions by way of example.

Q.1. To what extent do you think of yourself as a believer in a god?

Q.2. To what extent do you think you have spiritual beliefs or feelings yet have no belief in a god?

Q.3. To what extent do you feel that people are born with natural levels of goodness and badness?

Q.4. To what extent do any underlying religious beliefs you have affect your view of science?

The general multivariate analysis methods employed, and the R packages used, were the same as in Chapter 2. Any additional methods will be described as and when they appear in the results section.

Results

3.1.1. Comparative cluster analysis.

As the second questionnaire was designed to harvest data about religious and non-religious subcategories of prosagogic belief, the first exercise was to cluster the question responses and see whether the subjects responded in such a way that they treated the two types of question differently. Using Ward's method applied to the Euclidean distance matrix for the 48 questions in the new questionnaire, we can see that there are two or three main clusters (Fig. 3.1.0). Using the consensus method offered by the NbClust package (Charrad et al., 2014; see Chapter 2), across 26 metrics by which the optimal number of clusters can be chosen, the evidence was slightly in favour of three (13 metrics) over two (8 metrics), with no more than one metric favouring any number greater than this. Although we can see that the response distribution of religious supernatural belief questions (black dots) and non-religious supernatural belief questions (red dots) is reasonably well interspersed within the three main clusters, there is some clumping by question type at a finer level of separation and which questions segregate into the main clusters is illuminating.

The first, smallish, cluster of questions relates to traditional religious beliefs, a strong belief in god being one of them. This clusters with feeling able to connect with higher powers through prayer, praying for others, visiting places of worship, feeling that a godless universe would be lonely, feeling that religious beliefs affect their view of science and that emotions are driven by external powers. The latter was original intended as probing non-religious superstitions, but it is easy to see why it would align with traditional religious values.

The first cluster is a sister-group to a larger cluster of questions that comprise both religious and non-religious questions but, again, with clear sub-structure. One set relates to exclusively secular superstitions (using superstitious gestures and behaviours, having superstitious beliefs, thinking luck affects decisions, thinking luck comes in threes, thinking you can affect good and bad luck by behavior, avoiding tempting fate, thinking that lucky charms work, looking at horoscopes, acting as though machines have personalities, and following regular personal rituals). The other set

includes what might be called 'facultative' religious beliefs, such as turning to religion when stressed or ill, making religious gestures before doing something difficult, adopting "Pascal's wager" (a pragmatic belief in a god, just in case it turns out to be true when one dies), plus beliefs on the border of mainstream religion such as feeling that the dead are looking down on us, communicating with the dead, practicing religion without believing in a god and concealing religious beliefs for fear of what others might think. Also within this cluster are the non-religious superstitions of using thoughts, wishes and curses to affect other people's fortunes, and feeling that everyday objects, like mugs and bowls, have their turn to be used.

The third cluster, quite distinct from the other two, is a large group that includes the 'control' questions on social conformity (being capable of having flexible views, changing behavior not being difficult, willingness to accept that one might be wrong, not always having to be correct, a tolerance of others views, and cognitive dissonance: enjoying things that are bad for you by twisting the evidence), plus ones connected to religious tolerance (feeling religion is socially beneficial, showing respect towards religious figures such as priests and nuns, and not feeling that religion is bad for society). There are also spiritual beliefs not necessarily connected to mainstream religion (feeling spiritual but without god, a belief in innate goodness and badness, visualizing gods, angels and demons as having human form, feeling spiritual in churches and a tendency to believe supernatural or paranormal claims by others), secular superstitions (not walking under ladders, thinking people can tell you're looking at them), and beliefs that many would not class as superstitious at all, even if not strictly rational (a sentimentally attachment to some inanimate objects, talking to pets, thinking it helps to visualize objects when searching for them, fearing creatures of the night such as bats, thinking it is cruel to kill bugs and finding pretty insects more appealing).

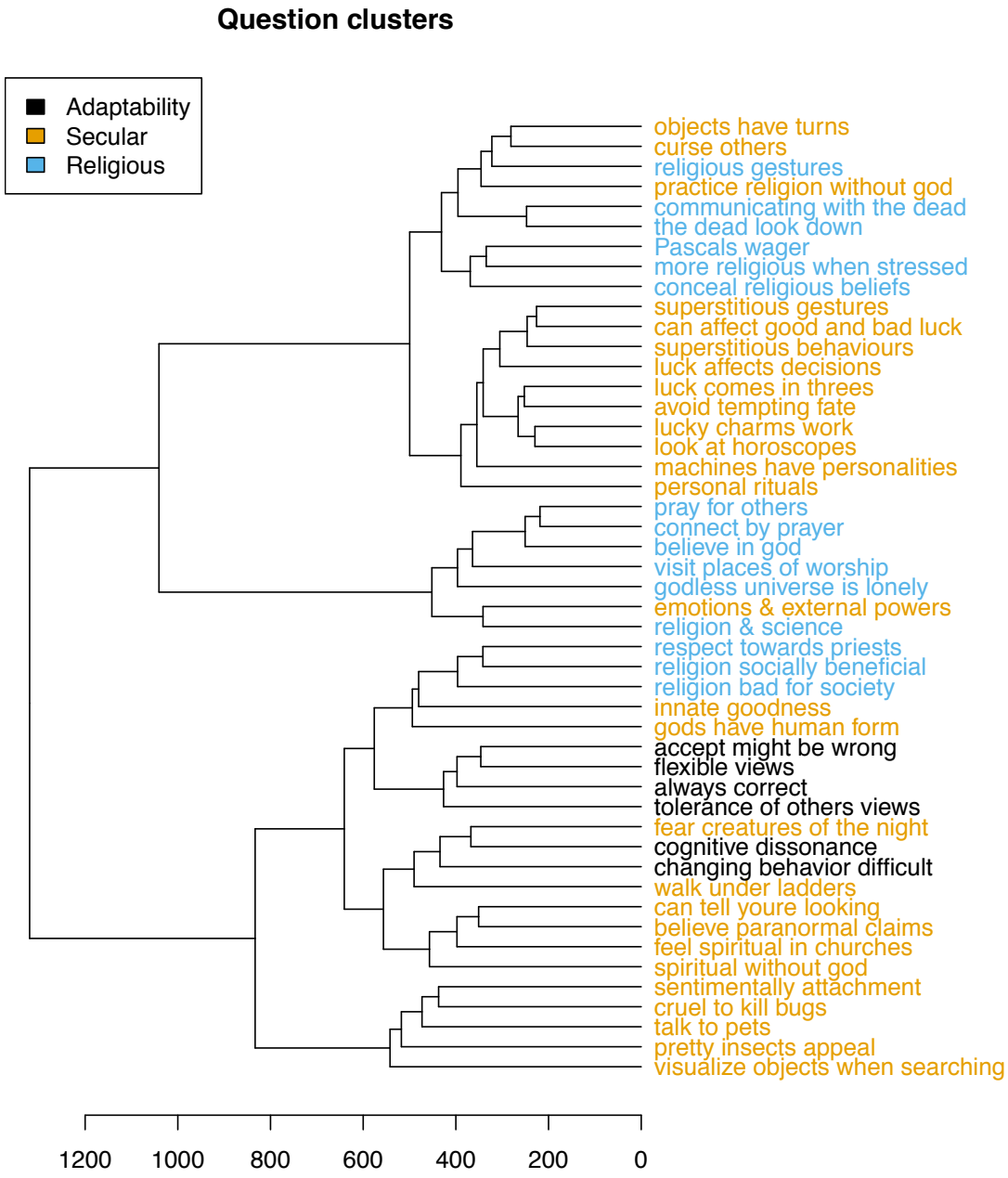


Figure. 3.1.0. Dendrogram based on Ward's method applied to the Euclidean distance matrix, showing question response clustering: the blue questions (religious superstitious beliefs) and orange questions (non-religious superstitious beliefs) scatter across the two or three main defined clusters, although there is finer-grained clustering by question type. This suggests that the subjects don't treat the two belief types as mutually exclusive; either because they are not separate concepts, or because the questioning causes them to be treated similarly. Black questions indicate 'control' questions concerning social tolerance, which clustered strongly together. The x-axis represents distance.

I next took the leading question from the new questionnaire: Q1. *To what extent do you think of yourself as a believer in a god, on a scale from no belief (atheist), to unsure (agnostic) to total belief (theist)?* and assessed the relationship with FA Factor 1 (superstition-rationality) from our Phase 1 methodology. The idea being to see how the 140 remaining subjects responded to more direct and probing questioning about their beliefs with respect to the factor, revealed in Chapter 2, that

might be expected to highlight interesting differences. To normalize the residuals, the percentage scores in response to Q1 were divided by 100 and arc-sine-square-root transformed, then regressed on FA Factor 1. A linear fit (in terms of the transformed response variable, so S-shaped in terms of the raw response scores) was highly significant ($F_{1,138} = 152.97$, $p < 0.001$) but a quadratic fit (a polynomial regression on Factor 1 and Factor 1 squared) was significantly better ($F_{1,137} = 4.69$, $p = 0.032$). A cubic (a polynomial up to the 3rd power) was not significantly better than the quadratic ($F_{1,136} = 1.45$, $p = 0.287$), so the quadratic is our final model: a modified S-shaped relationship where, as might be expected, 'Belief in a god' increases with superstition as compared to rationality (Fig. 3.1.1). However, the fact that there isn't complete separation (a step function from no belief in god to complete belief as one increases along the rationality-superstition axis) tells us that some, otherwise rational, people have the irrational ability to accommodate significant belief in a god, and that many, otherwise rational, people have at least some belief in a god.

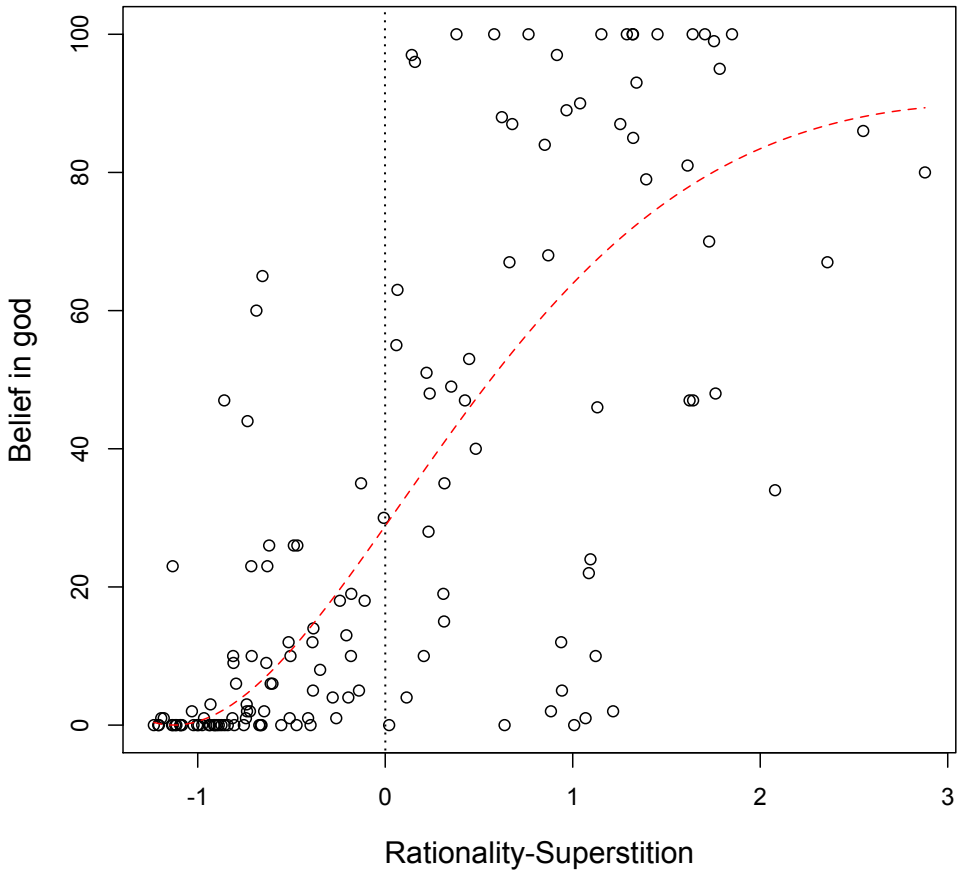


Figure. 3.1.1. Plot of questionnaire 2's, Q1 (belief in god) and Factor 1 from Chapter 2 (rationality-superstition). Showing that religious belief can be high in otherwise rational subjects, and is generally present at low levels in the rational. The sample size was 140 participants (from the original 300 participants in Methodology One).

I also cross-analysed the new questionnaire's Q1 against the two belief phenotypes identified in Chapter 2 cluster analysis of participants, to see whether there was the expected difference with respect to belief; there was (M-W-W test, W = 4123.5, p <0.001). Fig. 3.1.2 shows a boxplot, with group A (superstitious) on average reporting a high degree of belief in a god, and group B (rational) generally aligning with atheism or agnosticism. The median in the latter group is close to zero, as we would expect to see in the rational group, although there are quite a few higher god belief outliers. Even more striking perhaps is the broad range of levels of belief in god among the superstitious group.

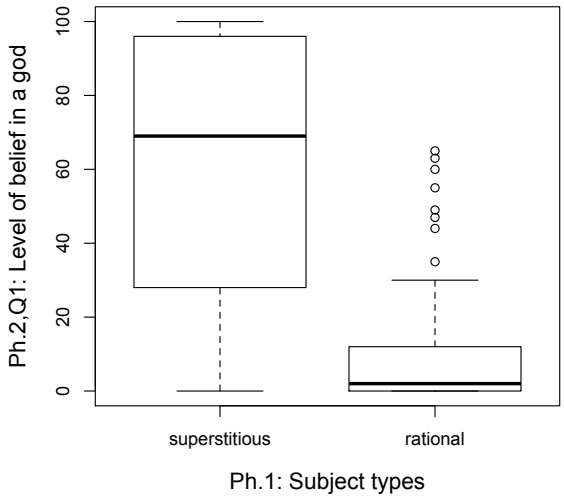


Figure. 3.1.2 Boxplot: comparing the Phase 1 phenotypes identified by cluster analysis of the Chapter 2 questionnaire against this chapter's Q1, belief in god. Belief in god is much higher in the superstitious group, and the median is close to zero in the rational group, although there are a few people who are far from self-identifying as atheists.

Let's now consider how the other questions in the new survey vary across the two phenotypes identified in Chapter 2. For each subset of questions (religious, non-religious and social conformity), I present boxplots and Mann-Whitney-Wilcoxon tests for differences in the median scores between superstitious and rational phenotypes. All the religious questions had significantly higher scores for superstitious phenotypes. None of the social conformity questions showed differences between the two belief phenotypes. For the non-religious questions, superstitious phenotypes had significantly higher scores for the questions relating to spiritual beliefs not necessarily connected to mainstream religion (feeling spiritual but without god, a belief in innate goodness and badness, visualizing gods, angels and demons as having human form, feeling spiritual in churches, practicing religion without a god, and a tendency to believe supernatural or paranormal claims by others) and some common secular superstitions (that you can put curses on others, luck comes in threes, an interest in horoscopes, that you can affect your good and bad luck).

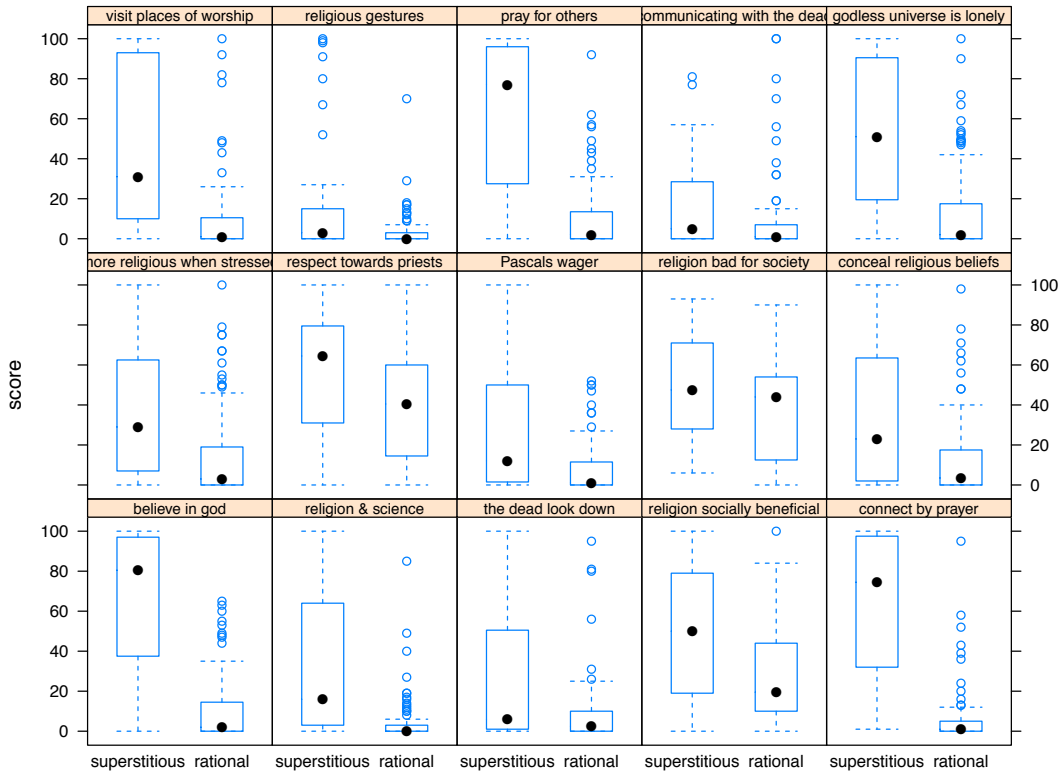


Figure. 3.1.3. Boxplots of the scores for 'religious' questions with respect to the superstitious and rational phenotypes identified in Chapter 2.

Question	W	p
believe in god	4124	<0.001
religion & science	3703	<0.001
the dead look down	3013	0.001
religion socially beneficial	3302	<0.001
connect by prayer	4288	<0.001
more religious when stressed	3356	<0.001
respect towards priests	3036	0.001
Pascal's wager	3309	<0.001
religion bad for society	2778	0.035
conceal religious beliefs	3188	<0.001
visit places of worship	3644	<0.001
religious gestures	3184	<0.001
pray for others	4034	<0.001
communicating with the dead	2860	0.011
godless universe is lonely	3764	<0.001

Table. 3.1 Religious questions. Results of Mann-Whitney-Wilcoxon tests for differences in the median scores between superstitious and rational phenotypes. N1 (superstitious) = 52, N2 (rational) = 88.

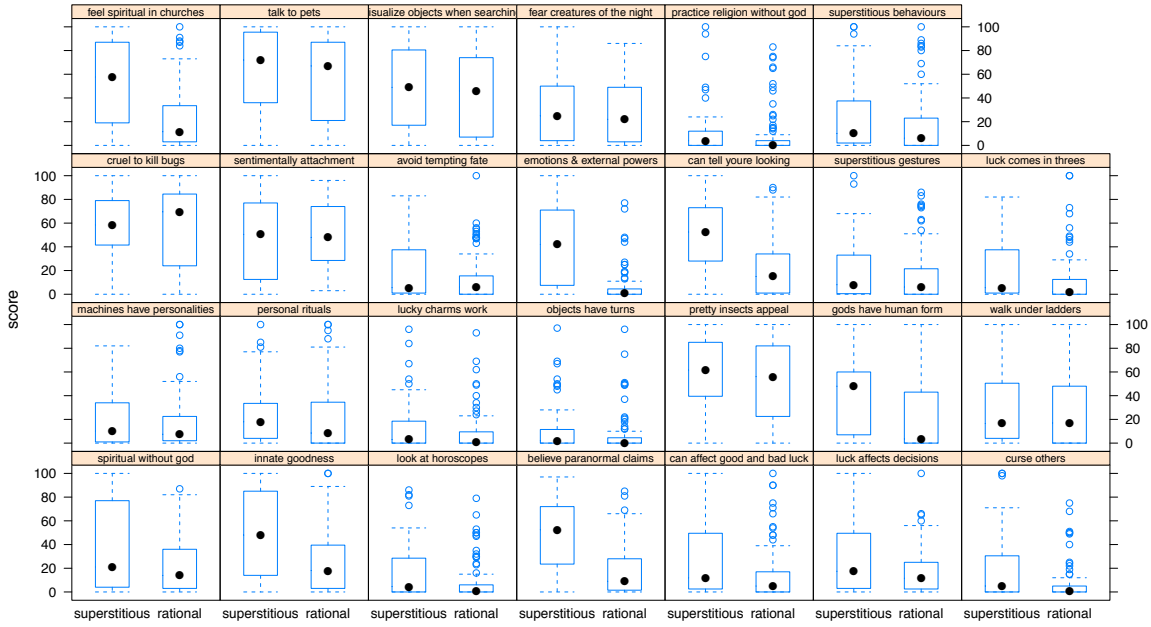


Figure. 3.1.4 Boxplots of the scores for 'non-religious' questions with respect to the superstitious and rational phenotypes identified in Chapter 2.

Question	W	P
spiritual without god	2672	0.097
innate goodness	3171	<0.001
look at horoscopes	2870	0.009
believe paranormal claims	3651	<0.001
can affect good and bad luck	2794	0.028
luck affects decisions	2691	0.082
curse others	3043	0.001
machines have personalities	2404	0.618
personal rituals	2710	0.068
lucky charms work	2697	0.071
objects have turns	2746	0.039
pretty insects appeal	2542	0.275
gods have human form	3194	<0.001
walk under ladders	2450	0.482
cruel to kill bugs	2177	0.634
sentimentally attachment	2208	0.732
avoid tempting fate	2538	0.276
emotions & external powers	3952	<0.001
can tell you're looking	3580	<0.001
superstitious gestures	2484	0.394
luck comes in threes	2898	0.007
feel spiritual in churches	3504	<0.001
talk to pets	2618	0.154
visualize objects when searching	2542	0.273
fear creatures of the night	2390	0.661
practice religion without god	2847	0.011
superstitious behaviours	2578	0.209

Table. 3.2 Non-religious questions. Results of Mann-Whitney-Wilcoxon tests for differences in the median scores between superstitious and rational phenotypes. N1 (superstitious) = 52, N2 (rational) = 88.

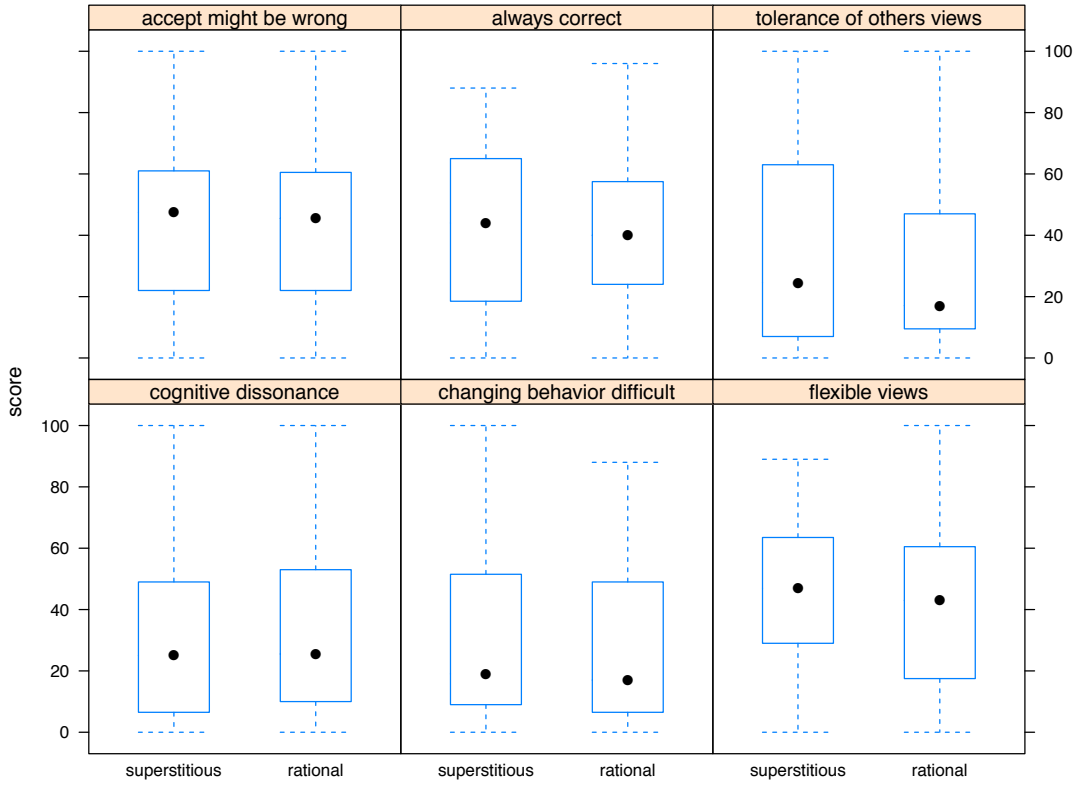


Figure. 3.1.5 Boxplots of the scores for 'social conformity' questions with respect to the superstitious and rational phenotypes identified in Chapter 2.

