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An Evolutionary Approach to the Adaptive Value of Belief

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Abstract

The word “belief” evokes concepts such as religious or political beliefs, however there is more to belief than cultural aspects. The formation of beliefs depends on information acquired through subjective sampling and informants. Recent developments in the study of animal cognition suggest that animals also hold beliefs and there are some aspects that underly the formation of beliefs which are shared with other animal species, namely the relationship between causality, predictability and utility of beliefs. This review explores the biological roots of belief formation and suggests explanations for how evolution shaped the mind to harbour complex concepts based on linguistic structures held by humans. Furthermore, it suggests that beliefs are shaped by the type and process of information acquisition which progresses through three levels of complexity.

Keywords: Biology of belief, utility of beliefs, acquisition of information, meaning, causality, predictability, utility, bias

1. Introduction

Definitions of belief vary according to the academic field in which it is discussed. A large body of literature about belief stemming from areas such as philosophy, sociology or cognitive psychology, demarcates the concept of belief as an exclusive human trait. However, as the study of animal behaviour progresses and sheds light on their states of mind, there has been a tendency to accept that non-human animals hold beliefs.

There is general agreement that a belief is a mental state that predisposes the believer to accept some propositions as being true. Such propositions relate to events or things that either have or do not have supporting evidence. If I believe that crystals have healing power and I also believe in the third law of thermodynamics, I am holding a belief that is not supported by evidence (the crystals healing power) and an evidence-based belief (the third law of thermodynamics) in my mind. To be more specific, a belief without supporting evidence to support its truth is often referred to as faith. Thus, whereas it is correct to say that Mary has faith in the healing power of crystals it would be incorrect to say that she has faith in the third law of thermodynamics.

But defining a belief as accepting a proposition as being true is deceptively simple. First, there is no agreement in relation to the definition of truth; second, the concept of ‘proposition’ suggests that beliefs are acquired through structured speech-based language, limiting them exclusively to humans. This requirement to

base the definition on language implies that babies and people unable to communicate through language would be unable to uphold beliefs.

An evolutionary approach to the study of belief requires a definition that is applicable across species. In this sense a belief should be defined as any information that is held as reliable, and can be applied to non-human species [1].

In order to formulate a belief, individuals need to acquire information about different things, for example about the world, other individuals and conceptual abstractions such as freedom, honour, good and evil, electrons, energy, etc. The type and strength of belief is shaped by the way information is processed by the believer and how it is acquired. The beliefs we create about the world play an important role in decision-making, therefore selecting what type of information should be accepted or rejected is important for survival. But what does it mean to say that someone holds a belief? Is belief an exclusively human attribute or is it extended to other animals?

In order to investigate the evolutionary origins of belief, it is important to interpret the terms 'proposition' and 'language' outside a linguistic framework. Here, a proposition is interpreted as a packet of information received by individuals and language is understood as a system of communication that involves shared coded information which is understood by the sender and the receiver. As such it applies to humans as well as to other animals. Examples of language are the songs of whales or birds, human speech, or body postures that indicate mental states such as submission, play fight, begging for food and mating displays. Each species has elaborated communication codes which vary in complexity and in behaviour science are defined as language. The Oxford Dictionary defines language as "a form of human communication consisting of words used in a structured way..." However, this is a limiting assumption since people can still communicate by other coded means that do not use speech and syntactic rules. The important point to retain from a definition of language is that the codes by which such communication is shaped must convey meaningful information. In this sense "meaningful" implies that the observer perceives a signal as an indicator of something else. For example, a wolf observes another turning on its back offering his genitals to be smelled. This is a behaviour which aims to communicate meaningful information: a code that informs the other about an intent to submit rather than attack. This body posture is a meaningful belief-inducing signal which determines consequent responses.

Beliefs are acquired in many different ways but, at the most basic level, via subjective perception and information received from others.

2. Types of beliefs

This section argues that beliefs are shaped by the type and process of information acquisition which develops through three levels of complexity as proposed by Pinto and Bright [1].

The first level consists of beliefs about the world, its physical structure and the individuals that populate it, knowledge about prey and predators, resource distribution, dangers, etc. The knowledge of this world and its physical characteristics can be acquired through simple observation and direct sampling. These are subjective beliefs that depend on the characteristics of the perceptive organs. When I look at a buttercup flower, I perceive it as being yellow, and this leads me to believe that all buttercups in the world are of this colour. To a bee, a buttercup is likely to appear violet. This exemplifies that the property "colour" depends on the characteristics of the visual organs, and not of the flower itself.

The second level refers to beliefs acquired through social interactions and are created through the acceptance or rejection of information propagated by others. At this level individuals not only collect information about the physical properties of the world through others (e.g., where to find food) but also about the complex interactions occurring in a social group. This type of information relates to identifying friends and foes, understanding social networks, recognising and predicting behaviours of others or identifying predators.

The third level consists of beliefs based on internal mental processes resulting from insight, introspection, and deduction. This is a type of information that embraces non-physical entities, abstract concepts learnt through information transfer or created by one's own mind and may also be informed by innate intellectual ability.

The conjunction between type and acquisition of information produces different types of beliefs as summarised in the table below and discussed in detail further on. Thus, as expressed in **Table 1**, beliefs about the world (type of information level 1) can be acquired through three different processes: direct sampling, communication and insight. The same three level processes apply to beliefs about others and to abstraction-based beliefs.

The lower right corner of this matrix (box 9) expresses processes limited to animals with higher cognitive abilities comprising all the faculties represented in all the other squares. Such characteristics would be predominantly attributed to humans. Nevertheless, as represented in **Figure 1**, all animals have an ability to

		Processes of information acquisition		
		1. Direct Sampling Empirical Acquisition	2. Communication	3. Insight
Type of information	1. About the World	1 Learning about perceptible events in the world. Direct perceptual experience. Folk Physics	2 Knowledge about the world acquired through informants	3 Insight learning. Deductive reasoning about aspects of the world imperceptible to the senses.
	2. About Others	4 Observation/Eavesdropping. Knowledge about others acquired through direct contact and observation.	5 Knowledge about others acquired via informants.	6 Understanding the states of mind of others. Attribution. Theory of mind. Folk Psychology
	3. About Abstractions	7 Awareness of internal states of one's own mind	8 Learning about abstractions acquired through direct tutoring from others.	9 Deductive and inductive reasoning, imagination, about things or events that do not exist in the physical world.

Table 1. Belief-information matrix. As we navigate the matrix from left to right, the processes supporting the acquisition of information lead to the origin of human beliefs. As we move down the matrix, the type of knowledge increases in complexity and becomes multi-modal this complexity is reflected in the type of knowledge held by animals with more developed cognitive abilities, culminating with humans.

