Astrocognition

Prolegomena to a future cognitive history of exploration

Dunér, David

Published in:
Humans in Outer Space : Interdisciplinary Perspectives

2010

Document Version:
Peer reviewed version (aka post-print)

2.1 Astrocognition: Prolegomena to a future cognitive history of exploration

David Dunér

2.1.1 The astrocognitive question

The human desire for exploration and man's encounters with the unknown are a fundamental part of the cultural history of mankind, from the first stumbling steps on the African plains to the recent explorations of our globalised and urbanised world. From the dawn of the hominids to the days of the modern man, this ever changing terrestrial being has expanded in ever increasing circles of spatial consciousness, in an endeavour to climb over mountains to the next valley, transcend vast oceans and fly through the air. The next small step, or giant leap for mankind, that of going far beyond the atmosphere and gravitation of the Earth to the unknown outer space, is decisive, but that, too, is part of the long history of mankind.

A true universal history includes space, not only the human history on this Earth, not only the short history of human civilisation: it must include the immense space, and, as we know it, the long history of matter from the big bang, through the formation of our solar system and the evolutionary history on Earth, to the future speciation of man and the final big crunch or the ever-expanding universe and eternity of time. History is crucial for an understanding of the perennial enigmas of who we are, where we come from, and where we are going. Historical narratives are essential, and the only way for an understanding of the big questions of science: the origins of the universe and the formation of galaxies, stars and planets, the evolution of life on Earth, the human species and the human mind.[1] Cognitive neuroscience can offer, as Mark Turner says, a wider conception of human history, not just brief temporal spans of decades or centuries we usually find in cultural and sociological history, but a phylogenetic history that runs over thousands and millions of years.[2] Here, I will radically extend the notion of human history to also include our evolutionary past and situate our thoughts in humankind's deep history.

In the course of everyday events and encounters the human mind has been enabled, through an evolutionary process, to understand, interact, deal with and adapt to the environment of this particular planet and to the minds of other human beings. The brain is thus well adapted to the biological, ecological, and physical characteristics of our planet, and the cultural, social and cognitive characteristics of the species *Homo sapiens*. The question is then:

> *What will happen to human cognition when humans encounter a totally different environment, physically, biologically and culturally; an extraterrestrial environment that the human brain is not accustomed to and developed for?*

That is what I will call *the astrocognitive question*. In short, what will happen to our minds in an unknown extraterrestrial environment?

In order to try to answer this question I will propose a new multidisciplinary field that I call astrocognition; that is literally "acquaintance of the stars", from the Greek *astron*, star, and Latin *cognitio*, knowing or acquaintance. Astrocognition could be defined as: "The study of human cognitive processes in extraterrestrial environments." This is the main issue here. But in a wider sense, it can also be defined as: "The study of the thinking universe."

This as an allusion to the definition of *astrobiology* in the 1996 NASA Strategic Plan: "the study of the living universe".[3] Astrobiology tries to find the necessary conditions for life in the universe and to develop theories of plausible features of extraterrestrial life. Astrocognition goes even further. The universe is not only living, it contains not just self-reproductive entities but it has also apparently led to self-reproductive organisms that are able to reflect on their own existence and on the universe they live in. We humans are the only species here on Earth that is to a greater extent able to reflect upon the universe. Through the self-conscious human being, the universe is, one might say, also self-conscious and able to reflect upon itself. It seems, then, that the universe is not only bio-friendly,[4] but also "cogito-friendly". Astrocognition deals exactly with this: the thinking universe and issues concerning cognitive aspects in a universal perspective.

The astrocognitive paradigm states that space and extraterrestrial environments, as well as contacts with other forms of life and societies, will change our thinking and belief systems. This leads to a discussion of what we can know and not know about the extraterrestrial; or, put another way, the limits of our human-based epistemology and the constraints of our evolutionary history. And further, what cognitive challenges we are likely going to face when we encounter the unknown; this is in line with the "phenomenology of space" proposed by Gísli Pálsson - the challenges our Earth-bound perceptual, cognitive, and psychological capacities face in a space context.[5] Philosophical, ethical and theological implications of extraterrestrial discovery have been discussed to only a limited extent.[6] But the cognitive implications have not been discussed at all. Thus, the purpose of this article is to show the possibilities of future space research for the humanities. Astrocognition is the science of the future firmly tied with the past and present.

I will give some examples of the possibilities for future astrocognition. Astrocognition studies for example:

(i) *universal astrocognition*, the mind in a universal context;
(ii) *incognita cognita*, the human mind's encounter with the unknown;
(iii) *situated astrocognition*, what will happen to the human mind situated in and in interaction with an extraterrestrial environment;
(iv) *cosmocognition*, the human mind's search for order in the universe, i.e. *kosmos* in its original Greek sense;
(v) *xenocognition*, the human mind's encounters and interactions with foreign beings, and other forms of non-human cognition;

(vi) *astrocognitive epistemology*, what we can learn through extraterrestrial explorations, interactions and encounters;
(vii) *interstellar communication*, how we can communicate and understand extraterrestrial messages;[7]
(viii) *extraterrestrial imagination*, how we think about and imagine the extraterrestrial.

Astrocognition is a multidisciplinary approach consisting of a wide range of perspectives from cognitive science, philosophy of mind, the history of science, theology, ethics, cultural studies, semiotics, computer science, neurology, evolutionary theory, and space technology. The only field dealing with the human being in itself and what it is to be human - especially in its relation to the non-human - is the humanities, and thus the humanities must be the core of any future research on humans in outer space.

2.1.2 The astrocognitive premise

The astrocognitive paradigm rests on a supposition that man is a historical creature. If we want to understand how space travel and encounters will change human culture, we need first to understand our prehistory; the limits and possibilities it has given us. Thus astrocognition starts from a fundamental, basic premise, *the astrocognitive premise*: "The human brain has developed through an evolutionary process here on Earth, with its specific environment."