Question	W	p
cognitive dissonance	2106	0.433
changing behaviour difficult	2520	0.318
flexible views	2555	0.250
accept might be wrong	2370	0.727
always correct	2314	0.912
tolerance of other's views	2504	0.352

Table. 3.3 Social conformity questions. Results of Mann-Whitney-Wilcoxon tests for differences in the median scores between superstitious and rational phenotypes. N1 (superstitious) = 52, N2 (rational) = 88.

The boxplots shown in Figs. 3.1.3, 3.1.4 and 3.1.5 compare the superstitious and rational subject groups in their scores for the three categories of question: religious superstitious, non-religious superstitious, and social conformity. They are accompanied by tables (3.1, 3.2 and 3.3), which provide the associated data respectively. We can see that the P values are all very low in Table. 3.1, indicating strong disparity. In Table. 3.2 the P values are marginally higher and in Table 3.3 they become statistically significant. This agrees with hypothesis as religion is expected to be more polarizing than general superstition, and the social conformity questions are the control as they equate to the efevresic results in Chapter Two.

Having seen how the responses to the questions in the second questionnaire cluster (Fig. 3.1.0), we can also determine how the participants cluster. Applying the same methods as before, but with the matrix of responses transposed, a tree with three (support from 13 metrics) or two clusters (support from 8 metrics; no higher cluster number supported by more than one metric) was favoured. These clusters, necessarily, split along the question clusters identified in Fig. 3.1.0: the large left-hand cluster consists of people responding similarly to questions about social conformity, religious tolerance and spiritual beliefs not necessarily connected to mainstream religion. The right-hand clusters contain two sub-clusters: to the left, a group responding similarly to questions about traditional religious beliefs and, to the right, a group responding similarly on secular superstitions. There is a highly significant association between the clusters identified here and those in Chapter 2 (chi-squared test = 63.662, d.f. = 2, $P < 0.001$). Looking at the three main clusters from left to right in Fig. 3.1.6 below, the ratio of superstitious to rational phenotypes from Chapter 2 is 16:82 in cluster 1, 19:0 in cluster 2 and 17:6 in cluster 3. Therefore, the large left-hand cluster is 84% rational phenotype while the two right-hand clusters comprise 86% superstitious phenotype. Within the latter, the sub-clusters with traditional religious beliefs as identified in this questionnaire are 100% of the superstitious phenotype from Chapter 2. The other sub-cluster, similar in secular superstitions, comprise 74% superstitious and 26% rational phenotype. Therefore, apart from in the group holding strong traditional religious views, there are non-trivial numbers of 'rational' individuals holding various types of superstitions from the secular to spiritual.

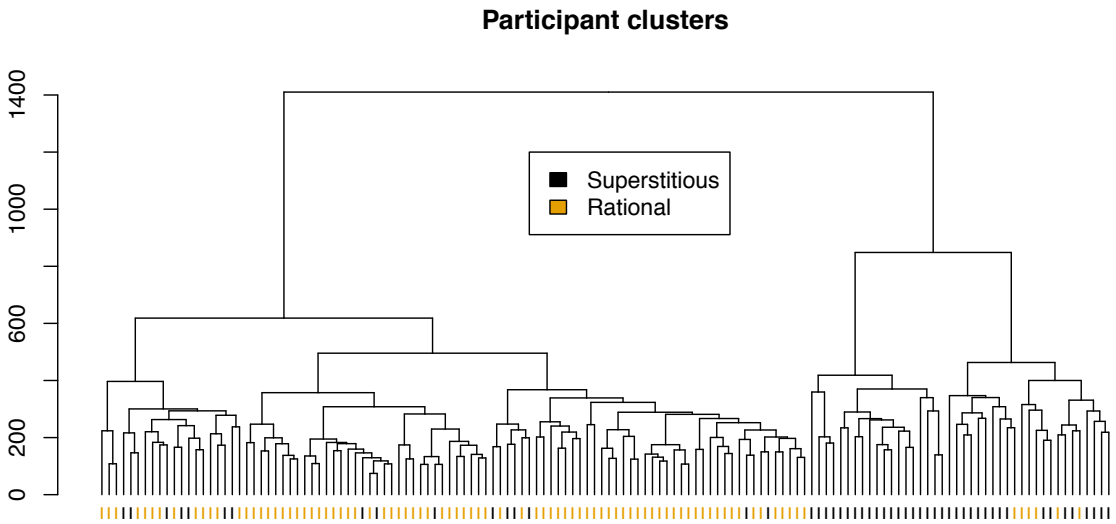


Figure. 3.1.6 Dendrogram showing participant clustering, based on Ward's method applied to the Euclidean distance matrix. The y-axis represents distance. At the bottom of the tree, black lines indicate participants classed as from a superstitious phenotype in Chapter 2; orange lines indicate the rational phenotype.

3.1.2. Paired-mean analysis.

As an extension to the above, I designed a test to see how the two types of supernatural belief relate to each other: i.e. is their relative expression correlated within a given person? Having calculated the mean score for religious questions (R), and for non-religious (NR) for each of the 140 subjects, I then regressed each on the other (Fig. 3.1.7). The slope of the regression of R on NR is 0.81, that of NR on R is 0.39, the relationships being highly significant ($t_{138} = 7.94$, $p < 0.001$, $R^2 = 0.31$). People with high responses on the religious questions also show high scores for non-religious questions; superstitious people tend to be superstitious in both religious and secular contexts.

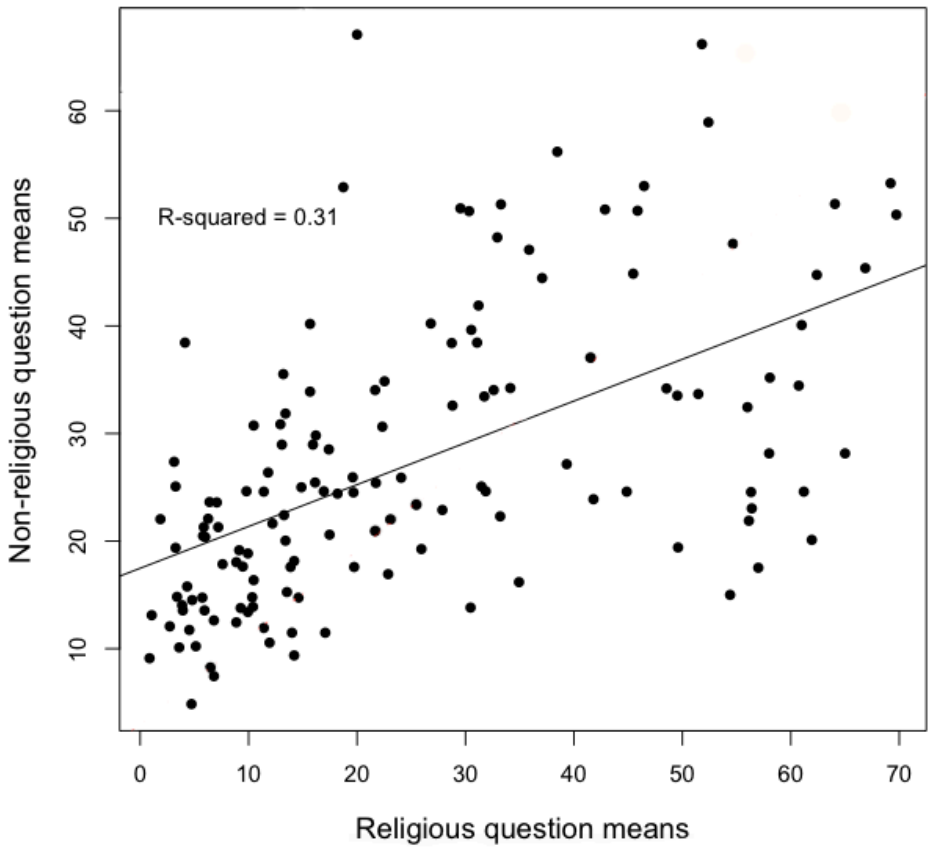


Figure. 3.1.7. Scatterplot of the mean score for religious questions (R) on the mean score for non-religious questions (NR), with each point representing a single participant (N=140). The black line is the best-fit line from regression of NR on R.

3.1.3 The special case.

The potency of the god meme is clearly a fascinating phenomenon and disclosure. Its ability to override normal rational sensibilities and mount itself in the belief systems of people who would otherwise eschew supernatural ideas, goes a long way to explaining how the supernatural meme has evolved in tandem with the human brain. It implies a fundamental need for the human mind to satisfy existential concerns, which are so pronounced that most minds, even the highly rational, are compelled to believe in a god to one extent or another.

To use computer terminology as a model, the belief system functions as a linker, whereby the brain (processor) parses input data to compile object files and the linker makes them executable: i.e. translates them into actions (behaviours). So, the configuration of the linker (belief system) is critical in determining the way that the organism responds to its environment and the way the environment responds to the organism.

The god meme seems to establish itself in the belief system so very readily because it effectively hacks the linker software, providing a framework of imposed logic that, although irrational, serves to block pathways of existential enquiry and so generates feelings of cognitive accomplishment. As a result, the brain settles for cognitive dissonance as a way to accommodate the meme. From then onwards, all existential enquiries enter a feedback loop and are absorbed by the god solution, instead of being allowed to ferment. Thus, the god meme operates as a psychological panacea to the angst brought about by sapient consciousness.

The god meme would seem to act as a supernormal stimulus to the brain, so that non-religious superstitious beliefs are more readily sanctioned once the god meme is in place, thereby increasing the hold of the supernatural meme and improving its prospects of survival. This is discussed in Chapter One: 1.4.0

Some work has been done on correlating 'cognitive style' (intuitive and reflective thinking) with level of belief in a god (Shenhav et al., 2011; 2016). The evidence suggests that people who are more intuitive or spontaneous in the way they think are also more likely to believe in a god than those who reflect or consider things more deeply. Intuition correlates with a higher likelihood of being incorrect at answering test questions, but is accompanied by a relative lack of concern. This can be seen to support the above hypothesis as it demonstrates that belief in a god is affiliated with cognitive shortcutting: i.e. the mind has license to extemporize and thus avoid investment of thought processing effort. Interestingly, the researchers see cognitive style as influencing belief in a god, but our hypothesis is that the two go hand in hand; i.e. that belief in a god allows the mind to be more intuitive, because the subject has effectively passed the responsibility for existential decision making and therefore is more inclined to go through the motions (be intuitive) rather than invest cognitive effort. From the ecological point of view there is an obvious balance between conservation of energy and the risk of poor strategy in relation to behavioural fitness, but the theory suggests that the supernatural meme compensates for any behavioural shortcomings because religious behaviour still conveys relative fitness in the context of sociocultural environments; i.e. where strategic errors are not as critical to survival and reproduction as they might be in a natural/wild environment.

3.1.4 Conclusions.

The responses to the questions clustered into 3 groups: those related to (i) traditional religious beliefs, (ii) secular superstitions and 'facultative' religious beliefs and, separated from the first two, (iii) social conformity, religious tolerance and spiritual beliefs not connected to mainstream religion.

Personal belief in god, from the first cluster, is strongly positively related to the rationality-superstition factor from Chapter 2. However, it is not a step function but a smooth s-shape, so

there are plenty of people intermediate in belief between the two belief phenotypes of chapter 2. Of the latter, the rational group show much less variation in their belief in god (which is low), whereas the superstitious group show both a higher average belief in god and more variation.

All the religious questions in the second questionnaire had significantly higher scores for superstitious phenotypes. None of the social conformity questions showed differences between the two belief phenotypes. For the non-religious questions, superstitious phenotypes had significantly higher scores for the questions relating to spiritual beliefs not necessarily connected to mainstream religion and some common secular superstitions.

Cluster analysis of the participants showed three main clusters. The largest comprised people with strong responses related to social conformity, religious tolerance and spiritual beliefs unconnected to mainstream religion. This group was distinct from two other clusters: those with strong traditional religious beliefs and those with strong secular superstitions. There was a highly significant association between the clusters identified here and those in Chapter 2. However, apart from the cluster of people holding strong traditional religious views, in the other clusters there were 16 and 26%, respectively, people with 'rational' phenotypes (from Chapter 2's analysis) exhibiting various types of superstitions from the secular to spiritual.

Chapter Four.

Methodology Three: Testing for phenotypes via cognitive plasticity and rigidity.

Abstract.

Having identified the likely presence of two or more belief phenotypes in Chapter Three, this methodology was designed to look for further evidence by using a mechanistic questionnaire, testing for plasticity and rigidity in participant responses. The hypothesis being that people are generally separated into two distinct cognitive types: one with a tendency to treat newly observed data as plastic and making it correspond to strong prior expectations; the other with a tendency to treat the data as hard or fixed and modifying expectations flexibly to accommodate them. The electronic questionnaire was designed in such a way that the participants' answers to lead questions inadvertently determined the following questions, so that they were provoked into expressing their level of conviction with the first answers. Analysis of the data showed that people are indeed generally divided into two cognitive belief types as hypothesized, but there is significant complexity within those groups, resulting in spectrums within those groups. This concurs with the overall theory, as it provides a high level of trait variation from which natural selection acts. Human belief systems are clearly influenced by many internal and external factors that determine their spectral position within phenotypic type.

4.1.0 Objectives and general approach.

For the third methodology the primary objective was to collect data from participants in such a way that it betrayed unconscious belief expression. The questionnaires used in Chapters 2 and 3 were straightforward, so that participants were simply asked to answer a set number of questions according to their preference. This inevitably means that participants need to be trusted, as there are reasons why they may choose to distort their answers or show inadvertent biases. With relatively small participant samples this makes the data vulnerable to claims that the results do not generalise. This is compounded by the relatively narrow geographical reach of those surveys (mainly southern UK).

The third questionnaire was designed to have worldwide distribution, a large sample size (thousands) and, crucially, respond to participant actions, without their knowledge, so that they played a role in designing their own questionnaire. The are a set of questions, or 'passes', that have a sub-question which is contingent upon the first response. Each pass takes the participant down three possible routes, depending on the way they respond to the primary question. Thus, they are either taken directly to the next lead question or to one of two lateral questions, before being taken to the next primary question.

The key objective was to test for varying plasticity versus fixity in participants' psychology. Thus the main questions offer straightforward scales of preference between prosagogic and epistemic poles: 0—100%. However the scale is invisibly divided into three equal portions, so that the participant determines their direction of travel by the percentage they provide.

A central response
(34 – 66%) takes the participant to the next main question, while low (0–33) and high (67–100) readings take the participants to lateral questions that test their level of conviction in regards to the initial response. The lateral question, although available as a continuous percentage scale, is recorded as binary (0–50, 51–100). Each pass therefore assigns a score to the participant, that they are unaware of, and which expresses a level of plasticity and a valence (yes/no): range -2, -1, 0, +1, +2. Thus, there are $30^{\wedge 5}$ (24,300,000) possible outcomes from a questionnaire comprising 30 lead questions and a potential additional 30 lateral questions. The survey was approved by the University of Bristol, Faculty of Science Research Ethics Committee.

Plasticity is a matter of interpretation to some extent, as those who express low overall readings – i.e. many 0s – may be simply neutral or indifferent rather than plastic: i.e. they don't care or are habitually indecisive. Thus, it may be those who express many 1s (either –ve or +ve) who are expressing the most plasticity of opinion, because they are actively demonstrating their mutability: dynamic plasticity.

Similarly it may be those who express many 2s (either –ve or +ve) who express the least plasticity (or the most fixity). Furthermore, if people alternate both sides of neutral then they are already expressing some plasticity to varying degrees by revealing a spectrum of opinions about the overall theme of supernatural ideas, whether they express dynamic plasticity or not.

A normal (Gaussian) distribution is predicted here, as there are likely to be high numbers of genes involved with many environmental variables acting in different directions. So, those with high plasticity should form the greater proportion, with reduced plasticity less frequent (-ve and +ve). However, there are various mechanistic possibilities to consider and investigate with regard to the underlying dynamic of such a distribution. The previous methodologies expose two phenotypes in operation, so how might this work?

One possibility is that a norm of 'how to believe' (determined by selection) generates Gaussian variation around it because multiple genes are involved and are subjected to developmental accidents, so that the two phenotypes are the result of superstitious and rational bias whilst being raised. A second possibility is that there are frequency-dependent advantages to both phenotypes, so that people are innately empirically-driven and rational or innately prior-driven and superstitious. Thus, Gaussian variation is generated around them in close formation. Either

way, the mechanism makes adjustments according to changes in natural and sociocultural selective factors so that norm or frequency alters, respectively.

It is logical that equilibrium, or rather stasis, between phenotype ratios is the current state across modern populations, because there are many sub-cultures comprising large societies, acting to cancel out any locally selected alterations and prevent genetic drift. Only where societies have a common culture and appropriately modest scale can the mechanism ordinarily cause directional selection due to sequential alterations drifting through the gene pool. However, religion can also impose cultural commonality when it is well organized and orchestrated, thereby dealing with the problem of increasing scale in society.

4.1.1 Designing and building the application.

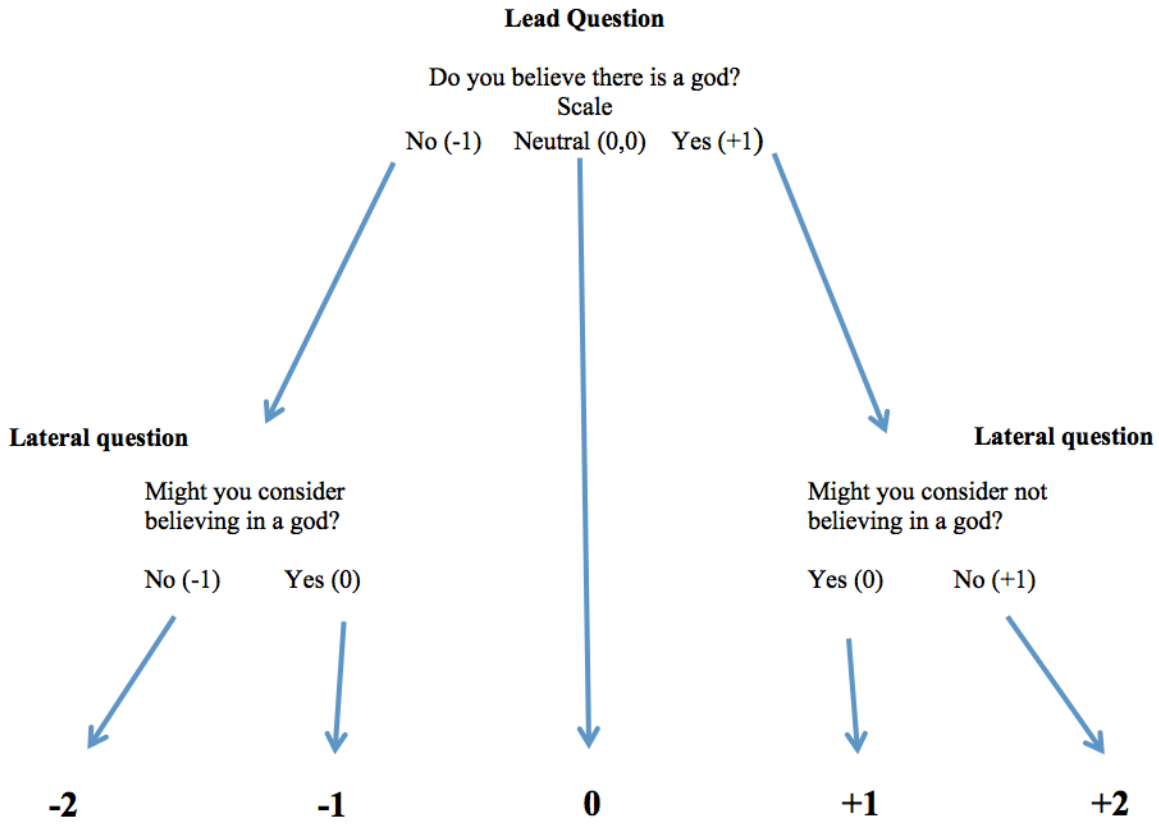
The third questionnaire took the form of an electronic app (application) linked to the crowd data sourcing website Amazon Mechanical Turk (www.mturk.com). The website has a large number of member participants worldwide, who have registered to complete tasks, complete surveys and provide various types of data for a nominal sum of money. Thus, when a questionnaire is loaded onto Mechanical Turk, with appropriate funding for the required sample, a notification is issued so that members are prompted to participate. Participants are described as 'workers' by the website, and the jobs are known as HITs (Human Intelligence Tasks).

The app itself was created by a software developer commissioned as a bespoke design, to suit the specific functional requirements described by me (Davies, 2018). No 'off the shelf' options were available at the time to provide an interactive tool that responds to participant choices to elicit a covert layer of data.

I have already discussed the potential problems with bias in questionnaires in Chapter One (1.13.0). There are similar issues with using Mechanical Turk too. For example, providing a standard fiscal incentive internationally may bias results due to the relative value of payment. Release timing may also cause bias due to different time zones. The ability to read the questionnaire in non-English speaking countries may also bias data according to education level and access to computer technology. There is also the matter of cultural bias, as some countries may have a culture of participation in scientific research whilst others do not. In more specific terms, there may be 'lateralization confounds' involved: i.e. where people actually think differently because their culture causes differences in cognitive processing, interpretation and reaction. In turn, there may be bias generated by acquiescence or alternatively a willingness to please. There may also be participation fatigue involved: i.e. where some people essentially participate to supplement their income and become blazé about the truthfulness of their input. So, as with questionnaires, it is necessary to acknowledge the inevitability of some bias in data via Mechanical Turk, despite efforts to counter it, and thus factor in the possibility of these bias

pitfalls as a caveat of admission (Calin-Jageman, 2018; Goodman & Cryder, 2013; Raihani et al, 2013; Antin & Shaw, 2012).

The third questionnaire comprised a total of thirty questions: relating to both theistic superstition and non-theistic superstition as two fundamental themes (Appendix 3). Thus, the subject was asked a minimum of thirty questions and a maximum of sixty questions, depending on their route through the questionnaire, which was inadvertently self-designated. That is to say, a subject with consistently moderate views would answer thirty questions, while a subject with consistently extreme views (in either direction) would answer sixty questions. Fig. 4.1.0 explains the pass mechanism: If the response to the lead question is neutral, then the pass reading in 0 (0,0) and the next lead question is asked; if the response is –ve or positive then a reading of -1 or +1 is held and a lateral question is asked; the response to the lateral question then determines the pass reading: -1 + -1 = -2, -1 + 0 = -1, 0 + 0 + 0, +1 + 0 = +1, +1 + +1 = +2. Thus, there are five possible pass readings. All questions were designed with the same orientation – negative belief left, positive belief right – so that the data were all suitably aligned for analysis.



Lead Question 1: Do you believe there is a god?				
No		Maybe	Yes	
Lateral Q: Might you consider believing in a god?			Lateral Q: Might you consider not believing in a god?	
No (-2)	Yes (-1)	(0)	Yes (+1)	No (+2)
Next Lead Question				

Figure. 4.1.0. Questionnaire pass model, using Pass 1. The participant sees a percentile scale for each primary question (the example given is just one of 30), but the scale is actually divided into three zones of percentage (0-33, 34-66, 67-100), which determines the direction taken. The lateral questions also have percentile scales, but are divided into two zones of percentage (0-50, 51-100). Below the pass model there is an example of a lead question and the two possible lateral questions.

All 30 passes are listed in Appendix 3. After completing the 30 passes, the participants were also asked a set of demographic questions (similar to those in Chapter 2, but extended) and asked to pinpoint their current location on an interactive map. The app provided them with a key-code for claiming payment from Mechanical Turk, which amounted to $2 for a ca. 15 minute questionnaire. Data were stripped of any identifying information (Mechanical Turk worker ID) for analysis. Just over 5,000 participants successfully completed the survey (the target was 5,000

but, because one survey was interrupted because of server problems, the replication of this incomplete batch resulted in more completions than target). The survey was run in batches of 100-200 over a period of 4 months, launching at different times of the day and night so as to maximise geographical coverage (many part-time 'workers' log on in the evening, after normal working hours). Thirty-four participants' data were excluded because their recorded locations were judged to be 'implausible' and so their data were considered unreliable. The implausible locations were scattered at very high latitudes in the various Arctic seas where, from Google maps, no land, research stations or bases are indicated. There was also a clutch of self-declared Hispanic Hindus in the same location in the Antarctic, which seems *a priori* unlikely. It is possible these were all legitimate workers on research ships, but I felt it best to be conservative. The Greenland and oceanic locations, seen in Fig. 4.1.1, were retained because habitation does exist at these sites.

4.2.1 The survey's reach.

Having run the questionnaire via Mechanical Turk, as explained, I collected 5012 data sets and used R to process and analyse them with most of the same statistical tools used in Chapters 2 and 3. Only new methods/packages will be described here. Fig. 4.1.1 shows a map giving the geographical coordinates provided by the participants: sample size 5012. It shows that the distribution was reasonably spread, if not uniformly, globally. R Packages "maps" (Becker & Wilks, 2018) and "ggplot2" (Wickham, 2009).