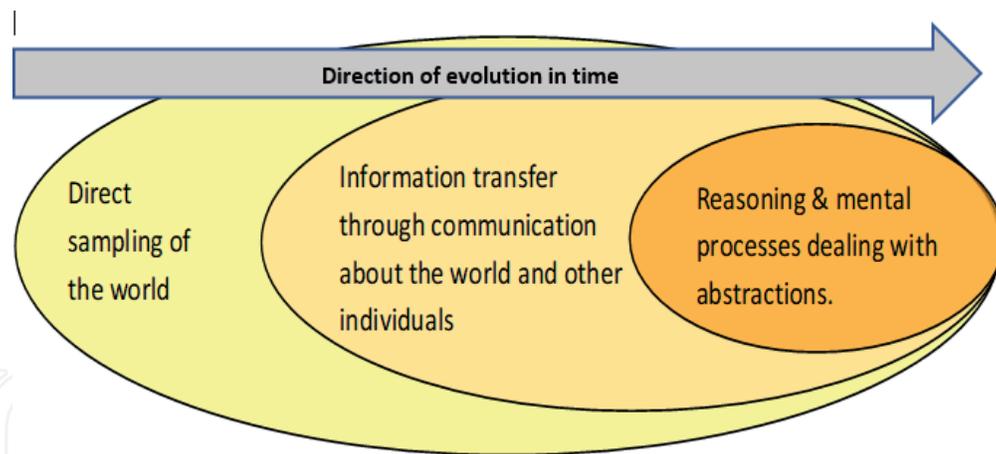


Figure 1.
The diagram represents the type of information acquisition at different levels of animal cognitive complexity. The smallest circle includes characteristics held by humans only.

perform direct sampling of the world and learn about its characteristics. Later in evolution, many animal species developed an ability to communicate information about the world and themselves to their conspecifics. More recently, animals with higher cognitive capabilities evolved to reason using some simple principles of logic, to identify and attribute mental states to others, to create theories of mind and deal with abstract ideas about non-existent objects. These are characteristics mainly attributed to humans, but there is evidence that primates [2], canids [3] and some corvid species such as Scrub jays *Aphelocoma californica* [4] can attribute mental states to others.

3. Processes of information acquisition determining belief types

In order to acquire and store information, animals have evolved a myriad of sensorial systems specifically dedicated to that job. The simplest form of information acquisition is through direct sampling, where each individual, tastes, probes and assesses the physical and chemical characteristics of its surroundings. But information can also be passed on by others through communication. New information can be stored through deduction, inference or insight. These processes are not exclusive to humans, and as we shall see, occur in many other vertebrate species.

The idea that reasoning is not exclusive to humans has been around for quite some time. In his book *A Treatise of Human Nature*, the Scottish philosopher David Hume (1711–1776) believed that animals were able to infer the relationship between cause and effect through learned expectations in the same way that humans do. However, he also suggested that this “inferential” ability held by animals is not through reason, but custom alone. In his work “*An Enquiry Concerning Human Understanding*” original published in 1748, Hume suggested that there are innate cognitive faculties shared by both animals and humans, and, in particular, that the ability to reason is based on empirical knowledge derived from repetition [5]. Nevertheless, he admitted that humans and animals differ in mental faculties in a number of ways, including: “*differences in memory and attention, inferential abilities such as making deductions in a long chain, ability to grasp ideas more or less clearly, capacity to worry about conflating unrelated circumstances, prudence relatively to making generalisations,, a capacity for a greater inner library of analogies to reason with, an ability to detach oneself and scrap one’s own biases, an ability to converse through language (and thus gain from the experience of others’ testimonies).*”

According to Cooper, principles of basic formal logical inference are found in the brain of many non-human animals [6]. The claim here is that frequent sampling of an environment produces an understanding of subjective probabilities in the animal with respect to the frequency of occurrence of events. These probabilities might, therefore, be considered to be belief. This ability to form statistical inferences has been recently observed in the kea, a New Zealand parrot [7]. So, the process underlying information acquisition is reflected in the formation of beliefs which, in turn, direct the process of decision making.

3.1 Acquiring information about the world

Evidence indicates that human infants from as early as 3 months of age can distinguish between animate and inanimate objects, and between biological and externally-caused motion [8, 9] and 8 to 10 month old infants can distinguish animals from non-animals, an ability unlikely to be merely perceptually learned [10] and most likely conceptually-driven and instantiated through evolutionary pressures [11]. Non-human species also have a naïve perception of basic physical phenomena. This is usually defined as folk or naïve physics. They also have some rudimentary conceptual understanding of folk physics from an early age; for example, what goes up must come down, that hitting small things like nuts with larger or heavier things such as stones is likely to break them, that a centrifugal force throws rotating things outwards [12]. Individuals do not need to hold a concept of forces and vectors to understand that if they swing a stone on the end of a rope fast enough, the stone will be thrown a long way if the rope is released. Every human holds a concept of folk physics from a very early stage of their development, but so do some animals. Without a basic concept of folk physics, which is an innate perception of the world, it would be impossible to survive and negotiate their environment. This innate understanding of how the world works seems to be evident when violations of natural laws occur. This is exemplified in dogs showing anxiety in face of magic tricks. Babies as well as animals look for longer and can show signs of anxiety when witnessing such tricks. Such anxiety can be seen in the videos published by the magician Jose Abonen where he performs a series of tricks on dogs [13, 14].

When a cat spots a bird on the top of a pole and jumps vertically, landing precisely on the spot, this is the result of an unconscious calculation of how much force to apply to the hindleg muscles. The cat jumps with a quasi-surreal precision, snapping its prey in a fraction of a second. Similar unconscious calculations, take place in the brain of a tennis player, a golfer or a snooker champion, where motor-intuition plays a major role rather than calculation of vectors and forces.

Some time ago, there was a story in the media that a female mathematician calculated the precise formula that enables us to parallel park a car in the minimal number of moves. Certainly, the majority of are able to parallel park their car even before this formula was invented.

This brings us to the next point about belief. Intuition is a form of subconscious belief that guides our actions based on previous experiences.

So, what information do animals need to believe in order to survive? The world around an organism consists of physical structures and parameters such as temperature, odours, landscape shapes and other organisms. Living organisms evolved systems to detect these physical characteristics, as well the presence of other forms of life. In animals, these systems became increasingly complex over the millions of years of evolution which developed ever more specialised structures to sense, sample and assess variations in the physical, chemical and social environs.

3.2 Acquiring information about the world through direct sampling (empirical knowledge)

Direct sampling and observation are the simplest methods of information acquisition about the world. This process leads to associative learning of cause and effect. This established association forms beliefs that can support which responses to adopt. Negative events will naturally elicit avoidance responses whereas positive outcomes will promote seeking and approaching behaviours. These actions are most likely based on an unconscious probability calculus based on what has been previously observed.

Over my lifetime I have learnt that there is a likelihood it will rain when the sky is covered in dark clouds, so when I go for a stroll and the sky is dark and cloudy, I'll take my umbrella because I hold the belief that it is likely to rain. This action was taken based on an averaged probability established along life-long observations of the sky.

Although taking an umbrella may not be crucial to ensuring my survival, for those living in wild unpredictable habitats averaging causal associations between events can be a matter of life and death. If a particular species of poisonous snake has been frequently seen in the grass nearby the water hole, the likelihood of a close encounter is high, so avoiding that area could be a matter of life and death. The computed average of previous sightings induces the brain to 'believe' that such snake could be seen again. Even if the snake has moved on, the belief that the animal could be found by the water remains. It may not be a true belief anymore, because the snake has moved on, but it serves the purpose of survival. The mind believes the intuitive probability as if it were a true fact. Such unconscious probabilistic computation is an evolutionary process that enables learning and coping with unpredictability.

When an animal encounters a snake, it naturally reacts with a mix of fear and curiosity. Learning which snakes are good to eat and which ones are deadly, requires memory and an ability to catalogue the objects. Those who attempted to eat a poisonous snake probably did not survive to pass on the information. Those who got bitten and experienced negative sensations will avoid getting close to a similar snake in the future, those that managed to eat it and survived, will probably do it again. Each surviving individual develops a classification system of the snakes in its world. When a novel snake crosses the path, the individual compares it with all the images of previously observed snakes and the consequences of coming close to them. The mind created a rule where snakes that look like this are good and snakes that look like that are bad. This rule becomes a 'belief' because in the animal's mind it is held as true.