Our thinking has an evolutionary origin.[8] The human mind has to a large extent evolved as an adaptation to certain problems that our ancestors have faced during the evolutionary development of our species. That is, the human brain is adapted to, firstly, the physical and biological environment of the Earth - to understand and interpret, interact and deal with, and orientate itself in the Earth's physical and biological environment, in relation to its specific conditions, such as planetary orbit, gravitation, light conditions, atmosphere, radiation, temperature, chemistry, geology, ecology, fauna and flora. Secondly, the human brain is also adapted to the mind and culture of the tellurian species *Homo sapiens*, to understand and interact with other beings of our species, to understand human feelings, thoughts, motives, etc., in a psychological and sociological interplay that forms our human culture. Culture can here be defined, in accordance with Chris Sinha, as the existence of intra-species group differences in behavioural patterns and repertoires, which are not directly determined by ecological circumstances, and which are learned and transmitted across generations.[9]

Thus, *Homo sapiens* could only have developed on this particular planet on which we now stand, with its specific conditions and evolutionary history. That is why it is nearly impossible for our earthly minds to really grasp for example:

(i) *the infinite universe*. We tend to think that, if the universe is finite, then it must have limits, but what in that case is beyond the limits of the universe? Everything seems to have a border, and there is always something on the other side of the border;
(ii) *the creation* or beginning of life on Earth. How could the

universe be created from nothing? Everything must have a beginning, we assume, nothing can be created out of nothing, without a purpose or a creator;

(iii) *meaningless things*, the meaninglessness of existence, that something does not have any meaning or purpose;

(iv) *space*, such as the relative space of Einstein's universe, the multidimensionality of space, and long distances like light-years;

(v) *time*, such as the relative time of Einstein's universe. Even our common objective, uniform clock time is sometimes hard to grasp - our subjective time could go slower and faster - and time spans longer than some few generations, or speeds faster than a running horse;

(vi) *the modern world*, the artificial environment of the city and the virtual reality of cyber space. There are arguments based on evolutionary psychology that claim that our brains are actually maladapted to our modern society.

Our brains are not developed for situations and phenomena – as those mentioned above - far from ordinary life. Sometimes it is said that the world is inherently understandable and that we can understand it by observing how it works. This conception is based on an idea that our brains are developed for understanding such things, but that is unlikely from an evolutionary perspective. The brain has developed for handling ordinary daily life experiences in a rather narrow space and time scale. Human understanding is constrained by its evolution and history; it has limits. The different worlds out there are likely to be far beyond our most vivid imaginations. We will be surprised.

2.1.3 Astrocognitive theory

Cognitive science can give clues to how we understand and think about the universe and reveal new perspectives on human encounters with the unknown. In short, cognitive science studies how the external world is represented, how we use cognitive tools for our thinking - such as language, image schemas, mental maps, metaphors, and categories, but also how we use and interpret, for example, drawings and images to enhance communication. It is about perception, attention, memory, learning, consciousness, reasoning and other things that we include in what is called "thinking".

Recent theories about human cognition could open up new perspectives on space encounters. The following does not aim to be a full, complete list of relevant cognitive theories, just a few examples from cognitive science that I believe could be useful in our task. First of all is the theory of *the embodied mind*.[10] We think with the body. The mind is not detached from the body. Thus bodies of other kinds and evolutionary backgrounds will have other minds and ways of thinking. This opens another question of astrocognition: how aliens from other evolutionary trails understand their world - or our world.

The theory of *situated cognition* claims that our cognitive processes are

not just inside our brains; we also use our environment for thinking.[11] The brain not only needs the body but also the surrounding world in order to function efficiently. The environment has an active role in driving the cognitive processes of what Andy Clark and David Chalmers called the *extended mind*.[12] Thus, cognition emerges in the interaction between the brain, the body and the world. There exists no sharp line between the brain and the world. We cannot be isolated observers. In other words, cognitive activity cannot be separated from the situations in which it occurs. There is a dynamic interplay between mind and environment, making a cognitive system of agent and environment. The agent both adapts to the world and changes the world. This change is not just pragmatic, but also epistemic, so the world becomes easier to adapt to.[13]

But during the evolution of human thinking, as Peter Gärdenfors argues, it seems that the mind became less dependent on the situation here and now, and more detached from the current environment.[14] Human cognition depends on constraints in the surrounding culture and evolves in a dynamic interaction with the technological environment. To this we can add what is called *distributed cognition*: that we are using our environment and tools for enhancing thinking, and we place our ideas and memories in things - books, computers, etc. So, in conclusion, where we are in time and space is totally fundamental to cognition. Extraterrestrial environments will probably act on and change our thinking. Our knowledge of extremophiles shows also that life can thrive in very different conditions than those we are used to. Perhaps the same applies to intelligent life. Aliens, developed in and adapted to an entirely different physical and cultural environment would probably have very different modes of thinking. Thinking in the universe could be very different from what we are used to in our westernised, anthropocentric and earthbound human culture.

A central cognitive process is the *perception* of patterns. We do not passively receive images and sounds from the surrounding world. Instead the brain actively searches for patterns in what it receives from the senses, and interprets them. This process is determined by both biological and cultural factors. We are especially efficient at seeing faces everywhere, for example the man in the Moon, or the face on Mars that Viking 1 captured with its camera in 1976. Other examples of our ability to see patterns are the star constellations, or how Giovanni Schiaparelli and Percival Lowell in the nineteenth century saw *canali* on the surface of Mars, which were interpreted as artificial waterways built by a Martian civilisation.

Fig. 1. *Interpretations of perceptions. Unusual celestial occurrences, like comets, are interpreted as terrifying omens in the shape of a blazing cross. (source: Lycosthenes, Conrad. Die Wunder Gottes in der Natur (1744).).*

We also think with *metaphors*.[15] Spatial experience is fundamental for cognition, as mentioned above, which leads to the fact that many basic words relate to bodily experiences. Our cognitive capacities, especially concerning concept formation, can be explained as a kind of metaphorical extension of spatial reasoning.[16] Abstract concepts relate to concrete, basic human experiences. In order to be useful our concepts must not only be applicable to known cases, they should also be able to be generalised to new situations as well. The unknown is then understood, described, and grasped through known experiences. Thus, our thoughts and descriptions of the unknown often tell more about ourselves than the things unknown. Metaphors are like tools for dealing with the unknown. Actually, astrobiology rests on metaphors, on a great analogy. From just one known case of a life-bearing planet we infer with an

inductive mode what potential extraterrestrial *loci* must be like in order to sustain life. When we think about and try to grasp the universe and the unknown, we have to use experiences from the known ordinary life on Earth that we are familiar with.