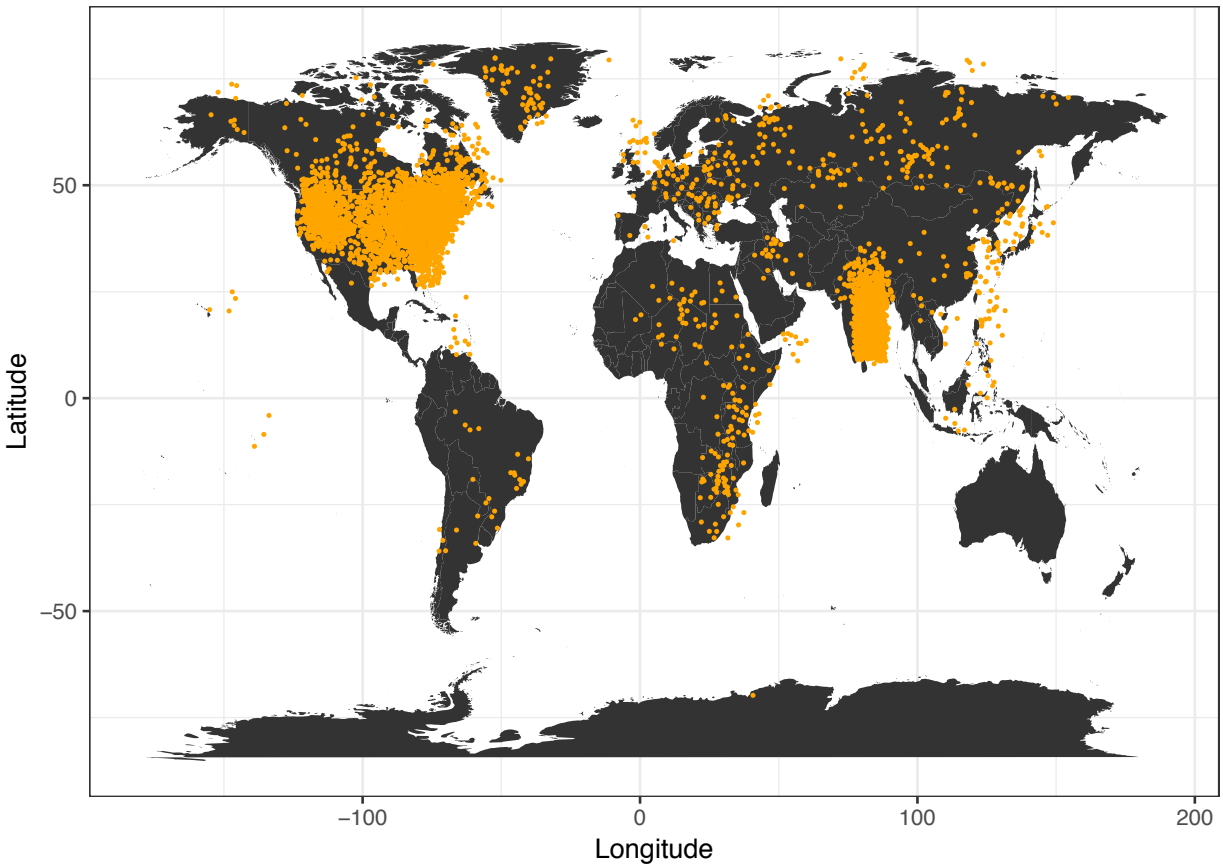


Figure. 4.1.1. Global map, showing distribution of sample: self-located by participants. The final sample size was 5012 participants.

There are marked concentrations in North America and on the Indian Subcontinent. This is because both regions have developed cultures whereby many people have signed up as participant workers with Mechanical Turk. Historically, Mechanical Turk began as a US website in 2005. It then became available to 'requesters' in India in 2010, and then various other countries in 2011 & 2016. Thus, there has been variation in the popularity of becoming non-US MTurk workers according to its availability, its promotion and relative fiscal motivation or incentive. Australia and New Zealand, for example, have yet to develop MTurk cultures, whilst the European countries have relatively few participants, largely because the hourly rate is low in relation to other employment in affluent countries.

Note that an underlying grid system on a relatively low-resolution map was used so, coupled with participant error, marker placement is not entirely accurate. Also, the app causes overspill due to the stacking of data-points in overcrowded locations, but the goal was not formal analysis, merely a rough sense of the global reach of the survey.

4.2.2 Overall distribution

The simplest overview of the responses is to sum the scores for each participant across all 30 passes (Fig. 4.1.2). The modal score is 0, less than 3% of the sample, with only 0.9% of the participants giving entirely zeroes for all questions. If there were one basic belief type driving the responses to the 30 passes, we would expect an approximately normal distribution of summed scores around this mode. This is because the summed response is the result of many small components (the 30 pass scores, each lying between -2 and +2) acting in different directions; the theoretical basis of a normal (Gaussian) distribution is just such a process but, in the limit, comprising an infinite number of components. What we see (Fig. 4.1.2) seems instead to have multiple peaks.

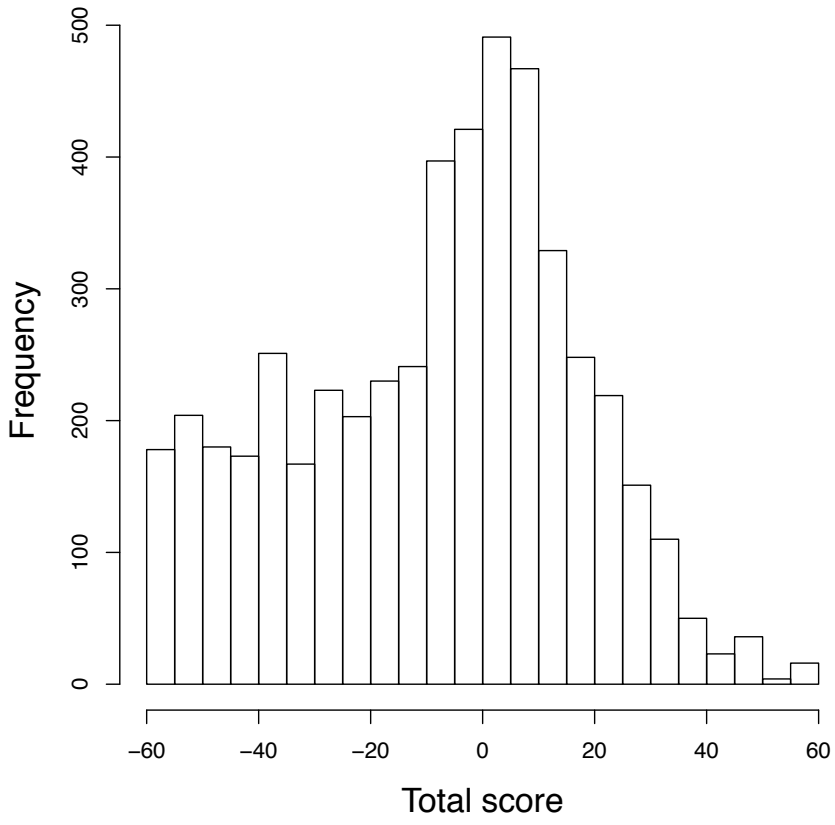


Figure. 4.1.2. Histogram showing the sum of all pass scores (-ve & +ve) for all participants.

A powerful way of investigating the possible basis of this multimodal distribution is Gaussian Mixture Modelling (Fraley & Raftery, 2002). As the name suggests, this involves fitting a mixture of Gaussian distributions to the data, each free to have a different mean and variance, using the so-called Expectation Minimisation algorithm. This was done using the Mclust function in the mclust package (Scrucca et al., 2016), which finds the optimal number of Gaussians (and their means and variances) based on the Bayesian Information Criterion (BIC; Burnham & Anderson,

2002). Like the, to ecologists, more familiar Akaike Information Criterion (AIC), the BIC is a metric for finding the optimal balance between good fit to the data and the complexity (number of parameters) of a model (Burnham & Anderson, 2002). BIC is defined in MClust as 2*(maximised mixture log-likelihood) + log (npar). In this version of BIC, which is an approximation of the Bayes factor used to compare the posterior probability of Bayesian models (Banfield & Raftery, 1993), the model with the maximum value is the preferred model (c.f. AIC and versions of BIC expressed in negative formulation, where the minimum is preferred. There is a useful discussion of this at https://stats.stackexchange.com/questions/237220/mclust-model-selection

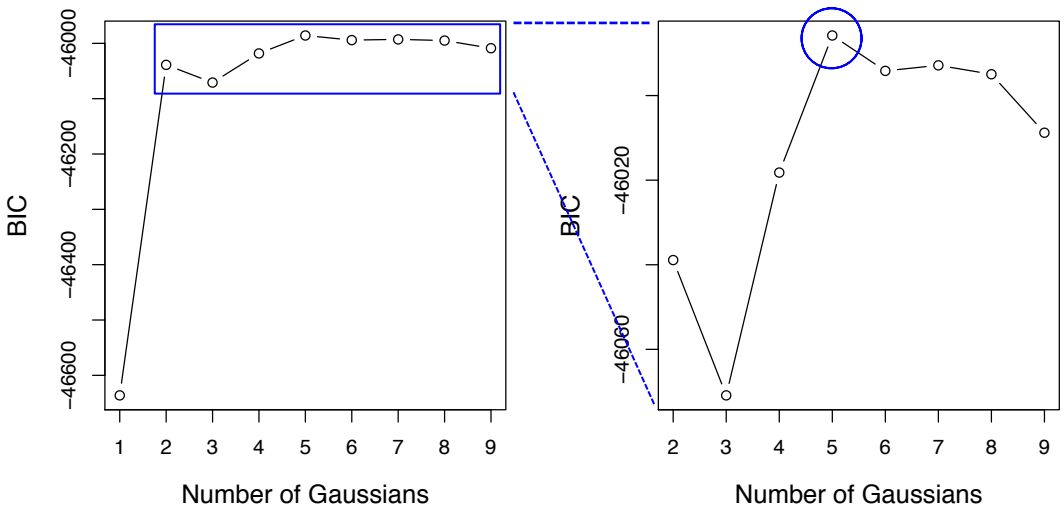


Figure. 4.1.3. Plot of the BIC for mixtures of one to nine Gaussians (the maximum tried). The right-hand panel zooms (stretches the Y axis) in on models with 2 to 9 parameters (blue rectangle), indicating that there is very strong evidence that a mixture of five Gaussians (blue circle) is the optimal.

From Fig. 4.1.3, we can see that there is clearly considerable evidence against the data being the result of one Gaussian. The difference in BIC between the models with one and two Gaussians is 597, which equates to a Bayes factor of twice this, 1194 (Jones et al., 2001). Any Bayes factor over 10 is considered 'very strong' evidence and over 100 is 'decisive' (Jeffreys, 1961). The difference between the BIC of the best model (five mixtures) and the next best (seven), is 7.05, equating to a Bayes factor of 14.1, very strong evidence a mixture of five Gaussians is the optimal description of what underlies these data (Fig. 4.1.4). We can see that there is evidence of a large group that is, on average, neutral-to-mildly-positive about superstitious beliefs, a smaller group that is strongly against all superstitious belief, one moderately favourably disposed plus two intermediate groups. What generates these groupings is explored in the sections that follow.

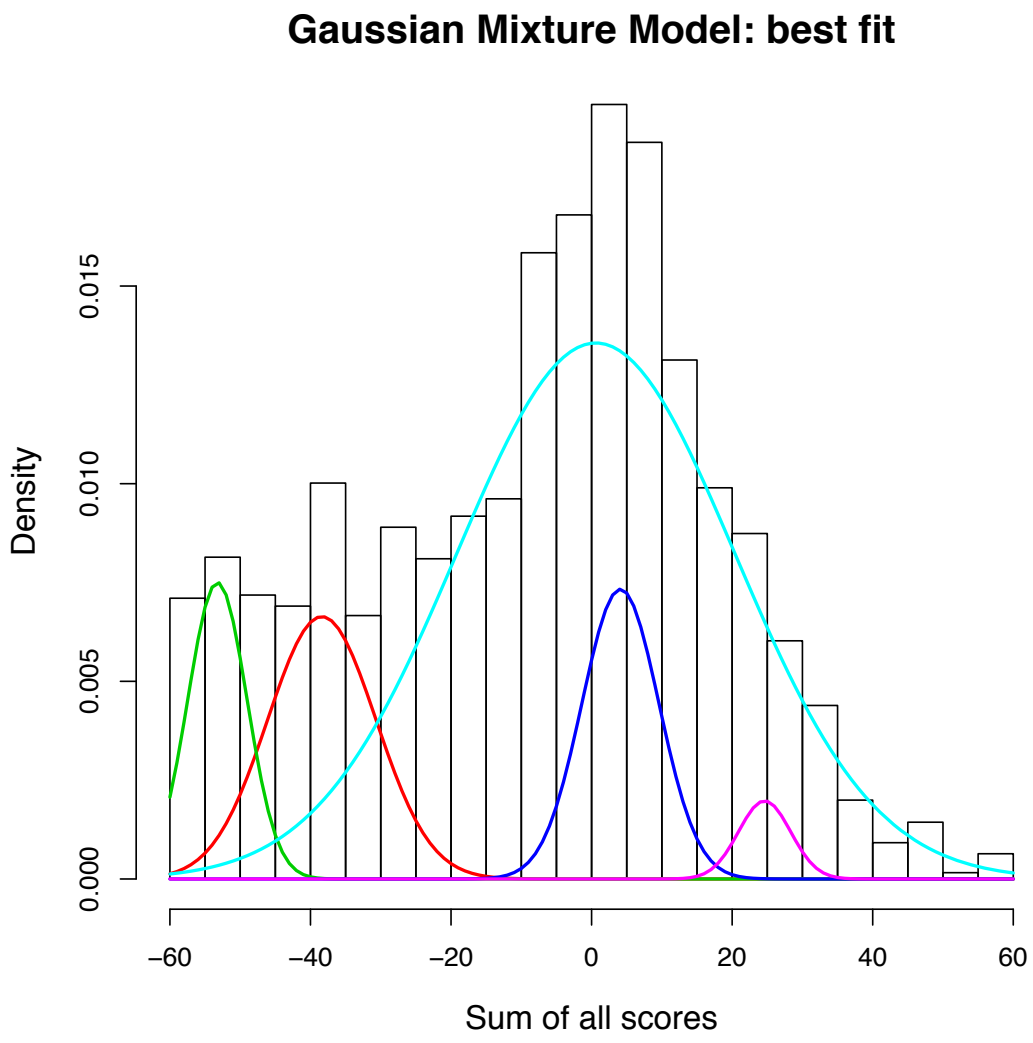


Figure. 4.1.4. The optimal mixture of normal distributions (x 5) underlying the summed response score data (Fig. 4.1.2), based on Gaussian Mixture Modelling.

4.2.3 Theistic versus non-theistic superstitions.

We can now break down the responses into passes (questions) concerning religious/theistic and secular/non-theistic superstitions. The sum of scores for theistic superstition passes is positively correlated with the sum of scores for non-theistic superstition passes (Kendall's $\tau = 0.50$, $z = 52.13$, $p < 0.0001$; Fig. 4.1.5). Because of the large number of overlapping data points, I have used 'hexagonal binning', a form of 2D histogram, to illustrate the relationship (package "hexbin"; Carr, 2018). The hexagonal shades of grey in the figure each represent groups of participant responses that have responded with that particular combination of theistic and non-theistic superstition passes – the darker the shade the more responses in that bin.

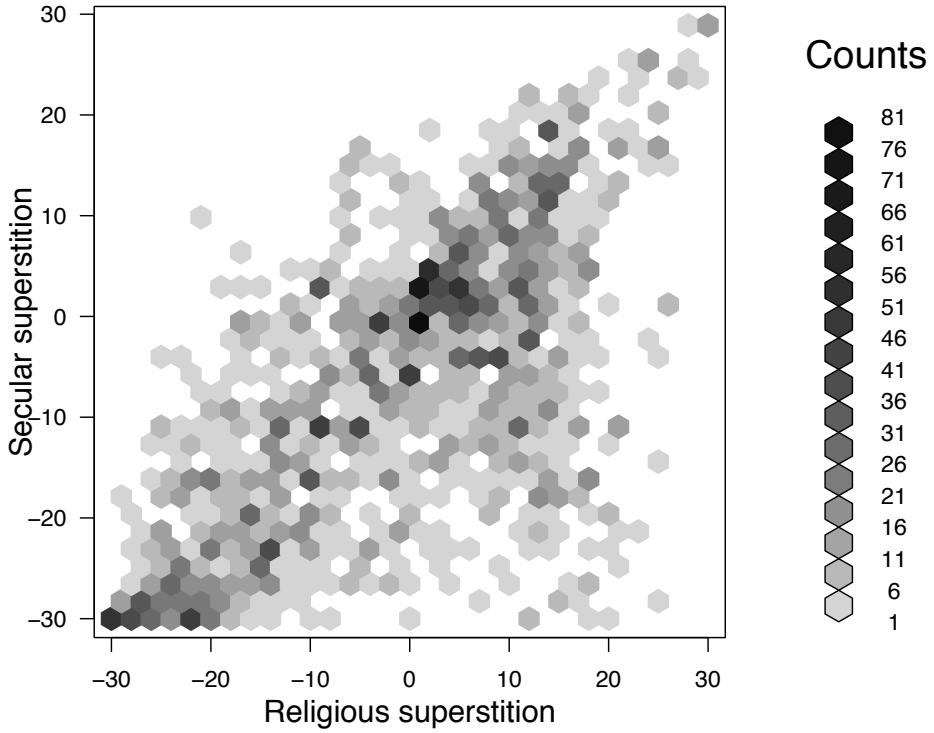


Figure. 4.1.5. Hexplot (2D histogram) of participants responding with particular combinations of theistic and non-theistic superstition scores. Darkness of shading represents more responses in that bin There is a generally positive (and significant rank-order) correlation, but with a bias towards theistic over non-theistic.

We can see a generally positive relationship with the highest densities in the regions representing antipathy to both secular and religious superstitions (bottom left-hand corner), and the region representing a neutral-to-mildly-positive attitude to both. Interestingly there were no pass responses to indicate high belief in the non-theistic theme along with an absence of belief in the theistic theme, yet there were a significant number of responses to indicate the opposite. The inference from the regions of greatest density is that there are essentially two types of religious people: i. Those who see these two classes of superstition as separate, and dismiss non-theistic concepts. ii. Those who either see a single concept, or also see two concepts but feel it is acceptable to believe in both. This is explored later on, with more detailed breakdown of the responses. It may also support the hypothesized 'supernormal' stimulus discussed in Chapter 3.

Using a Kendall test (non-parametric rank-order correlation coefficient) a number of monotonic correlations were tested for, to analyse the inference: i. Is the degree of strong negativity for

religious superstitions correlated with the degree of strong negativity for secular superstitions? Yes, positively (sum of -2 scores for secular superstitions vs sum of -2 scores for religious superstitions: $\tau = 0.61$); ii. Is the degree of mutable negativity for religious superstitions correlated with the degree of mutable negativity for secular superstitions? Yes, positively (-1:-1 correlation; $\tau = 0.32$; iii. Is the degree of neutrality for religious superstitions correlated with the degree of neutrality for secular superstitions? Yes, positively (0:0 correlation; $\tau = 0.49$; Is the degree of mutable positivity for religious superstitions correlated with the degree of mutable positivity for secular superstitions? Yes, positively (+1:+1 correlation; $\tau = 0.44$; Is the degree of strong positivity for religious superstitions correlated with the degree of strong positivity for secular superstitions? Yes, positively (+2:+2 correlation; $\tau = 0.48$). All four correlations are highly significant ($p < 0.001$), unsurprising given the sample size.

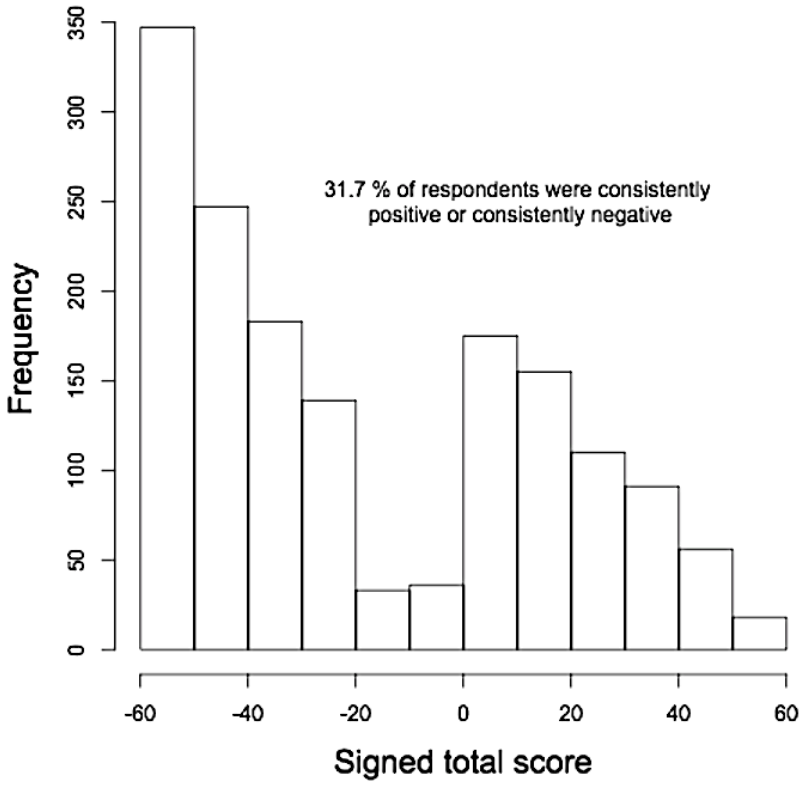


Figure. 4.1.6. Histogram of the sum of scores for participants who gave only –ve scores and only +ve scores: ratio is 2:1.

Looking at the distribution of those with consistent opinions on all questions (i.e. those who gave only –ve values and those who gave only +ve values), we can see an asymmetry (Fig. 4.1.6). Naturally, part of the central portion of the distribution is absent due to the omission of those who oscillated between -ve and +ve responses, but we can see a heavy skew on the negative side, with the distribution truncated at 60 (certainly not a normal distribution), but a more evenly spread distribution on the positive side. This indicates that the sample, although reasonably

large, had a large contingent of extremely anti-superstitious participants but very few as extreme on the pro-superstition side.

Those who gave solely –ve or +ve responses represented 31.7% (1589 participants) of the sample, those who gave solely zero responses represent 0.9% (45 participants) and those who alternated (both –ve and +ve) represent 67.4% (3378 participants). Thus, at the very least, this tells us that about a third of participants have consistently polarised views and that about two-thirds do not.

4.2.4. Plasticity versus fixity.

In order to examine the relationship between plasticity in opinions and fixity in opinions, comparisons were made between proportions of -2 and -1 readings in only negative or zero responders (Sample: 1061 participants) and proportions of +2 and +1 readings in only positive or zero responders (Sample: 528 participants). Then in those who gave mixed (+ & -) readings (Sample: 3378 participants). The 45 participants who gave zero only readings were excluded.

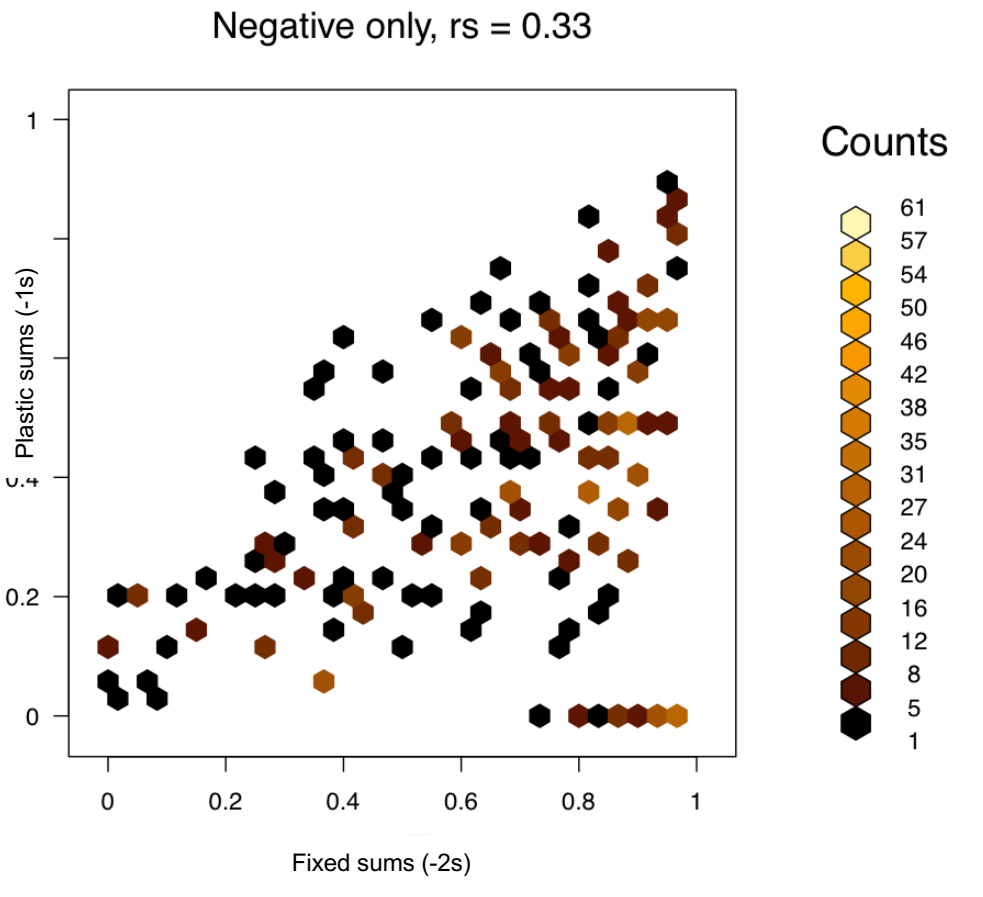


Figure. 4.1.7. Hexplot comparing sums of plastic responses (-1) and sums of fixed responses (-2) in only negative or zero responding participants (Sample: 1061 participants).

