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Evolutionary Psychology Meets Social Neuroscience

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Published in London, United Kingdom







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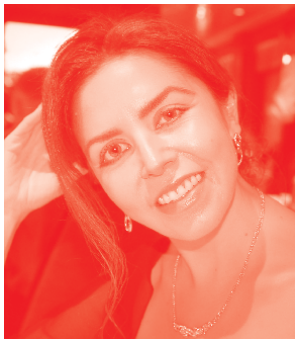

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http://dx.doi.org/10.5772/intechopen.92465
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First published in London, United Kingdom, 2022 by IntechOpen
IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, 5 Princes Gate Court, London, SW7 2QJ, United Kingdom
Printed in Croatia

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from orders@intechopen.com

Evolutionary Psychology Meets Social Neuroscience
Edited by Rosalba Morese, Vincenzo Auriemma and Sara Palermo
p. cm.
Print ISBN 978-1-83968-870-6
Online ISBN 978-1-83968-871-3
eBook (PDF) ISBN 978-1-83968-872-0

Meet the editors

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Vincenzo Auriemma, born in Italy, holds a bachelor's degree in sociology at the University of Salerno and a Ph.D. in sociology at the same university. He developed new techniques for empathy analysis in the relationship between sociology and social neuroscience. He is an expert in the history of sociological thought, neurosociology, institutions of sociology, and general sociology. He carries out transdisciplinary studies based on the relationship of sociology with other sciences in the investigation of empathy on both individuals and groups, in order to investigate whether it is a culturally constructed or genetically given aspect. He currently works as a postdoc research fellow at the Department of Political and Social Studies of the University of Salerno. He is the scientific director of the National Passa la Palla Network, which deals with combating bullying and cyberbullying, and is a member of both the Italian Association of Sociology (AIS) and the Sociology of the Person (SPe). He is part of a research group that focuses on the analysis of dropout in psychotherapy as a methodology of transdisciplinary research between the University of Cassino and the University of Salerno and a member of a research group that studies the well-being of patients and healthcare personnel at San Giovanni di Dio e Ruggi d'Aragona University Hospital, an affiliate of the University of Salerno.

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Contents

Preface

This book aims to open a debate full of theoretical and experimental contributions among the different disciplines in social research, psychology, neuroscience, and sociology and to give an innovative vision to the present research and future perspective on the topic.

Evolutionary psychology based on Charles Darwin's research aims to understand how human behavior, thoughts, and feelings are the result of internal psychological mechanisms produced by natural selection. Although this approach is applicable to any being with a nervous system, evolutionary psychology focuses its research mainly on human behavior.

Just as human physiology and evolutionary physiology have worked to identify physical adaptations of the body that represent human physiological nature, the aim of evolutionary psychology is to identify evolved emotional, cognitive, and social adaptations that represent human psychological nature.

The fundamental research areas of evolutionary psychology can be divided into two broad categories: the basic cognitive processes, and the way they evolved within the species, and the adaptive social behaviors that derive from the theory of evolution itself: survival, mating, parenting, family and kinship, interactions with nonparents, and cultural evolution.

Similar to the mechanisms of natural selection for physical characteristics, the mind follows biological laws, and psychological abilities, such as the theory of mind and the ability to represent the intentions, thoughts, beliefs, and emotions of others, have had to adapt and must be functional according to the social life of individuals and groups. In addition, sociology takes the same aspects into consideration, emphasizing the interaction, symbolic and otherwise, of individuals. The latter investigates the neural mechanisms underlying the same social behaviors that are of interest to evolutionary psychology.

Evolutionary Psychology Meets Social Neuroscience explains at individual and group level the fundamental behaviors of social life, such as altruism, cooperation, competition, social exclusion, and social support.

> *"It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is most adaptable to change."*
>
> *Charles Darwin*

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Chapter 1

Introductory Chapter: *(trans)* Disciplinarity - A New Alliance between Sociology and Neuroscience

Vincenzo Auriemma, Chiara Fante, Rosalba Morese and Sara Palermo

1. Year 2021: the need for a new theoretical framework to understand social relations and the consequences on the individual's well-being

To begin any debate within a discipline, in our case applied neuroscience in the social sciences, it becomes important to start from the historical and conceptual reconstruction of the fundamental axioms and main paradigms. This is for a two-fold reason. First, because, the so-called "young sciences" are less and less accustomed to the culturally given element, thus moving more toward the "cognitive goal and advancement of knowledge" than toward the evaluation of the processes by which these goals are achieved. Second, because paradigm shifts, as well as changes in method and inference, lead to the abandonment of original concepts in favor of new ones derived from them more and more rapidly. Given the above, we believe it is important to revisit the historical and scientific value of concepts such as "attachment," "adaptation," "theory of mind," "empathy," "abandonment," "social inclusion and exclusion," and empathy. This need is expressed both from the point of view of the history of sociological thought, and from the point of view of the history of social sciences in general and, today, of social neuroscience. Today, we are going through a structural change in society, in which less and less direct contact (due to the software that allow us to interact) and the expression of emotions are no longer expressed in face-to-face relationships. The mediation of emotions, more and more often, takes place through a screen, rather than through intelligent software (AI), which, as a modern digital and immaterial appendage of our body, makes us part of the internet of things and (hyper-connected), even plus, part of the intrinsic mechanisms of the Internet of Things.

Social relationships are indispensable in the life of each individual and condition his way of thinking and his emotions. The individual, in fact, has a sort of interdependence with the social environment. However, social relationships are not always lived serenely or satisfactorily in a digitally unstructured environment, as these are often alienating contexts and able to produce vulnerability a progressive desertification of the individual's ego also for clinical settings [1, 2].

The massive use of social communication channels, in combination with the rise of virtual reality, becomes a central element of any critical reflection and research proposal. Human beings need social relationships. The evolutionary point of view suggests that group membership is a fundamental aspect of social life due to

survival. Disruption of social interactions predisposes to even more serious health risk factors when the disruption occurs because one is intentionally excluded from other people. This experience can cause an experience of severe psychological distress, in which strong negative emotions of sadness and depression, a high level of stress had expired ([3] p. 3).

Given the current scenarios—also secondary to the pandemic situation we are facing—and the digital drift that began a few years ago, concepts of abandonment, isolation, and empathy are back in vogue and increasingly central in prevention and intervention models.

As mentioned above, the pandemic has accentuated distances and isolation, and has led to seeking the relationship but mediated by the digital channel, bringing the dichotomous characteristics of "input" and "output" typical of computing to an extreme, especially in the fields of education and recreation. Education and leisure managed and experienced through ICT-IoT platforms are a common experience for all. Whether this experience is real and meaningful is another matter entirely. What are the consequences and the aftermath for the psychophysical well-being of the individual we are only just beginning to understand?

We deal with new learning and relational processes and new meeting places. The first suggestion in this regard comes from Prensky [4]: "we are living more and more in a world characterized by the man-machine." Anyone who does not understand this and is not trying to find the new environment, whether they like it or not, is already left behind. "Adapting to the rapidly changing and technologically advanced new environment is one of the greatest challenges of our time. And this certainly applies to education as well". Indeed, human interaction through new technologies necessarily implies an unnatural degree of "disincarnation" (which, as previously anticipated, favors, and supports the processes of ego desertification).

It is presumed that the main iatrogenic element of the relationship mediated by ICT-IoT platforms is the difficulty in making use of non-verbal communication indices. Not only gestures, facial expressions, and spontaneous posture, but also smells and vocal colors are lost in the confinement of the webcam. These are all key elements for the correct interpretation of communications, which lead from the denotation to the connotation of the message, and, consequently, to the rereading and interpretation of the implicit and affective aspects of the communication.

Several types of research in the social sciences and communication that the ability to understand and participate in these modes of interaction are a component of the human social experience (see, e.g., [5]) also in the difficult period [6]. Despite the possibility of synthesizing some emotional features, through emoticons and audio supports, bringing out some paraverbal aspect of human communication, it is still not possible to reach the totalizing experience of the real one, in person, face to face.

Human interactions are based not only on the exchange of information, but also on the implicit and affective methods of communication put in place. Emphasis, understanding, misunderstanding, interest, boredom, amazement, amusement, irony, compassion, and acceptance are based, at least in part, on non-verbal communication. Learning interactions that are mediated by telecommunication systems suffer from limitations in non-verbal modes of exchange that do not effectively support the communication of these pragmatic signals [7]. This observation led to the research and development of the ICT-IoT platform and digital application to support the exchange of affective information for online web learning. Researchers are examining the cultural and social changes that emerge from the interactions with new media, by the new knowledge in the field of cognitive science [8] and future studies of embodied cognition [9] may provide new insights regarding the effects of technological tools (i.e., Virtual Reality, VR) on the sense of "social presence" even in the area of education [10].

2. The road of neurosociology

We want to focus on how much the advancement of knowledge—and of the methods/processes for knowing—could lead to a better understanding of the typical concepts of the social sciences and psychology (such as abandonment, exclusion, and empathy), but also how each individual interprets and experiences these conditions. What will be increased within our reach will be understood as each empathizes with the other even before entering into verbal or gestural contact [11].

We argue with the possibility that to do this, the thin boundaries that divide the human sciences seek to make themselves permeable to each other with the utmost attention, reasonableness, and respect for the peculiarities of each. This (trans) disciplinary exchange can take place by recognizing the social and cultural factor as equal to the biological-ontological one: If it is true that at the base of the understanding of human relationships there are mirror neurons, it is equally true that culture and social environments influence mirror neurons and the evolution of the species (Turner, 2011).

Doing so could lead to the explanatory capacity of neurosociology, whose intent is to study social relations and socialization about the structures and functions of the nervous system. Importantly, neurosociology stands in close relation to neurobiology (and its branches) and social psychology. Thanks to this approach, methods, and intervention, strategies can be perfected in the areas of education, social distress, deviance, crime, health genesis, integration, and cooperation [12].