Another important adaptive process is the ability to generalise from one or few observations. Generalisation, discrimination and categorisation are mechanisms present in all vertebrates [15, 16]. They are adaptive learning processes that protect the animals against future dangerous encounters or promote the recognition of resources that provide survival.

Evolutionary mechanisms such as mimicry (a process where harmless animals mimic dangerous ones through the evolution of similar colouration and patterns) have evolved due to the ability of predators to categorise their prey. Take for example the red milk snake (*Lampropeltis triangulum sypila*), which presents a pattern similar to the venomous coral snake (*Micrurus lemniscatus*). The milk snake has a survival advantage because its shape and colours induce a belief of danger in predators. There are plenty of examples in nature where animals develop patterns that resemble big eyespots leading to predator avoidance. Does a bird which avoids eating a butterfly, after having been flashed a set of eye spots, entertain the belief

of having been seen? It could be said that the predator holds the 'belief' that those patterns are real eyes. For the strategy to work, it has to induce a belief on the mind of the predator.

In this context, animal beliefs result from evidence based on present and past direct perceptual experience. One could argue that these examples demonstrate nothing more than an animal's ability to establish causal relations and categorise the objects, however these are processes essential in supporting the formation of intricate beliefs in animals with higher cognitive abilities later on in evolution.

The association between a cause and an event can lead to the building expectations. Whereas in non-human animals' expectations allow them to predict recurrent events, in humans, expectations do not need to refer to the repetition of factual events, but could result from a repetition of claims about events believed to be true. Here the repetition of the claim replaces the subjective experience of sampling or observing recurrent events, especially if the information comes from someone that is respected by the subject. It is here suggested that the search for patterns in random events is a hard-wired process which feeds a need for predictability (discussed in detail in Section 5.3).

As new information is accumulated, ideas and insights not directly derived from empirical gathering of information can be formed. Since these ideas are created by progressive accumulation of information, there is a likelihood that the individuals develop an emotional attachment to the novel idea, especially if it has resulted in the solution of previously encountered problems. This process is the first step of a successive chain of complex processes that will eventually lead to embracing beliefs with great conviction.

3.2.1 Acquiring information about the world through communication and learning

In the 1960s, Karl von Frisch decoded the language of bees, discovering that the wagging dance of scouts indicates the position of the food source in relation to the sun [17]. If the bee walks upwards in the hive, it means that the food is in the direction of the sun. If the dance is about 30 degrees to the right of the vertical, it means that the food source is 30 degrees to the right of the sun and so on. Bees do not use rectangular coordinates (in rectangular coordinates, we describe points as being a certain distance along the x-axis and a certain distance along the y-axis) but instead they appear to work with polar coordinates (angles and distances). It is tempting to assume that bees know more about angles than the majority of humans on the planet. The question "how do the bees know the size of the angle?" tells us more about how humans think. When we describe a process by the use of scientific models it does not mean that the animals use the same model to execute the process.

For communication to take place, the information must make sense to the receiver, that is, it must have a semantic meaning. From an ethological perspective, meaningful information is a signal that is decoded in such a way that triggers a response in accordance with the content of the message. In ethology, complex signals used in communication are defined as language, and in this context each signal has a meaning. The meaning of the message may change due to variations introduced by the sender or differences in the perception of the information at the receiving end. This may lead different receivers to formulate different "beliefs" about the very same information. Simple signals have little scope for error, however the probability of occurrence of errors in signal transmission and transduction increases with the complexity of the signal and of its detection mechanisms. This is an obvious induction that follows from the rule that increased complexity offers more opportunities for error. These errors are likely to occur as much in animals as in humans who may misinterpret the meaning of the message during verbal

communication which, due its high level of complexity, increases the variety and frequency of error occurrence. Errors may therefore change the truth value of the original message.

Communication is a process present in all living organisms, from simple cells to humans. The content of the communicated information depends on how the signals are produced. Signals can be classified as chemical, pressure, vibratory or light based.

Chemical signals are detected by specific cell membrane receptors that identify a variety of molecules. Pressure based signals rely on detection by pressure sensitive neurons. Vibratory signals are the result of sound waves propagated through the vibration of a medium such as water or air. Alarm calls and speech are forms of communication based on the production of vibratory signals. Finally, light-based signals are those that require vision or light sensitive neurons to be detected. The receiver has signal specific organs or structures that make sense of each type of signal inducing behavioural changes in the receiver, which may react immediately or store the information for a delayed response.

During communication, the sender releases information that enables the receiver to either react immediately or store the information for a delayed response which can span for as long as it is kept in memory. Information storage is the seedbed for the genesis of beliefs. This raises the question; does the wagging tail of a bee induce a belief in the receiver? It is indeed prompting a response, and the success of the responder in finding the food source depends on the decision to follow the information provided by the scout. Following the directions provided by this information is likely to consist of a hardwired stimulus–response code where the sensorial mechanisms of the receiver respond with simple if-then type of logical rule. This explains how, in the example above, bees can tell the position of a food source based on the information provided in the wagging dance. Bees do not necessarily need to be empowered with a belief mechanism to follow the instructions; this example serves to illustrate how these simple hard-wired algorithms provide the original tapestry supporting more complex neuronal systems that will end up supporting beliefs as we understand them, in later evolutionary stages. The decision whether to accept the information provided by scouts as true or not, depends on the reliability of the signal. Since their survival depends on it, bees need to be equipped with systems that enable them to access how reliable (true or not) the signal is. A naïve receiver might accept the signal as being true without the need for subjective experience. If it is difficult to construct a concept of bee's beliefs, and it is more likely that higher vertebrates base their decisions on beliefs formed by reception of information from others.

In social animals, information can be acquired in two ways; either the individual acquires information through 'eavesdropping', which means learning through observation of what others are doing, or through intentional communication, where the sender sends a signal with the aim to manipulate the receiver's behaviour. Manipulation here means to induce a desired change on the other's behaviour.

Eavesdropping and is a ubiquitous learning process among vertebrates in which non-intended receivers acquire information through mere observation of the sender. Imitation by observation is also a learning process that can induce beliefs. Juveniles learn through copying what adults do, without intentional intervention from the adult to engage in active directed teaching, and adults learn from each other in the same way. Ethology literature is full of examples of birds and mammals learning by observation. Experiments with Norwegian rats [18] and hens [19] shown that when different foods are offered to a demonstrator, the observers emulate the demonstrator's choices. If the demonstrator showed signals of sickness after eating a particular type of food, the observers avoided that food even if the

food offered was good. Cane Toads were introduced into Australia to protect sugar cane plantations from insect plagues. These frogs are highly poisonous and there are reports of wildlife killed by attempting to predate on them, but only the back is poisonous. Raptors and corvids that have evolved in the same ecosystem as these toads learnt to consume only the less toxic body parts of these toads. Since these toads have been introduced into North Queensland, the local birds did not know about this technique until some clever animal identified a new foraging strategy. There is some anecdotal evidence that Torresian crows (*Corvus orru*) which are native of Australia, have learnt to flip the toads onto their backs and consume only their internal organs. This behaviour became widespread among the birds through cultural transmission [20].

Thus, learning by observation and imitation leads is based on trust in the demonstrator. Trust is indeed a basic component of belief. Elephants and cattle follow the matriarch because they trust she will take them to greener pastures. In vertebrate migrations, there is always a component of “belief” in the navigation capabilities of the leader.