A moderately positive correlation was discovered between the proportions of -2 and -1 readings in only negative or zero responders (Fig. 4.1.7). That is to say that participants generally gave similar numbers of -2 and -1 responses, despite the accompanying number of zeros. However, there is a clear bias in many participants towards -2 responses, such that a significant cluster (bottom right) gave only -2 responses. Furthermore, there is an absence of participants with -1 bias (top left). This tells us that fixity outweighs plasticity in the only negative or zero field of responses.

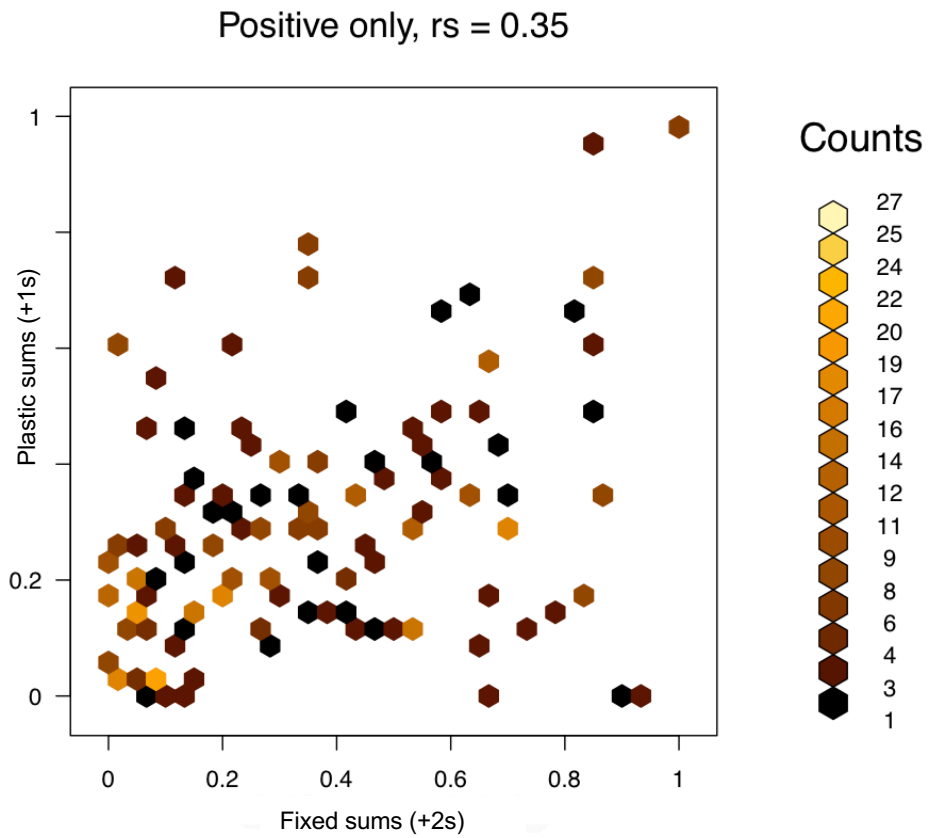


Figure. 4.1.8 Hexplot comparing sums of plastic responses (+1s) with sums of fixed responses (+2s) in only positive or zero responding participants (Sample: 528 participants).

A moderately positive correlation was again discovered between the proportions of +2 and +1 readings in only positive or zero responders (Fig. 4.1.8). That is to say that, as with negative responders, participants generally gave similar numbers of +2 and +1 responses, despite the accompanying number of zeros. However, the results are far less clear-cut than those with only negative or zero responses. This time there is a far less pronounced bias towards fixity and clustering towards the bottom left, indicating that the readings were generally accompanied by higher proportions of zeroes (neutral readings).

The next analysis was to compare number of +1 and -1 readings against the number of +2 and -2 readings, in those participants who alternated in response (gave a mixture of positive, neutral and negative readings).

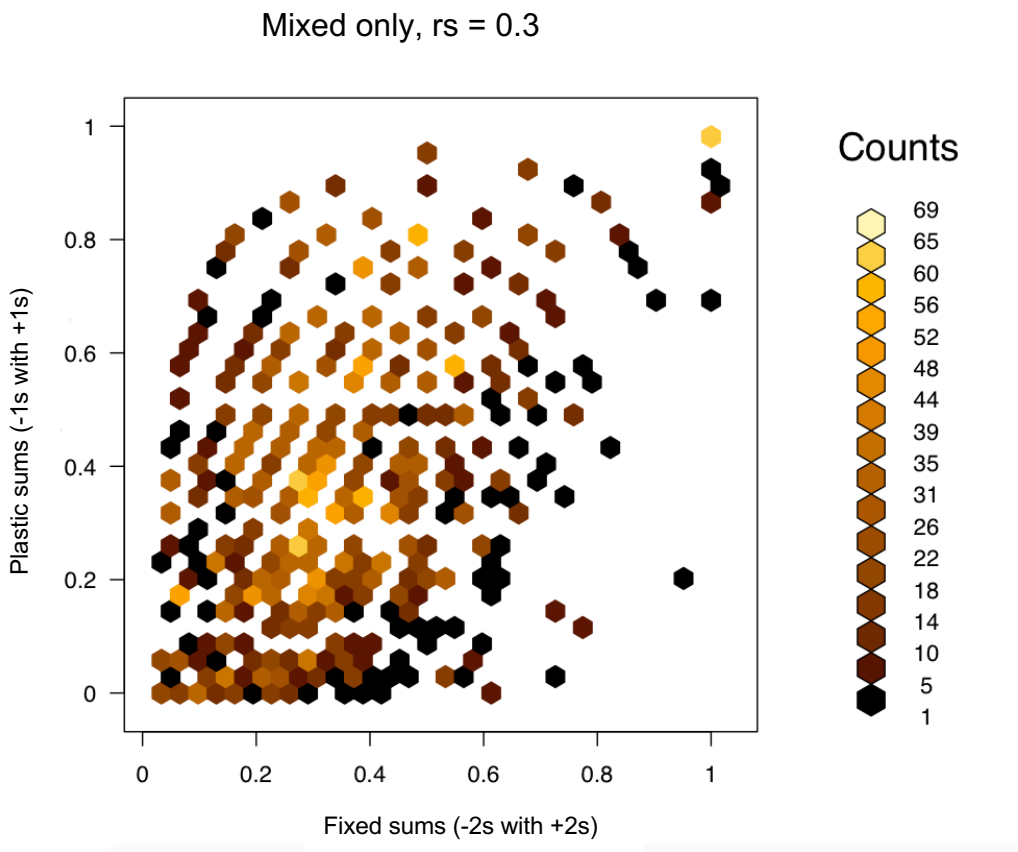


Figure. 4.1.9. Hexplot of plastic sums (-1s with +1s) against fixed sums (-2s with +2s) in alternators (gave mixed positive, neutral and negative readings). Sample: 3378 participants.

There is a moderately positive correlation between +1/-1 readings and +2/-2 readings in alternators (Fig. 4.1.9). This time there is a 'double bias': higher plasticity tends to be accompanied by lower neutrality, whilst higher fixity tends to be accompanied by higher neutrality.

4.2.5. Likert scale analysis.

We can now start to break the responses down into the patterns of answers to individual questions/passes (and the relationships between them). The first detailed analysis of the data was to treat the responses as a Likert Scale for each of the 30 questions, with regard to the proportion of response types they elicited from the participants (Fig. 4.2.0) . A Likert Scale is the term psychologists use to describe an ordinal response metric (Likert 1932); here there are five response types: fixed negative (-2), modified negative (-1), neutral (0), modified positive (+1), fixed positive (+2).

I used R packages “multcomp” (Hothorn et al., 2008), “corrplot” (Wei & Simko, 2017), “likert” (Bryer & Speerschneider, 2016), “mvtnorm”(Genz & Bretz, 2009), “survival” (Therneau & Grambsch, 2000), “TH.data” (Hothorn, 2017), “MASS” (Venables & Ripley, 2002) and “xtable” (Dahl, 2016).

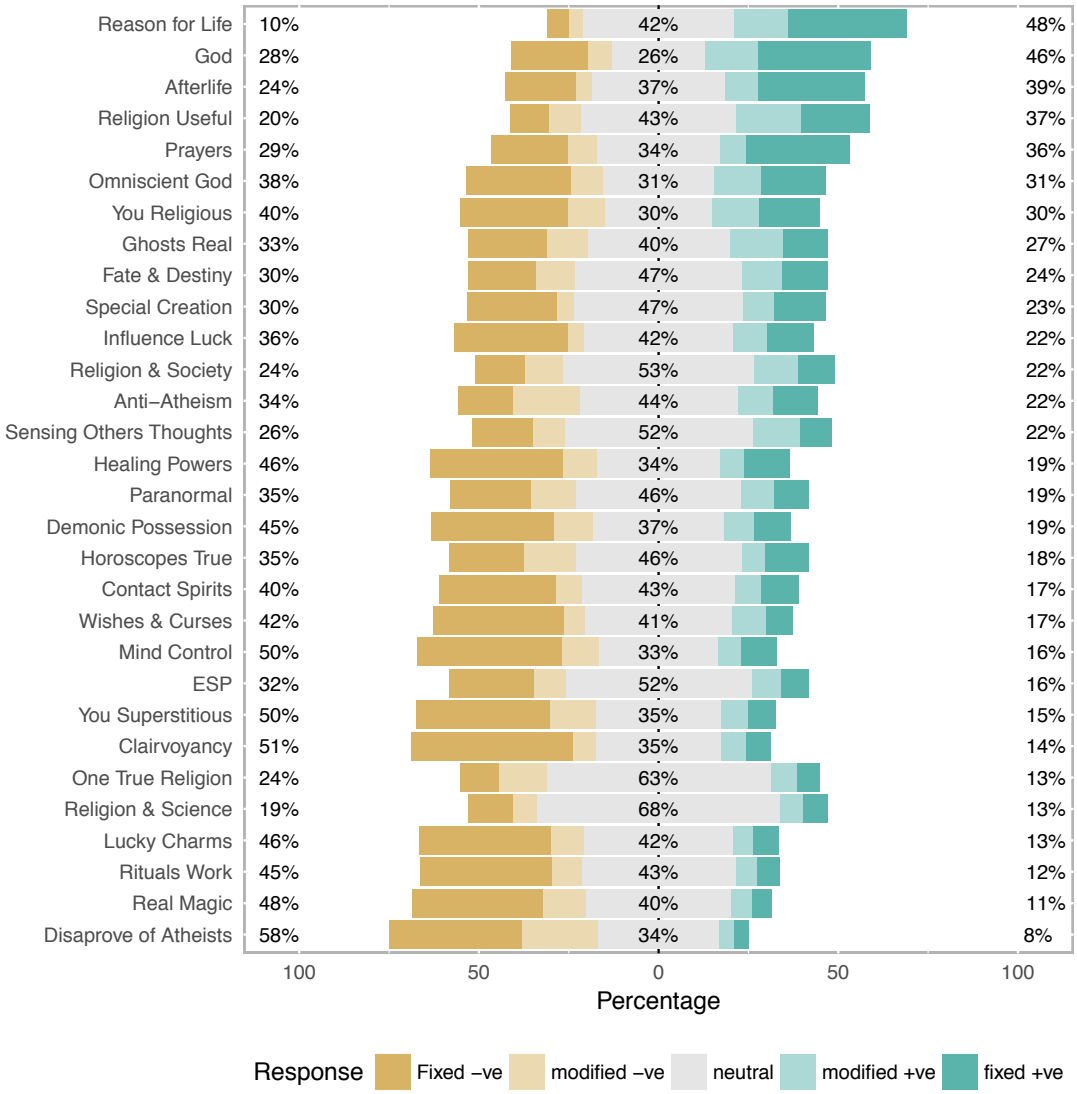


Figure. 4.2.0. Likert scale of all data for five responses from entire sample. The bars have been sorted with respect to the strength of positive responses, both fixed and modified, (the % totals on the right), with the % of negative responses (both fixed and modified) given on the left. The full questions that correspond to the shorthand notations in the figure are provided in Appendix 3.

One can interpret the outcome in Fig. 4.2.0 in various ways, but there appears to be a trend (bottom to top) towards personal relevance eliciting stronger positive and negative readings respectively. That is to say, the questions seem to evoke more potent emotional spiritual reactions towards the top of the scale in those with prosagogic inclinations. For example: belief in

a *reason for existence* and *belief in a god* are highly charged ideas emotionally, perhaps because they engage and support psychological vulnerability, or existential angst.

Conversely, the idea of disapproving about atheists receives a strong negative response. This suggests that those with strong epistemic inclinations are defending their stance and that those with strong prosagogic inclinations are indifferent about atheists, as opposed to viewing them as a threat. It is worth noting that the response for '*anti atheism*' rather than '*anti atheist*' is found towards the centre of the figure (34% disapproval cf 58% disapproval for anti-atheist), implying that covert ideas are floated with more moderation than overt actions.

The reading for *belief in real magic*, second from bottom, suggests that both the prosagogically inclined and the epistemically inclined are in agreement, but probably for different reasons: i.e. the religious see magic as an indication of pagan and godless spiritual belief, whilst the empirical see magic as pseudo-scientific nonsense.

Overall, despite the weighting of negative and positive responses across the scale, the neutral readings remain fairly constant. Removing three outliers, they range from 30-52 percent (cf 10 to 58% for negative responses and 8 to 48 for positive). The low outlier is *belief in god* (26%) demonstrating that people tend to be quite decisive in this regard: they either believe or they don't believe. The high outliers are *one true religion* (63%) and *religion & science* (68%), indicating that many people are indifferent or undecided on those matters.

4.2.6 MCA (Multiple Correspondence Analysis).

I next conducted MCA (Multiple Correspondence Analysis), which is a type of factor analysis for categorical data (Everitt & Hothorn 2011). It converts many correlated variables into new factors or components that capture most of the correlated variation and so simplify interpretation of the data; thus that the most important causes of the variation can be isolated. I used R package "FactoMineR" (Le et al., 2008).

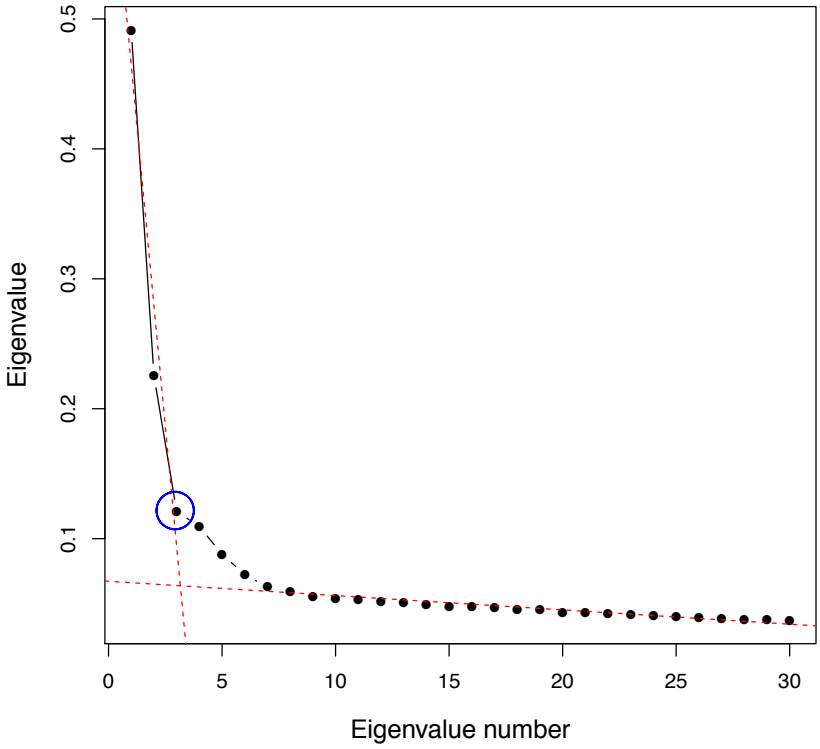


Figure. 4.2.1. Scree plot of MCA showing that three components express most of the variation in responses.

First, I did the MCA with respect to the questions and how they can be summarised. By generating a scree plot of eigenvalues (Fig. 4.2.1) we can see that, in terms of a 'natural break', a case could be made for three to six components being a useful summary of how participants responded to the 30 passes. Three components capture most of the variation in responses between them, with a further three or four components representing relatively minor variation before the plot slope tails away. The sum of the eigenvalues for the first three totals 84% of the first six dimensions.

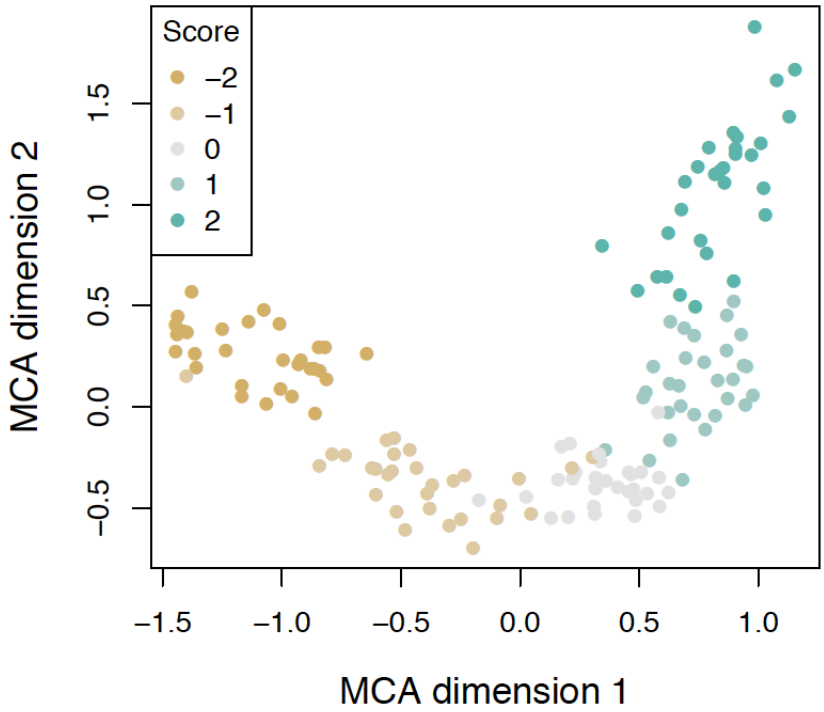


Figure. 4.2.2. Dimensions plot from Multiple Correspondence Analysis with respect to the questions, using the first two dimensions as the X & Y axes: Thus dimension 1 = valance (degree of positivity/negativity) and dimension 2 = strength of opinion.

Fig. 4.2.2 plots the first two components from the MCA on the questions (as opposed to the participants) according to the five categories of response: -2, -1, 0, + 1, +2. The conclusion is that dimension 1 represents the valence of the questions: i.e. the degree of positivity and negativity in response. Dimension 2 represents the emotional response to the questions: i.e. strength of opinion, be it positive or negative. The other components represent more subtle interactions with the questions.

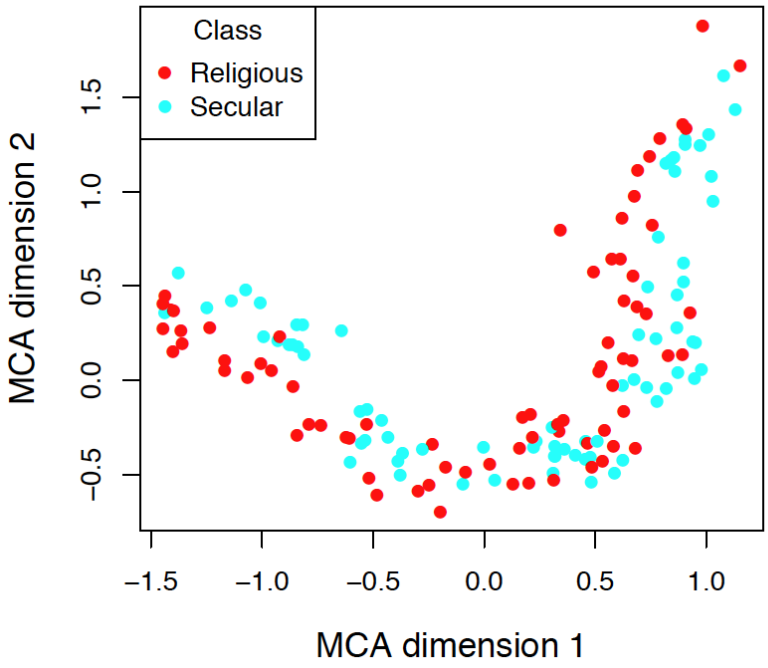


Figure. 4.2.3. Dimensions plots MCA with dimensions 1 and 2 used to quantify, respectively, valance and strength of opinion: with regard to theistic (religious) supernatural beliefs (red) and non-theistic (secular) supernatural beliefs (blue).

The 150 dots in Fig. 4.2.3 (-2 to +2) represent each of the 30 questions multiplied by five categories of response. By annotating with respect to the two categories of question – theistic (involving god) or non-theistic (merely supernatural) – we can see that both categories more-or-less correspond in terms of distribution and pattern, although there is a slight shift on dimension 1: i.e. the valance of the secular questions (blue) was generally more positive than that of the religious questions (red).

4.2.7. Cluster Analysis.

By either analysing the raw responses, or the coordinates from all of the individuals with respect to the first 6 MCA components, it was then possible to perform cluster analysis of the participants' responses: i.e. to data-mine for patterns. Two types of cluster analysis were performed to assess the robustness of the patterns: HAC (Hierarchical Agglomerative Clustering) on the raw data and K-means clustering of the coordinates in the six MCA dimensions. The former is ubiquitously used in phylogenetics to generate evolutionary (taxonomic, cladistic, phenetic) trees and measures of relatedness. The latter is frequently used for unsupervised machine learning: i.e. the ability of computer programs to self-learn or self-improve performance independent of further human input (Lantz, 2013).

The outcome of HAC analysis is determined firstly by the measure of distance between members of each cluster or group. Thus, the choice of distance is therefore a consideration. Choices include the Euclidian distance (square root of the sum of the squares of the distance in each dimensions), the Manhattan distance (sum of the absolute distances in each dimension), and a generalisation of the latter two measures, the Minkowski distance (the nth root of the sum of the of the distance-to-the-power-n in each dimension). Of these, the Euclidean distance is the most widely used and perhaps intuitive measure of distance so, without any principled reason to use another distance measure, as in Chapter 2 and 3, this was used. The next consideration is the method of agglomerating points or clusters of points. This might be the shortest distance between clusters (single-linkage clustering) or it might be the average distance (mean linkage clustering & median linkage clustering). As explained in Chapter 2, Ward's method has desirable properties of producing compact, rather than strung-out, clusters, and so was used. The third determiner is demarcation: i.e. where groups divide into subgroups. This is ultimately subjective but, as in Chapter 2 and 3, by both visual methods (scree plot) and looking for consensus among the multiple metrics that have been advocated in the literature, a robust solution can be achieved.

HAC analysis was run with the R package "cluster" (Maechler et al., 2017) having first used "nomclust" (Sulc & Rezankova, 2017) to calculate the simple matching coefficient. In order not to make any *a priori* assumptions about whether the 5-point scale used for the question responses is even ordinal, far less a continuous measure, I initially treated -2, -1, 0, +1 and +2 as simply five unordered categories. The simple matching coefficient between two nominal (categorical) variables is just the proportion of cases where the two match (Sokal & Mitchener 1958; Boriah et al., 2008). This is done for all possible pairs and thus produces a matrix of 'proportions of match'. This is known as a proximity matrix. This is then inverted by 'proportions of mismatch' to produce a distance matrix, to enable cluster analysis (Sokal & Michener, 1958; Boriah et al., 2008).