3. Neuroscience for social studies

"In my career as a sociologist, I first became interested in neurosociology around 1987, when a student lent me Michael Cazzaniga's book *The Social Brain*. If the human brain was social, I thought that sociologists and their students should be the first to learn about it, not the last."

This is how David D. Franks, Professor Emeritus of Sociology at the Department of Sociology at Virginia Commonwealth University, began to make the first considerations about the usefulness of social neuroscience in the sociological field and about the contribution that sociology could provide to neuroscience research and development. Franks is rightly credited with bridging the gap between sociology and neuroscience through a series of publications culminating in his *Handbook of Neurosociology* [13].

Neurosociology has the ambition to create a strong bridge between sociology and neuroscience where methods and knowledge of both disciplines can pass in two directions; but, above all, it is concerned with studying human interactions and socialization in relation to the social functions of the nervous system from a "clinical" point of view, that is, in a context of proximity between observer and observed and where there is involvement with the situations and facts on which the neurosociologist acts. Therefore, *neurosociology uses the knowledge of neuroscience to spread the "practical" aspects of sociology*, and in this perspective, we can frame it as a specialization of clinical sociology. The latter, in fact, aims to "intervene to change" "singular" situations, whether they are of an individual or a group or a community, an organization or an institution [14].

Considering social neuroscience tout court, it mostly inquires how evolutionary pressure has favored the emergence of the specialized social brain networks that allowed humans to build up complex societies. It has been shown, for example, that very basic behaviors such as cognitive processes underlying reward and punishment are influenced by higher-order variables such as social status and group membership.

These processes are also shown to be testable and valuable on specific clinical populations. In particular, social neuroscience has suggested an association between impulsive behaviors and altruistic punishment [15]. Just for an example, dopamine replacement treatment and dopamine-agonists in Parkinson's disease have been associated with impulse-control disorder and impulsive-compulsive behavior able to affect social decision-making [15–17]. With a transdisciplinary approach, it was possible to understand how "Frontal-executive dysfunction determines an alteration of social functioning through a mechanism of subversion of online action-monitoring, which associates disinhibition with volition. Genetic polymorphisms, alterations of the nigrostriatal substance, and impairment in the medial prefrontal cortex and in the Default mode network (DMN) seem to be able to explain these mechanisms" ([15], p. 1).

This demonstrates how our tendency to form groups based on dispositions, preferences, and ideologies can influence basic cognitive processes and—at the same time—how neurobiological and psychophysiological factors can modify social cognition and behaviors.

4. Conclusions

Digital Innovation is a very broad and transversal concept, and at the heart of all those technological, organizational, cultural, social, and creative changes that improve everyday life. In just two words: *Digital Transformation*. The evolution is continuous, not only in the technologies themselves, but also in the applications, in the communicative, relational, didactic-formative, and organizational models of groups and organizations.

Since the study of human relations and social reality can increasingly become transdisciplinary, inasmuch as the study of this subject is by its very nature interdisciplinary and transcends the often-artificial boundaries that separate and distinguish the various scientific disciplines. The advancement of ICT-IoT will allow us to create a new human-machine symbiosis that will improve the quality of life and the way we interact. Tending to this ultimate goal, the sciences will have to ally themselves to find the best models of fruition and adaptability of these new technologies to the psychological needs of human beings—with particular attention to the enhancement of empathic and identification processes. Neurosociology will allow us to keep up with the social, cultural, and economic changes we are going through.

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Chapter 2

An Evolutionary Approach to the Adaptive Value of Belief

Anabela Pinto

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.

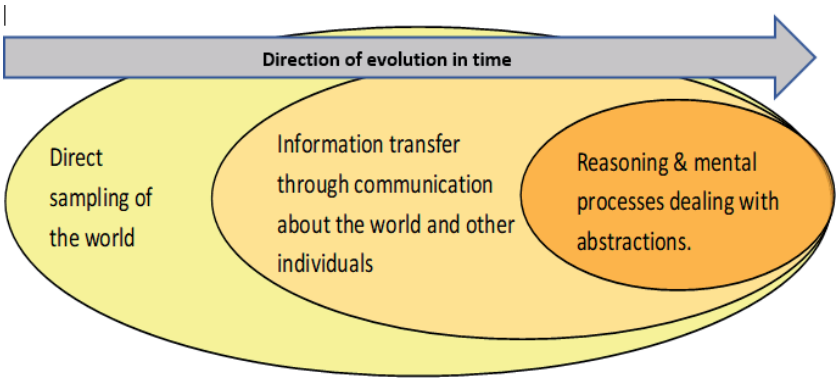

Figure 1.
The diagram represents the type of information acquisition at different levels of animal cognitive complexity. The smallest circle includes characteristics held by humans only.

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 syspila*), 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 waggling 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 waggling 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 waggling 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 s 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 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 refer to female preference for males with exuberant characters as if they "believed" it was a good male to mate with. The use 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 characters 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 aesthetical 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 present 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 us 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 paternicity 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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Chapter 3

Social Inclusion and Exclusion: How Evolution Changes Our Relational and Social Brain

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Abstract

Belonging to social groups is an important need for human beings and social exclusion has a significant psychological impact on individual wellbeing. Social neuroscience has clarified the similarity of the neuronal substrate between physical pain and social pain during the experience of social exclusion. Pain is the oldest signal that something is wrong for our brain, and the anticipation of pain motivates a move away from perceived dangerous or noxious stimuli. The Evolutionary Theory of Motivation (ETM) considered group affiliation as an adaptive goal that supports the individual's adaptation to the environment; however, invalidating experiences may induce avoidance of its pursuit. In this perspective, social exclusion could thus be considered as the result of failures at one or more levels of the human motivational systems. This chapter attempts to understand the neuroscience findings on social exclusion in this theoretical framework.

Keywords: social inclusion, social exclusion, social pain, social brain, Evolutionary Theory of Motivation, cooperative system

1. Introduction

Within this chapter, we will deal with a discourse that is increasingly treated only in part, excluding modern and, above all, interdisciplinary theoretical approaches. Social discourses on emotions often appear more fitting but less "attractive", as they are difficult to verify empirically without adequate cooperation between the sciences. Therefore, our interest is to bring out a focal point, emotion, understood as the emotional capacity of living beings, to be considered in all its aspects and understood as a social emotion. Starting from this premise means considering relationships full of emotions, both positive and negative. However, it will be necessary to deepen some aspects, perhaps little known by the less accustomed to this type of topic, such as the processes of social exclusion, rather than evolutionist theories. These aspects are fully part of the logic of social action dear to Max Weber. Even in the literature, we have many examples of these aspects, some evident others to paraphrase - for illustration the social exclusion that emerges, with brute force, in *The Scarlet Letter*, rather than Orwell's speeches about the eye that constantly watches over society. Therefore, the first step will be to deepen these first two aspects, inserting them in scientific and empirical discourses.

Based on these premises, this chapter is a first attempt to link the neurosciences findings on social inclusion and exclusion with an evolutionary theory of human motivation.

2. Social inclusion and social exclusion

Human beings have a fundamental need to belong to social groups [1] and to be accepted by other people [2, 3]. The intergroup emotions theory [4, 5] defines the role of emotions in relationships between groups: inter-group behaviour is thus driven by emotions that are uniquely social, feeling emotions like other group members, involves a further involvement and sense of belonging [6]. Emotions can be positive and negative that characterise the experience based on perceived intensity [6]. For instance, social exclusion has a significant psychological impact since it expresses the subjectivity of the individual's experience with possible consequences such as anxiety and depression [6]. The emotion felt during the experience of social exclusion is very strong and intense, it represents a real pain characterised by separation and rupture from the social group [7], by social exclusion we mean being kept out, or rather excluded, left alone or isolated from other people [8]. The experience of social exclusion is also called social pain. When people express the emotions and the emotional state they feel when they are excluded, the words often used refer to wounds, broken hearts, ruptures. Pain is a complex subjective experience involving many aspects: the physical sensation associated with a sensation, the negative or unpleasant subjective feeling. The anticipation of pain motivates a move away from dangerous or noxious stimuli, and the memory of a pain encountered in the past can be a powerful and motivating force for the immediate experience of pain [6].

3. The brain and the social exclusion

Social neuroscience studies the neural basis of the psychological processes that exist between the brain and social interactions, through neuroimaging techniques such as nuclear magnetic resonance (MRI), functional nuclear magnetic resonance (fMRI), transuranic magnetic stimulation (TMS) [2, 3, 9, 10]. Authors have begun to investigate the similarity of the neuronal substrate between physical pain and social pain during the experience of social exclusion [10]. Einsenberger et al. [10] conducted a study on social exclusion using fMRI to determine whether the regions activated by social pain were similar to those activated by physical pain. The affective component of physical pain deals with signalling a negative state and motivating the behaviour to reduce it. The affective component of physical pain is processed, in particular by the dorsal portion of the anterior cingulate cortex (dACC) and by the anterior insula. The anterior angled cortex (ACC) functions as a neuronal alarm system that monitors conflicts and identifies when an automatic response is inappropriate or in conflict with the intended goal [10]. In humans, ACC is activated by the noise of crying babies [10]. The dACC is a structure known to be activated during the experience of physical pain, which has also been found to be activated during social pain [10, 11]. For this reason, pain is the oldest signal that something is wrong, and activates this brain region [10]. In particular, the dACC is associated with suffering rather than with the sensory component of pain [10]. The most famous neuroimaging study on social exclusion is conducted by Eisenberger et al. [10], the participants are scanned in the fMRI setting, while participating in an interactive virtual session of the game, Cyberball. The game

consists of playing virtually with two other players to pass the ball. In truth, no other participants were present in the simulation of the game but it was a computer program, which was given a story of circumstance to make the identification of the participants truthful to make them believe they were playing with other people. The game of Cyberball is recognised to be able to manipulate effectively feelings of inclusion and exclusion [11]. In the first session of the game, the participants were included in the dribble while in the following round they were partially excluded through the game [10]. When participants in the experiment realised that they had been excluded from the game, and seeing that another participant was not excluded, the researchers noted an increase in dACC and anterior insula activity, a circuit very similar to that typically seen in studies on physical pain [10, 12–15]. But why are social exclusion behaviours still enacted today? Social exclusion allows man to live and evolve selectively, surrounding himself with people similar to him who share closeness, similarity and identification to better adhere to group norms. The social exclusion mechanism allows the protection and maintenance of the same group in which to identify oneself.