Another cognitive ability is *categorisation*.[17] All living creatures seem to categorise the environment in terms of edible versus inedible, benign versus harmful etc. Categorisation becomes more complex in humans. The human mind tends to categorise, seeing hierarchies and similarities between things, for example stellar spectra or species and genera in taxonomy. But do they really exist outside our minds? The classification of species - whether it is artificial or natural - has been debated ever since Linnaeus and Buffon.[18] Behind this is our ability to see sameness in diversity. Our categories are based on experiences and a sort of inductive reasoning that, according to Eleanor Rosch, give rise to prototypes from which we construct our categories.[19] These prototypes, I would underline, are developed through experiences of this actual world we are living in and will be unfit for use in another world where we have never set foot. New encounters will force us to change those of our categories that have ceased to work.

Intersubjectivity, the sharing and representing of others' mentality is an important part of our inner worlds. Empathy, the representing of other human beings' emotions, motives, intentions and desires, bodily expressions of emotions, beliefs and knowledge, are impossible without a rich inner world. Cooperation on detached goals requires advanced coordination of the inner worlds of the individuals.[20] Future encounters with aliens will face severe problems concerning intersubjectivity, coordination of inner worlds, and empathy etc., due to totally different biological and cultural conditions. A human and an extraterrestrial will probably have trouble even in perceiving the same target, in aligning their attention, adjusting their actions, and imitating each other.

Communication is situated in and constrained by its surroundings.[21] Language has an evolutionary history and has evolved due to its enhancement of communication between humans, used for describing the world around us, but perhaps more importantly as a social interplay: to express feelings, for socialising and creating bonds, etc. Cognitive linguistics aims to situate language within more general cognitive capacities. According to John Taylor, language can be understood as a set of resources that are available to the language user for the symbolisation of thought, and for the communication of these symbolisations.[22] The reference of a symbol is a detached representation; the symbol refers to the inner world, in contrast to the signal that refers to something in the outer environment. Symbols are conventional signs, or arbitrary as Ferdinand de Saussure called them, dependent on culture.[23] We may figure out the reference of the signal, but will probably have severe problems understanding extraterrestrial symbols. Cognitive semiotics, which deals with our use of signs, symbols, etc. for communication between humans, will I believe have great importance for interstellar communication.

Can we understand a message from outer space? Are we able to recognise it at all as an intelligent message? The first problem that arises in this situation of interstellar communication is realising that it really is a message at

all, as Göran Sonesson has pointed out.[24] Some regularity and order, finding a repetition in the pattern, is not enough. We have to understand that someone has an intention that we should understand it as a message. Next comes the problem of deciphering what the message means. Cultural semiotics, developed among others by Yuri Lotman, studies sign systems and the correlations between different systems.[25] In order to understand a message the receiver must be able to fill in the gaps between the receiver's perception of the message and the sender's intention with it.[26] The problem is that the creator of the message and the receiver of it are situated in different and specific cultural and social contexts. Relating to interstellar communication, this gap will be huge, with totally different ecological and cultural contexts. As Douglas A. Vakoch clearly states: "In the absence of knowledge of physical and cultural clues, communication between two species can be almost impossible."[27] If we want to formulate a message comprehensible to an intelligent extraterrestrial we must, as Sonesson has also stated, go beyond our specific human biology, ecology, and culture. Designing a language for cosmic intercourse, like Hans Freudenthal's *lingua cosmica*, will probably be in vain.[28] The famous Pioneer plaque now traversing deep space is also too firmly restricted by human culture and cognition, and will most likely be incomprehensible to an extraterrestrial. Even though the aliens would be familiar with the content of the same kind of mathematics, chemistry, or physics as we are, their expressions of it would probably not be the same as ours when our life-worlds are different.[29] The aliens and ourselves live in different cognitive or, if you wish, semiotic worlds with ways of thinking and signification that are not in agreement with each other.

Finally, man is constantly searching for *meaning*. When we find that something is caused by an agent we presume that there is a purpose behind it, that the act is goal-directed. We tend to search for meaning in everything. That is a driving force for culture, theology and sciences. We search for a meaning in the universe and creation. These cognitive abilities mentioned above - and many others - are important and will be tested in future encounters with the unknown.

2.1.4 How can we get empirical data?

As yet we have no or very little experience of extraterrestrial environments. What, then, should we do in the meantime, if we want to study human encounters with the unknown? How could we increase our understanding of astrocognitive processes? To begin with, we actually have experience of unknown environments - here on Earth. Of course, we nearly every day encounter greater and lesser unknown things in unfamiliar situations: when we meet foreigners, read new books, enter new buildings, perform new tasks, and so on. Human encounters with the unknown seem to be a human universal. These encounters with the unknown can here and now be studied in at least three different empirical ways.

We can get further empirical data from:

(i) *Observations* of authentic cognitive processes in practical action. This can be done from anthropological studies of

cultural encounters, when mutually unknown cultures meet and interact. This includes trying to learn other ways of understanding reality and living it in a more basic physical sense - going native, so to speak. The anthropologists' encounters with unknown cultures and their attempts to find meaning in foreign rituals and ways of life, is a study in itself on the meta-level. Further information can be gained from psychological and sociological studies of our modern life: how our palaeolithic hunter brain works in the postmodern city jungle. Even zoological and ethological studies of animal communication, and intraspecies communication between man and animal, can give some clues to future communication with non-human entities.