Animals that have been injured by humans demonstrate a capacity to generalise their distrust to the whole species, even if some humans are completely harmless. So, in order to place trust on others, the individuals need to hold the belief that no harm is likely to come from that relationship.

3.2.2 Acquiring information about the world through insight

Insight learning is defined as a solution to a problem that seems to have come from nowhere. It is also generally understood as being a type of learning that uses reason to form conclusions, inferences or judgements, to solve a problem [16].

In some cases, it might have been the result of accidental acts, in other cases it might have resulted from the application of trial and error for a considerable number of times, until a solution suddenly appeared. In the latter cases, the insight is in adopting the most successful strategy and improving on it. Insight learning has been observed in non-human animals. In the 1940's the colourful shiny metal foil lids of milk bottles, delivered to the door of southern English homes, caught the attention of a bunch of inquisitive tits. By pecking through the lid, the birds reached the cream. It took it no time to conclude that this was a rich source of easy food. Forty years later, this behaviour could be observed among tits all over England [21].

There are thousands of stories like this describing how humans and other animals learn to improve on a particular behavioural strategy that arose by chance. The event might have been accidental, but the decision about repeating the behaviour that led to the event, and thus taking advantage of a totally accidental discovery, constitutes an insight.

It has already been established that the most basic form of information acquisition about the world occurs through subjective sampling or empirical knowledge, however there are cases where insight learning seems to have taken place as for example the use and manufacturing of tools. Tool use to extract food evolved independently in different species, such as chimpanzees [22], capuchin monkeys [23], New Caledonian crows [24, 25] rooks [26], and dolphins [27, 28]. The fact that these occurrences have been described in nature in some groups and not others in the same species, suggests that tool use behaviour might have resulted from spontaneous insight learning and propagated inside the group through cultural transmission.

While insight learning itself may not lead to the formation of beliefs, the same neural processes involved in insight learning are likely to explain the origin of spontaneous beliefs. For example, when confronted with novel objects, humans may attribute qualities in origin and utility based on information previously observed

in similar objects. This leads to the formulation of beliefs about the utility or the source of the novel item. This may explain why certain objects are given mystical status without any apparent logical reason.

Establishing a causal relationship between the frequencies of certain events in the presence of this object may lead the subject to gain insight about its utility as a mystical force. This would explain the creation of sacred objects as a novel tool for the solution of real human problems. Attributing curative powers to a stone for example is creative thinking. The association between the occurrence of an event and the presence of a particular object induces a moment of insight establishing causal relationship to make sense of what just happened. For example, if an environmental catastrophe happens just immediately after the arrival of a stranger in the village, there may be a tendency to associate these two salient events. However, the direction of the causality is more likely to blame the stranger for the freaky event, than blame the event for the sudden arrival of a stranger. This is probably because it is more frequent to attribute agency and intentionality to a human, than to the forces of nature.

Explanations of the physical world through these bursts of ‘insight’ instead of empirical evidence, have been observed consistently across the history of humanity. Just think of the association between epidemics and witch hunts in the Middle Ages. Unfortunately, the mind is faster at believing in these irrational connections and to seek evidence and some of these past myths persist in modern times. For beliefs? These beliefs are sustained not only due to social conditioning and conformity but also because the brain requires much more energy to think rationally, learning new things and seek evidence, than just accepting beliefs that are widely available and ready to be selected.

3.3 Acquiring information about others

Why is it important to acquire information about others? These others can be friends or foes, co-operators or selfish free-riders. Confusing these categories may be fatal to an animal or a human. Approaching a predator believing it is a harmless friend is a risk not worth taking. Approaching a conspecific displaying agonistic behaviours, can result in injury. Allowing out-group members to approach the in-group resources, could mean disaster. The “others” have different degrees of “otherness” depending on group and species membership and this deeply biological strategies have influenced the beliefs embraced by not only by humans but many other species.

3.3.1 Acquiring information about others through direct sampling and observation

Information about others can be acquired through direct observation of their behaviours or indirectly through informants.

Thorndike’s laws of exercise and recency establish that an animal has a tendency to learn the behaviours that were most frequently displayed and the most recent actions [29]. So, a simple computation of the frequency of different types of behaviours in particular circumstances enables the animal to establish a conditional association. Thus, information about others can easily be learnt from the frequency of previous agonistic or affiliative encounters with conspecifics, or through the observation of interactions between other individuals. Memorisation of these observations contributes to the formation of beliefs about the observed individuals. The mechanism is generalised in all animals, including humans and there is no need to form complex mental representation of the intentions of others in order to gather information about them. Assessing the frequency of behavioural patterns is

sufficient to predict many behaviours. If I see my neighbour leaving the house every day at 9:00 AM to go for a run, I can establish that he is likely to do it again tomorrow, without creating a theory that he thinks that exercise is good for his health. Maybe he does it only to escape his wife's daily morning grumpiness. Independently of what his motivation is, I can still hold the belief that he will be running every day for the weeks to come.

Information about others can also be gathered without involvement of consciousness. Take for example mating displays. Advertising male quality based on colour or exuberant ornaments is expressed in many males from invertebrates to higher vertebrates, with the sole objective of attracting the females' attention. These signals evolved as badges to advertise quality, but that does not mean that these traits evolved to intentionally induce the females to "believe" that a male with the most exuberant traits is better. There is no intentionality in evolution of traits. The word "belief" is sometimes used as a metaphor to explain certain types of animal behaviour. It is a shortcut to a more complex explanation that may mislead the non-specialists. For example, in mate selection it is not unusual to refer to female preference for males with exuberant characteristics as if they "believed" it was a good male to mate with. The use of the word 'believe' here is a substitute to explain that females have inherited a genetic programme that drives them to select males with exuberant characteristics. It just happens that these males are also those who convey more survival advantages to their offspring. Physiological and morphological traits are also good indicators of partner quality in humans. Female's hip-waist ratio or male shoulder-hip ratio are characteristics subconsciously valued by humans in mate selection. Evidence that most females like males with certain characteristics such as facial symmetry, broad shoulders etc., may not be the result of a cultural fashion, but rather the result of a genetically determined programme that controls mating behaviours [30, 31]. Nevertheless, human females are led to "believe" that by enhancing certain characteristics that signal sexuality, will attract the desired male. This belief is a mix resulting from evolutionary drives and culturally influenced fashion. So, whereas the evolutionary strategy in mate selection is to seek out the best partner to mate with, the tactics used by humans to attract partners are influenced by cultural factors and the tastes of the times. In societies where female breasts are valued by males, there is a tendency to seek artificial means of enhancing such indicators of reproductive quality by resorting to breast implants. In other societies with different cultural traditions the preference may be for large buttocks. This variation in preference is influenced by culture, but the motivation to select traits that are indicators of fitness is determined by our evolutionary story and, unbeknownst to us, enters the realm of cultural aesthetic preferences. Whether the preference is for large breasts or buttocks there is a common factor in these two indicators; they both indicate a reasonable amount of fat storage which would help survival in times of resource shortage.

3.3.2 Acquiring information about others through informants

There are three aspects to take into consideration in the process of communicating information about others. First the individual must detect the presence of another and identify its features, e.g., whether it is a member of the group or an intruder. Second this information is passed on using a code. Third, the code must contain signals that describe the identity of the other and its intentions.