According to some approaches to the study of human motivation, human beings are motivated to stay e in groups and to create a sense of belonging [16]. From an evolutionary perspective, social inclusion can be considered an adaptive goal that supports the individual's adaptation to the environment; however, invalidating experiences and learnings may connect the pursuit of adaptive goals with the perception of danger and prevent its achievement [17]. This point of view may be an interesting perspective to view the neural basis of social inclusion and exclusion describe above.

4. The evolutionary theory of motivation

The Evolutionary Theory of Motivation (ETM; [16, 18–20]) is a theoretical model developed in a clinical context from a cognitive- evolutionary framework and currently represents a common ground for different approaches, not only concerning psychopathology. This evolutionary perspective suggests that the Motivational Systems developed by every human being are based on innate and universal dispositions that can be defined as predispositions to act towards specific goals, selected by evolution. They should not be regarded as fixed patterns of action, but as tendencies to pursue particular forms of interaction with the environment, including the social one [20]. According to the "Triune Brain Theory" [21, 22], human motivational systems can be organised into three hierarchical levels, corresponding to the different needs that emerged from the evolutionary process: survival (Brain Stem or Reptilian Brain), interaction with other group members (Mammalian Brain) and "epistemic" needs (Neo- Cortex Brain). The most archaic motivational system may be called '*non-social*'; its primary aim is the maintenance of homeostasis, defence and exploration of the environment. This system is based on the activity of neural networks located in the Brain Stem and basal ganglia. It is common to all vertebrates and does not require interaction with other members of the species. With the appearance of the limbic system during evolution, new motivational thrusts that regulate social interaction can be identified: the ETM postulates the existence of "Interpersonal Motivational Systems" (IMS; [16]) that operate in all mammals, including humans. Each of these systems has a different neuro-functional representation [23] and aims to achieve a specific adaptive goal (**Table 1**).

This second level is therefore made up of systems capable of regulating communication between members of a social group, starting from birds and mammals that

Attachment system	Search for protective closeness and help
Caregiving system	Protection and comfort offered
Sexual system	Reproduction and formation of sexual couple
Ranking system	Definition of social rank (dominance and submission)
Cooperative system	Sharing of goals, alliance

Table 1.
Interpersonal motivational systems and their goals (modified by [16]).

can recognise conspecifics. The formation of cohesive social groups has therefore required the emergence of systems that organise the different emotions and consequent motor actions into typical sequences for each goal [24]. The IMS are specific for each critical situation that can be faced using an appropriate interpersonal position and are activated or deactivated according to the achievement of the goal. The activation of IMS produces unconscious mental activity and implicit relational knowledge [25, 26], which represent the first level of consciousness, definable as "Protoself" [27]. Moreover, the activation of each motivational system, the achievement of its goal, and the obstacles posed by the environment result in the construction of memory patterns capable of modulating subsequent experiences [16]: while pursuing a specific goal, assessments aimed at maintaining survival and a state o minimum security are necessary [28]; the achievement of the evolutionary aim might be hindered by implicit memories learned in an interpersonal and social context [16].

The third hierarchical level involves epistemic motivations supported by the activity of neocortical circuits and concerns intersubjectivity (Stern XX) and the construction of meanings:

> *"The new evolutionary goal directs an individual to attribute meaning to his/her life by giving order, consistency and unity to the knowledge possessed and incarnated through the activation of the oldest limbic and non-social motivational systems to harmoniously organise his/her vision of self, others and the world ([29]; pg. 2)".*

Through the emergence of Neo-Cortex, all pre-existing goals and motivations related to social interaction can become conscious and objects of verbal thought [20]. Among Motivational Systems, there is a recursiveness of information flows that bidirectionally links the archaic level with the more recent evolutionary levels. Each system processes information from the previous levels (bottom-up pathway) and the higher levels send excitatory or inhibitory signals to the lower level systems (top-down pathway; [24]). Furthermore, recognising Jackson's Theory as a theoretical framework of reference [30], the ETM suggests that the more recent structures, which have control over the more archaic ones, are the most sensitive to 'dissolution' in the face of environmental events. The consequent manifestations of a switch-off in the higher brain functions would therefore be ascribed to the activity of the lower ones: this would become clear in the case of traumatic, life-threatening situations [16]. At this point, it may be interesting to consider the impact that the loss of safety conditions has on the functioning of the neural circuits supporting social behaviour. As Porges' Polyvagal Theory makes well clear [31], the ability to identify a secure environment and a safe conspecific is a necessary skill for mammals to switch-off their brainstem-regulated defence systems and to engage in social interaction with group member. This mechanism requires a complex regulation of the autonomic state through the vagus nerve [32]. For the human being, therefore, states of safety are a key pre-condition for relational involvement and for

getting access to higher brain structures, which enable the building of conscious Self- narratives.

4.1 The cooperative system and the emergence of intersubjectivity

While systems of supply and demand for care, the formation of a sexual couple and competition for social rank are present in almost all mammals, only in a few species it is possible to identify a system that regulates cooperative behaviour between group members [33] and, from the perspective of ETM, this system reaches a unique complexity in humans being [20]. The cooperative system is triggered by the perception of goals that are more easily pursued sharing actions of at least two members of the group, in contrast to situations where access to resources is limited and competition is necessary (rank motivation system). The emergence of social groups in the course of the evolutionary process would then make it possible to maximise survival by sharing resources and by organising relationships of submission and dominance. The definition of social status is associated with the suppression of destructive aggressive behaviour towards members of one's species. Indeed, although activation of the social rank system involves some type of intraspecific aggression, it is manifested with "ritual agonistic behaviours" [34]; this mechanism is observed in simple vertebrates and consequently does not require the intervention of limbic structures, which are evolutionarily more recent [24]. Even though the best-known explanation of cooperative behaviour is 'reciprocal altruism' based on the idea that it represents a conditional strategy based on individual benefit [35], the ethologist Michael Tomasello has identified behaviours that are not supported by personal advantage in the human being. For example, children at 18 months show helping behaviours to strangers without getting any benefit for themselves [36] and at 12 months actively search for shared attention with an adult on the same object only for the mutual sharing purpose [37]. This finding suggested that intersubjectivity may have emerged as an enhancement of the ability to cooperate with other group members in the evolutionary process. The possibility of actively sharing attention with the other would create the basis for intersubjectivity and for recognising oneself as similar to the other, not only based on morphological similarity (already guaranteed by our Mammal Brain), but also on intentionality [38]. Intersubjectivity, as an emerging motivation in development, would enable language development and make it possible to share experiences [16]. Furthermore, *"the highly developed cooperative/altruistic system in humans that coevolved with intersubjective abilities is instrumental in building mutuality, trust, and hope"* ([19], p. 892).

5. ETM and social inclusion: some preliminary considerations

Currently, ETM represents an important theoretical framework in the clinical context to study psychopathology and to develop approaches that emphasise the importance of cooperation in the psychotherapeutic relationship [39]. However, ETM is a comprehensive evolutionary-based theory of human motivation and then it can represent an interesting map to analyse social phenomena such as inclusion and exclusion. In this theory's view, briefly outlined above, the individual social inclusion might be considered as the result of the achievement of evolutionary goals and some environmental conditions can support it (**Figure 1**). First of all, it is only the feeling of a safe environment that guarantees relational engagement and exploration (Brain Stem; [40]); on a neurobiological level, the perception of threat can trigger the archaic defence system, inhibiting the activation of higher brain areas.

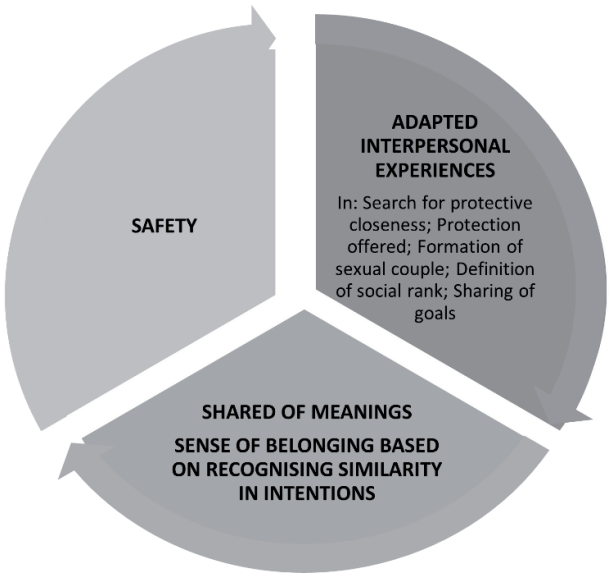

Figure 1.
A potential mapping of social inclusion conditions in the ETM context.

This adaptive survival strategy makes it impossible to pursue evolutionary higher goals that require interaction with others members of the group.