(ii) *Neurological experiments*, such as experiments that study perception of the self and the body. For example, experiments have been carried out by Henrik Ehrsson that test reactions to changes in the normal sensory feedback, in order to imitate clinical conditions that disturb normal brain functioning - for instance illusions of out-of-body experiences.[30] Simulations, or manipulations, of this and other kinds may reveal reactions to astrocognitive possibilities.

(iii) *Computer simulations*, such as virtual reality experiments with parameter variation. I propose that three-dimensional virtual reality environments should be constructed in a virtual reality lab where the test parameters can be slightly altered, such as the speed and echo of sounds, light conditions, humidity, temperature, distances, transparency, air, etc. Then the test subjects can be observed: what they do and how they act in these environments. For example, the attention of the test subject in an unknown environment can be observed with eye-tracking equipment. Even haptic devices (the virtual sense of textures, etc.) may be used in order to act on a complete set of sensory input.

These empirical methods have limits, though. The first (i) is restricted by the fact that it is all but impossible to find isolated situations without previous knowledge and preconceptions. The other two alternatives (ii, iii) are limited by our putting into the experiment factors that we already know of, and elaborating by using parameters that we are aware of. But we also have another option for studying authentic cognitive processes in practical action: (iv) *historical encounters* with the unknown found in travel diaries, scientific reports and other historical documents. In history we can find isolated cultures and environments with little or no previous knowledge of each other. Throughout history, man has always ruminated and thought about the unknown. Science deals actually with the unknown; about how we can grasp it and make it into something known and possible to understand. In all these cases of confrontation with the unknown, man has used his earthbound cognitive abilities.

2.1.5 Historical questions of astrocognition

In order to understand how we think as humans, I would say it is necessary to put the human being in a historical time setting and study the changes of cultures, environments, modes of thoughts, etc., both diachronically and synchronically; that is to say, phylogenetic, ontogenetic and historical studies of change - for example the development of species, individual organisms and cultures -, but also of fixed points in time for comparative and multidisciplinary perspectives. Human distinctiveness, as Merlin Donald puts it, is not only a function of biology, but also owes much to the specificities of human history.[31] The human being is an historical animal; it has an evolutionary history but can also reflect on its history and is more or less conscious of it. In one respect, past historical cultures are alien, unfamiliar and unknown environments. The quest for understanding these distant pasts is not unlike the understanding of contemporary distant extraterrestrial cultures and environments. But there is one big difference: in the case of the distant human past on Earth we can use our cognitive abilities developed through our evolutionary history that we have in common. Two fields have special relevance to the astrocognitive paradigm: the history of imagination and the history of exploration.

To begin with, the *history of imagination* has deeper implications than we can readily imagine. Throughout history, man has always imagined other worlds - the nonexistent and the utopian; in science fiction man has imagined extraterrestrial worlds and life forms; and in fantasy societies outside our time and space have been conceived of. But all these speculations are actually about our own existent world and say more about ourselves than the outer world itself. Human imagination always comes back to actual sensory experience and is based, among other things, on metaphorical processes of the mind. You might say, according to a Lockean tabula rasa: all ideas that come to be in the mind must have first been in the senses. With the help of our cognitive abilities we put together known things, actual sensory experiences, to create new ideas. Narrative constructions of reality, as Jerome Bruner has explained, are also about how we organise our experiences and memories in the form of stories and myths.[32] Our occupation with science fiction is a way of envisioning various actions and their consequences, which can have further use as a tool for planning and for readiness for the future. Our thoughts about science fiction are also mixed with our ideas of utopias, of the perfect society. A future Mars colony is a utopia and raises the classic utopian question: what is needed to build a future society from scratch? So in all, how we talk and write about space is not in the least irrelevant, something that has been underlined by Ulrike Landfester.[33] This leads to the need for historical analyses of ideas and speculations concerning the unknown, extraterrestrial life, space travels and astrobiology.[34]

The other field, the *history of exploration*, itself needs to be further explored. This approach leads to studies of the early history of the exploration of the Earth, from a new angle. In these early travels, man encountered the unknown: new continents, life forms, cultures, and other unfamiliar things. How did these travellers actually handle the unknown?

2.1.6 The history of exploration

Exploration appears to be inherent to humans, as it says in the rationale of the European Science Foundation's Standing Committee for the Humanities and the European Space Sciences Committee position paper of Humans in Outer Space. There seems to be an "inherent human quest for odysseys beyond the atmosphere". Throughout the ages explorers have searched for

> "fire, fresh water, food, milder weather, new hunting grounds, stone, minerals, spices, terra incognita, gold, precious stones, other life forms, rare animals, high mountains to climb, mysterious places to reach, and in the process bringing back answers, novel things to study, theories, and many more questions asked."[35]

Several drives and behaviours such as curiosity, the acquisition of new territories and riches, national prestige, etc. lay behind this. It is also an intellectual endeavour. Looking around us, in the world, in space, we may understand a little bit more of what it means to be human and how we as an earthly species fit into the universe.[36] In a study of eighteenth-century exploration of the Earth, Mary Louise Pratt calls this endeavour a movement towards a "planetary consciousness", in reference to circumnavigation and mapping of the world's coastlines, the Linnaean taxonomy project and the French expedition of Charles Marie de La Condamine and its determination of the shape of the Earth.[37] Exploration of the universe extends this quest to a deeper cosmic consciousness.

History as a guide to frame our thinking about the implications of encounters with extraterrestrial life has been proposed by, for example, Steven Dick and Luca Codignola.[38] As an attempt to look forward, we look back. By analysing historical responses to past discoveries we can gain perspectives on how worldviews have changed in connection with encounters. In line with this, I would like to complement it with an evolutionary and cognitive perspective on explorations: the zest for exploration has an evolutionary origin. Explorations to a great extent have to do with emotions as a vital part of the drive, such as curiosity and admiration. In the "Vienna Vision on Humans in Outer Space" it is emphasised that the inherent human curiosity for exploring the unknown is at the heart of the dialogue.[39] To this I would add that the emotion of curiosity has cognitive, evolutionary benefits. Without curiosity and a drive for exploration we would not have found food, water, shelter, mates, etc.