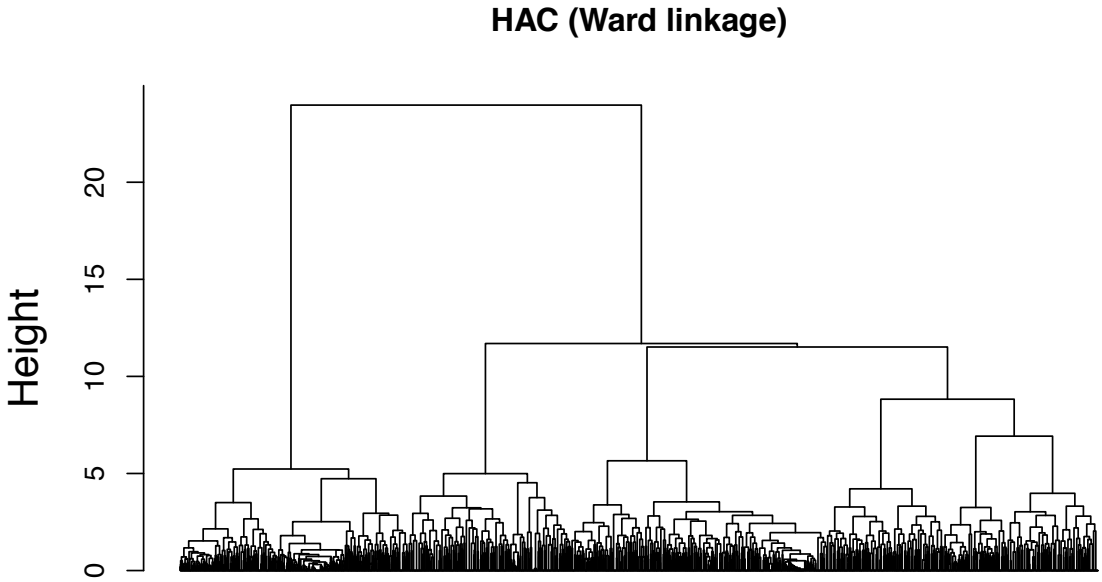
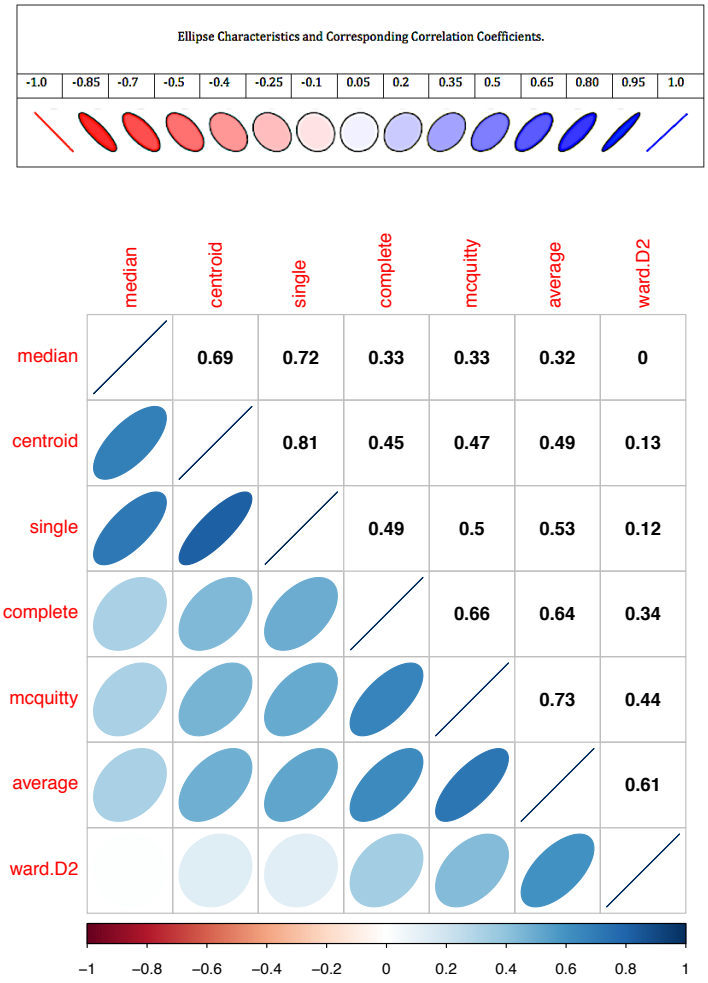


Figure. 4.2.4. Dendrogram, based on Ward's method applied to the Euclidean distance matrix from simple matching coefficients, showing clustering of entire sample: 5012 participants.

Fig. 4.2.4 shows a dendrogram using Ward method linkage (lack-of-fit sum of squares) between all participants based on the raw data with simple matching, generated by using the R package "ape" (Paradis et al., 2004). The overall dataset comprises two clear clusters, with one of those clusters (right) containing four sub-clusters distinguished at similar heights.

The next procedure was to look for correlations between different methods of hierarchical clustering, using a cophenetic correlation matrix. Fig. 4.2.5 shows this visually, using the package "dendextend" (Galili, 2015), indicating that the correlations range from highly positive (blue ellipses) to neutral (white circles). There are no negative correlations (red ellipses).

The Ward method of HAC has become the preferred approach among statisticians and is the one used hereon. The 'median linkage' method had the most pronounced disagreement with the Ward method, as expressed by a correlation coefficient of only 0.003, but it produced a completely unstructured dendrogram. The other methods agreed with the Ward method sufficiently well to sanction its use.



	average	single	complete	ward.D2	mcquitty	median	centroid
average	1.0000000	0.5294947	0.6369549	0.6068045	0.7298280	0.3246762	0.4894944
single	0.5294947	1.0000000	0.4917687	0.1212741	0.3418207	1.0000000	0.8142244
complete	0.6369549	0.4917687	1.0000000	0.3418207	1.0000000	0.4370159	0.4450742
ward.D2	0.6068045	0.1212741	0.3418207	1.0000000	0.4370159	0.0029292	0.1329582
mcquitty	0.7298280	0.5003864	0.6638791	0.4370159	1.0000000	0.3258888	0.4694375
median	0.3246762	0.7159386	0.3251873	0.0029292	0.3258888	1.0000000	0.6858533
centroid	0.4894944	0.8142244	0.4450742	0.1329582	0.4694375	0.6858533	1.0000000

Figure. 4.2.5. Cophenetic correlations between different cluster methods. The numeric values are tabulated alongside the graphic. All correlations are positive against the Ward method, except median linkage, which has no correlation.

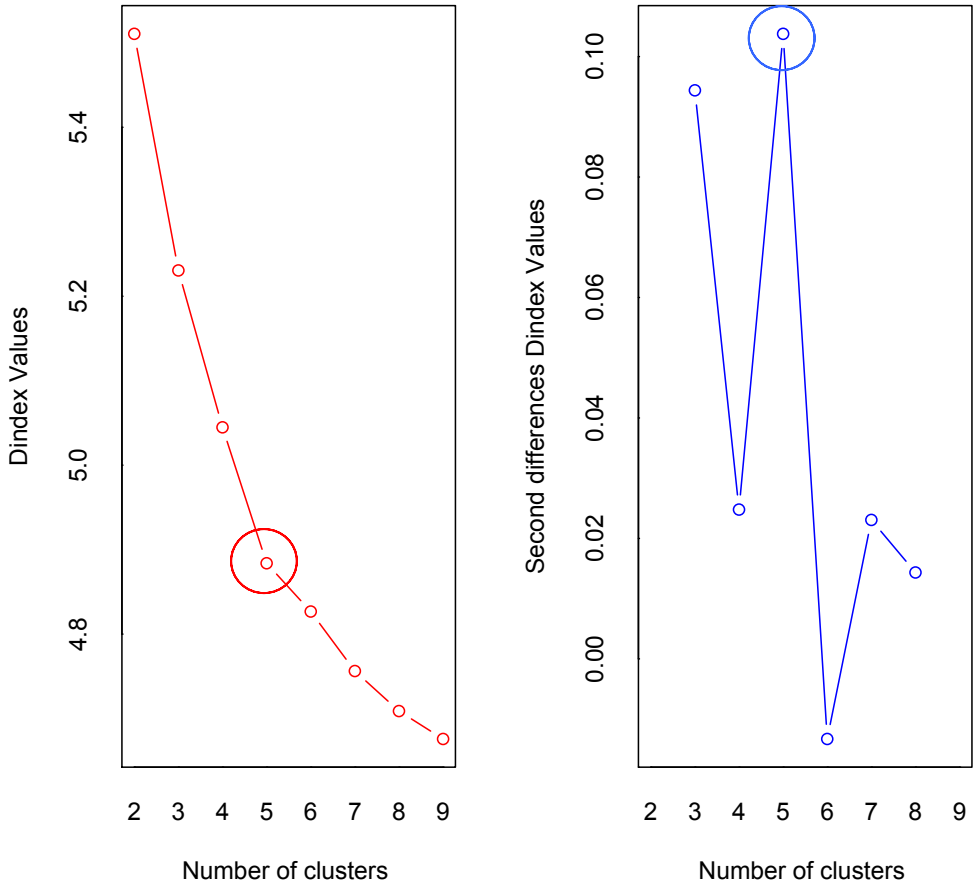


Figure. 4.2.6. Finding the optimum number of clusters: D-Index plot from the R package "factoextra". In the first plot we look for a significant 'elbow' in the plot line. In the second plot, the rate of change, we look for the highest peak in the plot line. Both correspond with 5 clusters as the optimum number (red and blue circles).

Using R package "factoextra" (Kassambara & Mundt, 2017) the next step was to define the optimum number of clusters. We can see, in Fig. 4.2.6 (above), that the D-Index values both correspond with 5 clusters. Using the NbClust package, as in Chapters 2 and 3, I looked for a consensus between quantitative metrics proposed for determining cluster number.

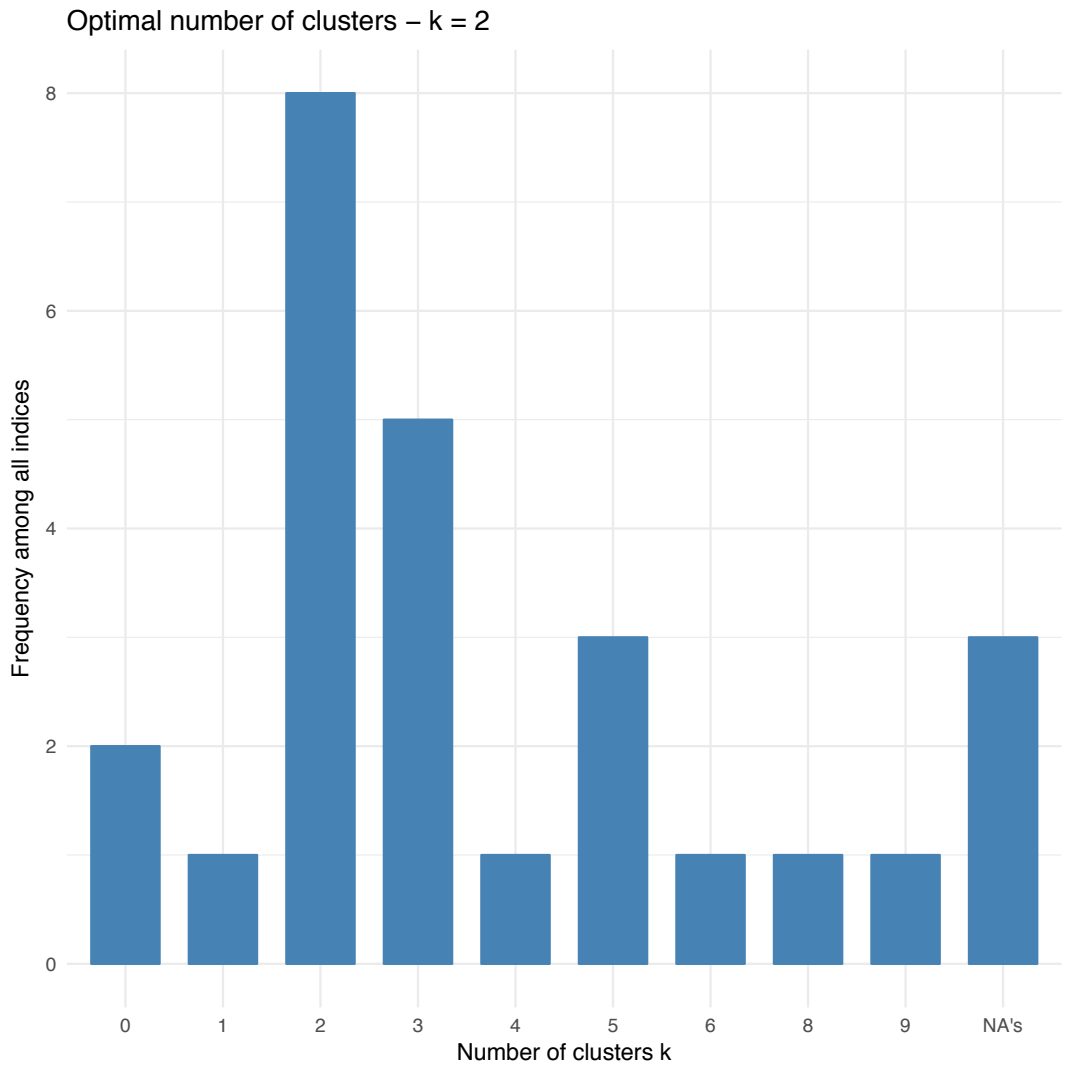


Figure. 4.2.7. Column graph of the Ward method results, again indicating 5 clusters.

In Fig. 4.2.7 one can clearly see that two clusters are selected by the greatest number of metrics, whilst three and five clusters, respectively, receive the second greatest number of 'votes'. This matches what we see in the dendrogram: two main clusters, one of these with four sub-clusters – totalling five. Thus, to avoid missing perhaps interesting differences at higher resolution, I chose five clusters for further analysis.

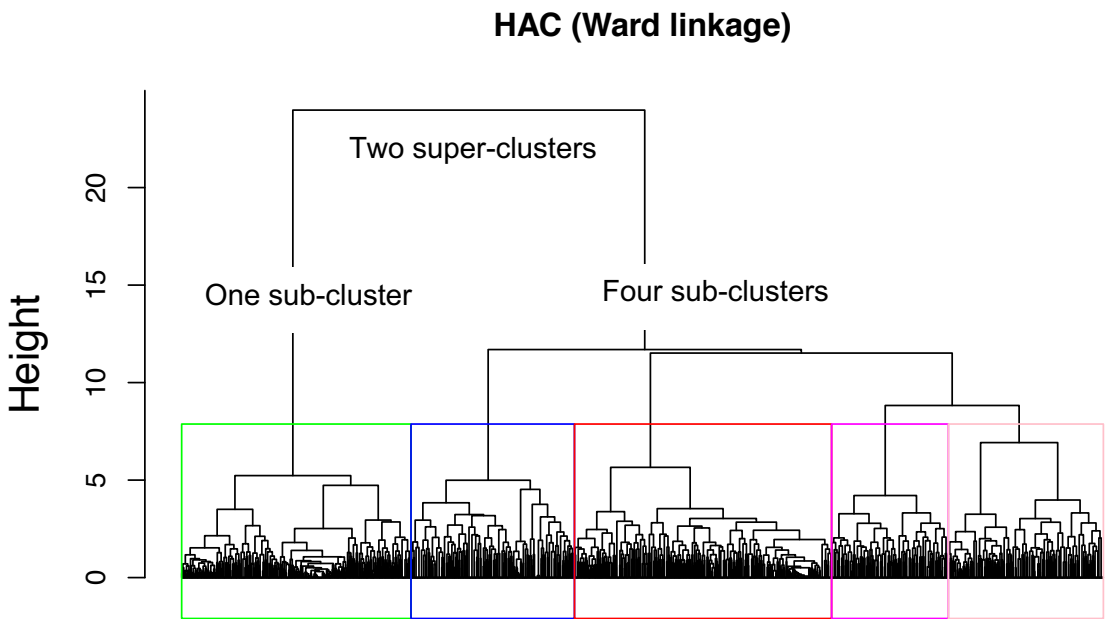


Figure. 4.2.8. Dendrogram from Fig. 4.1.6 with optimal clustering indicated: two super-clusters & five sub-clusters.

Fig. 4.2.8 outlines the five clusters identified from simple matching of the raw data on participants' responses. Having defined the clusters, the next stage was to look for commonality between responses from the participants within those clusters: i.e. what unites them. The data processing involved in order to achieve this objective was complex and required some fairly sophisticated machine-learning packages in the R package "caret" (Kuhn et al., 2018), a convenient common interface for implementing the packages "C50" (Kuhn & Quinlan, 2017), "rpart" (Therneau & Atkinson, 2018), "OneR" (Von Holger, 2017) "class" (Venables & Ripley, 2002) and "gmodels" (Warnes et al., 2015).

Rank	Pass Theme	Prediction Accuracy %.	Rank	Pass Theme	Prediction Accuracy %
1 *	Healing powers	57.02	16	Are you religious	49.10
2	Saying prayers	55.57	17	The paranormal	49.00
3	Omniscient god	54.71	18	Astrological predictions	48.66
4	Clairvoyance	54.37	19	Extra sensory perception	48.54
5	Supernatural rituals	54.03	20	Influence of luck	47.21
6	Contacting spirits	53.73	21	Sense others thoughts	47.13
7	Mind control	52.91	22	Are you anti atheism	46.87
8	Demonic possession	52.23	23	Does society need religion	46.09
9	Believe in ghosts	52.04	24	Disapprove of atheists	45.69
10	Is there an afterlife	51.96	25	Does religion have a use	45.11
11	Wishes and curses	51.04	26	Are you superstitious	44.23
12	Is magic real	50.88	27	Creation over evolution	43.97
13	Fate and destiny	50.86	28	Religion over science	42.48
14	Belief in a god	50.52	29	Reason for life & existence	42.24
15	Lucky charms	50.02	30	One true religion	39.72

Table. 4.1. List of passes in descending order of single rule prediction of cluster membership; measured against 0.2 as chance (5 clusters, so a 1 in 5 chance by random guessing). Those highlighted were subsequently used to 'fingerprint' the characteristics of each cluster.

4.2.8. Single rule analysis.

The first and simplest approach was to find out which single 'rule' (pass question and how it was answered) best predicts membership of a cluster. One-rule classification is the conceptually simplest, but still surprisingly powerful, algorithm commonly used in machine learning designed to find 'rules' (simple decision criteria) for classification. This was achieved by (automatically) seeing which response for which pass was the best predictor of cluster membership.

As there are five clusters then chance accuracy is 20%. We can see, in Table 4.1, that the best outcome was 57% accuracy (chi-squared = 4377.3, d.f. = 16, $p < 0.0001$) for one rule across all five clusters (belief in healing powers). This might be interpreted as a low percentage of accuracy, but it is still nearly three times more accurate than chance and it involves just one pass out of thirty. In fact, the range was 40—57% across all 30 questions, so they all predict membership of a cluster by at least twice chance.

Using the top four passes from the one-rule algorithm -- do you believe in the power of prayer, do you believe in an omniscient god, do some people have healing powers, do you believe in clairvoyance (highlighted in Table 4.1) -- it was possible to generate Likert scale 'signatures' or 'fingerprints' for the five clusters: Fig. 4.2.9. The first two passes in each cluster have the theistic

theme, whilst the second two have the non-theistic theme. Visually we can see that the five clusters have distinctly different profiles for the same four passes.

These signatures (Fig. 4.2.9) tell us that: i. Those in Cluster 1 (28% of participants) tend to be neutral in their responses to both themes. ii. Those in Cluster 2 (18% of participants) tend to have a positive reaction to both themes. iii. Those in Cluster 3 (25% of participants) tend to have negative reactions to both themes. iv. Those in Cluster 4 (17% of participants) tend to have positive reactions to the theistic them but negative reactions to the non-theistic theme. v. Those in cluster 5 (13% of participants) are generally negative to both themes but are rather indifferent to the power of prayer.

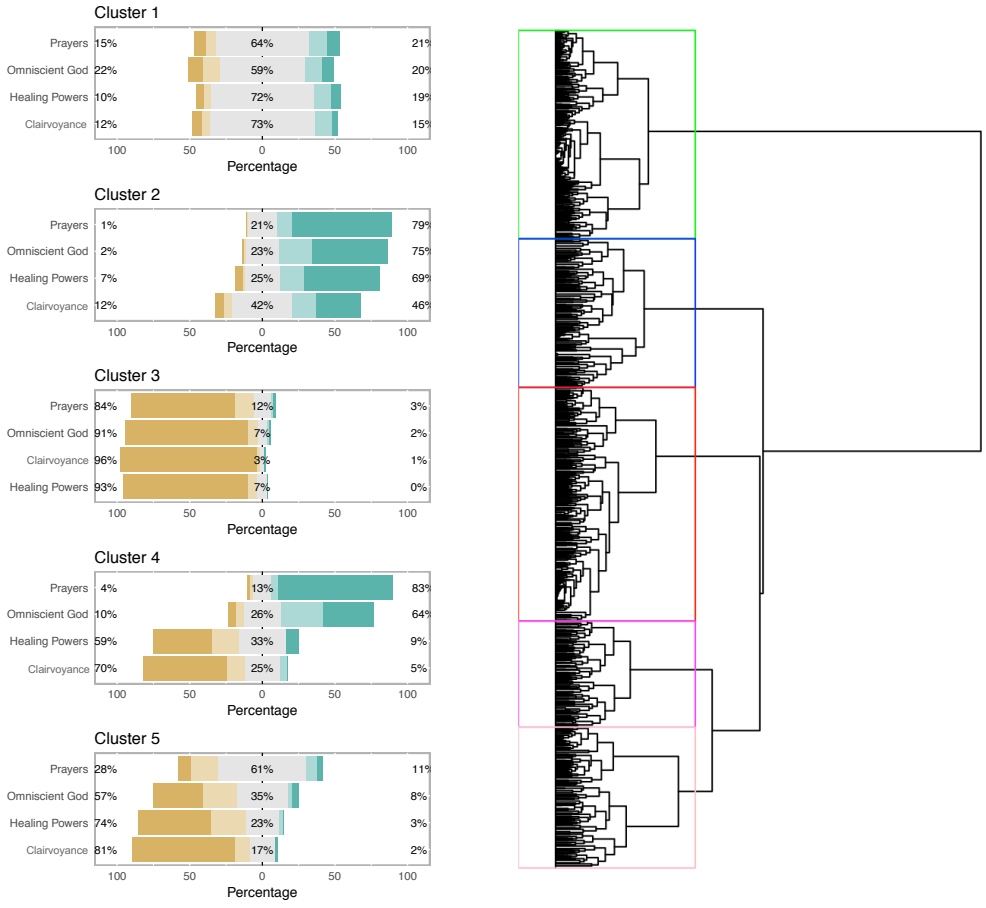


Figure. 4.2.9. Likert plots showing combined prediction of cluster membership using the top four passes in terms of prediction using the 'one rule' algorithm. The dendrogram from Fig. 4.2.8 is rotated to assist with interpretation. We can see that the first division (between Cluster 1 and the other Clusters) relates to overall levels of opinion, as those in Cluster 1 demonstrate discretely high levels of neutrality.

As the dendrogram (Fig. 4.2.8) has two super-clusters, then we can see that participants in super-cluster 1 tend to have commonality in not expressing particularly strong views either positively or negatively, whilst those in super-cluster 2 to have commonality in expressing clear views, but belong to four sub-clusters of pattern variation in their positive and negative expressions. Note that the top two questions – prayers/omniscient god – relate to theistic beliefs, whilst the bottom two questions – healing powers/clairvoyance – relate to non-theistic beliefs.

4.2.9. Multiple predictors of cluster membership

A more nuanced description of cluster membership can be obtained by combining the best predictors above using a Classification And Regression Tree (CART; e.g. Lantz 2013). This, effectively non-parametric, method attacks classification by starting with a binary split: what two-way split of a single predictor best splits the data (where 'best' is defined on information theoretic grounds according to the so-called Gini index, using the package "rpart"; Therneau & Atkinson 2018). Then, for each split in the data, the process is to create a branching decision tree. In this way, a CART naturally incorporates interactions between variables (the decision criteria for a split down one branch may be the opposite of that at the other branch), something that would be computationally very expensive in traditional multiple regression problems (here, with five clusters to predict, a multinomial generalized linear model). The process is most easily understood by talking through the results (Fig. 4.3.0).

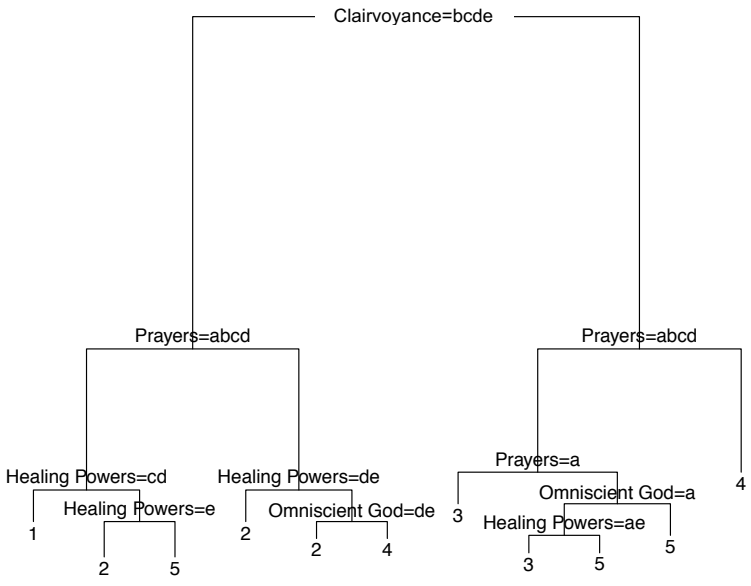


Figure. 4.3.0. CART (Classification And Regression Tree) to predict membership of the five belief type clusters in Fig. 4.2.8: based on responses to passes on *Clairvoyance*, *Healing Powers*, an *Omniscient God* and the *Power of Prayers*. The predicted clusters are numbered 1 to 5 according to Fig. 4.2.8, on the 'leaves' at the bottom of the tree. The codes at each split – abcde - refer to responses -2, -1, 0, +1 and +2 respectively (strong rejection, wavering rejection, neutrality, wavering approval and strong approval). The indicated code refers to the rule for the left-hand branch, the remainder branching right.