Moreover, social security is a key condition for the emergence of mentalisation and can be provided by different types of social relations, each linked to specific motivational systems [28]. Then the social and family environment should support the achievement of our 'limbic goals' in safe conditions: seeking protective closeness in case of distress, offering support to another perceived as vulnerable, establishing clear hierarchical positions without destructive aggression and sharing resources to pursue common goals (Mammalian Brain). Finally, validating experiences related to the pursuit of interpersonal goals and the resulting implicit knowledge can sustain the development of higher conscious cognitive skills, such as sharing experiences and creating a sense of belonging with others who, despite differences, we recognise as like ourselves (Neo-Cortex Brain). In the framework of ETM, experiences of social exclusion could thus be considered as the result of failures at one or more levels of the human motivational systems: impossibility to feel security in one's environment, inability to have good relational experiences related to limbic goals (e.g., adapted cooperative and competitive experiences), and failure to share meanings and to develop a deeper sense of belonging that is not only based on individual similarity and physical proximity. These repeated experiences can induce social pain and suppress the pursuit of group affiliation and of social inclusion.

6. Conclusions

Exploring such complex topics using multiple points of view must become an attitude for all modern sciences. It is starting from the particularity and exclusivity of each one, from neuroscience to sociology, from biology to psychology, that we can face the challenges presented here and in the future. The thought immediately goes to the monitoring and management of the post-pandemic situation, since currently the tendency is to focus on the short to medium term effects. Increasingly, it is emerging that Covid-19 infection can have major consequences, even months

after recovery. The international scientific literature has included them in what is called Post-Covid or Long-Covid Syndrome. Addressing aspects of social exclusion becomes a necessity. This challenge can only be met by collaboration between disciplines, psychobiology and psychology, sociology and neuroscience. Only in this way we will have a complete interpenetration of the hyperplexities and questions that we are not able to highlight alone.

Funding

This research was supported by PRIN 2015 PER-FORMARE IL SOCIALE. Formazione, cura e inclusione sociale attraverso il teatro, principal investigator (PI) Prof. Bernardi.

Conflict of interest

"The authors declare no conflict of interest."

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Chapter 4

Social Supports Available to Persons with Disabilities in Nigeria

Chinyere Onalu and Nneka Nwafor

Abstract

Disability entails more than the mere physical deformity such as stroke; however, a disability could manifest in different forms; mental, emotional, sensory and intellectual disability among others. People with disability are faced with a lot of challenges and they experience depression, isolation and social exclusion which were explained in studies from the natural and behavioral sciences. Also, Social workers and Psychologists alike have often discussed the importance of social inclusion and social support for people living with a disability. Social support helps to reduce psychological stress, enhance the quality of life and achieve social inclusion. Lack of social support increases the risk of depression, social exclusion, maladaptive behaviors and mortality. In this paper, we will give a thorough explanation of Social support and its forms. We emphasized the influence of neurobiology, personality features, social system and perception on who gets social support and to what extent. The paper also discussed Nigeria's perceptions of disability and the social support networks in Nigeria, using vast literature. From literature, social supports are of different kinds however, this paper emphasized the need for functional social support which entails changing negative perceptions about disability. In other words, social support should not be just assisting the individual to access their immediate needs but should entail involving them in decision making – social inclusion.

Keywords: disability, inclusion, Society, support, Nigeria

1. Introduction

Disability is part of the various challenges that confront human beings at different places in the world. This is to say that disability is a phenomenon that transcends national boundaries, cut across gender, class and race. It was estimated that about one million people, who accounted for 15% of the global population has one form of disability or the other [1, 2]. The term 'disability' refers to different kinds of impairments and deformities which restrict people's ability to cope well in society. It is a condition that breeds various impediments on the physical, economic, political and social well-being of people living with a disability. It manifests in various forms ranging from physical disability, emotional, sensory, intellectual, and psychological among others. Sometimes, traumatic experiences which people had to render them incapacitated thereby hinder their ability to function optimally well in the society where they live [3]. Disability can also be hereditary, developed during childhood or due to old age, as a result of fatal accidents, natural disaster, and diseases among others [4–6]. In other words, disability encompasses a baby born blind, a child who developed

autism disorder, a soldier who lost his sight during the war, a man with dementia as a result of old age, a woman with an amputated leg and a student with speech disorder among others.

Each form of disability has its implications depending on its severity. For instance, Autism Spectrum Disorder (ASD) is a disability with its peculiarities. Persons with ASD find it difficult to have social interaction, however, their communication is usually marred by constant repetition and they are also known for exhibiting certain stereotype behaviors [5]. People who are deaf or dumb also have peculiar challenges, quite differently from people living with amputated legs. In other words, some disability is more severe than the other and their challenges and needs vary depending on the form of disability.

Generally, there are grave implications on the social, psychological, economic, political and overall wellbeing of people living with a disability [7]. While people without disability face a lot of challenges, those living with dia disability are disproportionately challenged. They are faced with multifaceted challenges which are more severe to compare with those without any disability. According to the world report on disability, people with disabilities experience inequalities, lack of political participation, violations of their rights and denial based on their disability [6]. Consequently, disability is a big barrier to social inclusion. Ordinarily, the experience of being incapacitated confers a sense of limitation, low self-esteem, depression and most often, people with disability withdraw from social participation. Based on their disability, they are more vulnerable to discrimination, poverty, and social exclusion. It is also worth knowing that people living with severe kind of disability are mostly affected by loneliness which further increases the chance of developing ill mental health. Also according to Sengonul [8], support and warmth from love ones was attributed to as a part of socialization, through which the young people are introduced to rational behaviors, prosocial and moral development. However, a deficiency in learning rational behaviors necessary for psychological and social integration in the society is regarded as 'disallowance socialization' [9]. In other words socialization has a close link with physical, social and mental developments of individuals.

2. Coping with a disability condition

The onset of disability can be traumatic to the disabled and their families especially when they find it difficult to cope with. According to Southwick et al. [10], there is a psychological and neurobiology variances on how different people cope with traumatic conditions. Research evidence has shown that personality features such as neuroticism, extraversion, conscientiousness among others, influence how people cope with traumatic conditions such as disability [10, 11]. Unfortunately, there is a dearth of literature on disability and neurosciences, however, insights could be drawn from the theory of personality, that explains how the Ego and the Superego operates and how one's personality determines their ability to absorb shock and adapt to life's experiences. This is to say that there are persons who are better placed to cope with disability better than the others, based on their personality features. For instance, Onyishi [11] explained that people with open-mindedness and extroverts tend to have a large circle of friends and relationships - social network. It is worthy to note that, in coping with disability, social support from friends, family and significant others reduce psychological stress and boost longevity [12]. However, social support is a product of the social network. Reviewed literature has shown that the more social support network one has, the greater their chance of life satisfaction and longevity.

Furthermore, Stress buffering model also posits that people with support from family, friends and other social network suffers less from depression than those that lack social support network [11]. For, Jensen et al. [13], Social support reduces depression for both genders, across disability diagnoses and all ages. Therefore people with disability who lacks social support are subject to isolation, depression, withdrawal from the society, most often than none, subject themselves to a state of oblivion, by way of lack of social participation. All these could lead to mental ill health. Based on existing literature, the paper agrees, that people with disability, with enough social support, have a great chance for social inclusion which further increases life satisfaction whereas, lack of social support is the dawn of social exclusion which intensifies the gravity of disability. It points out that every social system is characterized by socially excluded groups particularly people with disability and the availability of social support is the onset of social inclusion. However, the degree of social support one gets is depending on their social disposure, influenced by personal traits and perceptions about disability. Put differently, the psychological ability and personal perceptions about disability make a difference in how people living with disability access social support.

3. Social exclusion and disability: a two-way relationship

Disability is undoubtedly among the most vulnerable conditions at risk of social exclusion. Scholars in both natural and behavioral sciences have explored the effect of social exclusion on wellbeing and social conditions. Studies have shown that social exclusion has a big effect on neural activities at different regions; ranging from the insula, anterior cingulate cortex, temporal and prefrontal cortex. The chronic experience of being socially excluded activates reactions at the nervous system which they described as neural activations. These neural activations stir feelings of sadness, distress and other negative emotions in the excluded person. However, these studies acknowledged that other factors such as the genetic make-up of the individual, disease, and psychological state and life experiences also have its influence [10, 14–17].

Views from the behavioral sciences show that there is a two-way relationship between social exclusion and disability. While people with disability are at greater risks of social exclusion, people who are socially excluded are at greater risks of disability [4, 7, 18]. The rate of poverty and unemployment for people with disabilities are disproportionately high. And according to Lang et al. [19], people with disability are less likely to be employed and received adequate health care and are more likely to become infected with diseases, experience abuses and undue influences on their major life's decisions. For instance, the rate of unemployment for people with disabilities in Nigeria, is 77.3 per cent, compared with 49.2 per cent for those without a disability [20]. In other words, people living with a disability are confronted with poverty, and the latter can result in disability which is a hallmark for social exclusion.

The implication of disability on the economic, social and psychological well-being of the disabled is most severe in a society characterized by poverty, discrimination and lack of social welfare [7]. However, people with disability suffer more due to the structural conditions of society. They are confronted with social exclusion from their family, friends, community, as well as the government. The discrimination against people living is stemming from the perception that they are not capable to make any meaningful contribution to society. Social exclusion, therefore, sets in when people with disability lack; decision making, employment, income, adequate health care and other material resources. Based on this, they are

most likely to be withdrawn from society; because their perception is also not different from the prevailing societal perceptions. And the effect of being excluded at the individual level can be more devastating, leading to a feeling of low self-esteem, depression, isolation, social deprivation and self-harm [4]. According to Jose [21], psychosocial disability further increases social exclusion, reduces the quality of life and the entire wellbeing of people.

4. Social support for people with disability

Social support is a term used to describe the 'comfort' created by friends, family, group, community, institution and significant others, which helps people in coping with various life challenging situations. Social support involves conveying a feeling of value, worth and acceptance towards the individuals. We have formal and informal social supports: formal social support may include support from the church, social club and other organization or institutions, while the informal support includes support from the families and friends.