For the most part, the history of exploration has dealt with what travellers actually saw, whom they met, where they travelled, what islands and geographical features they observed. A great part concerns logistic problems and how they travelled from spot to spot, for example navigation on the seas and how they followed unbeaten tracks, coastlines, rivers, mountain ranges, and valleys. Another interest has been the sociological and political aspects of travelling, such as networks, power relations, contacts, collaboration, crewmembers' careers, and how the encounters have resulted in political and economical change.[40] But if we want to understand how encounters with the

unknown in a more fundamental way change our thinking and belief systems we have to rewrite the history of exploration and study it from a new angle: from a cognitive perspective. A cognitive history of exploration could go further and, in fact, study the lacunae of the mind - what they did *not* see because of a selective mind directed to particular things. It could also study how our minds try to grasp and interpret what the senses offer us and how our preconceptions and earlier experiences direct us to conclusions about what we encounter. The narrations follow also genre specific norms, and the 'real' travels merge with the fictive travels. The history of polar expeditions has already been useful for studying technical and logistic problems with isolated expeditions in unfriendly environments. I think that travels in tropical and subtropical environments can also help us to understand the cognitive processes of encounters with unknown organic environments.

As a consequence of this approach, we have to go far back in time, before our globalised world; to a time when there were still entirely unknown white spots on the Earth, cultures that had no deliberate external contact whatsoever, and having no knowledge or awareness of each other. The pre-globalised world can be dated to a time in human history when differences between foreign cultures and environments seemed to be greater, or more accurately: the gaps between their life-worlds were greater; their cultures were more isolated, independent, and self-sufficient; mutual contacts were fewer. There was a wide gulf between cultures in regard to culturally constrained preconceptions, knowledge, and ways of life, etc. Yet they had the same human cognitive abilities and an evolutionary history in common.

With respect to scientific expeditions of the early-modern period, we can find that a cognitive approach reveals and sustains a wide range of arguments for what happens to the human mind in unknown environments. First and foremost, there is an interaction with the environment leading to a wider *spatial conception* or *consciousness*. Not just texts, ideas, traditions and cultures lead to historical change, but also the body, the environment, space and matters around us, dimensions, topography, logistics, buildings, communication routes, etc.[41] We relate to home and away, inside and outside, existing and non-existing. Travels into unknown geographies change our spatial conceptions and develop the relationship between mental space and real space.[42]

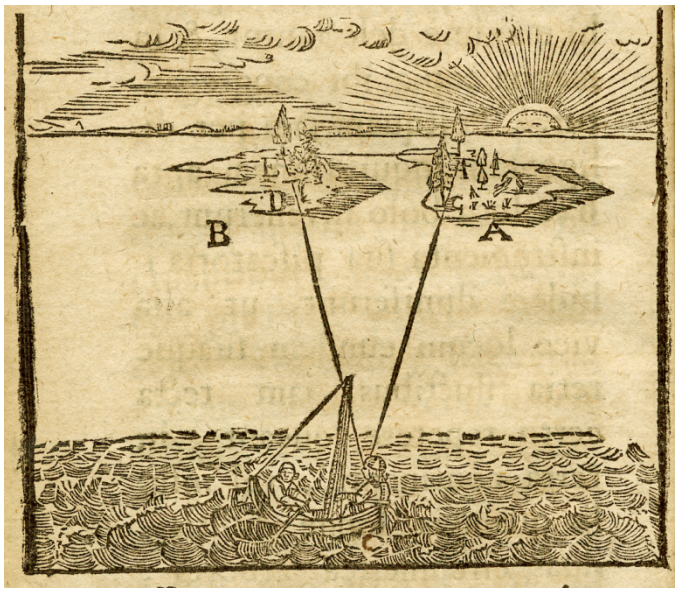

Fig. 2. *Spatial consciousness. Two fishermen on cod fishing who orientate themselves with reference to the angles between the boat and the trees on two small islands. Harald Vallerius describes the spatial significance of geometry, how right angles can be used in geodesy, in a dissertation on angles,* De angulo*, from 1698 (source: Lund University Library.).*

Encounters lead to *cultural change* and change our thinking, categories, and belief systems. While many theories and disciplines - such as anthropology, cultural studies, post-colonialism - claim to study cultural encounters, they have focused more on political, ideological and sociological issues. A cognitive history, but also cultural semiotics, can in a more fundamental way study communication and what is going on in the individual mind's encounter with the unknown.

We are often not able to fully understand other intelligent life; often we actually cannot even see that other lives are intelligent lives. It is difficult to see the complexity of cultures and the differences between the tribes or groups we encounter. We tend to *dehumanise* the others and see complex cultures as primitive cultures. This is due to cognitive challenges for the human mind concerning, for example, empathy, intersubjectivity and the coordination of the inner worlds. One way to cope with this - if it concerns other members of our own species - is to go native, like for example the German explorer Carsten Niebuhr, who in the 1760s travelled through Arabia Felix and tried to fit into the Arabian culture using his cognitive abilities, learning and imitating in order to acquire language skills and customs.[43]

We often have severe *communication problems*. Misconceptions are frequent in cultural encounters due to different life-worlds, cultural backgrounds and experiences. Culturally- and environmentally-bounded concepts, symbols, categories, etc. differ and complicate communication.

The unknown is a *reflection of the known*. Travelogues always tend to refer back home, to the familiar and known, to former experiences and knowledge; traditionally to western culture and its preconceptions and ideologies. In descriptions of unknown new things, we always use known things that we are used to. When the American settlers saw the red-breasted *Turdus migratorius*, it reminded them of the European Robin (*Erithacus rubecula*) and

they called it *Turdus migratorius* for American Robin. It is actually more closely related to the Common Blackbird (*Turdus merula*) than the Robin. There are lots of such examples from biological taxonomy.