Gathering information about others is important, especially when animals live in groups. This information is useful in different ways, contingent upon the characteristics of the group. For animals living in colonies, where there is no obvious social structure, resource competition such as nesting places or predatory pressures on

the offspring are the main factors playing a role in learning about others. In social groups inter-individual relationships are more important. Social animals need to learn about hierarchies, advantages and risk in affiliative and agonistic behaviours. What we believe about others is an important aspect in the decisions that humans and other animals have to make in relation to the rest of the group.

Decision-making depends on the available information and the expectation of a determined solution. When one individual sends information to another about a third one, it is sometimes referred to as gossip. During this process individual A collected information about individual B, created a judgement and passed it on to a third individual C. Communicating information to a conspecific about others requires some level of intentionality and a higher level of complex thinking. It is difficult to imagine this process occurring without the use of language. Passing information about B requires complex processes such as an ability to catalogue the behaviours usually exhibited by B and list of signals that inform C about these characteristics. However, many animals can assess behaviours of group members in relation to others in order to extrapolate information about a third party. If member X always shows fear in the presence of member Y, an observer W is more likely to exert caution when close to member Y. The animal might have not observed any agonistic interaction between the two individuals in question, but the withdrawal behaviours of one individual may lead the observer to infer and therefore create a belief that the other is probably an aggressor. This mechanism however, does not constitute transfer of information about a third party through communication. It is a belief that results from direct observation and inference.

This is an example of formulation of beliefs through direct observation, but beliefs about others can also be formed through an informant advertising the presence of predators, putative aggressors or competitors. A problem arises when there is a need to communicate the qualities of others. For example, Vervet monkeys have different calls that identify different types of predators [32]. This requires a capacity for cataloguing the predators in categories and communicating them to receivers that understand the codes that identify such categories. Yet, it is difficult to acquire clear evidence on whether animals can pass on information about the intentions of others.

Understanding intentions requires the ability to formulate a theory of mind. And even if they can do so, to date there are no studies proving that animals are able to send information about the states of mind and intentions of others. This would require appropriate signals that indicated not only the presence of an aggressor or a predator, but also that this individual had the *intention* to do something. This something would also need a coded signal. For example, could a monkey communicate to another that his companion is fearful or has an intention to steal his food? Communicating others' states of mind depends on the perception of the observer.

There is indication that some species developed an understanding of tertiary relationships which involve interactions and relations among third parties, even when the observer is not directly involved [31]. This requires an understanding of how each category relates to each other. In this case an individual must monitor not only his own relationship to others but also the relationships of others among them. In summary, they need to understand the social pecking order.

Learning about others through informants leads to reputation building, this is usually referred to as 'gossip'. Reputation consists of a belief about a third individual based on information provided by another. Reputation building is important especially in the establishment of direct and indirect cooperation between individuals that are not directly on the receiving end of the altruistic act [32].

It has long been assumed that gossip and reputation building is exclusively restricted to human societies where information supporting beliefs about others can

only be passed on through conceptual language. However, in this case the concept of gossip is usually loaded with negative connotations. But in animal behaviour, the concept 'gossip' refers simply to passing on information about others. Gossip in animal societies is more reliable than in human societies because the credibility of the information is more often attributed to the status of the informant than to the plausibility of the event.

3.3.2.1 Providing information about one's self

Although reputation building needs a chain of communicators to spread the message, the type of message that is being passed on is of special interest to those which are the focus of the gossip. Providing information about oneself induces beliefs in others which is important for the establishment of social relations. This occurs in two levels: The first level is unintentional, and subjected to evolutionary selection. This is reflected for example in stereotyped ritualised behaviours that are characteristic of a species. The second level assumes intentional motivation which clearly aims to induce a belief in others. Although the motivation that triggers the onset of the signalling sequence may not be under control of the subject's mind, the decision to express it could be under volitional control. In many species, animals may refrain from displaying mating behaviour if the social conditions are not favourable. For example, lower rank male primates avoid displaying to females if higher rank males are close.

Recruiting help for oneself is widely present among many mammals and birds. For example, macaques recruit help in agonistic encounters, [33], and juvenile crows recruit help to feed when competing with adult groups [34]. This is a process based on passing on information about oneself. Recruiting help for conspecifics may rely on how much the recruiter is considered to be worthy of help which is a function of reputation. This is a type of information shared by the group and surely relates to cost-benefit balance of reciprocity.

3.3.3 Acquiring information about others through insight: Folk psychology and theory of mind

Some definitions of belief require that the believer experiences mental states and intentionality, but, it does not need to be so. It is sufficient to learn about behaviours and their outcomes to be able to predict what comes next. If a pride of lionesses is sleeping under a tree, this represents no danger for a herd of zebras grazing in the neighbourhood. Even if some lionesses get up, move around and lay back, this is an indication that the zebras are safe for the time being. However, there are particular lion behaviours that are indicators that they are ready to start a hunt. Watchful zebras would then be more alert to any lion movements and body postures. So, the zebra does not need to have a theory of mind about what is going on in the mind of the lioness, but instead it just needs to have learnt that after specific body postures, a lioness is likely to attack. This observation would trigger the zebra to emit an alarm call and make all the group disband. In this case each member of the group would believe the calling zebra.

However, research with non-human primates indicates that these animals have complex mental states, can formulate a theory of mind, are capable of tactical deception [35] have empathy, can assess the knowledge of others and even hold an incipient moral system. Studies in other species, such as dolphins, dogs, parrots and corvids, suggest that these animals may hold some basic belief system which enables them to assess and plan several outcomes in decision making. In order to make decisions, these animals must hold a certain level of understanding about how their world works, and the behaviours of others.

As it was described above, to have an insight means that the individual found a solution for a problem or unexpected understanding of something without awareness that reasoning processes are taking place. Insight learning occurs suddenly when the individual discovers new relationships based on prior knowledge suggesting the absence of conscious reasoning.

This insight requires no conscious awareness of the reasoning process and there is no reason why it should not occur in animals. Insight learning is possibly a process that appears in a much earlier stage in evolution than conscious reasoning. Opinions about others may be the result of insight learning. When asked to justify their opinions about someone else, humans often engage in *a posteriori* rationalisation frequently concluding with “I just had a *feeling* about him”. Resorting to “having a feeling” as an explanation, suggests lack of rational justification for such belief about the other. This irrational feeling might be the result of earlier stages of the evolutionary processes at work.

4. Acquiring information about abstract concepts

An abstract concept refers to entities that are neither purely physical nor spatially constrained and are created by the mind. For example, truth, freedom, goodness, fairness, beauty, happiness and suffering are abstract concepts. Representations of numbers are also abstract concepts but the perception of quantities can be experimentally tested in humans and animals. There is evidence to support the claim that the brain has specific areas associated with knowledge of numbers and their relations (‘number sense’) [36] suggesting an evolutionary legacy of abstract, domain-specific knowledge. Abstractions such as a sense of fairness also seem to have an evolutionary root. In tests described as inequity aversion tasks, studies on capuchins and dogs have shown that they are able to detect unfairness and wrongful actions [37]. Therefore, there are grounds to suggest that the abstract concepts that underlie human beliefs, especially those relating to morality and sociality, share a common neural substrate with other species and are not an exclusively human novel evolutionary acquisition.

4.1 Acquiring information about abstractions through direct experience or awareness of one’s mental state

Due to the very nature of abstractions, we can only know if someone holds an abstract concept in their mind, if they communicate it to us.