Social support can be emotional (such as providing care or creating a condition of being cared for), instrumental (giving tangible gifts such as money, food and cloth) or informational (giving useful advice or information that will help the recipient). More elaborately, Southwick et al. [10] grouped social support as follows: structural social support - the available social network and social interactions; functional social support - the perception that social interactions have been beneficial in terms of meeting emotional or material needs; emotional social support - behavior that fosters feelings of comfort arousing the feeling of being valued and/or cared for; instrumental/material social support - tangible resources and services that help solve practical problems; and informational/cognitive social support - provision of advice or guidance to help the individual cope with difficulties.

Several studies have shown that those that have supported are less vulnerable to stress. Through social support, problems are minimized and people's social, psychological, emotional, economic and political wellbeing are positively affected. For instance, a study by Adedimeji et al. [22], using 50 HIV positive people revealed that social support, to a great extent, improves people's health, because providing care to someone, improves their immunity and longevity. Forouza et al. [23] in a cross-sectional study using 136 people with physical disability also found that social support is one of the social determinants of health, plays an important role in improving psychological conditions in people's lives. In more recent studies, Liao et al. [24] using 1297 males and 1666 female of 65 years of age, found that social support can prolong life expectancy and lower the mortality among those with impairment, the aged and those with a major disease. Another study by Gellert et al. [25] using 108 couples support that perceived social support is positively related to the quality of life while the reverse is negatively related to distress. This is to say that, people with perceived social support tend to cope better with stressful conditions and enhanced quality of life. Eisenberger [14] and Southwick et al. [10] also arrived at a similar conclusion at different time and location. In other words, having a social relationship and being aware that help is readily available can have a positive effect on the individuals' health and overall wellbeing. On the other hand lack of social support can have great consequences for people with life challenging situations. It compromises the physical and mental wellbeing of people and increases mortality [26].

Consequent upon this, people with disability requires social support to cope and overcome the tremendous burden of their disability. However, social support is encompassing, in the sense that it does not benefit the recipient alone (the person

living with disability), it also benefits their family members and caregivers. If we could understand that the impact of social support is not just for the benefit and wellbeing of the recipient alone, then we can equally agree that social support is encompassing as it affects the society at large. In other words, providing social support is not a responsibility confided to the friends and families of the recipients. Providing social support is both a formal and informal obligation. The informal actors in providing social support include the family, friends and relations of the recipients, while the formal actors may include the government, agencies (the church, mosque, community and schools), organizations (social club, unions and groups), and professionals (social workers and psychologist) among others.

The paper points out that social support is encompassing and is not limited to the personal wellbeing of the recipients, but the society at large. There is functional social support, which when given aims at changing the perception of the person living with a disability. Groups and associations give social support to their members, so also national and international organizations.

5. Disability and social support in Nigeria

Nigeria as a country has a population of over 180 million people with half of its population living in 'poverty' and 30% in extreme poverty [20]. The estimated number of persons living with disability in Nigeria is25 million [27], While National Population Commission [NPC] cited in Okogba [28] put the number at 19 million.

Some scholars have tried to link the rate of disability in Nigeria with the rate of poverty. However, the major argument has been that poverty increases people's vulnerability to disability. According to Amadusun [7], the effect of disability in a society characterized by poverty can be very devastating. For Haruna [4], disability is both a cause and consequences of poverty. This cannot be contested against, given that poverty may restrict people's access to good health care, whereas severe health conditions, such as polio if not treated, can render people permanently incapacitated.

In a similar vein, the rate of disability in Nigeria is attributed to the frequent road accidents, the outbreak of infectious and chronic diseases like polio, smallpox, and meningitis, stroke, among others which render people incapacitated [29]. Besides, Holden et al. [30] opined that the rate of disability in Nigeriais due to the frequent conflict and violence experiences especially in the northern part of the country.

Disability is a condition that should be managed well thus people with disability requires proper consideration. It is important to note that the culture of taking care of people with disability dated back to the medieval periods. Each society has a way of taking care of disabilities. In Nigeria it could be traced back to the olden days, the disabled were being catered for by their family members. However, much has improved today, especially the recent inception of Social work profession in Nigeria, and the roles of the church, mosque, organizations, institutions and other support groups who recognizes the need to provide support to people with disability.

First and foremost, the Nigerian social workers, in collaborations with other professionals, governmental and non-governmental agencies provide social services to the people with disability in Nigeria. The roles of social workers in working with people with disability include; demolishing structural barriers that impede people's wellbeing, fighting against poverty, conveying a feeling of acceptance to the disabled persons and changing perceptions about disability beginning from the individual level to the societal level. The involvement of social workers in serving persons with disability is paramount for their well-being given that social workers

assess individuals from the point of 'strength' derived from Strength perspective (SP). The SP model posits that individuals are a bank of capability, which when harnessed can be used to enhance their wellbeing and that of others. Since people with disability are trainable and have the innate abilities [4], social workers are very important actors in harnessing these strength to help them reduce dependency and increase life's satisfaction however the place of social work in serving people living with a disability is beyond the scope of this paper. Different disability groups were formed in Nigeria whose aims and objectives are to take care of people living with a disability.

Despite these available supports, people with disability continue to face tremendous challenges, mostly as a result of the general perception of being disabled. This paper submits that much more is needed to be done, particularly in changing the perceptions of those living with disability through functional social support [10].

It is worthy to note that perceptions and attitude of a particular society has a great influence on people with disability. This is to say that perceptions about disability induce either positive or negative attitude towards the people living with a disability. Negative attitude towards people with disability can be a result of negative perceptions. Influenced by prevailing cultural norms intersected by religious and superstitious belief, the Nigerian society perceives persons with disability both negatively or positively depending on the type of disability. In some of the negative perceptions, people with disability were viewed as people who committed abomination either in their present lifetime or the previous one [7, 30–32]. According to Haruna [4], some disability conditions such as mental retardation among others were seen as a punishment from God. Talk of the sharia in north There is also a prevalent belief in witches and evil spirits as being responsible for some disability conditions. Based on this, the disabled person is most often isolated and is left at the mercy of his/her family members [20, 33]. As a result, they suffer from social exclusion and were most often ignored by the government.

On the other hand, there were also positive perceptions and attitude towards people with disability. Some culture view disability as extraordinary thus, treat people with disability with gentleness. For instance, Nyagweso [32], observed that the people of the Igbo tribe in the Eastern part of Nigeria treat people with disability with great kindness. The paper also explained how the Yoruba's in the western part of Nigeria perceives disability. The Yoruba's associated disability to *Obatala* (the god in charge of molding human bodies). It narrated how *Obatala*got intoxicated due to alcohol and in the process, he fashioned people with impairment and deformities. With this prevailing belief, the Yorubas views people with disability with pity and provides special care for them. According to Haruna [4], about 90 per cent of Nigerians view people with disability as liabilities - those who require charity, who should be assisted in form of giving financial aids, support and other forms of humanitarian assistance. Based on these perceptions, the predominant attitude towards a disabled person in Nigeria is exclusion and pity, thus they were given alms in form of charity. Even though members of the society, groups and organization provides care in form of charity to these group, they were not involved in the mainstream of the society – their voice does not count even in the decisions that affect their lives. This type of social support hinders social inclusion. According to Southwick et al. [10], some social support may not necessarily be positive. This is because, through the practice of begging some people living with disability in Nigeria see their condition as a pitiable one, thus it has become common to see them begging on the streets and in the markets places. A survey by United Nation found that 'begging' is one of the commonest occupations for people living with disability in Nigeria [34]. And their perceptions about disability are not different from the general perceptions about disability. According to Southwick et al. [10], although

certain personality features are associated with one's enthusiasm to seek and access the available social support, however, the type of social support and the social system moderate the degree and the extent to these features can strive.

This paper argues that people with disability may have innate potentials that could help them access social support network; however, they need functional social support to sustain them. Social support for them should also include: (1) changing negative perceptions about disability (2) empowerment- involving them in the mainstream of the society where their voice could be heard, especially in decisions that concern them. (3) defending their human rights (4) demolishing walls of poverty, discrimination and social exclusion. They should be supported to maximize their potentials and contribute to social and economic development.

6. Conclusion

Based on the literature, social support is a lifesaver. People living with disability experience a lot of life straining challenges, however, some of these challenges were as a result of their disability which further undermines their ability to be productive and live a fulfilled life. People with disability are trainable, have innate potentials and the ability to be productive, thus they require functional social support from people to utilize these potentials. The paper also argues that social support for people with disability should not be limited to providing information, giving emotional support, tangible gifts or materials, rather it encompasses demolishing structural barriers such as social exclusion, marginalization and stigmas which they are most vulnerable to. This is why professionals like social workers are good actors in providing social support. Social workers are known for enlightening the public through which they change negative societal perceptions about disability, instilling the right perceptions and attitudes. Social workers through their professional interventions fight against discrimination and social exclusion.

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Chapter 5

Biological Determinants of Hostility

Valery V. Gafarov, Elena A. Gromova, Vladimir N. Maksimov, Igor V. Gagulin and Almira V. Gafarova

Abstract

Our aim was to study the association of hostility with the DRD4, DAT, MAOA genes in an open male population of 25–64 years old. A representative sample of men aged 25–64 years (n = 657 men, average age 44.3 ± 0.4 years) was examined in 1994–1995 and 45–64 years old (n = 781 men, average age - 56.48 ± 0.2 years) in 2003–2005 using the methods proposed by the WHO international program "MONICA-psychosocial" and "HAPIEE". All respondents completed the hostility questionnaire on their own. Genotyping of the DRD4, DAT and MAOA gene polymorphisms was carried out. It was established that the level of hostility in the male population was 76.9% in the group of 25–64 years old and 60.3% in the group of 45–64 years old. Genotypes 4/6, 4/7 of the DRD4 gene are reliably associated with a high level of hostility; the genotype 4/4 of the DRD4 gene is associated with an average and lower level of hostility. There was no association of individual genotypes and VNTR alleles of DAT gene polymorphism with different levels of hostility. It was found that among individuals with low-active alleles of the MAOA-L gene (alleles 2 and 3), a high level of hostility was more common - 50.9%. The results of constructing a logistic regression model showed that the presence of low-active alleles (2; 3) of the MAOA gene increases the likelihood of hostility OR = 2.103 (95% CI 1.137–3.889, p = 0.018). Based on the received data we can assume that the long alleles of the DRD4 gene and the low-level allele of the MAOA-L gene are associated with hostility.