In Fig. 4.3.0, the first CART split (top of the tree) is based on the response to the question about belief in clairvoyance. The first rule is to take the left branch for responses -1, 0, +1 and +2 (indicated bcde) and the right branch for the remaining response -2. So the primary split is between those who strongly reject the possibility of clairvoyance (-2 response) and everyone else. Taking the first, right-hand, branch of 'clairvoyance-rejecters', the next split is on the basis of belief in the Power of Prayers, forking left if you are anywhere from strongly negative to mildly positive (abcd) and forking right if you are a strong believer in prayer. That right branch ends at cluster 4, which we had previously identified (Fig. 4.2.9) as people with strong religious superstitions but strongly against secular superstitions. And this is indeed where the decision tree has taken us: the first, right-hand, branch being rejection of clairvoyance and the second right-hand branch being strongly favouring prayer. Conversely, the left-hand branch at that second node for the 'clairvoyance-rejecters' leads us to a split, again on Prayers, with the left-hand fork being strong rejection of prayers (coded a) as one path to cluster 3 members. The latter, previously identified (Fig. 4.2.9) as against all superstition, matches that CART profile: no time for clairvoyance or prayer. The CART approach, although identifying finer degrees of separation between our five clusters (classification accuracy is 76% as compared to 57% with the One Rule method), doesn't fundamentally change our interpretation of the five clusters. Cluster 1 members are fairly neutral in their responses to both religious and secular superstitions Cluster 2 members are positive about all superstitions, while those in Cluster 3 strongly reject all forms. Cluster 4 members strongly support theistic (religious) beliefs but strongly reject non-theistic (superstitious) beliefs. Those in cluster 5 are generally negative about most superstitions, but have no strong views against the role of personal prayer.

4.3.0 Demographic statistics.

The demographic breakdowns of the sample (Table 5.0) are not analysed as such, but merely plotted for comparison of net religious (theistic) and net secular (non-theistic superstitious) scores.

Gender:

Type	Other	Female	Male	Trans F-M	Trans M-F
Count	39	1941	3024	2	6

Age Group:

Group	16-25	26-35	36-45	46-55	56-65	66-75
Count	949	2574	855	439	165	30

Ethnic Race.

Group	Arab/N Afr.	E Asian	Asian Sub-C	Black	Hispanic
Count	23	493	1216	368	185
Group	Latino	Mixed	Native/Other	White	
Count	44	140	132	2411	

Religion.

Group	Buddhist	Christian	Hindu	Jewish	Muslim
Count	63	1583	1276	69	105
Group	Native	No Religion	Other Religion	Pagan	
Count	1	1762	116	37	

Strength of Faith.

Group	None	Some	Strong
Count	1212	1951	1849

Sexual Orientation.

Group	Asexual Other	Bisexual	Celibate	Hetero	Homo G/L
Count	171	511	7	4187	136

Table. 4.2. Demographic breakdown for the sample (N=5012) in terms of the frequencies falling into various grouping. Abbreviations: Trans F-M (transsexual female to male), Trans M-F (transsexual male to female), N Afr (North African), Asian Sub-C (Asian sub-continent), Homo G/L (homosexual gay/lesbian).

4.3.1. Demographic differences in strength of belief.

So, what of the demographic differences in strength of belief? The following analyses and boxplots were generated separately with regards to theistic and non-theistic superstition

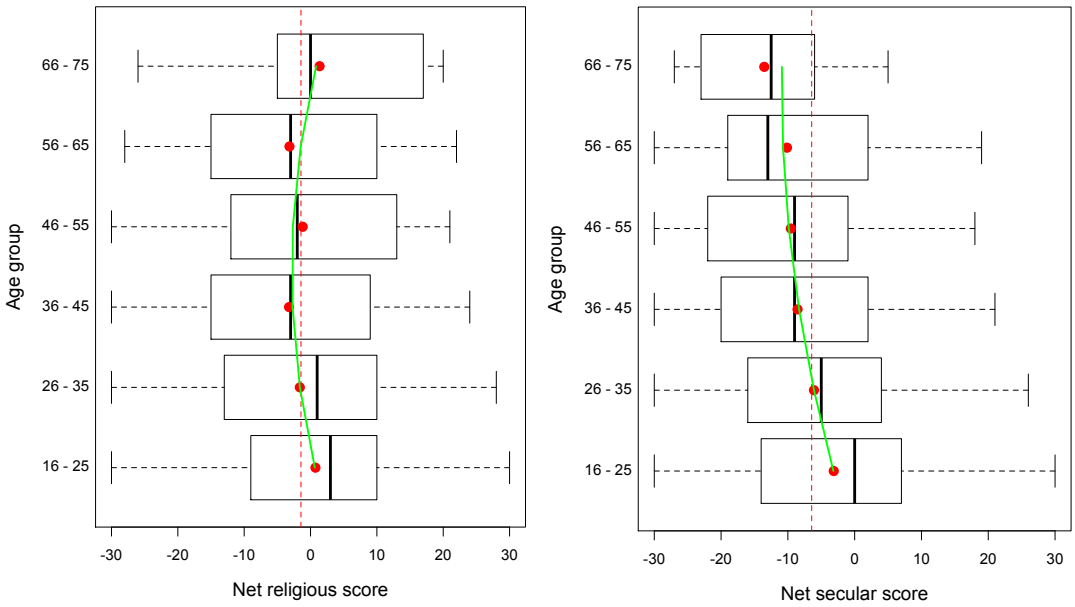


Figure. 4.3.1. Boxplots comparing belief levels (left panel: sum of religious scores, right panel: sum of secular scores) between different age groups, with a dashed red line to indicate the mean across all ages. As with all the boxplots that follow, the red dot is the mean, the thick black line is the median, the box spans the inter-quartile range, and the 'whiskers' reach to the first data point within 1.5 inter-quartile ranges of the box limits. Any points outside the whiskers are plotted as open circles and, by convention, are considered to be possible outliers.

The differences in age group (Fig. 4.3.1) are similar to those found in Chapter 2. Treating age as categorical, there is a significant difference in the mean religious ($F_{5,5006} = 8.67$, $p < 0.0001$) and secular ($F_{5,5006} = 24.13$, $p < 0.0001$) scores. Treating age as a continuous predictor, a quadratic fit is significantly better than a linear for religious score ($F_{1,5009} = 6.59$, $p = 0.0103$) but, as can be seen in Fig. 4.3.1, this is because the decline in secular score levels off with age rather than being reversed in old age (best-fitting model: score = -6.43 – 144.68*age + 35.07*age^2). For the secular score, a quadratic fit is also significantly better than a linear for religious score ($F_{1,5009} = 18.43$, $p < 0.0001$), the decline in religious score with age being reversed in old age (best-fitting model: score = -1.44 – 54.35*age + 58.75*age^2). One interpretation is that people tend to become less believing in both types of superstition as they become more 'worldly' (less naïve) with age, but they then tend to become more believing in a god or gods as they reach old age and move closer to death: i.e. they are either hedging their bets or in need of reassurance. However, as with Chapter 2, we cannot dismiss age cohort effects as a cause.

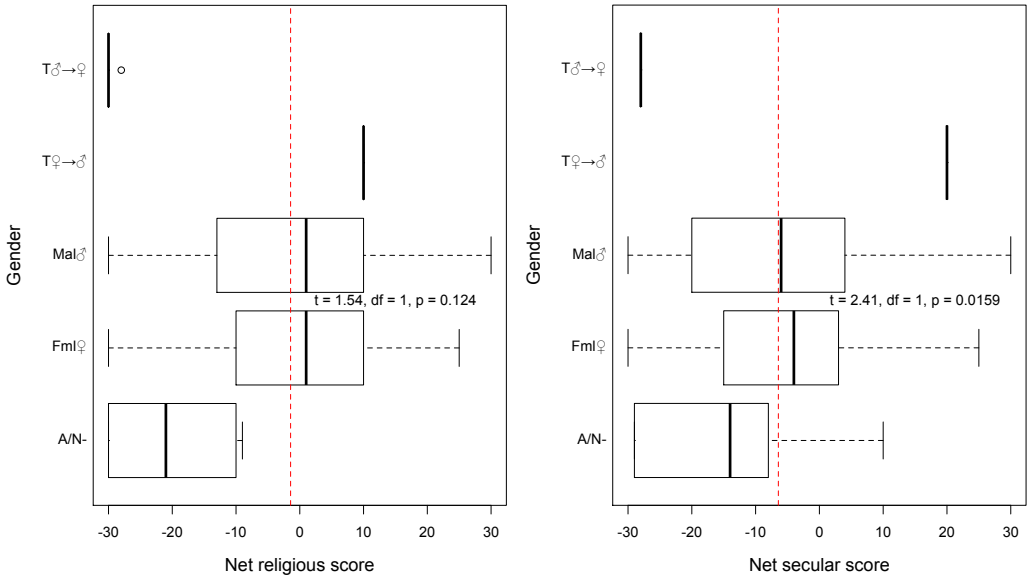


Figure. 4.3.2. Boxplots comparing belief levels between different genders (left panel: sum of religious scores, right panel: sum of secular scores). The groups are: Transsexual male to female, transsexual female to male, conventional male, conventional female, androgynous/binary/other.

The differences in gender group are intriguing (Fig. 4.3.2; religious score: $F_{4,5007} = 26.08$, $p < 0.0001$; secular score: $F_{4,5007} = 10.56$, $p < 0.0001$). Transsexuals were too rare in the sample to analyse meaningfully (6 M-to-F and 2 F-to-M), although all the M-to-F transsexuals were uniformly anti-superstition. Whilst there is no real difference between the conventional male and female groups for religious score ($t_{4431.7} = 1.54$, $p = 0.1240$) and females exhibited only slightly more secular superstition than males (mean difference = 0.94, $t_{4548.3} = 2.41$, $p = 0.0159$), the 'androgynous/binary/other' group has marked anti-superstition ($p < 0.0001$ for Bonferroni-corrected post hoc t-tests versus both males and females, for both religious and secular superstition). It is a relatively small sample (39) but consistent, perhaps indicating that those who do not identify with conventional gender have a sense of social alienation that is expressed by cynicism towards the notion of 'reason' or 'explanation' that is implied by faith (theistic or non-theistic).

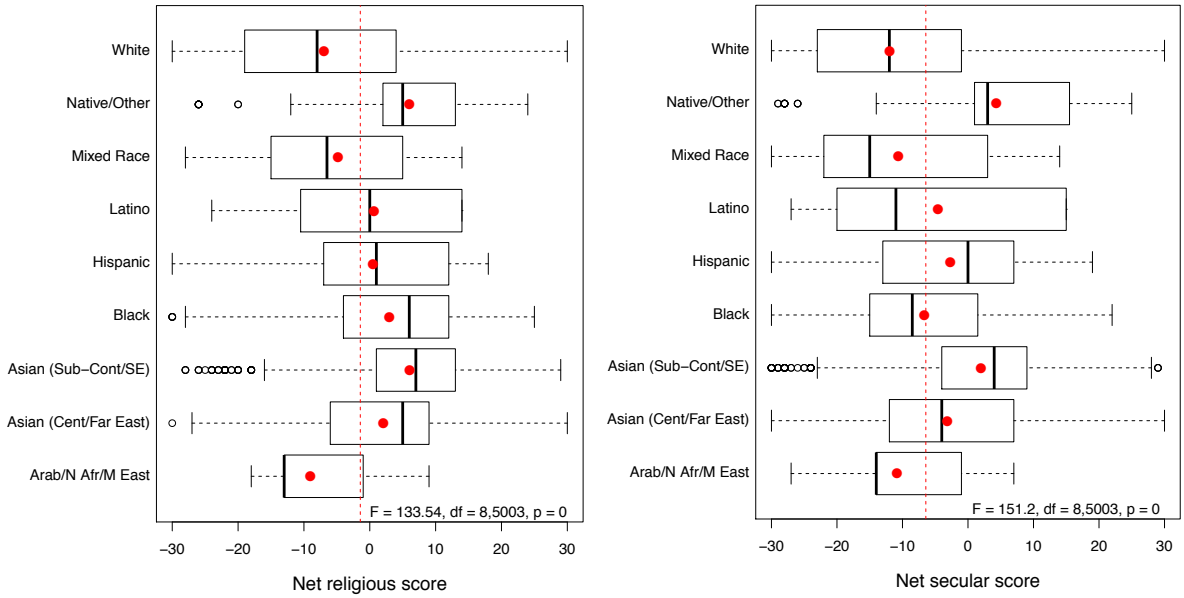


Figure. 4.3.3. Boxplots comparing belief levels between ethnic groups (left panel: sum of religious scores, right panel: sum of secular scores).

The differences between ethnic groups (Fig. 4.3.3) are significant (religious: $F_{8,5003} = 133.54$, $p < 0.0001$; secular: $F_{8,5003} = 151.20$, $p < 0.001$) with 'native' and Asian sub-continent relatively high and white and Arab generally low on both types of superstition. However, because the extent to which differences may be attributed to culture (including religious denomination) rather than race is unknown, there is little merit in dissecting the pair-wise differences. Also, for some groups (e.g. 'Arab' with N=23), the sample is very small (23).

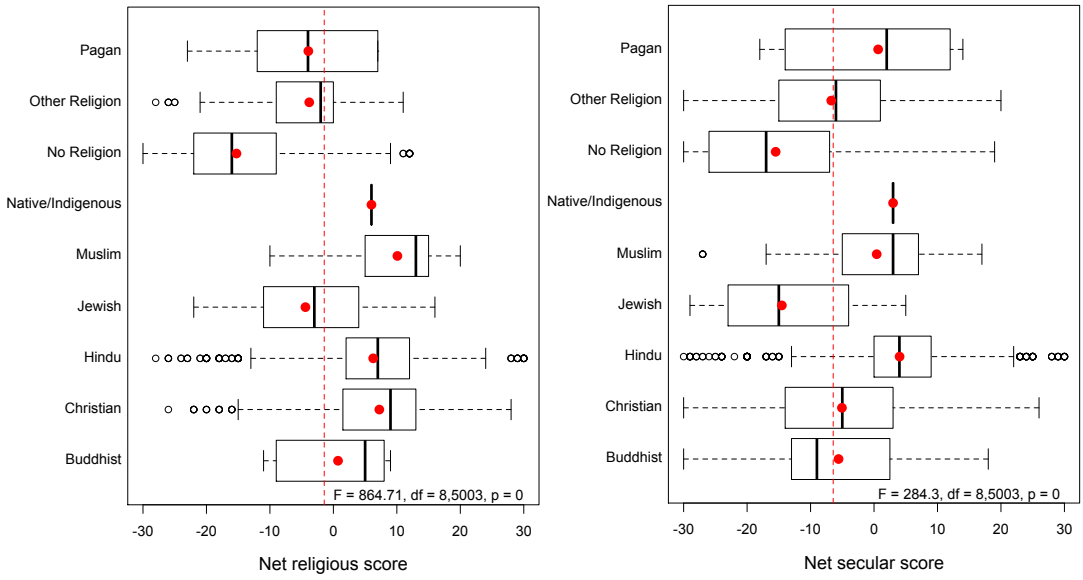


Figure. 4.3.4. Boxplots comparing belief levels between different denominations.

The significant differences between denominations (Fig. 4.3.4; religious: $F_{8,5003} = 864.71$, $p < 0.0001$; secular: $F_{8,5003} = 151.20$, $p < 0.001$) seem to concur with expectation. For example, the Pagan group clearly has higher belief in non-theistic superstition than theistic, and the No Religion group has marked animosity towards both types of superstition. Buddhism straddles the neutral zone because Buddhist doctrine is more about belief in internalized doctrine than external supernatural forces. Judaism perhaps has neutral-negative readings because it is possible to identify with being Jewish racially without belief in Judaism.

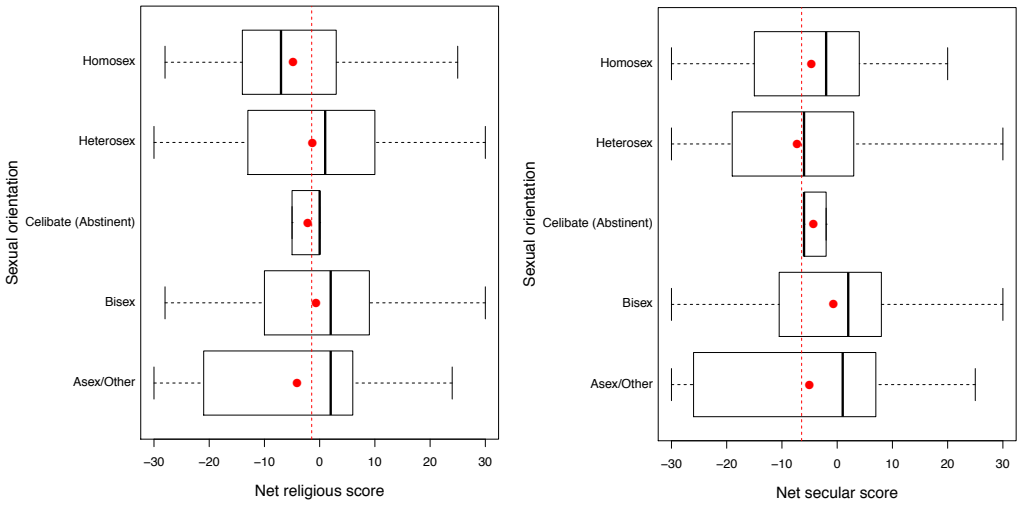


Figure. 4.3.5. Boxplots comparing differences in belief between sexual orientations.

There were significant differences in both classes of superstition with respect to sexual orientation (Fig. 4.3.5; religious: $F_{4,5007} = 4.20$, $p = 0.0021$; secular: $F_{4,5007} = 27.74$, $p < 0.001$), in both cases attributable to higher levels of superstition in bisexuals compared to homosexuals (religious: $t_{5007} = 3.19$, $p = 0.0091$; secular: $t_{5007} = 3.02$, $p = 0.0161$), asexual/other (religious: $t_{5007} = 2.86$, $p = 0.0260$; secular: $t_{5007} = 3.63$, $p = 0.0020$) and, with regard to secular superstitions only, heterosexuals ($t_{5007} = 10.31$, $p < 0.0001$); all other Bonferroni-corrected pair-wise comparisons were non-significant. That said, we can see that magnitudes of differences between the categories of sexual orientation are small.

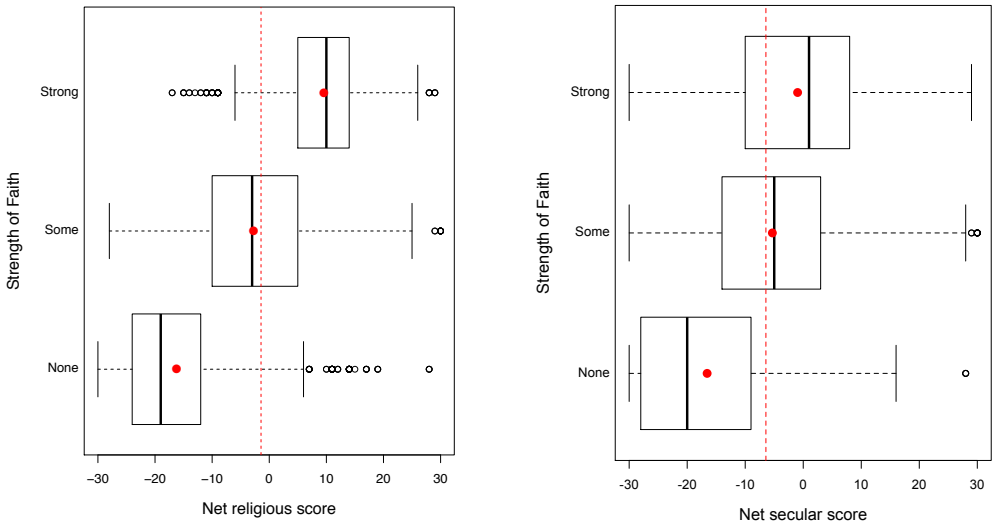


Figure. 4.3.6. Boxplots comparing self-judgement in participants on their own level of faith.

Looking at self-judgement of level in religious faith (Fig. 4.3.6) we can see that, from the relationship religious score, on average most people are pretty accurate as assessing themselves ($F_{2,5009} = 2740.00$, $p < 0.0001$), but there are a few participants who are clearly rather inaccurate. It may be that they have a perception of themselves, for particular sociocultural environmental reasons, which is some distance from their underlying belief psychology. The secular superstition score follows the same general pattern ($F_{2,5009} = 588.4$, $p < 0.0001$), unsurprising as we already know that there is a positive correlation between religious and secular summed scores.

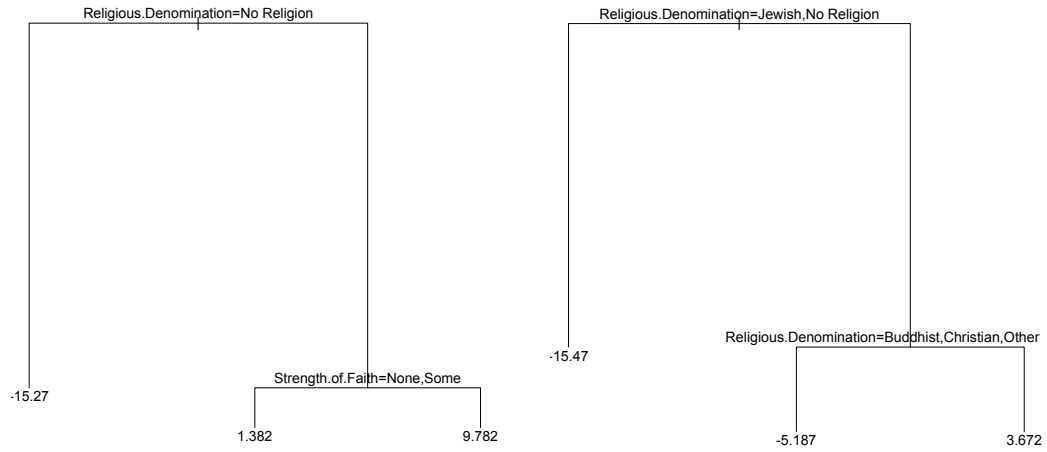


Figure. 4.3.7. Classification And Regression Tree (CART) models for summed religious scores (left panel) and summed secular scores (right panel). The numbers below the 'leaves' are the mean score for people having the factor combinations included in the tree model.

By considering all demographic predictors of summed score, using CART, we can determine which of these have a meaningful influence. For religious scores, only religious denomination (none vs the rest) and strength of faith (none and some vs strong) remained in the model, which explained 61% of the score variation (Fig. 4.3.7); all other demographic factors were irrelevant. The nature of the prediction is obvious: those with no religion had low scores; those with a religion and a strong sense of faith had high scores; those with a religion but no or some faith had intermediate scores. For secular scores, perhaps surprisingly, only religious denomination had predictive power. Jews and those with no religion had low scores; Hindus, Muslims, Native/Indigenous and Pagan had high secular superstition scores; Buddhists, Christians and Others had intermediate scores.

4.3.2 Discussion and conclusions.

Before discussing the implications of the findings, it is important to consider whether the sample, while large, was representative. For example, a fairly large contingent of the sample was strongly anti-superstitious, with a sizeable number having strongly disagreed with all aspects of superstition, whilst very few were found at the extreme of the pro-superstition spectrum. We might doubt this is typical of humanity, because of the recruitment of participants through Mechanical Turk. This necessarily attracts regular computer users, who are (as the sample shows) more likely to be males in the 25-36 age range, and probably more likely to be of high intelligence and scientifically educated, not to mention fluent in English. For such people, superstitious ideas may contravene their leanings towards a technological culture. Furthermore, it may be that those who live within particularly religious/superstitious cultures have a tendency

to amplify their anti-superstition sentiments in reaction to the milieu of their surroundings. In scientific terms, this is properly known as secular heterodoxy. That said, the sample had a good proportion of Christians and Hindus (although few of other religions) and over a third declared themselves to have 'strong' faith.

Another bias that may arise from the process of filling in a questionnaire, even online, is a variant of 'observer effect'. Whereas the Hawthorne effect (Macefield, 2007; Merrett, 2006) relates to subjects changing their behaviour whilst being observed due to awareness, in this instance the subjects have been inadvertently filtered prior to the experiment. Thus, it might be termed 'indirect observer effect'. Of course, I have no direct evidence that such distortion exists and that the observed distribution is indeed typical of the Western- and technologically leaning populations from which the participants came.

The survey had worldwide coverage (barring Australia), and recruited 5,012 participants. The demographic differences in views, while in several cases statistically significant, were of small to modest magnitude, detected on account of the high statistical power from the large sample size. On average, the strongest held views were in favour of there being a reason for living, and a rejection of what scientists would regard as more fanciful secular superstitions like clairvoyance and mind control. The idea of disapproval of atheists received a strong negative response, although more were against atheism, the concept, rather than atheists the adherents. The issue on which fewest people had strong views, positive or negative, was on whether there was a clash between science and religion.