If I lay down a plan for a journey, I may go through the route in my mind before starting the car. For example, I may choose the easiest route, or the shortest, taking into consideration the traffic on all possible routes. By creating a schema of possible routes, I am producing abstractions and when deciding to take route A rather than B, I base this decision on my beliefs about these abstractions. Route B may be full of traffic at this time of the day. Does this mean that when animals are considering courses of action, they are creating abstract concepts in their minds?

This is important to consider in social animals that hunt co-operatively. Each member of a pack of wolves, or a group of chimpanzees, learns how to best position themselves to ambush prey. One could argue that they have learnt the tactic through trial and error or from observation of others. However, by accepting that learning took place, it is reasonable to hypothesise that the animals created mental maps comprising abstract concepts. Once they acquired such schema, the abstraction supports a belief.

The force of gravity, for example, is an abstract concept since we cannot touch it, or cannot see it directly. The concept derives from observations of things falling down. Many animals are also aware of this phenomenon, but does it mean that they hold an abstract concept of gravity? Do people who know nothing about gravity hold an abstract concept? An abstract concept could be here interpreted as a rule or a schema of the behaviour of things in the physical world. A further development of an abstract concept could be an attempt to make sense of the event.

Despite the difficulties in penetrating the minds of animals, there is however some empirical data demonstrating the formation of abstract concepts in pigeons [38] and African grey parrots [39].

4.2 Acquiring information about abstractions through communication

Whereas learning through observation and example can be acquired by many animals, learning about the world and others, based on narrative or verbal tutoring, requires the use of speech and the ability to formulate mental models of the narrative's topic.

The spreading of moral and epistemic values in society is an example of a form of learning abstraction through communication. We accept that biodiversity is a good thing, that justice and fairness should be encouraged, and that the water boils at 100° C. Some accept that God made the Universe whereas others prefer a Big Bang Theory as a form of explanation. Many people defend that humans have more value than animals and that killing is wrong. Some of these axioms are beliefs taken for granted and those who dare to go that extra mile to question them are looked upon with frowning disapproval by consensus or educated opinion. Most of these axioms were probably acquired solely by information transfer and not much introspection or critical appraisal.

Abstractions are assumed to be more present in human than animal minds, but then how are we to know what abstractions animals believe in? Abstract thinking allows for the creation of non-physical concepts that cannot be tested or proved, and abstract concepts are the very essence of complex belief systems such as religion.

There is a fundamental difference between religion and science. While the first is based on dogma and beliefs that cannot be tested, science follows a methodological approach which requires repeatability and evidence. Nevertheless, people still hold beliefs about scientific issues. A theory, for example, is a formulation of a belief waiting to be tested and supported by evidence. The lay-person will have to decide whether to accept or reject experts based on appeals to authority. The decision is based on a belief whether the experts are trustworthy. The non-specialists simply hold a belief and an expectation, based on the information provided by others, that these scientific principles are true.

The majority of educated people believe that matter is made of atoms, however, those who can actually provide the evidence are a small proportion of the world's population - the physicists. The rest of us just make a subjective decision whether to accept or reject that claim. Descriptions of the atom have changed in time and education levels. We start by accepting the wisdom of our schoolteachers that an atom consists of a nucleus of protons and neutrons encircled by several layers of electrons. As we progress in our education and knowledge, more particles and waves are added to the model ending up in something difficult to conceptualise by non-specialists such as quantum theory. As non-experts in the field, we just resign ourselves to the belief that what they are saying is true. Some of us may even argue vigorously in public in support of those who provided us with such information. We may accept the new model of the structure of the atom because it makes sense

in our logical reasoning, but so did it when we learnt about the orbiting electron structure suggested by Niels Bohr in the beginning of the twentieth century. Who are we to deny one or the other? What is under discussion here is not the validity of the belief, but the biological and psychological mechanisms that trigger us to accept those ideas.

Group membership plays an important factor in the acceptance or rejection of beliefs through appeals to authority, or appeals to popularity, pre-disposing individuals to accept the ideas held by the group without questioning. Challenging the ideologic *status quo* is dangerous because novel ideas can destabilise group coherence. In such cases the challenger is either ostracised or submitted to persuasive techniques ranging from suggestive to coercive.

Social pressures to conform with the rules and behaviours that identify a social group are present in humans as in non-human animal societies. The difference is that humans exercise control over others to uphold the same abstract beliefs that function as a badge for group identification whereas in animals, scent and ritualised behaviours are the badges of their social group.

Although we are aware of the manifestations of physical dimensions, forces, fields, and other physical experiences, it wasn't until very recently in the evolution of the brain that we started understanding the likely nature of these phenomena. Hopefully, we all accept that electricity is the result of the movement of electrons, but very few of us, unless we are physicists, have seen evidence that electrons exist. We simply believe what we are told by those we accept as experts. Why do some of us believe a physicist offering an incomprehensible theory for the origin of the universe, while others believe in the future predictions of astrology?

The issue is not about the object of belief, but the communication strategies of those that provide us with the information we believe in. Our mind is open to be convinced, some more open than others. Some information is accepted on the basis of critical scrutiny while other information is not, and this is perhaps the factor that distinguishes human beliefs from those held by animals: the ability to reason logically over the plausibility of the information.

4.3 Acquisition of information about abstract concepts through insight

Most abstract concepts are communicated through words. Sometimes there are no words available to explain them. For example, the very concept of 'truth' is a difficult one to explain in a way that is universally uniform. Whereas for western societies ascertaining the truth of a claim is important and means correspondence to the facts other perceptions of truth seem to align with the pragmatic theory of truth, which asserts that the truth of a belief on whether it has useful application in the world. In political dictatorships the truth of the facts is not as important as utility of a claim. If the claim does its job, it does not matter whether it is true or not. Learning abstract concepts through insight is most noticeable when a person is learning a foreign language. Not all words find equivalence in our own language and as such we learn the concept by perceiving in different sentence constructions. Eventually we start grasping an understanding of the meaning of the word even though there is no correspondence in our own language. Abstract concepts from a foreign language become understood by insight. For example, the Portuguese sentence "pain in the soul" finds no correspondent in English. It is an abstract concept that refers to mental states associated with physical pain in the area of the heart. It covers states such as depression, sadness, longing for someone or something, bereavement, nostalgia. There is no word in English that encompasses all these mental states in one. A Portuguese person may use this expression in presenting her symptoms to a puzzled British therapist. However, with the progress of the therapy

and association of the expression with the different states of mind, the therapist eventually has an insight of its meaning to the client.

5. The adaptive value of beliefs

Thinkers, scientists and philosophers reach their own conclusions through methodological approaches specific to their field of expertise. In the process, they innovate, discover new methodologies, suggest theories. In summary, they gain insights into the problems they are addressing. When creating testable hypotheses, they make assumptions held as true, testing them for inconsistencies, flaws, mistakes, illogicality, etc. Hopefully, after a certain amount of time and painstaking testing, some of these assumptions, become a 'truth' in the mind of the thinker and her followers even though it is only a hypothesis. This truth will only survive until new evidence refutes it. A new paradigm replaces the former and the cycle restarts. This paradigm shift was thoroughly discussed by the American philosopher and physicist Thomas Kuhn in his 1962 book *The Structure of Scientific Revolutions*.

Many of our present social and personal beliefs result from cultural inheritance, our reliance on other people and sources we trust. Our survival depends on a large number of "specialised believers" telling us what to think.