Keywords: DRD4 gene, DAT gene, MAOA gene, hostility, open population, men

1. Introduction

Hostility is a personality trait that includes cynicism /distrusting others, anger, overt or repressed aggression [1]. From an evolutionary point of view, hostility contributes to a large number of vital functions, including: achievement of resources, deterrence of rivals, and organization of social hierarchies [2]. It is not surprising that hostile human traits are deeply rooted in its genetic basis considering the relevance of these tasks for offspring survival and development [3]. Under the assumption, numerous studies have confirmed the high heritability of pathological hostility, defined as a set of maladaptive and exaggerated hostile manifestations, such as antisocial and violent behavior [2].

From the standpoint of the psychobiological model of personality Cloninger C.R. antisocial behavior (hostility) is determined by a high 'novelty seeking' [4] and

is due to the genes function of the dopaminergic brain system [5, 6]. The dopamine receptor gene DRD4 is mapped on chromosome 11, in the 11p 15.5 region [7]. The most important role and significance is played by the widespread polymorphism of various numbers of tandem repeats of 48 bp. (VNTR) in exon 3 of the D4 gene. The human dopamine D_4 receptor contains polymorphism within the third cytoplasmic loop of the protein. The polymorphism is characterized by a varying number of direct imperfect 48-bp repeats in the gene. The alleles vary not only in the number of repeats (2–8 or 10 repeat units) but also in the sequence of the repeats [8]. One hypothesis to account for this would be that different size cytoplasmic loops affect the conformation of one or more transmembrane domains, thus altering the ligand binding site. Another possible hypothesis argues that the polymorphism affects signal transduction by altering interactions with G-proteins or other intracellular effectors [8]. It is believed that individuals with longer DRD4 (R7) alleles have higher scores for 'novelty seeking,' however, the attempts to confirm this relationship have yielded conflicting results [9].

The dopamine transporter (DAT), which is encoded by the SLC6A3 gene, mediates the active reuptake of dopamine from the synapse and is a principal regulator of dopaminergic neurotransmission. The SLC6A3 gene contains 15 exons spanning approximately 60 kb, mapped gene to chromosome 5p15.3. Vandenbergh et al. identified a 40-bp variable-number tandem repeat (VNTR) polymorphism in the 3-prime untranslated region of the DAT1 gene with repeat copy numbers ranging from 3 to 11. [10]. As in the case of the DRD4 gene, the DAT gene polymorphism may be associated with some pathological conditions in pathogenesis, which play the main role in dopamine metabolism disorders. However, the results of the study of the association between DAT and 'novelty seeking' are still contradictory [11].

The MAOA gene is located on the short arm of the X chromosome (Xp11.4-p11.23) [12], it encodes the enzyme monoamine oxidase A, this enzyme catalyzes the degradation of key brain neurotransmitters involved in pathological hostility, such as serotonin (5-hydroxytryptamine; 5 -NT) and two catecholamines - norepinephrine and dopamine [13]. In 1998, Sabol and colleagues identified a functional variable number of 30-bp. tandem repeats (MAOA-uVNTR) in the promoter region of human MAOA [14]. This repeat is present in repeats 2, 3, 3.5, 4, 5, or 6 (R), which are associated with different effects on the transcriptional and enzymatic activity of the gene [14]. The most common alleles are 4R and 3R. Alleles with 3.5R or 4R are transcribed more efficiently than alleles with 2R or 3R, and classified as alleles with high activity (MAOA-H) and alleles with low activity (MAOA -L), respectively [15].

The transcriptional efficiency of the 5R allele is controversial in the literature, because it has been classified as a low activity allele [12] and a high activity allele [16]. In a more recent study, it has been shown that the transcriptional activity of MAOA-uVNTR in carriers of alleles 2R and 3R will be lower, and in individuals with alleles 3.5R, 4R, and 5R - higher [17]. There is no functional classification of the 6R allele. Since MAOA is on the X chromosome, males only have one copy, whereas females have two copies; therefore, females can be homozygous or heterozygous. Caspi and colleagues reported on the first study G × E (gene x environment) of aggressive human behavior that showed that exposure to childhood maltreatment predicts later antisocial behavior (ASP) in males with the MAOA –L allele [18]. This innovative finding prompted numerous replication attempts in the following years, with varying results. However, two meta-analyzes, one in 2006 [19] and the other in 2014 [20], have confirmed the initial findings of Caspi et al. [18]. Thus, the aim of our study was to study the association of hostility with the DRD4, DAT, and MAOA genes in an open population of men aged 25–64 years.

2. Materials and methods

A representative sample of men living in the Oktyabrsky district, Novosibirsk city, Russian Federation was examined. The sample of men 25–64 years old (n = 657 men, average age 44.3 ± 0.4 years) in 1994–1995 was examined under the WHO MONICA program (Multinational Monitoring of Trends and Determinants of Cardiovascular Disease) [21]. A sample of men 45–64 years old (n = 781 men, average age 56.48 ± 0.2 years), respectively, was examined within the framework of the IV screening of the international program HAPIEE" (Health, Alcohol and Psychosocial factors In Eastern Europe) [22] in 2003–2005.

All respondents independently completed the hostility questionnaire, which was proposed and tested in the WHO program 'MONICA-psychosocial.' They singled out a high level of hostility (HH), average level of hostility (AH), no hostility (NH), and the respondents also completed the Jenkins Activity Survey (JAS) [21].

Genotyping of the studied polymorphisms of the DRD4, DAT and MAOA genes [23, 24] was carried out according to the published methods in the laboratory of molecular genetic studies (Head is Prof. Maksimov V.N.) Statistical analysis was carried out using the software package SPSS version 11.5. To verify the statistical significance of the differences between the groups, Pearson's Chi-squared test $\chi 2$ was used. To estimate the OR (odds ratio) of disease development by logistic regression, genetic (genotypes and alleles) parameters were used as covariates (factors), hostility was a dependent variable [25, 26]. Reliability in all types of analysis was accepted at a significance level of $p \leq 0.05$.

3. Results

In the male population of 25–64 years of age (III screening) the prevalence of hostility was 76.9% (AH - 19.1%, HH - 32.5%). In the population of 45–64 years of age (IV screening), the prevalence of hostility was 60.3%, AH - 19.7%, and HH - 40.6%. **Table 1** shows the distribution of carriers of various VNTR genotypes of DRD4 gene polymorphism by the level of hostility.

In a comparative aspect, it turned out that carriers of the 4/4 genotype are more often found in the group with an average level of hostility (73.9%): than in the group with a high level of hostility (40.2%) as among carriers of all other genotypes of the DRD4 gene ($\chi 2 = 23.263$ $\upsilon = 1$ $p < 0.0001$), and in comparison with carriers of genotype 2/4 OR = 3 (95% CI 1,1–8); ($\chi 2 = 5.178$ $\upsilon = 1$ $p = 0.023$); than in the group where hostility is completely absent (56%), as in comparison with carriers of all other genotypes of the DRD4 gene OR = 2.2 (95% CI 1.2–4); ($\chi 2 = 6.990$ $\upsilon = 1$ $p < 0.01$), and in comparison with carriers of genotype 2/4 ($\chi 2 = 5.119$ $\upsilon = 1$ $p < 0.05$). Also, carriers of genotype 4/4 were more frequently found in the group with a low level of hostility (64.3%) ($\chi 2 = 13.044$ $\upsilon = 1$ $p < 0.0001$) or hostility was completely absent (56%) ($\chi 2 = 5.515$ $\upsilon = 1$ $p < 0.01$) than in the group with a high level of hostility (40.2%), when compared with carriers of all other genotypes.

On the contrary, carriers of longer alleles of the DRD4 gene - genotype 4/6 more often had a high level of hostility (7.1%): the lower level of hostility (2.7%) in comparison with carriers of the 4/4 genotype ($\chi 2 = 4.866$ $\upsilon = 1$ $p < 0.05$); they had the lack of hostility (1.8%) in comparison with carriers of genotype 2/2 ($\chi 2 = 3.844$ $df = 1$ $p < 0.05$); carriers of the genotype 2/4 gene ($\chi 2 = 4.014$ $\upsilon = 1$ $p = 0.045$); carriers of the 4/4 genotype ($\chi 2 = 5.192$ $\upsilon = 1$ $p < 0.05$). In the group with an average level of hostility there were more carriers of genotype 4/6 (5.4%) than in the group where there was no hostility (1.8%) ($\chi 2 = 4.401$ $\upsilon = 1$ $p = 0.05$), in contrast to carriers genotype 2/4.