Fig. 3. *A cognitive history of exploration. Our minds try to grasp and interpret what the senses offer us, and our preconceptions and earlier experiences direct us to conclusions about what we encounter. (source: Sigfridus Aronus Forsius's Physica. Sea monsters, fishes, whales, sirens, crocodiles etc. (1611).).*

The interpretation of the seen, the environment and nature, goes back to cognitive abilities like memory, categorisation, perception of patterns, and so on. This acquired pre-knowledge, conscious or unconscious, our *preconceptions*, forces us to interpret what we see in one way or another. We use previous knowledge, narratives, myths, and religious conceptions in order to make sense of what we encounter. A famous example is when Christopher Columbus encountered America. He did not see a new continent and he did not encounter a new human race. He came to India, and met Indians. Columbus' account shows also, like many other descriptions from unknown environments, how difficult it is to describe the seen. Concepts and words are lacking. He then saw high and beautiful mountains, wide fields, and forests, fertile plains that, as he says in his letter from America immediately after the first voyage, surpassed your conceptions if you had not previously seen them.[44] The new things seen are impossible to imagine or describe - you have to see them with your own eyes.

This is also true for interpretations of foreign cultures. The traveller takes concepts from his own known culture and superimposes them on the different, unknown culture, projecting himself onto the unknown other. We see the other as a mirror image of ourselves. The very term 'discovery' unveils an egocentric

perspective in the modelling of cultures.[45] Discoveries and encounters are seen from a local, personal point of view, not from a global perspective, and we have no other option. The ego is in dialogue with the other, alter and alius, in Sonesson's words: our own, the ego-culture, stands in relation to the extra-culture and the non-culture.[46] The ego-culture deforms texts from other cultures and times in line with its own needs. Our own culture stands for order in contrast to the other's chaos and disorder. Anna Cabak Rédei gives striking examples of this from the travel accounts of Germaine de Staël from her journey to Germany and Russia during her exile from 1803–1812.[47] Most travelogues appoint western culture to the ego and the visited culture to the other. In some few cases we have the opposite - for example, the Japanese Hoshu Katsuragawa's description of Russia in the eighteenth century.[48]

Fig. 4. *Cultural encounter with an Indian family in North America. (source: Woodcut by Thomas Campanius Holm from 1702 after a sketch by Per Lindeström from 1654. Thomas Campanius Holm, Kort beskrifning om provincien Nya Sverige uti America (1702).).*

We need the other in order to create an image of ourselves, not just in the Saidian collective sense, but also from the perspective of the individual. This ego-perspective of the human mind leads to *subjectivity*. Thus travelogues and descriptions often say more about the traveller than about the actual objective world. According to Edward Said, ideas about the other say more about western culture than the Orient itself.[49] From a cognitive perspective, what we always have are human internal conceptions of the world, not the real objective, external world. The world is filtered through our minds.

Finally a kind of *nostalgic isolation* during expeditions is a frequent theme. Emotions of isolation, that there is no turning back, the loss of contact with relatives and friends, evolve in the mind's journey through territories

detached from the familiar environment. An unknown environment - like distant planets in outer space - is frightening, likewise unknown creatures never seen before. This anxiety is due to of a lack of orientation. Our ordinary cognitive tools for handling our known environment are put aside and do not work anymore.

2.1.7 Astrocognitive hypotheses

Something similar to this that took place in the history of exploration of the Earth will happen again when we encounter an entirely new and unknown extraterrestrial world. But the human mind will then face even harder cognitive challenges, when the gap between the worlds is likely to be huge, far greater than the gaps upon our Earth.

Based on historical research on the history of exploration of our Earth, I suppose that we - when we in the future tread a new world - will face similar cognitive problems. Thus we can assume at least nine *astrocognitive hypotheses*. Encounters with the unknown outer space will:

(i) change our spatial consciousness;

(ii) change our thinking - conceptions, categories, belief systems, culture, and the meaning of things. What we so far have come to believe through science and human cogitation will face anomalies. The old categories, systems, and beliefs will fall short in the understanding of new unfamiliar things. Our thinking, science and belief systems will then have to be revised, which will lead to adjustments, adaptations, and compromises.

The children of space settlers will use same cognitive abilities as their parents and they will belong to the same historical tradition. The first generations of space settlers will have nearly exactly the same cognitive tools as we have. But in the long run after many generations in space the genetic-cultural co-evolution of the human descendents might have resulted in slightly different or new cognitive tools that enhanced their ability to live efficiently in their new extraterrestrial environment. The conceptual organisation of space and time would probably change for example.

We will:

(iii) not be fully aware of whether that which we encounter is intelligent life, perhaps not even that it is something living;

(iv) not be able to understand their feelings, motives, and desires, i.e. their inner worlds. To feel empathy for an alien will be problematic.[50] Different evolutionary and cultural history makes different ethics and social behaviours;

(v) probably not be able to or at least have severe problems in communicating with ”it”.

(vi) describe the extraterrestrials with human, earthly conceptions, and anthropocentric terms and qualities. We will start from our known culture, biology and science and force it onto the unknown. But why does intelligent life have to look like us? We need an awareness, as Landfester brings to mind, that what we may encounter out there cannot

be presumed to be like us, neither in knowledge or learning, in body or spirit.[51] The way we think about the universe is anthropocentric and geocentric, firmly caught in the evolutionary history of our Earth as a part of the anthropocentric history of mankind. A truly cosmocentric view will be hard to achieve.[52]

Fig. 5. *We describe the aliens with human conceptions, and anthropocentric terms and qualities. Anthropomorpha or manlike creatures, the missing links between man and animal: Homo troglodytes, Lucifer or Homo caudatus, Simia saturus and Simia pygmaeus, Linnaeus, Carl. Anthropomorpha (1760). (source: Lund University Library.).*

And furthermore:

(vii) it will be difficult, if not impossible, not to force our preconceptions onto the unknown. We cannot escape from a non-preconceptualised understanding;

(viii) the travelogues and descriptions of these new worlds will for the most part say more about ourselves than about the real, or so to speak objective, extraterrestrial world. An independent world outside us might exist, but we will never be able to reach it;

(ix) crewmembers and settlers in outer space will feel emotions of isolation.