We believe in the insights of others that preceded us and adopt them as truths. The teachings of the Buddha and the Middle Eastern religions, the insights of Classical Greek philosophers about the mind and nature, the discoveries of the Enlightenment and the progress of the industrial revolution, all are examples of personal insights that spread in space and time. Some insights are independently arrived at in different cultures and time frames, their common aspects suggesting that they may be intuitive across humankind. Similar social norms and recommendations based on an awareness of human nature that ensure that social order is upheld are found in tribal societies that never had contact with each other. Some of these rules have deep roots in biology, such as those aimed at controlling female behaviour to ensure the paternity of the offspring. Many of these norms passed on from generation to generation become enshrined in our present cultural norms and are still held as unquestionable dogmas. Similarly, questioning religious and scientific dogmas is still frowned upon by members of the groups that hold such doctrines. Individuals become emotionally attached to such beliefs and express anxiety and defensive reactions when such beliefs are challenged. This begs the question by which processes do beliefs operate to induce such strong emotional attachment?

There are aspects of the content of the belief that tap deeply into our biology [1]. When the information content of a belief aligns in some way with processes that provide survival strategies, that information perceived as meaningful is ardently protected and any challenge to its truth is aggressively repelled.

Which attributes make up the mind is much debated; however, their common features include the integration of a sensorial mechanism which contributes to make sense of an individual's external and internal world. Whether or not the individual is conscious of that sense or meaning is irrelevant to definition, since proving presence of awareness in most animals empirically is impossible due its subjective nature. In the *Descent of Man*, Darwin laid out the case for believing that the difference between the minds of humans and other animals was 'certainly one of degree and not of kind'.

There are at least four basic conditions that make a belief meaningful. First the belief must offer an explanation for causal events, secondly it must offer a sense of predictability, thirdly, the information received must be reliable and correspond to what is believed to be fact and finally, that belief must have some utility providing

survival advantages [40]. But before each one of these conditions is addressed, it is necessary to understand the notion of meaning.

5.1 A biological approach to the concept of meaning

The concept of meaning can be approached through a philosophical point of view such as ‘what is the meaning of life’, a psychological cognitive approach, such as ‘what you are telling me makes no sense in my mind’ and through a linguistic approach which begs for definitions such as in ‘what is the meaning of this word?’. The linguistic description of meaning plays an important role in communication and spread of beliefs. A sound, a word, a sentence, all have meaning when they contribute to the comprehension of the message. But comprehension or understanding is also a function of the subjective experiences of the receiver. If I say “table” it induces different mental images in the receiver. It can be a word that simply categorises objects with four legs and a surface high enough to allow our legs under it. But there are many variations of the concept table. Is it in wood or metal and glass? Is it unassuming with straight lines or convolutedly decorated with arabesques? The word table may confer a limited number of characteristics that are common to most people that have experienced the shape and function of furniture but its meaning varies accordingly to function. Is it a dining table, a coffee table or a desk? Whereas descriptive words for objects may be easy to define by just pointing at it or simply describing its function, abstract concepts may have different meanings to different people. For example, what is the meaning of the concept of freedom of speech? Does it mean I can say whatever I feel like or does it encompass a certain level of censorship to prevent incitement to harm others? What is the meaning of friendship? Does it require unconditional loyalty or does it give room for compassionate lies?

Frequently, what gives meaning to some of these abstract concepts is the level of emotion associated with them. People who believe in freedom, or God, or homoeopathy may feel threatened when their beliefs are challenged because such beliefs define the individual, her nature, his cultural identification, her expectations. Holding strongly to beliefs provides a sense of security and predictability. Such emotions are defined by neurological processes that transduce the sound of words, to their meaning and to their emotional valence; e.g. whereas to some people the word spider evokes fear and the word mouse evokes of cuteness, to others the word mouse may evoke feelings of fear and anxiety. A thing has meaning when its description aligns with our preconceived mental models. If I am learning statistics, a t-test only has meaning if I have a prior knowledge of means and other arithmetic calculations. Asking someone to do a t-test on a set of numbers without previous understating of basic concepts, renders the requirement meaningless. Furthermore, it may induce a state of anxiety due to acknowledgement of ignorance about that subject.

The informational content of a message acquires meaning, when it is compared with a mental database of previously learnt units of knowledge and it aligns or provides incremental increases to that knowledge. It follows that meaningful information is more useful than meaningless information. It functions as a tool of survival, based on which we can induce and deduce further knowledge. It is therefore reasonable to assume that an emotional connection between pieces of meaningful information is formed. On the other hand, meaningless information triggers a sense of discomfort and rejection. Meaningful information comes associated with an emotional protective layer to challenge. This explains the strong tendency to confirmation bias and rejection of new sources of knowledge that disconfirms our beliefs.

Individuals develop an emotional attachment to familiar information to the point of suffering great anxiety when that information is deemed false.

Festinger [41] defined meaning as the perception of coherence between one's beliefs and the real world. "When these things align, we are left with the sense that the world is ordered, controlled, and understandable. When this coherence is disrupted, however, meaning is threatened and we feel distressed and anxious as a result".

The sense of meaning could then be seen as an adaptive feature derived and supporting beliefs. Adaptive beliefs are those which contain information that contribute to individual survival. A belief is adaptive if the information about what caused an event is reliable, predictable and useful. Beliefs shaped in this context are very likely to be strong which means, they are upheld in the mind with vehemency and any challenge to the belief is perceived as a threat to constancy. Some mental processes are common across species because they are built on neural structures that have roots in common ancestors. Perhaps the most primitive processes are those that refer to identifying the causes of what happens around oneself. The next step consists in an ability to predict future events and prediction can only be successful if it relies on the accuracy and reliability of previously stored information.

5.2 Causality: understanding causes and sequences of events

As discussed above the establishment of associations between cause and effect is perhaps the most ancient form of learning. Such associations provide the organisms with opportunities to test and improve its tactics during the acquisition of resources essential for their survival. Beliefs about the cause of events are perhaps one of the most important factors for survival. When we know what caused an event, we can somehow predict the outcome next time a similar cause is enacted. The concept of causality is coupled with the perception of agency. An agent is a living or inanimate cause which triggers an event, but very often humans attribute intentionality to the agent.

Detection of the cause-effect association is quite powerful and the motivation to find an explanation for the cause sometimes disregards rational thinking. If the explanation satisfies, then it is likely to be promptly accepted as true.

Explanation of causes are often associated with the presence of an agent. In humans, when the cause is unknown because there is no direct observation of the causal event, there is a tendency to create an invisible agent and attribute human characteristics such as intentionality. This is an important component of magical thinking and is the origin of animistic religions which created a backcloth to religions with deities. Animism attributes intentionality to forces of nature without anthropomorphic representations of entities. In animism, the believer appeals to the forces and energy of nature. They refer to the spirit of the elements such as the wind, the water, the earth as if they were fuzzy undelimited agents with consciousness and aims. Religion with gods is built on this principle where the agent is no more the forces of nature, but some invisible figure that concentrates those forces. These agents can be represented as animals whose characteristics identify with the natural phenomenon or humans.

The assumption that we are hardwired to discern relationship between cause and effect induces us to pay more attention to events that coincide, or are salient especially when they support our beliefs, thus reinforcing confirmation bias and often supporting beliefs in the paranormal.

5.3 Predictability

Assuming predictability is a strategy for coping with uncertainty. It helps in planning future decision making. Uncertainty leads to anxiety and stress and, as

such, beliefs that promote a false impression of predictability are naturally easier to accept. Observations of animal behaviour and historical narratives have shown evidence that safe environments promote co-operation and trust among the members of a social group, whereas instance of resource shortage and unpredictable social settings are conducive of social instability often expressed in varied forms of aggression [1].