Genotype	Hostility							
	No		Low		Average		High	
	n	%	n	%	n	%	n	%
2/2	10	9.2	5	4.5	4	4.3	7	6.6
2/3	0	0	0	0	0	0	1	0.9
2/4	18	16.5	14	12.5	7	7.6	14	12.5
2/5	0	0	1	0.9	0	0	1	0.9
2/6	1	09	4	3.6	1	1.1	4	3.6
2/7	0	0	0	0	0	0	1	0.9
3/3	2	1.8	2	1.8	3	3.3	1	0.9
3/4	8	7.3	6	5.4	4	4.3	6	5.4
3/6	0	0	0	0	0	0	3	2.7
3/7	0	0	0	0	0	0	2	1.8
4/4	61	56	72	64.3*	68	73.9	45	40.2*
4/5	1	0.9	1	0.9	0	0	2	1.8
4/6	2	1.8	3	2.7	5	5.4	8	7.1
4/7	1	0.9	0	0	0	0	8	7.1*
4/8	0	0	0	0	0	0	1	0.9
5/5	2	1.8	1	0.9	0	0	0	0
5/6	1	0.9	0	0	0	0	1	0.9
6/6	2	1.8	3	2.7	0	0	4	3.6
7/7	0	0	0	0	0	0	3	2.7
	χ^2 = 88.126 df = 54 p = 0.002							
allele	n	%	n	%	n	%	n	%
2	39	7.9	29	12.9	16	8.7	35	15.6
3	12	5.5	10	4.5	10	5.4	14	6.3
4	152	69.7	168	75.0	152	82.6	129	57.6
5	6	2.8	4	1.8	0	0	4	1.8
6	8	3.7	13	5.8	6	3.3	24	10.7
7	1	0.5	0	0	0	0	17	7.6
8	0	0	0	0	0	0	1	0.4
	χ^2 = 80.293 df = 18 p = 0.0001							

Table 1.
Frequencies of genotypes and alleles of VNTR polymorphism of the DRD4 gene in the population and the association of their hostility.

Carriers of genotype 4/7 of the DRD4 gene more often belonged to the group with a high level of hostility (7.1%) than to the group where there was no hostility (0.9%), in comparison: carriers of all other genotypes of the DRD4 gene OR = 8, 3 (95% CI 1.02–67.5); ($\chi 2$ = 5.480 υ = 1 p < 0.01); carriers of genotype 2/2 ($\chi 2$ = 5.488 υ = 1 p < 0.01); carriers of genotype 2/4 ($\chi 2$ = 5.756 υ = 1 p < 0.01); carriers of genotype 3/3 ($\chi 2$ = 3.704 υ = 1 p < 0.05); carriers of genotype 3/4 ($\chi 2$ = 4.874 υ = 1 p < 0.05); carriers of the genotype 4/4 ($\chi 2$ = 7.199 υ = 1 p < 0.001).

More often, there was no hostility in carriers of genotype 2/2 (9.2%), genotype 2/4 (16.5%), genotype 3/4 (7.3%). Carriers of genotype 2/6 and genotype 6/6 of the DRD4 gene had equally common a high level of hostility - 3.6% each. Carriers of genotype 3/3 of the DRD4 gene more often had an average level of hostility - 3.3%. Carriage of other genotypes of the DRD4 gene in men, differing in the level of hostility, did not exceed 3% ($\chi 2 = 88.126$ υ = 54 $p < 0.01$).

The distribution of hostility levels among carriers of alleles of the DRD4 gene ($\chi 2 = 80.293$ υ = 18 $p < 0.0001$) is presented in **Table 1**. Allele 4 of the DRD4 gene was more common in the group with an average level of hostility (82.6%): than in the group with high the level of hostility (57.6%) both among carriers of all other alleles ($\chi 2 = 29.496$ υ = 1 $p < 0.0001$), and in comparison with carriers of allele 2 OR = 2.5 (95% CI 1.3–4,8); ($\chi 2 = 8.914$ υ = 1 $p < 0.01$); in the group with a complete absence of hostility (69.7%) as among carriers of all other alleles of the DRD4 gene OR = 2 (95% CI 1.2–3.3); ($\chi 2 = 8.985$ υ = 1 $p < 0.01$), and among carriers of allele 2 ($\chi 2 = 8.178$ υ = 1 $p < 0.01$).

Carriers of allele 4 also were more often in the group either with a low level of hostility (75%) ($\chi 2 = 15{,}194$ υ = 1 $p < 0.0001$) or in the group where there was no hostility at all (69.7%) ($\chi 2 = 7.026$ υ = 1 $p < 0.01$) than in the group with a high level of hostility (57.6%) in comparison with carriers of all other alleles. Carriers of the "short" allele 2 were more common in the group where there was no hostility (17.6%) than in the group with an average level of hostility (8.7%) in comparison

Genotype	**Hostility**							
	No		**Low**		**Average**		**High**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
8/8	1	1	2	1.9	0	0	1	0.9
9/9	4	4	4	3.8	3	3.5	4	3.4
6/10	1	1	1	1.0	1	1.2	0	0
8/10	1	1	0	0	0	0	0	0
9/10	31	31	37	35.6	37	43	44	37.6
10/10	60	60	55	52.9	45	52.3	63	53.8
10/11	0	0	3	2.9	0	0	1	0.9
10/12	0	0	0	0	0	0	1	0.9
11/11	2	2	2	1.9	0	0	3	2.6
	$\chi^2 = 18.930$ υ = 24 p = 0.756							
allele	n	%	n	%	n	%	n	%
6	1	0.5	1	0.5	1	0.6	0	0
8	3	1.5	4	1.9	0	0	2	0.9
9	39	19.5	45	21.6	43	25	52	22.2
10	153	76.5	151	72.6	128	74.4	172	73.5
11	4	2	7	3.4	0	0	7	3
12	4	2	7	3.4	0	0	7	3
	$\chi^2 = 14.553$ υ = 15 p = 0.484							

Table 2.
Frequencies of genotypes and alleles VNTR of DAT gene polymorphism in the population and their association with psychosocial factors.

with carriers of all alleles ($\chi 2 = 7.142$ υ = 1 p < 0, 01). Carriers of the "long" allele 6 were more common in the group with a high level of hostility (10.7%): than in the group with an average level of hostility (3.3%) as compared with carriers of all other alleles OR = 3.5 (95% CI 1.4–8.9); ($\chi 2 = 8.238$ υ = 1 p < 0.01), and in comparison with carriers of allele 4 ($\chi 2 = 12.605$ υ = 1 p < 0.0001); than in the group where there was no hostility among the carriers of all alleles ($\chi 2 = 8{,}164$ υ = 1 p < 0.01); and compared with the group with a low level of hostility (3.7%) ($\chi^2 = 6.087$ υ = 1 p < 0.01) in comparison with carriers of allele 4. Carriers of allele 7 more often fell into the group with a high level of hostility (7.6%) than in the group where there was no hostility (0.5%) OR = 17 (95% CI 2.3–135); ($\chi^2 = 14.379$ υ = 1 p < 0.0001), in a comparative aspect with carriers of all other alleles of the DRD4 gene.

No associative relationship was found during the comparative analysis of individual genotypes and alleles of the DAT gene with different levels of hostility (**Table 2**).

The results of molecular genetic analysis of the various alleles distribution of the MAOA gene in the male population of 45–64 years old are presented in **Table 3**. Highly active alleles (3.5 and 4) were found in 4.5% and 57.1% of men, respectively; alleles with low activity were distributed as follows: allele 3 - in 37.2%, alleles 2 and 5 - in 0.6%.

We found out that in the frequency distribution of the MAOA gene alleles in men differing in the level of hostility individuals with highly active alleles of the MAOA-H gene did not have hostility - 72.1%, and in men with low-active alleles of the MAOA-L gene, a high level of hostility was more common - 50.9% ($\chi 2 = 7.026$ df = 2, p = 0.03) (**Table 4**).

gene MAOA		
allele	**n**	%
2	1	0.6
3	58	37.2
3.5	7	4.5
4	89	57.1
5	1	0.6
Total	156	100.0

Table 3.
MAOA gene allele frequencies in a 45–64-year-old male population.

	Hostility					
gene MAOA	**NO**		**Average**		**High**	
	n	**%**	**n**	**%**	**n**	**%**
MAOA-H (allele 3.5; 4; 5)	49	72.1	20	64.5	28	49.1
MAOA-L (allele 2; 3)	19	27.9	11	35.5	29	50.9
total	68	100	31	100	57	100
	$\chi^2 = 7.026$ df = 2. p = 0.03					

Table 4.
MAOA gene allele frequencies in an open population of males 46–64 years of age compared to hostility levels.

Question relation	gene MAOA	Agree		Disagree	
		n	%	n	%
people often disappoint me	MAOA-H (allele 3.5; 4; 5)	47	54.7	50	71.4
	MAOA-L (allele 2; 3)	39	45.3	20	28.6
	χ^2 = 3.933 df = 1. p = 0.047				
I think most people have to lie to "*going to be just fine*."	MAOA-H (allele 3.5; 4; 5)	23	41.8	74	73.3
	MAOA-L (allele 2; 3)	32	58.2	27	26.7
	χ^2 = 13.669 df = 1. p = 0.0001				
I often felt that strangers look at me critically	MAOA-H (allele 3.5; 4; 5)	14	41.2	83	68
	MAOA-L (аллель 2; 3)	20	58.8	39	32
	χ^2 = 7.053 df = 1. p = 0.008				
I often find that people are jealous of my good thoughts because they did not think about it first	MAOA-H (allele 3.5; 4; 5)	35	48.6	62	73.8
	MAOA-L (allele 2; 3)	37	51.4	22	26.2
	χ^2 = 9.424 df = 1. p = 0.002				

Table 5.
MAOA gene allele frequencies in an open population of men 25–64 years old compared to a different pattern of hostile behavior.

The analysis of the pattern of hostile behavior showed that individuals with low MAOA-L alleles were more likely to agree with the statement that 'people often disappoint them', as well as with the maxim 'I think most people have to lie to '*going to be just fine*' and' I often felt that strangers look at me critically', and 'people are jealous of my good thoughts because they did not think about it first' than carriers of the highly active MAOA-H gene (**Table 5**).

The results of a comparative analysis of the behavioral activity of men differing in the presence of low- or high-active alleles of the MAOA gene in the genotype are shown in **Table 6**. Most people with low MAOA-L alleles in their youth were considered 'definitely assertive and competitive' (53.3%) than men with MAOA-H alleles (46.7%) (χ2 = 10.080 df = 3, p = 0.023).