People who tended to respond positively on issues they felt strongly about (the -2's and +2's in my scoring scheme), tended to respond positively about issues they wavered on (the -1's and +1's), and likewise for those who were generally negative. Theistic (religious) and non-theistic (secular) superstitions are moderately positively correlated, but the 'space' defined by these axes is not evenly populated, either in terms of density or the regions occupied. High belief in the secular superstitions was rarely found alongside an absence of religious themes, yet the opposite combination was much more common. The most common combinations were antipathy to both secular and religious superstitions and a neutral-to-mildly-positive attitude to both. Indeed, cluster analysis of all responses showed the largest divide was between those with neutral or variable views in regard to any form of superstitious belief, and those with clear views, positive or negative. The latter 'super-cluster' has four sub-clusters, separated by variation in their positive and negative views of religious and secular beliefs: those who strongly reject all superstition, those who strong accept all superstition, those who accept religious but reject secular superstitions, and a fifth group with largely negative views except for a mildly positive view of the value of personal prayer. Remarkably, the signature of these five clusters was detectable even in the simple summed scores (using a Gaussian Mixture Model).

Chapter Five.

Discussing the results from Methodologies One (Ch. 2), Two (Ch. 3) and Three (Ch.4).

Abstract.

This chapter overviews and discusses results of the multivariate analysis of the data from the three phases of investigation, described in Chapters Two, Three & Four, with regard to their fit with the various hypotheses that make up the general theory expounded in Chapter One. Methodology One supported the tripartite structure of human belief systems; Methodology Two supported the supernormal stimulus of religious supernatural beliefs; Methodology Three supported division into two belief phenotypes. The combined result is a paradigm for human belief systems that explains how they might be adaptive and establishes a foundation upon which further research can be mounted by demonstrating uniformity in the underlying structure and mechanism of belief systems, despite their diversity in expression at the surface.

5.1.0 Discussion.

The theory that belief systems are adaptive is simple in its concept, as it is only that 'belief *affects* behaviour *affects* selection *affects* genes *affects* belief' and so on, in a perpetuating evolutionary cycle: Fig. 5.1.0. However, rendering a narrative to explain how, why and when the mechanism came into being, and the way it works, is relatively complex with many interrelated elements.

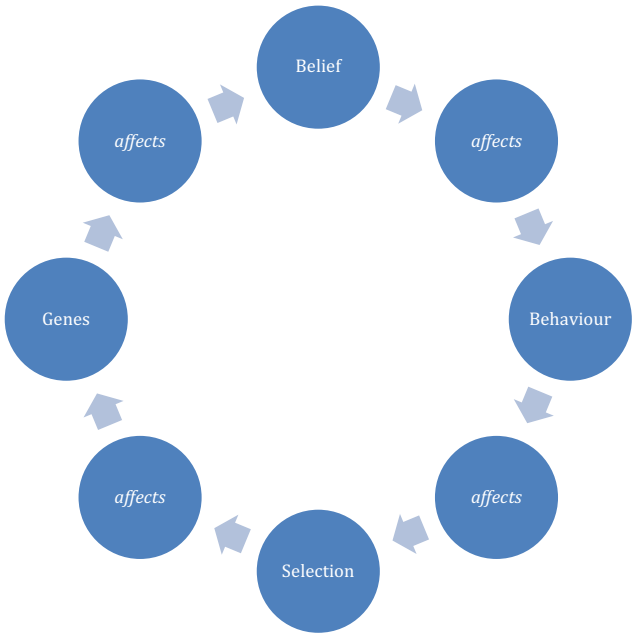


Figure. 5.1.0. The cyclical dynamic between belief, behaviour, selection and genes that is hypothesized to make belief systems adaptive.

The content in **Chapter One** aimed to elucidate each of the interrelated elements by presenting circumstantial evidence and by using sequential logic in order to construct a cogent argument in defence of the adaptive theory. At the outset, I should be clear that the theory cannot be conclusively proven because, ultimately, the origins of the brain structures and mechanisms that support belief lie in prehistory and leave no fossil traces. However, a major goal of Chapter One was to show that the theory is thus consistent with evidence from so many angles that it becomes a serious candidate explanation in the face of potential countering argument. That evidence came from social and biological anthropology, evolutionary theory (including cultural evolution), statistical decision-making and animal behaviour. In this instance I am presenting a new theory that, in turn, relies on an old theory. What-is-more, and fittingly, the adaptive theory inevitably erodes the very beliefs that attempt to counter evolutionary theory itself.

Fundamental to the adaptive mechanism is the notion of the ICA (Imagined Causative Agent), which manifests its psychological effect in the form of the supernatural beliefs that cause superstition, which is in turn expressed via behavioural cohesion and behavioural alignment, so generating sociocultural selection and biasing the gene pool in favour of the supernatural meme. Thus, there is genetic-memetic coevolution.

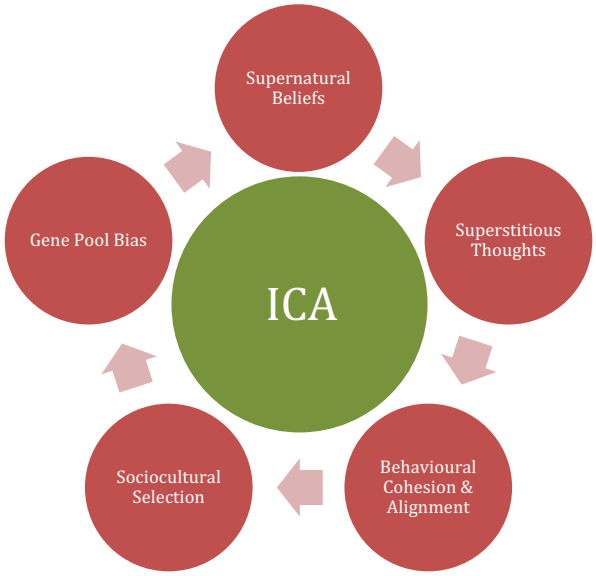


Figure. 5.1.1. Imagined Causative Agent (ICA): the cyclical dynamic generated by the ICA; by which the supernatural meme is hypothesized to exploit sociocultural selection and so bias the gene pool to perpetuate its own survival.

The proposed ICA orchestrates an adaptive cycle so that relative fitness in beliefs and behaviours is modulated by the sociocultural environment, inside which, a given version of the supernatural

meme exists (Fig. 5.1.1). Therefore relative survival and reproduction of the genes that generate inclination towards those beliefs and behaviours is context specific.

The methodology in **Chapter Two** was firstly concerned with investigating whether the three hypothesized types of belief – epistemic (empirical), prosagogic (supernatural) & efevresic (societal) – are discrete concepts in the collective human belief system. Secondly, whether there is an antagonistic relationship between epistemic and prosagogic beliefs, as they are hypothesised to belong to a common scale. Thirdly, whether efevresic beliefs are discrete from the other two, as they are hypothesized to belong to a separate scale.

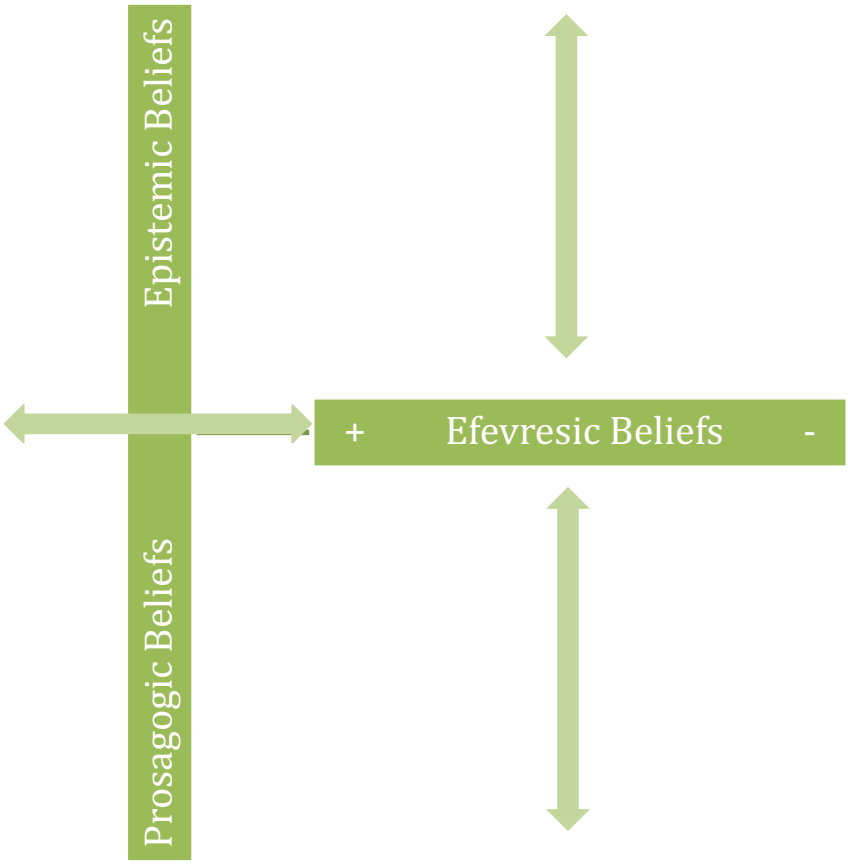


Figure. 5.1.2. Diagram to illustrate the indirect relationship between the prosagogic-epistemic belief scale and the efevresic belief scale in every human belief system. Positive efevresic beliefs equate with general societal conformity, functionality and success, but they can associate with any position along the prosagogic-epistemic scale, which equates with conformity, functionality and success according to context specific sociocultural selective factors.

Looking at the results of Methodology One: The proposed tripartite belief structure is well supported by the boxplot shown as Fig. 2.1.3. and the hypothesis that prosagogic and epistemic beliefs belong to a shared scale, with efevresic belief belonging to a separate orthogonal scale are well supported by the correlations shown as Figs. 2.1.4 & 2.1.6.

In all three regards, it is reasonable to conclude that analysis showed a clear fit with the hypotheses. Therefore the proposed model (Fig. 5.1.2) for the way beliefs are arranged is supported by the results. Most importantly, this model enables comparison of human belief systems from any sociocultural contexts as it demonstrates a fundamental commonality in underlying structure despite the wide diversity in presentation of belief systems worldwide. Therefore, an international sample was sanctioned for the third methodology (Chapter Four) with some confidence that data from people of varying cultures would be valid.

Chapter Three was primarily concerned with investigating the relationship between superstition and rationality in human belief systems. The hypothesis was that the supernatural meme essentially works in two modes (religious and non-religious), which enables it to both covertly and overtly influence the human mind and therefore elicit suitable behaviours for its own survival.

Firstly, the analysis shows that people tend to have heightened levels of belief in a god relative to their view of other superstitious beliefs. Secondly, the analysis suggests that the notion of a god may function as a 'supernormal stimulus' (Fig. 5.1.3), so that it makes the mind more susceptible to believing in other supernatural ideas to suit the supernatural meme. With the weight of the god concept in place, the balance of likelihood that other supernatural ideas will be believed increases.

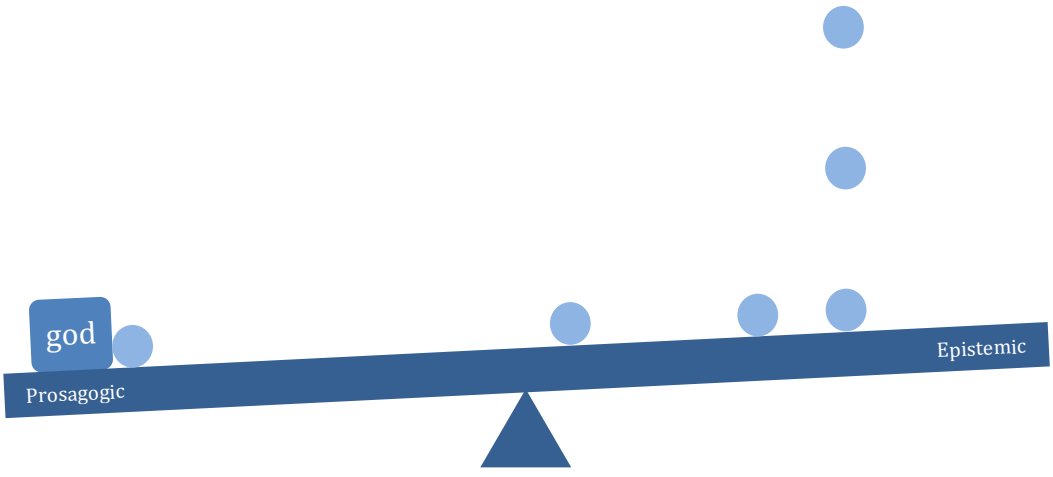


Figure. 5.1.3. Seesaw analogy for the supernormal stimulus of the god concept. With the weight of the god concept set in place, other supernatural ideas (falling blue balls) are more readily accepted when they might otherwise be rejected from the epistemic end of the seesaw, due to the psychological bias.

Looking at the results of Methodology Two: The hypothesized supernormal stimulus is supported by the plotting of level of belief in a god against a scale of rationality: superstition shown as Fig, 3.1.1, suggesting two groups – low and high belief in a god. This is further supported by the dendrogram shown as Fig. 3.1.6, which clearly shows agreement with the idea that there are two general camps. Furthermore, the scatterplot shown as Fig. 3.1.7 demonstrates that the more people believe in a god the more likely they are to believe in other supernatural ideas. Thus, the evidence suggests the action of the 'god meme' as a supernormal stimulus and that two or more 'belief phenotypes' are present, upon which the mechanism acts.

More generally cluster analysis of the participants showed three main groups, the largest consisting of participants with strong responses related to social conformity, religious tolerance and spiritual beliefs unconnected to mainstream religion. This group was quite separate from two other clusters: those with strong traditional religious beliefs and those with strong secular superstitions (but not both). These three groups of participants were, to a high degree, the same as those identified in Chapter 2. In addition, the analysis demonstrated that inclination to believe in supernatural phenomena was present in all subjects although notably less so in the cluster of people holding strong traditional religious views. Otherwise, approaching 20% of people with 'rational' phenotypes (from Chapter 2's analysis) exhibited various types of superstitions from the secular to spiritual. This is fundamental to the very idea that belief systems are adaptive as it provides circumstantial evidence for a proposed universal mechanism.

The corollary was to investigate the structure that generates this trait variation by designing a means of collecting data that betrays underlying patterns in thought processes across a suitably large sample of people without their being aware. This was the topic of Chapter 4's analysis.

Chapter Four was primarily concerned with the relationship between fixity and plasticity in human minds with regard to their belief systems. The hypothesis was that people possess differing ratios of both in their psychology, which determines their basic belief inclinations, with many variables then determining behavioural outcomes. The survey had just over 5,000 participants and, barring Australia, had worldwide coverage. The demographic differences in views were of small to modest magnitude, detected on account of the high statistical power from the large sample size.

On average, the strongest held views were in favour of there being a reason for living, and a rejection of those secular superstitions that are both most at odds with science and (unlike crossing your fingers before doing something with an uncertain outcome), likely to have significant costs in terms of both how one leads one's life and financial expenditure. The idea of disapproval of atheists also was rejected strongly by most, and supported by few, although more found atheism, the concept, unappealing. Few people had strong or even mild views, positive or negative, about there being a clash between science and religion. This is relevant to the argument

in this thesis that, contra Dawkins (2006), most people do not see science and religion as fundamentally different ways to think about the world.

The degrees to which people supported theistic (religious) and non-theistic (secular) superstitions were moderately positively correlated. However, strong belief in the secular superstitions was rarely found alongside an absence of religious inclination. The opposite combination was much more common, what one might view the traditional religious position of strong adherence to the superstitions of one's own faith (but, of course, not seen as superstitions by the adherents) and rejection of any superstitions that require belief in a supernatural agency other than one's god. That said, perhaps unsurprisingly in a sample derived from regular computer users and thus people well entrenched in societies where technology provides the answer to many of life's problems, the most common combinations were antipathy to both secular and religious superstitions and a neutral-to-mildly-positive attitude to both.

Cluster analysis showed that the largest divide was between those with neutral or variable views in regard to any form of superstitious belief, and those with clear views, positive or negative. The latter super-cluster had four sub-clusters: those who strongly reject all superstition (the hyper-rationalists of Chapters 2 and 3), those who strongly accept all superstition, those who accept religious but reject secular superstitions, and a fifth group with largely negative views except for a mildly positive view of the value of personal prayer. Chapters 2 and 3, with an order of magnitude smaller sample size, did not have the resolution to distinguish the latter three groups and pooled these as 'religious'.

Looking at the results of Methodology Three: The hypothesized presence of cognitive phenotypes is summarized by the dendrogram shown as Fig. 4.2.8. It shows that the sample fell broadly into two camps, further sub-divided into five smaller camps (1:4). This implies the presence of at least two phenotypes as determined by relative levels of cognitive plasticity and rigidity. Further analysis, shown as Fig. 4.2.9 demonstrates that membership of the different camps is shown to rely of particular belief patterns. Those in the isolated Cluster 1 were essentially highly cognitively plastic, as they expressed high levels of neutrality or indifference in their beliefs. Those from Clusters 2 & 3 were highly cognitively rigid, but in different directions – 2: irrational/superstitious, 3: rational/non-superstitious. Those from Cluster 4 fell somewhere between, as they had high belief in religious superstition but low belief in non-religious superstition. Similarly, those from Cluster 5 had low belief in non-religious superstition, but expressed moderate belief in religious superstition, as if hedging their bets. So, we can see that the five clusters comprise a set of response types, but relative cognitive rigidity and plasticity can relate to both ends of the spectrum in terms of belief categories, which is to be expected. So, phenotype expressions appear to be determined by two dominant and meshed factors: i. Rationality versus superstition. ii. Plasticity versus rigidity. They seem to be orthogonal, as it is clearly possible to have diametrically opposed beliefs ranging from extreme to moderate.

Although the analysis cannot distinguish between innate and environmental influence on the spectrum of responses, my proposition is that an individual's position in the distribution will be determined firstly by their phenotype, secondly by factors from both their natural environment and their sociocultural environment, and thirdly by 'internal' variables relating to development, personality, health and so on.

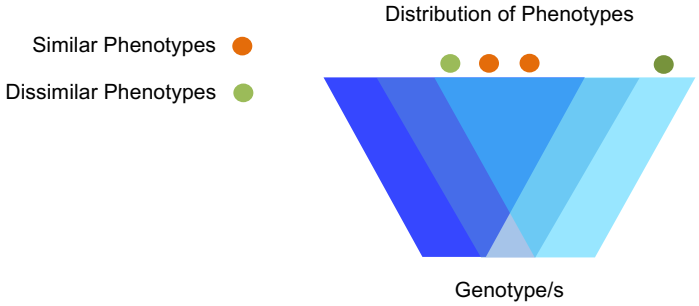


Figure. 5.1.4. Genotype-phenotype model; to explain that two similar phenotypes (orange balls), in belief system and behaviour, might result from two genotypes by radiating overlap, due to the accumulative effect of natural, sociocultural and internal variables. On the other hand, they might result from just one genotype. Similarly, two dissimilar phenotypes (green balls) might result from either one or two genotypes.

Other factors are an individual's opportunity to reproduce, their frequency of reproduction and their choice of reproductive partner or partners, with regard to those genotypes/phenotypes. One can see then, that the hypothesized mechanism must be quite subtle as an adaptive process so that populations make only small adjustments over generations and maintain sufficient genetic variety to cause subsequent adaptation to occur. It is possible two genotypes are in frequency-dependent coupling, so they both produce phenotypes with behaviours that sociocultural selection acts on favourably.

It is sociocultural selection that the supernatural meme is hypothesized to exploit, as it effectively hones the selective process by imposing amplifying sociocultural factors via superstition to ensure its own survival. This is especially so with organized religion, as the sociocultural factors that determine societal acceptance and rejection become more precise and accentuated. Thus, progression towards organization makes evolutionary sense for the supernatural meme, as it equates with improved psychological control, making it self-selecting.

It is notable also, that the supernatural meme amplifies its prospects of survival via the 'extended phenotype' (Dawkins, 1982). Religious people leave a religiously informed sociocultural environment as their phenotypic legacy, which serves to help impregnate the minds of new

generations with the supernatural meme. For example; cathedrals, churches, shrines, cemeteries, sacred art, crucifixes, the bible, relics, hymns, prayers, commandments, rituals and so on, are all extensions of the Christian version of the supernatural meme, left by the religious phenotype in past generations.

5.1.1 Conclusions.

Bringing together the results from all three methodologies and their fit with respective hypotheses, the accumulative evidence is highly persuasive of an ecological basis for human belief systems, because there are discernable emergent patterns to demonstrate that belief systems are not arbitrary and random in their distribution, but instead indicate that they manipulate human behaviours in such a way that they effect biological fitness, by determining the chances of propagating genes (survival and reproduction) within the context of sociocultural environments.

The results also suggest an overarching mechanism, based on phenotypes, that causes the selective process to steer a course within parameters, with the result that populations generally avoid deleterious outcomes by becoming neither too zealous nor liberal in their beliefs and associated behaviours, as both have the potential to reduce group adaptability. The mechanism would appear to be governed overall by the inherent advantage of the human species being social, yet needing to deal with environmental changes, so belief systems and their associated behaviours, in combination with phenotypes and selection, ensure that populations remain within parameters to optimise their biological fitness within context. Put another way, it is not useful to have so much genetic variation that social cohesion is lost, nor is it useful to have so little genetic variation that adaptability is compromised.

It seems reasonable, therefore, to conclude that human belief systems' being adaptive is the 'most likely' explanation for their existence and function, especially given their elaborations and inclusion of supernatural ideas that don't relate directly to interaction with the environment. The only alternative, that they are non-adaptive, would mean that beliefs are arbitrary and randomly distributed so that belief systems would express no meaningful patterns across samples. Given the reach of review in Chapter 1 and the rigour of the experimentation and multivariate analyses in Chapters 2 to 4, this seems very unlikely, even without conclusive proof. It would also imply no rationally based notion of function, adaptive or otherwise, which is simply not logical given that all other aspects of human design have been selected for their ecological benefit. Thus, the weight of argument is strongly in favour of adaptiveness over non-adaptiveness.

On the matter of religious beliefs, it is evident that ideas of a god, or gods, are elaborations of the ICA that have come about as a result of the supernatural meme diversifying and improving its prospects of survival within the collective human consciousness. Therefore, an ecological explanation for all supernatural ideas is provided, which does not require their existence outside

of the human mind. Thus, there has been genetic-memetic coevolution in relation to human belief systems ongoing since the sentient-sapient horizon in our chronospecies. The adaptive mechanism has remained unchanged for all of that time, but variants in the ICA have become so diverse that it has been necessary to strip back and simplify our understanding of beliefs, behaviours and selection in order to find the mechanism.

Pascal's wager illustrates the preoccupation created by the ICA concept of a god in the human mind. It is an argument by 17th century philosopher Blaise Pascal that it is rational to believe in a god because the costs during life, if there is no god, are finite whereas the benefits after death, if a god does exist, are infinite (Connor, 2006). However it presumes that such a god would punish those who hadn't believed and reward those who had believed, which I would argue has questionable logic; as a judgemental god would only notice the sins of believers and not the absence of sins in non-believers, as one has to believe to be able to sin. Thus a non-believer would be immune from judgement if a god exists, having never been made available for judgement.

By understanding that beliefs come in three types and comprise two scales it immediately becomes possible to pare away the cultural 'noise' and appreciate, I suggest, that the mechanism is a constant across all forms of society. There are two main options for the underlying genetic control for my proposed belief mechanism. The first is that there is one genotype that underlies a single pan-human mechanism which generates multiple phenotypes according to socio-environmental circumstances. This is the phenotypic plasticity option. Here, the genes that produce the flexible phenotype are adaptive precisely because they allow the phenotype to be fit-for-socio-cultural-purpose. This scenario, counterintuitively, proposes that the religious and rational phenotypes in Chapters 2 and 3, and the five main clusters in Chapter 4 (including the seemingly diametrically opposed virulently anti-superstition sceptics and the traditionally religious), are all products of the same underlying belief mechanism. The hyper-rational opponents of religious dogma and clairvoyance alike still have beliefs – convictions that they will hold onto despite any contrary evidence – but these beliefs are adherence to the theories of science. There is a strong position in the doctrine of science that, contrary to the Popperian principle of falsification, theories are never dismissed on the basis on one key experiment (Kuhn, 1962; Lakatos, 1978). The current dogma is maintained and alternative explanations sought for data inconsistent with them, until the accumulated evidence is large and, usually, an alternative theory is available that explains the new evidence (Kuhn, 1962). This is belief – belief that can ultimately be altered ultimately by hard evidence – but belief nonetheless.

The second main option is that two or more of the observed belief phenotypes are underpinned by different genotypes, for example 'indifference' and 'conviction' (the two major clusters of Chapter 4) or 'secular' and 'religious' (the two major clusters of Chapters 2 and 3). For these to coexist, there would either have to be negative frequency-dependent selection, with roles for

both in society and the advantages of each dependent on their frequency relative to the other, or a heterogeneous environment in space or time, with each genotype favoured in one area/time and gene flow between them. In terms of heterogeneity in time, the optimistic scientist might argue that the superstitious belief genotype (and its associated memes) was adaptive in the past, in the absence of scientific theory and decisive data (via the scientific method), but that the environment and so selection has changed, favouring the rational belief genotype and its associated memes. This view would suggest the genetic polymorphism behind the belief clusters we see today is a transitional polymorphism, with the rational genotype replacing the superstitious as the environment changes to one dominated by technological and scientific models with which to understand the world. Only time will tell.