Predictability is intrinsically associated with pattern detection. The perception of patterns, even when they are absent in reality, confers a sense of control. Patternicity equates constancy and repeatability [1].

The perception of patterns and the need for predictability underpin the onset of superstitious behaviours present in humans and animals [42]. A pursuit of predictability is yet more pronounced in situations marked by environmental social instability. For example, studies on political preferences suggested that the way humans perceive insecurity and unpredictable events may have some influence on their political beliefs. Research revealed that helping people imagine they are completely safe from harm can make them (temporarily) hold more liberal views on social issues [43, 44] and that a perception of threat can make liberals lean more towards conservative views [45].

When the information is provided by an informant rather than through subjective sampling, the reliability of the message can vary in levels of accuracy since many factors may corrupt the informational content from the time it leaves the informant and arrives at the receiver. The type and intensity of these modifications affect the reliability of the message and may therefore provide misleading information. The occurrence of ambiguity in the message is frequently interpreted as satisfying the desired goals inducing a belief that the message offers predictions that satisfy their expectations. This process is open to behaviour manipulation. Corrupted informational content may be unintentional, deriving from random mistakes or misperception, but can also be intentional where the informer sends purposefully dishonest signals. Since dishonest signalling is widespread in nature, detection systems have co-evolved to counteract such signals.

Conveying truthful and fake information are processes that promote the survival of individuals but are not without trade-offs. While cheating can be advantageous to individuals that interact only once, it will work against the cheater once the interaction is repeated and detected. Then cheating does not pay anymore. In social groups where most individuals know one another, the cheater may collect immediate rewards but once it is detected, it is promptly punished by elements of the group. However, in human social groups when the cheating is propagated through words that meet the desires and expectations of the receivers, the cheater can get away with his lies for quite a long time. Humans seem to be open to accept lies, as long as they align with their wishful thinking. In evolutionary terms this seems to be a process that would eventually vanish from the population, given its negative impact. However, it is not all negative, for there is also a need to conform with the beliefs of the group as a means of gaining protection.

5.4 Utility

Group membership in mammals is usually established by sharing similar scents. In humans, scent identification is complemented by the sharing similar ideas where thinking like the tribe becomes the equivalent of smelling like the tribe and fitting in the same social group. Similar scents indicate a level of kin relations and, accordingly to kin selection theory based on mathematical models developed by George R. Price [46] and popularised by W.D.Hamilton [47], altruism and cooperation are more prevalent among individuals that share the highest number of genes. This

implies that individuals are more likely to protect those who share genes with them, than those who do not.

Likewise, in human societies this rule could be applied to ideas in the sense that those individuals that share the same stances as me are more likely to protect one another. These ideas were popularised by Richard Dawkins [48] who coined the word *memes*, suggesting that the transmission of information from mind to mind follows similar rules like the transmission of molecular information through genes from parents to offspring.

This convergence towards homogenous ideas inside the group may explain the success of religion, political factions, belief in conspiracy theories, doomsday and other cults, reflecting a process of group cohesion previously regulated by scent similarity. This is reflected by what political scientists call *elective affinities*—the notion that there is mutual attraction between ‘the structure and contents of belief systems and the underlying needs and motives of individuals and groups who subscribe to them’ [49].

Many beliefs are not derived from personal experience, but from trusted sources or communities. So, giving up those beliefs may threaten ties with the community. When established beliefs have a useful function there is a tendency to conserve them since the sharing of common beliefs promotes group cohesion. On the other hand, homogenous group thinking prevents creativity which may result from a reluctance to conform with established rules. Rebels threaten the cohesion of the group and in order to keep them under control it is necessary to develop punitive mechanisms that discourage deviating from the *status quo* [50].

Thus, a strategy based on a hierarchical system of policing develops. But this strategy is not exclusive to humans, or mammalian social groups. It is also observed in groups of social insects such as ants and bees. Note that there is a difference between the evolutionary concepts of “strategies” and “tactics”. While strategies refer to a set of behavioural adaptations that evolved over time, tactics refer to the individual actions taken to pursue a strategy [50, 51]. The concept of utility can also be observed in individuals who believe in conspiracy theories. A conspiracy theory, however unlikely, represents an identification badge identifying that social group. In human societies the sharing of beliefs plays the same function as scent sharing in kin related animal groups. Common beliefs are the “intellectual scent” that unites a group. Conspiracy theories often offer theories that contradict the prevailing or official narrative of facts or events. They offer alternative explanations that appeal to those who believe they have a reason to distrust mainstream narratives. They usually refer to the existence of some hidden enemy and the individual finds safety in the confinements of their like-minded group. The belief in conspiracy theories relies on faith promoted by group think rather than evidence. The individual then finds a false sense of safety inside these ideological bubbles.

Perhaps one of the most puzzling aspects of beliefs which confer survival utility is the placebo effect which seems to have positive effects in healing of the mind and body. Perhaps one of the main characteristics of this effect is that it is grounded on the human’s tendency to magical thinking and embrace convictions rather than simple beliefs.

6. Conclusion

It is possible to identify four basic categories of beliefs that provide meaning and tend to be strongly protected. Beliefs that serve some purpose have great utility, especially if that purpose is the acquisition of power and dominance over a group. Thus, promoting beliefs about one’s divinity or ability to perform miracles confers

power over those who expect to enjoy the benefits of a relationship with such individuals. Beliefs that offer explanations for unknown phenomena are useful in the sense that, by offering knowledge, they help with predictability which, in turn, reduces anxiety. When beliefs are useful, they can easily turn into convictions.

Empirically acquired beliefs are expectations based on the repetition and patternicity of previous experiences. Thus, I believe the sun will rise tomorrow because I have experienced such a pattern in the past. My dog believes it is about to go for a walk, because I always put on a specific coat and get the leash from the coat hanger. My cats believe they will be fed every morning and, as I enter the kitchen after I wake up they are standing and waiting by the cat bowls. These are beliefs shaped by associative learning.

Informational acquired beliefs are those acquired by perception of messages sent by others. The similarity between alarm calls in Diana Monkeys and reading the news by humans resides in the content of what is communicated, perceived and interpreted by the brain. The difference relates to the medium by which the message is sent and the semantic complexity of its content.

Understanding how empirically shaped beliefs may trigger behavioural responses is relatively straightforward, but informational acquired beliefs require an assessment of their reliability or truth. And in humans such beliefs contribute to more than simple behavioural responses. They have effects on the mind and the self. This is reflected in approaches based on religion or psychotherapy. Through the means of self-suggestion, individuals can change their state of mind leading to calmness or anxiety, happiness or depression. Most of these states of mind are induced by the content of the information and not by experience.

Research on economic decision-making in animals has provided even more support for the assumption that animals hold beliefs. Economic decision making involves weighing up different beneficial alternatives to maximise payoff. This means that animals are given a choice between accepting an immediate small reward or delay the decision to acquire a larger reward. This implies that the animal has a knowledge and must hold an expectation or belief that a larger reward is to come later. Such behaviours have been observed in chimpanzees (*Pan troglodytes*) brown capuchin monkeys (*Sapajus spp.*), dogs, sea lions (*Zalophus californianus*), corvids and parrots [52].

Evidence of processes that support the presence and formation of complex types of belief in animals are a good indication that human belief construction has biological roots and is an adaptation resulting from evolutionary pathways.

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