The results of building a logistic regression model showed that the presence of low-active alleles (2; 3) increases the chance of hostility OR = 2.103 (95% CI 1.137–3.889, p = 0.018) (**Table 7**).

When you were younger. Did most people consider:	Definitely assertive and competitive		Possibly assertive and competitive		Perhaps more relaxed and carefree		Definitely more relaxed and carefree	
gene MAOA	n	%	n	%	n	%	n	%
MAOA-H (allele 3.5; 4; 5)	21	46.7	31	72.1	30	75	15	53.6
MAOA-L (allele 2; 3)	24	53.3	12	27.9	10	25	13	46.4
χ^2 = 10.080 df = 3. p = 0.023								

Table 6.
MAOA gene allele frequencies in an open population of men 46–64 years old compared with the type of behavioral activity Jenkins Activity Survey (JAS).

Variable	B	SE	Wald (χ^2)	df	p	OR	95% CI for OR	
							lower	upper
MAOA-L (allele 2; 3)	0.743	0.314	5.618	1	0.018	2.103	1.137	3.889

Table 7.
Likelihood of hostility in men with MAOA-L (logistic regression model).

4. Discussion

The studied population of men aged 25–64 can be characterized as highly hostile - almost two-thirds of individuals experienced hostility of varying degrees, which served as a prerequisite for the search for its primary source. One of the most interesting lines of research on human behavior is genetic research. According to the work of various authors, it has been established that some mental and emotional characteristics of a person are associated with polymorphism of exon 3 of the gene for the neurotransmitter system of the dopamine receptor 4-subtype (DRD4) [5, 6]. The studies show that genotypes with different tandem repeat number (VNTR) polymorphism in the DRD4 gene cause differences in the biological function of the dopamine receptor encoded by this gene. The most common alleles for this VNTR are alleles with 2, 4, or 7 copies of the repetitive DNA. Today, the 7-repeat allele (long allele) is known to function differently from the other two shorter alleles. Three functional domains seem to be altered by the status of the VNTR genotype: (1) the ability of the receptor to transmit signaling information [27]; (2) the level of mRNA transcribed from this gene [28]; and (3) protein–protein interactions with the DRD2 receptor [29]. The role of these functional differences in explaining the association of the DRD4 gene with behavioral traits, including the pursuit of novelty [30] and ADHD (hyperactivity syndrome) [31], is not yet clear. It is possible that one or all of these biological differences affect the brain's ability to respond to dopamine, which plays a significant role in 'reward' and motivated actions [32]. Thus, one of the possible reasons for the higher frequency of 'long' allelic variants of the DRD4 gene in our population among men with high levels of hostility is that the system of neurons using dopamine as a neurotransmitter is associated with the provision of reinforcement or 'reward'. It is with the 'long allelic variant' of the DRD4 gene that the lower sensitivity of the receptor to dopamine is associated. Those with both chromosomes containing 'long' alleles (encoding a less sensitive receptor) need stronger external signals in order to feel comfortable. These people need large doses of dopamine for the receptors to respond to it [33]. Probably hostility in men with a 'long' allelic variant of the DRD4 gene is one of the manifestations of the 'novelty seeking'.

On the other hand, the results of many studies GxE (gene x environment) are often interpreted as evidence of biologically based differences in environmental sensitivities. The theoretical works by Belsky 2009, Ellis 2008, 2011 and others [34–37] claim that these results reflect evolutionarily selected adaptive individual differences in environmental susceptibility (ie, differential susceptibility theory) [35, 37]. Differential susceptibility theory states that people who are more sensitive to adverse environmental conditions and who are at a higher risk of negative outcomes in these conditions may also benefit more from exposure to a favorable environment. Differential susceptibility theory is often contrasted with stress and later models of beneficial sensitivity [38], which postulate vulnerability exclusively to negative and positive environments, respectively. It is possible that DRD4 7

repeat genotypes will be associated with differences in environmental sensitivity based on this prior literature.

The process of dopamine uptake by neurons plays an important role in dopamine metabolism which is an active transmembrane transport using a dopamine transporter. At the same time, the reuptake of the mediator is important not only for the rapid completion of the action on the target organ; it also prevents the depletion of presynaptic dopamine stores during rhythmic activity. Therefore, the study of the dopamine transporter gene (DAT), localized on chromosome 5 (5p15.3), is of greater interest to researchers in connection with pathological changes in mental activity [39]. In our work, we did not obtain an associative relationship between individual genotypes and alleles of the DAT gene with different levels of hostility, which does not exclude the possibility of searching for possible associations in a larger sample in the future.

While other genes involved in the pathways of neurotransmission of monoamines are associated with antisocial behavior [40], the unique reputation of the MAOA gene lies in a large number of independent studies confirming its role in aggressive behavior [41], which served as the premise of our study. Most of the clinical data on the relationship between MAOA and hostile behavior patterns comes from genetic studies of numerous polymorphic variants of this gene [12]. The richest source of data on the functional role of MAOA in hostility is the original variable number tandem repeat polymorphism (uVNTR), which contains alleles with different repeats (2, 3, 3.5, 4, 5, and 6) [14]. According to the researchers, the two most common alleles of uVNTR, containing 3 and 4 repeats, are present in 35–39% and 59–63% of Caucasians, respectively; conversely, variants with 3 repeats are more often present in most African (52–59%), Asian (53–61%), and Latin American (70%) populations [42]. In our population the allele with 4 repeats - in 57.1% of men and with 3 repeats - in 37.2% appeared to be the most represented which is consistent with the world data covering Caucasoid samples [42]. The 2R and 3R alleles produce non-significantly different levels of transcription, but both demonstrate significantly less transcription that the 3.5R, 4R, and 5R alleles [17].

Some studies have shown the association between repeat 2 and 3 alleles with multiple aspects of aggression, including hostility and antisocial behavior [2]. The first meta-analysis of interactions between MAOA-uVNTR and childhood maltreatment and future antisocial behavior was published by Kim-Cohen et al. [19]. This meta-analysis showed that the association between child abuse and mental health problems, including antisocial behavior (ASD), symptoms of attention deficit hyperactivity disorder (ADHD), and emotional problems, was stronger in males with MAOA-L [19]. A second meta-analysis was published by Byrd and Manuck in 2014 and included 27 original papers that investigated the interaction between MAOA-uVNTR and childhood maltreatment of ASD (2014). This meta-analysis confirmed the association between MAOA and a higher likelihood of ASD among MAOA-L male carriers who were abused during childhood [20]. Lavigne JV et al. emphasized the importance of expanding the spectrum of psychosocial risk factors included in the G × E studies to provide more specific models of various phenotypes, including those with impulsive and hostile behavior [41].

In our population, men with low-active alleles of the MAOA-L gene more often had a high level of hostility - 48.2%, which is consistent with the world data. The results of building a logistic regression model showed that the presence of low-active alleles (2; 3) increases the risk of hostility by 2.103 times. In addition, a hostile pattern of behavior manifested itself in interpersonal relationships with other people, so people with low-level MAOA-L alleles more often believed that 'people disappoint them more often,' suspected people of lying, especially if it was associated with career growth, more often felt critical views of other people on

themselves, believed that others were jealous of them. Also, individuals with low MAOA-L alleles were more often considered by people to be 'definitely assertive and competitive.'

Our results highlight another interesting aspect of the study of psychological phenotypes associated with various MAOA uVNTR alleles, including specific aggression subtypes. Numerous studies have shown that low-activity options are associated with active rather than latent aggression. For example, carriers of alleles with 3 repeats are more inclined to a greater propensity to participate in hostile responses against provocations of alleged opponents and competitors [43]. Our data on the relationship of some polymorphic variants of the DRD4 and MAOA genes with hostility may determine future directions of research on the molecular basis of hostility and help in determining diagnostic markers and therapeutic goals of this condition.

5. Conclusion

The prevalence of hostility among men was 25–64 (76.9% of them had a high level of 32.5%), 45–64 years old was 60.3% (40.6% had a high level). Among men aged 25–64 years of the megalopolis of Western Siberia,the Russian Federation, the most common polymorphism of the DRD4 gene is: genotype 4/4 (57.9%); DAT gene: genotype 10/10 (54.8%). Genotypes 4/6, 4/7 of the DRD4 gene, alleles 6 and 7, respectively, were significantly associated with a high level of hostility. There was no association of individual genotypes and alleles of the DAT gene with different levels of hostility. Highly active alleles of the MAOA gene (3.5 and 4) were found among men 45–64 years old in 4.5% and 57.1%, respectively; alleles with low activity were distributed as follows: allele 3 - in 37.2%, alleles 2 and 5 - in 0.6%. Among men 45–64 years old with highly active alleles of the MAOA-H gene, hostility was more often absent (72.1%), and with low-active alleles of the MAOA-L gene, a high level of hostility was more common (50.9%). The presence of low-active alleles of the MAOA-L gene (2; 3) statistically increases the likelihood of hostility, OR = 2.103.

Acknowledgements

The research was carried out under the state assignment within the framework of budget theme No. AAAA-A17-117112850280-2.

DOI: http://dx.doi.org/10.5772/intechopen.97526

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Edited by Rosalba Morese, Vincenzo Auriemma and Sara Palermo

This book aims to open a debate full of theoretical and experimental contributions among the different disciplines in social research, psychology, neuroscience, and sociology and to give an innovative vision to the present research and future perspective on the topic. The fundamental research areas of evolutionary psychology can be divided into two broad categories: the basic cognitive processes, and the way they evolved within the species, and the adaptive social behaviors that derive from the theory of evolution: survival, parenting, family and kinship, interactions with nonparents, and cultural evolution. Evolutionary Psychology Meets Social Neuroscience explains at individual and group level the fundamental behaviors of social life, such as altruism, cooperation, competition, social exclusion, and social support.

Published in London, UK

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ISBN 978-1-83968-872-0
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