2.1.8 Conclusions

My aim was to search into the limits of our earthly brains that human evolution and culture have given us, to try to find out what we can know and what we will likely encounter in the future. I have tried to show how earthbound and historically constrained we are as thinking beings. Our intellects do not transcend space, instead, our cognition is situated in space.

Fig. 6. *Cultural life on the mountains of the Moon? (source: Dunér, David. "Centro Cultural de Monte de Luna" La Palma, Canary Islands, Spain: 2009.).*

To summarise: what will be achieved with astrocognition? We will get further theoretical, scientific knowledge of:

(i) how we encounter the unknown;

(ii) how the human mind interacts with space and the environment around us.

These two achievements will be valuable even though we might never go beyond our solar system. From this we would learn more about human cognition and how it has been developed here on Earth. But we will also get practical knowledge. Astrocognitive research will prepare us for:

(iii) future space expeditions, thus preparing a new kind of explorer astronaut and how we behave in a new unknown world;

(iv) terra-forming and how to live in an extraterrestrial environment;

(v) communication with aliens.

And furthermore:

(vi) future comparative research on cognitive processes of extraterrestrial minds can reveal new knowledge of how humans think. We will then know more about the specifically human ways of thinking and meaning-making, specific or typical characteristics of our species. Are we unique in the universe? This approach can lead to the development of not just an anthropocentric, but also a cosmocentric perspective on cognition.

(vii) Finally, an astrocognitive inquiry will give indications as to what a human being is from a truly universal point of view. Encounters with other minds here on Earth or on extra-solar foreign planets out there in deep space among billions of stars and galaxies can give a more universal answer to the question: "*What is thinking?"*

Special thanks to Erik Persson, Per Lind, Lars Hall and Göran Sonesson for valuable comments during the preparation of this article.

[1] Jakosky, Bruce M. “Philosophical Aspects of Astrobiology.” A New Era in Bioastronomy. Vol. 213. Eds. Guillermo A. Lemarchand, and Karen J. Meech. San Francisco, CA: ASP Conference Series, 2000. 666.

[2] Turner, Mark. “The Cognitive Study of Art, Language, and Literature.” Poetics Today 23.1 (2002): 18; See also Richardson, Alan, and Francis F. Steen. “Literature and the Cognitive Revolution. An Introduction.” Poetics Today 23.1 (2002): 1–8. 3; Dick, Steven J., and Mark L. Lupisella. Eds. Cosmos and culture: Cultural evolution in a cosmic context. Washington, DC: NASA History Series, 2009.

[3] NASA. ”Strategic Plan 1998: With 1999 Interim Adjustments.” NASA Policy Directive (NPD)-1000.1a of 1998/1999. NASA 10 Jan. 2010 <http://www.hq.nasa.gov/office/codez/plans/NSP99.pdf>.; Chyba, Christopher F., and Kevin P. Hand. “Astrobiology: The Study of the Living Universe.” Annual Review of Astronomy and Astrophysics. 43 (2005): 31–74.

[4] Davies, Paul. Cosmic Jackpot: Why Our Universe Is Just Right for Life. Boston: Houghton Mifflin, 2007.

[5] Pálsson, Gísli. “Celestial Bodies: Lucy in the Sky.” Humans in Outer Space – Interdisciplinary Odysseys. Eds. Luca Codignola, and Kai-Uwe Schrogl. Vienna: SpringerWienNewYork, 2009. 69–81. 79.

[6] Davies, Paul. Are We Alone? Philosophical Implications of the Discovery of Extraterrestrial Life. New York: Basic Books, 1998; Race, Margaret S. “Societal and Ethical Concerns.” Planets and Life: The Emerging Science of Astrobiology. Eds. Woodruff T. Sullivan, and John A. Baross. Cambridge: Cambridge University Press, 2007. 483–497; Bertka, Constance M., Ed. Exploring the Origin, Extant, and Future of Life, Philosophical, Ethical and Theological Perspectives. Cambridge: Cambridge University Press, 2009.

[7] Schetsche, Michael. ” Encounters Among the Stars. Exosociological Considerations.” (in this volume).

[8] Gärdenfors, Peter. How Homo Became Sapiens. On the Evolution of Thinking. Oxford: Oxford University Press, 2006.

[9] Sinha, Chris. “Language as a Biocultural Niche and Social Institution.” New Directions in Cognitive Linguistics. Eds. Vyvyan Evans, and Stephanie Pourcel. Amsterdam: Benjamins, 2009. 289–309. 292; Cf. Tomasello, Michael. The Cultural Origins of Human Cognition. Cambridge, MA: Harvard University Press, 1999.

[10] Varela, Francisco J., Evan Thompson, and Eleanor Rosch. The Embodied Mind. Cognitive Science and Human Experience. Cambridge, MA: MIT Press, 1991; Lakoff, George, and Mark Johnson. Philosophy in the Flesh. The Embodied Mind and its Challenge to Western Thought. New York, NY: Basic Books, 1999; Krois, John, Mats Rosengren, Angela Steidele, and Dirk Westerkamp. Eds. Embodiment in Cognition and Culture. Amsterdam: Benjamins, 2007.

[11] Clark, Andy. Being There. Cambridge, MA: MIT Press, 1997; Brinck, Ingar. “Situated Cognition, Dynamic Systems, and Art. On Artistic Creativity and Aesthetic Experience.” JanusHead 9.2 (2007): 407–431.

[12] Clark, Andy, and David Chalmers. “The Extended Mind.” Analysis 58.1 (1998): 7–19.

[13] Gärdenfors, Peter. “Cognitive Science: from Computers to Ant Hills as Models of Human Thought.” A Smorgasbord of Cognitive Science. Eds. Peter Gärdenfors, and Annika Wallin. Nora: Nya Doxa, 2008. 11–34. 28; Wallin, Annika, and David de Léon. “How Should We Study Interaction?.” A Smorgasbord of Cognitive Science. Eds. Peter Gärdenfors, and Annika Wallin. Nora: Nya Doxa, 2008. 133–148. 139.