On the matter of the human condition, it is clear that selectively favoured belief behaviours have been characterized by both aggression and passivity towards other humans in given contexts, which is why humans have the capacity for extremes in their treatment of other humans: cruelty and kindness. As these extremes have both improved fitness they have become characteristic of the human condition genetically, making us equally cursed and blessed: we all have the capacity for positive empathy and negative empathy, due to the selective pressures on our ancestors and the ways of thinking, and associated behaviours, these have favoured. For those who hope for accord, it is disappointingly evident that humans are seemingly hardwired to favour those with whom they share the most and to disfavour those with whom they share the least, and part of the assessment of similarity is through belief inclinations and their expressed behaviours.

So, not only are belief systems adaptive – they have adapted us in such a way that our beliefs and behaviours could be viewed as maladaptive in the context of modern sociocultural environments, where finding difference is not conducive to the continuance of the contemporary societal model. That is, unless we adhere to the possibility, described earlier, that rationality is a new genotype sweeping through modern society to fixation, we cannot help ourselves having, sometimes irrational or maladaptive, beliefs because that it is the way we are made. Similarly any scientific ambition for a secular humanity, free of religion, would be thwarted. For one thing, my analyses and those of others discussed, show that all humans have at least some supernatural belief inclination and that many humans have a lot. Secondly, there is no scientific equivalent to superstition by which it would be possible to orchestrate and police behaviour without enforcing an oppressive regime (and this would be a regime contrary to the inclinations of most scientists). Nor would it be possible to reconfigure humanity genetically, without centuries of selective breeding. Thus, I would argue, depressingly to some, that there is no prospect of designing a new wholly rational human to fit with an idealized vision of future society. Instead we are stuck with a design shaped by billennia of evolution, and it would be fruitless trying to shoehorn it into the shape of an unrealistic idea of what humanity should be – from the scientific point of view.

On the matter of belief in evolution itself, and indeed this theory, it is clear that a significant portion of humanity will not believe in it, because they cannot, regardless of any evidence and argument presented to them, due to the religious model they are bound by. Their genetic make-up has been so channelled by the supernatural meme in their ancestors that it renders them psychologically dependent, so the only option would be to change allegiance to another religion that accommodates scientific progress and so allow cognitive dissonance to prevail. Of course, in reality that scenario is not likely to be very frequent, because one would have to either move to a different sociocultural environment, one that supports your 'new' religious view, or change the views of all around you. The former does happen, via migration, at a low frequency, with the clearest examples actually being of religiously conservative groups leaving their country of origin because the dominant religious view has changed (e.g. The Pilgrim fathers, the Huguenots). The latter – mass enforced change in belief system – have happened too, Nazism and Stalinism being recent examples, but ultimately failed.

So, where is the benefit in learning that belief systems are adaptive if we can do nothing to change humanity for the better? Well, for a start the notion of 'better' is a subjective judgement, so perhaps it would be appropriate to abandon the rational stance of the scientist and accept humanity for its ability to be irrational. Moreover, by understanding the belief mechanism we can understand how to manage cultural relations more effectively on the global scale. The starting point is to realize that all human cultures have their own versions of the same supernatural meme and that it holds sway over their psychology in much the same way, even if it seems foreign and alien due to the particular behaviours it has cultivated. Secondly, it pays to realize that our own behaviours can seem just as foreign and alien to other cultures, so managing cultural relations requires mutual understanding of the underlying effect of the supernatural meme.

My penultimate conclusion relates to the point of origin and subsequent evolutionary journey of the ICA (Imagined Causative Agent), as without the ICA the supernatural meme could not have been conjured and could therefore not have proliferated into its diverse range of manifestations in the human mind.

The hypothesized ICA began as a simple memetic ritual in the chronospecies and only began to include supernatural content when sapient intelligence facilitates existential enquiry and complex communication of ideas: i.e. proto-superstition became superstition. Eventually the concept of a god/gods developed as one of many ways to explain and describe the ICA, which remained unaltered throughout the evolutionary journey, but became embellished from a simple behavioural activator into a complex of fantasies, due to speciation of the supernatural meme within increasingly organized sociocultural environments and selection favouring individuals more genetically inclined to believe and perpetuate the meme due to conferred biological fitness from behavioural cohesion and behavioural alignment: i.e. the gene:meme interface. Thus, any

version of the supernatural belief system is someone's ICA, whether it is a simple and occasional superstition or a complex and involving religion. Fig. 5.1.5 is a diagrammatic summary of the adaptive theory.

Finally, the ethnographic examples in Chapter One demonstrate that the supernatural meme has elicited remarkable cultural variety in superstitious behaviours across the globe, yet they appear to have very similar roles as drivers for sociocultural selection in each and every society. This is the lynchpin in understanding the human condition and the real benefit, societally as well as scientifically, to be had from taking the standpoint that belief systems are adaptive, because it opens the door to seeing commonality beneath the patina of difference.

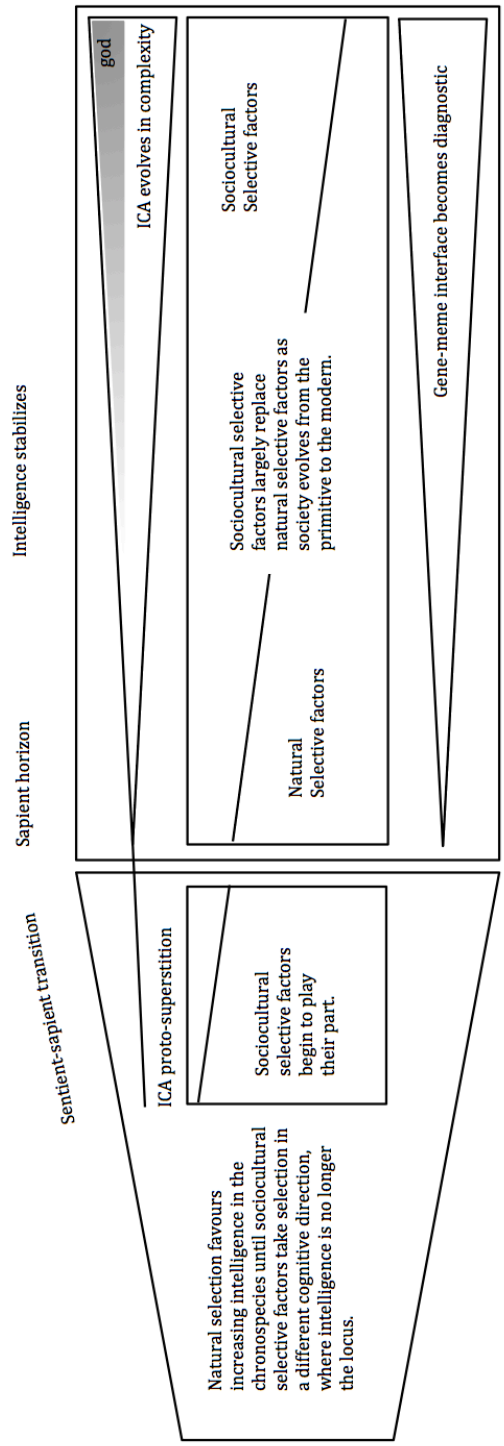


Figure. 5.1.5. Diagram explaining the hypothesized origin and subsequent evolutionary journey of the ICA (Imagined Causative Agent) in parallel with the transition from natural selective factors to sociocultural selective factors.

Glossary of terms.

- **Chronospecies**: The collective term for the linear evolution of a single species, comprising the various 'prototype' stages throughout its prehistory.
- **Efevresic beliefs**: These are non-empirical beliefs that relate to societal behaviours – also known as societal beliefs.
- **Epistemic beliefs**: These are empirical beliefs that relate to scientific understanding and are antagonistic to prosagogic beliefs – also known as scientific beliefs.
- **Meme**: These are communicated ideas that perpetuate their survival and evolution by affecting behaviour, in this context.
- **Prosagogic beliefs**: These are non-empirical beliefs that provide understanding by means of supernatural ideas and are antagonistic to epistemic beliefs – also known as supernatural beliefs.

Appendix of Questionnaires.

Appendix 1.
Questionnaire 1.
48 questions answered using a percentile scale.
Q1. To what extent do you think it has always been a matter of sense to you that a spiritual world exists alongside our own world?
Q2. To what extent do you think that society can only work if people think and behave according to the same moral and ethical codes of right and wrong?
Q3. To what extent do you think that certain things can bring good or bad luck in life, including numbers, animals, omens, charms, curses and jinxes?
Q4. To what extent do you think that only science can explain the way everything works in the world, even though scientists have yet to find all of the answers?
Q5. To what extent do you think that humans have high intelligence to make it possible to connect and communicate with the spiritual or supernatural world?
Q6. To what extent do you think that people should be judged and punished by society for bending and breaking the rules and laws by which society works?
Q7. To what extent do you think that people who say they lack spirituality are either mistaken or stubborn and will eventually discover or admit the truth?
Q8. To what extent do you think that the idea of evolution is better than the idea of creation at explaining how so many different plants and animals came to exist on earth?
Q9. To what extent do you think that supernatural forces are responsible for unexplained phenomena, unexpected events and unlikely coincidences?
Q10. To what extent do you think it is more natural for you to follow and obey the rules and laws of society than to ignore and break them?
Q11. To what extent do you think that positive and negative thinking have the power to affect our fortunes and luck in life, for the better or for the words?
Q12. To what extent do you think that ideas and theories about how the world works should only be accepted if supported be evidence from scientific tests and experiments?
Q13. To what extent do you think it is more sensible to follow superstitions than to ignore them, just in case there is some truth behind them?
Q14. To what extent do you think it is necessary for everybody to follow and obey the same sets of rules and laws for society to keep order and control?
Q15. To what extent do you think we get what we deserve in life because good and bad thoughts and intentions have an underlying effect on where destiny takes us?
Q.16.To what extent do you think that spiritual and paranormal phenomena cannot logically exist because the laws and principles of science fail to explain them?
Q.17. To what extent do you think that the earth's animals and plants were created as they are and have not evolved or changed from one species to the next over time?
Q.18. To what extent do you think it is important to have a good understanding of social rules and manners in order to make a good impression and achieve success?
Q.19. To what extent do you think that scientific evidence or proof is not relevant in the case of spiritual and paranormal ideas because they go beyond science?

Q.20. To what extent do you think that scientific explanations are more reasonable than other explanations for how the world works, as they seem more intelligent and rational?
Q.21. To what extent do you think that something being alive is more than just a collection of chemical reactions and biological processes as described by science?
Q.22. To what extent do you think it is necessary to share the interests, politics and general views of your social group in order to be accepted and feel that you belong?
Q.23. To what extent do you think that everyday supernatural practices genuinely work, such as astrology, clairvoyance, telepathy, fortune telling, magic and wishing?
Q.24. To what extent do you think that people are attracted by ideas of spiritual guidance to avoid responsibility and blame for their decisions and actions in life?
Q.25. To what extent do you think that connecting with the spiritual world is simply a matter of making the mind accepting and open to spiritual experiences?
Q.26. To what extent do you think that you have similar ideas about how to properly behave and treat others as most of the people in society around you?
Q.27. To what extent do you think that spiritual ideas must be true because millions of people have believed in them for thousands of years and still do?
Q.28. To what extent do you think that children should be taught to compare the merits of competing spiritual and scientific ideas before forming their opinions?
Q.29. To what extent do you think that humans have life forces that continue to exist after death in the form of supernatural entities, such as souls, sprits and ghosts?
Q.30. To what extent do you think it is important to be social, so that you and your friends and family form a network of support and understanding for one another?
Q.31. To what extent do you think it is destiny or fate that determines our fortunes in life, rather than random or chance factors and our decisions and choices?
Q.32.To what extent do you think that spiritual and superstitious ideas are outdated, because they come from a time when people had little scientific understanding?
Q.33. To what extent do you think that paranormal phenomena and abilities must exist because such ideas are so widespread and accepted in everyday life?
Q.34. To what extent do you think that a fair society is one with open communication and a democratic approach to deciding what the laws and rules should be?
Q.35. To what extent do you think that dreams contain supernatural messages and warnings to help us make the right decisions and choices in life?
Q.36. To what extent do you think that spiritual ideas can feel farfetched, but you still have them anyway, because they give you something extra that you need as a person?
Q.37. To what extent do you think that spiritual ideas provide a sense of meaning and purpose to life that cannot be found with purely scientific ideas?
Q.38. To what extent do you think that developing an ability to sympathize and empathize with others is key to being popular and having successful relationships?
Q.39. To what extent do you think it is acceptable for children to be encouraged to believe in supernatural ideas such as fairies, wishing Santa Claus and magic?
Q.40. To what extent do you think that a purely scientific view of the world is more satisfying than a spiritual and supernatural view, because it relies on known facts?
Q.41. To what extent do you think that children imagine their toys have personalities and the ability to talk and move because they have an instinct for the idea of life forces?
Q.42. To what extent do you think it is necessary for society to have structure, so that some people are more important than others according to their responsibilities?
Q.43. To what extent do you think that you sometimes have a sixth sense, which informs you of things about to happen or warns you of danger and so on?
Q.44.To what extent do you think that spiritual and paranormal ideas are unlikely to be true, but they must still be considered because science cannot disprove them?
Q.45. To what extent do you think that you have a purpose or calling in life, because you seem to have been steered or led in a particular direction for some reason?
Q.46. To what extent do you think that children should be taught good ethics and morals, so that new generations keep society working properly?
Q.47. To what extent do you think that spirituality attracts you because it offers you life a sense of routine, reassurance, stability, belonging and happiness?
Q.48. To what extent do you think it is hard to understand where spiritual ideas come from, because you seem not to have witnessed or experienced anything to suggest them?

Appendix 2.

Questionnaire 2.
48 questions answered using a percentile scale
Q.1. To what extent do you think of yourself as a believer in a god?
Q.2. To what extent do you think you have spiritual beliefs or feelings yet have no belief in a god?
Q.3. To what extent do you feel that people are born with natural levels of goodness and badness?
Q.4. To what extent do any underlying religious beliefs you have affect your view of science?
Q.5. To what extent do you allow yourself to enjoy things that are bad for you by twisting the evidence?
Q.6. To what extent do you consider what horoscopes say, even if you don't believe in them?
Q.7. To what extent do you believe those claiming to have supernatural or paranormal experiences?
Q.8. To what extent do you struggle to alter your behaviour even when you know it endangers you or others?
Q.9. To what extent do you feel that dead relations or friends look down on you to approve or disapprove?
Q.10. To what extent do you think religion has a generally beneficial or good effect on society?
Q.11. To what extent do you think you are able to adapt or change your views?
Q.12. To what extent are you superstitious, and do things to bring good luck or to avoid bad luck?
Q.13. To what extent do you connect by prayer, thought or gesture to a higher power?
Q.14. To what extent do bouts of good luck or bad luck affect the decisions and choices you make?
Q.15. To what extent do you try to use thoughts, wishes and curses to affect other people's fortunes?
Q.16. To what extent do act as if machines, like cars and computers, have personalities?
Q.17. To what extent do you go through rituals or habits before leaving home, or eating or going to bed?
Q.18. To what extent do you use mascots or lucky charms to improve you chances of success?
Q.19. To what extent do you act as it everyday objects, like mugs and bowls, have their turn to be used?
Q.20. To what extent do pretty insects, like butterflies, appeal to you more than plain ones, like moths?
Q.21. To what extent do you imagine angels, demons and gods to have human form, regardless of belief?
Q.22. To what extent are you more open to religious thoughts when unhappy, ill or stressed?
Q.23. To what extent do you feel respect towards religious people, such as priests, monks and nuns?
Q.24. To what extent do you shun belief in superstition, by deliberately walking under ladders and so on?
Q.25. To what extent do you think it is cruel to injure or kill spiders, insects and other bugs?
Q.26. To what extent do you become sentimentally attached to possessions, like cars, houses and jewelery?
Q.27. To what extent do you feel it is sensible to believe in a god just in case it turns out to be true when you die?
Q.28. To what extent do you think religion has a generally detrimental or bad effect on society?
Q.29. To what extent do you avoid tempting fate, by not saying you're having a good day, or similar things?
Q.30. To what extent do you hide religious or spiritual beliefs due to fears about others' reactions?
Q.31. To what extent do you choose to visit places of worship to attend sermons and say prayers?
Q.32. To what extent are you likely to make religious gestures before doing something difficult?
Q.33. To what extent do you think strong emotions, like love, are driven by unknown powers?
Q.34. To what extent do you think you are willing to accept that your views might be wrong?
Q.35. To what extent are you inclined to pray for others when they are ill or need support?
Q.36. To what extent do you feel that people can become aware when you look or think about them?
Q.37. To what extent do you have a habit of making superstitious gestures, such as crossing your fingers?
Q.38. To what extent do you think it is true that good or bad things come in threes?

Q.39. To what extent do feel spiritual when you visit religious buildings, shrines, tombs and graves?
Q.40. To what extent do you have a tendency to think your views are correct and other views are wrong?
Q.41. To what extent do you find yourself communicating with deceased relatives or friends?
Q.42. To what extent do you think you are able to tolerate views different from your own?
Q.43. To what extent do you like the idea of a godly universe, as the alternative feels rather lonely?
Q.44. To what extent do you talk to pets and other animals as if they can understand you?
Q.45. To what extent do you find it helps to mentally visualize objects when searching for them?
Q.46. To what extent do night creatures, like bats, inspire more fear than day creatures, like songbirds?
Q.47. To what extent do you practice religion due to a need for it, but have no belief in god?
Q.48. To what extent do you follow superstitious beliefs, such as walking round ladders or crossing fingers?

Appendix 3.

Questionnaire 3.
30 passes: 30 lead questions, 60 lateral questions.
Each pass comprises either one lead question, or one lead question and one lateral question.

Lead Q 1: Do you believe there is a god?				
No		Maybe	Yes	
Lat Q: Might you consider believing in a god?		(0)	Lat Q: Might you consider not believing in a god?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 2: Do you think you are a superstitious person?				
No		Maybe	Yes	
Lat Q: Have you ever tried a superstitious habit to see if it changed your luck?		(0)	Lat Q: Have you ever avoided a superstitious habit to see if it changed your luck?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 3: Do you think some people have paranormal abilities?				
No		Maybe	Yes	
Lat Q: Are you open to the idea that paranormal abilities may actually exist?		(0)	Lat Q: Are you open to the idea that paranormal abilities may not actually exist?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 4: Do you think of yourself as a religious person?				
No		Maybe	Yes	
Lat Q: Do you ever think that religion might be helpful in times of need?		(0)	Lat Q: Do you ever think that religion is wrong for condemning people with other beliefs?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 5: Do you think it is possible to influence your luck?				
No		Maybe	Yes	
Lat Q: Have you ever tried tempting your luck to see if anything bad happens?		(0)	Lat Q: Have you ever tried ignoring luck to see if everything stays the same?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 6: Do you think some people can perform real magic?				
No		Maybe	Yes	
Lat Q: Are you prepared to consider that magic may actually be possible?		(0)	Lat Q: Are you prepared to consider that magic is just skilled illusion?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 7: Do you dislike the atheist idea that there is no god?				
No		Maybe	Yes	
Lat Q: Do you ever think that belief in a god can make people nicer to others?		(0)	Lat Q: Do you ever think that godly belief can make people unpleasant to each other?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 8: Do you think astrology and horoscopes, or star signs, are true?				
No		Maybe	Yes	
Lat Q: Have you ever tried reading horoscopes to see if they match real life?		(0)	Lat Q: Have you ever thought that horoscopes are just fun and not really true?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 9: Do you think some people can contact the spirit world?				
No		Maybe	Yes	
Lat Q: Are you willing to consider that some people may be able to contact spirits?		(0)	Lat Q: Are you willing to consider that people actually cannot contact spirits?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 10: Do you think religion has a useful purpose in society?				
No		Maybe	Yes	
Lat Q: Do you think that religion can give people useful guidance for living better lives?		(0)	Lat Q: Do you ever think that science explains the world better than religion does?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 11: Do you think there is a reason for existence?				
No		Maybe	Yes	
Lat Q: Have you wondered whether there might be a reason for existence?		(0)	Lat Q: Have you ever thought that things might exist for no reason?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 12: Do you think that entities such as ghosts and spirits exist?				
No		Maybe	Yes	
Lat Q: Do you ever wonder whether entities might actually exist?		(0)	Lat Q: Do you ever wonder whether entities might not exist?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 13: Do you think religion is necessary for society to work properly?				
No		Maybe	Yes	
Lat Q: Do you think religion can help in making people obey societies rules and laws?		(0)	Lat Q: Do you think people can still have strong morals and ethics without religion?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 14: Do you think that what happens in life is down to fate or destiny?				
No		Maybe	Yes	
Lat Q: Have you felt that some coincidences are so unlikely they were meant to be?		(0)	Lat Q: Have you ever thought that you can decide your own fate or destiny?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 15: Do you think clairvoyants can predict your future?				
No		Maybe	Yes	
Lat Q: Do you ever think that some clairvoyants may have the gist of foresight?		(0)	Lat Q: Do you ever think that clairvoyants may be fooling themselves and others?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 16: Do you think there is still a place for religion in the modern scientific world?				
No		Maybe	Yes	
Lat Q: Do you ever think religion can offer things to people that cannot be found elsewhere?		(0)	Lat Q: Do you think it is okay for society to have some people who are not religious?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 17: Do you think that wishes and curses can bring good and bad luck?				
No		Maybe	Yes	
Lat Q: Have you ever tried making wishes or cursing people to see what happens?		(0)	Lat Q: Have you ever thought that wishes and curses are really all in the mind?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 18: Do you think there is an afterlife for souls when people die?				
No		Maybe	Yes	
Lat Q: Do you ever think there may be some form of soul that exists after the body dies?		(0)	Lat Q: Do you ever think there may be nothing to leave the body when it dies?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 19: Do you think there is only one true religion?				
No		Maybe	Yes	
Lat Q: Do you think followers of all faiths should be respected for their beliefs?		(0)	Lat Q: Do you think followers of other faiths should be respected for their beliefs?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 20: Do you think people can sense when others think about them?				
No		Maybe	Yes	
Lat Q: Do you think science should investigate the possibility of humans having extra senses?		(0)	Lat Q: Do you think coincidence might create the false impression of an extra sense?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 21: Do you think some people are gifted with healing powers?				
No		Maybe	Yes	
Lat Q: Are you open to the notion that some people may have real healing powers?		(0)	Lat Q: Are you open to the notion that healing power is actually a false belief?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 22: Do you think atheists should be disrespected for not believing in a god?				
No		Maybe	Yes	
Lat Q: Do you ever think that atheists might be happier if they had some kind of faith?		(0)	Lat Q: Do you think atheism can benefit society by showing that religion is a better choice?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 23: Do you think that superstitious routines, gestures and rituals work?				
No		Maybe	Yes	
Lat Q: Have you ever thought that superstitions might work for those who believe?		(0)	Lat Q: Have you ever thought rituals only seem to work because we choose to believe?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 24: Do you think some people can make things happen with their minds?				
No		Maybe	Yes	
Lat Q: Are you intrigued to know whether some people may have special powers?		(0)	Lat Q: Are you intrigued to know whether science may eventually disprove these powers?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 25: Do you ever pray to a god or make religious gestures?				
No		Maybe	Yes	
Lat Q: Do you think you might pray to a god in a life-or-death situation, just in case it works?		(0)	Lat Q: Do you ever wonder whether there might be no-one listening when you pray?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 26: Do you think that charms and talismans can bring good luck?				
No		Maybe	Yes	
Lat Q: Have you ever carried a lucky charm anyway, just in case it worked?		(0)	Lat Q: Have you ever forgotten a lucky charm and realized that nothing unlucky happened?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 27: Do you think some people have extra sensory perception, or ESP?				
No		Maybe	Yes	
Lat Q: Are you interested in knowing whether ESP might turn out to be genuine?		(0)	Lat Q: Are you interested in knowing whether ESP might turn out to be false?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 28: Do you think there is a reason or purpose to life?				
No		Maybe	Yes	
Lat Q: Do you think the idea of a god can have value because it gives others a purpose in life?		(0)	Lat Q: Do you think a person's life can still have purpose without belief in a god?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 29: Do you think that god knows everything that you think and do?				
No		Maybe	Yes	
Lat Q: Do you ever feel that you are being judged by an unseen power?		(0)	Lat Q: Do you ever think that you only imagine that you are being judged?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

Lead Q 30: Do you think people can be possessed by demons?				
No		Maybe	Yes	
Lat Q: Might it be that minds can be taken over by powers we have yet to understand?		(0)	Lat Q: Might it be that mental demons are really only the result of illness or hypnosis?	
No (-2)	Yes (-1)		Yes (+1)	No (+2)

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submitted questionnaire answers and of each questionnaire itself. All was hosted on a public web server running Linux. The Amazon Mechanical Turk API (https://docs.aws.amazon.com/AWSMechTurk/latest/AWSMturkAPI/Welcome.html) was called by the application to retrieve the payment requests of questionnaire participants, and subsequently, approve or reject those requests. Upon completion of a questionnaire the participant would be given a unique code that would be stored within the database against their set of answers. They would then use that code in the payment request submission. The application would then retrieve the request via the API, extract the code from the response, and then search the database for a matching answer set with that code. colin_davies@hotmail.com

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