[14] Gärdenfors, Peter. “The Evolution of Thought.” A Smorgasbord of Cognitive Science. Eds. Peter Gärdenfors, and Annika Wallin. Nora: Nya Doxa, 2008. 81–97. 81.

[15] Lakoff, George, and Mark Johnson. Metaphors We Live by. Chicago, IL: University of Chicago Press, 1980.

[16] Gärdenfors, Peter. “Concept Learning.” A Smorgasbord of Cognitive Science. Eds. Peter Gärdenfors, and Annika Wallin. Nora: Nya Doxa, 2008. 165–181. 167.

[17] Lakoff, George. Women, Fire, and Dangerous Things. What Categories Reveal about the Mind. Chicago, IL: University of Chicago Press, 1990; Taylor, John R. Linguistic Categorization. Oxford: Oxford University Press, 2003.

[18] Mayr, Ernst. The Growth of Biological Thought. Diversity, Evolution, and Inheritance. Cambridge, MA: Harvard University Press, 1982; Atran, Scott. Cognitive Foundations of Natural History. Towards an Anthropology of Science. Cambridge: Cambridge University Press, 1990; Berlin, Brent. Ethnobiological Classification. Principles of Categorization of Plants and Animals in Traditional Societies. Princeton, NJ: Princeton University Press, 1992; Wilson, Robert A., Ed. Species. New Interdisciplinary Essays. Cambridge, MA: MIT, 1999; Coyne, Jerry A., and H. Allen Orr. Speciation. Sunderland, MA: Sinauer, 2004; Atran, Scott, and Douglas Medin. The Native Mind and the Cultural Construction of Nature. Cambridge, MA: MIT, 2008. 9, 23.

[19] Rosch, Eleanor. ”Principles of Categorization.” Cognition and Categorization. Eds. Eleanor Rosch, and Barbara B. Lloyd. Hillsdale. NJ: Erlbaum, 1978.

[20] Concerning intersubjectivity, see Thompson, Evan. Ed. Between Ourselves: Second-Person Issues in the Study of Consciousness. Thorverton: Imprint Academic, 2001.

[21] Christiansen, Morten H., and Simon Kirby. Eds. Language Evolution. Oxford: Oxford University Press, 1997; Deacon, Terry. The Symbolic Species: The Co-Evolution of Language and the Brain. New York:

Norton, 1997; Tomasello, Michael. Origins of Human Communication. Cambridge, MA: MIT, 2008.
[22] Taylor, John R. Cognitive Grammar. Oxford: Oxford University Press, 2002. 30.
[23] Saussure, Ferdinand de. Cours de linguistique générale. Lausanne: Payot, 1916.
[24] Sonesson, Göran. "Preparation for Discussing Constructivism with a Martian." Les Signes du Monde: Interculturalité & Globalisation: Proceedings of the Eighth Congrès de l'Association International de Sémiotique, 7-12 July 2004, Lyon, France. Lyon: Université de Lyon, 2007. <http://jgalith.univ-lyon2.fr/Actes/articleAsPDF/SONESSON_(martiens)_pdf_20061114153124>.
[25] Lotman, Yuri. Universe of the Mind. A Semiotic Theory of Culture. London: Tauris, 1990.
[26] Cabak Rédei, Anna. An Inquiry into Cultural Semiotics: Germaine de Staël's Autobiographical Travel Accounts. Lund: Lund University, 2007. 43, 45f.
[27] Vakoch, Douglas A. "The View from a Distant Star: Challenges of Interstellar Message-Making." Mercury 28.2 (1999): 26–30; See also Arbib, Michael A. "Minds and Millenia: The Psychology of Interstellar Communication." Cosmic Search 3.1 (1979): 21ff; Vakoch, Douglas A. "Constructing Messages to Extraterrestrials: An Exosemiotic Perspective." Acta Astronautica, 42.10–12 (2000): 697–704; McConnell, Brian. Beyond Contact: A Guide to SETI and Communicating with Alien Civilizations. Sebastopol, CA: O'Reilly, 2001; Dunér, David. "Cognitive Foundations of Interstellar Communication." Communication with Extraterrestrial Intelligence. Ed. Douglas A. Vakoch. Albany, NY: State University of New York Press (in press).
[28] Freudenthal, Hans. Lincos: Design of a Language for Cosmic Intercourse. Amsterdam: North-Holland, 1960.
[29] Sonesson, Göran. op. cit.
[30] Ehrsson, H. Henrik. "The Experimental Induction of Out-of-Body Experiences." Science 317 (2007): 1048, also see 1020f; Henrik Ehrsson's group - Brain, Body & Self Laboratory." 28 Dec. 2009. Henrik Ehrensson's Group Website 10 Jan. 2010 <www.neuro.ki.se/ehrsson/index.html>.
[31] Donald, Merlin. Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition. Cambridge, MA: Harvard University Press, 1991; Donald, Merlin. A Mind so Rare: The Evolution of Human Consciousness. New York: Norton, 2001.
[32] Bruner, Jerome. "The Narrative Construction of Reality." Critical Inquiry 18.1 (1991): 1–21. 4.
[33] Landfester, Ulrike. "Missing the Impossible: How We Talk and Write about Space." Humans in Outer Space – Interdisciplinary Odysseys. Eds. Luca Codignola, and Kai-Uwe Schrogl. Vienna: SpringerWienNewYork, 2009. 94–106.
[34] Dick, Steven J. Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant. Cambridge: Cambridge University Press, 1982; Guthke, Karl S. Der Mythos der Neuzeit: Das Thema der Mehrheit der Welten in der Literatur- und Geistesgeschichte von der kopernikanischen Wende bis zur Science Fiction. Bern: Francke, 1983; Crowe, Michael J. The Extraterrestrial Life Debate 1750–1900: The Idea of a Plurality of Worlds from Kant to Lowell, Cambridge: Cambridge University Press, 1986; Dick, Steven J. The Biological Universe: The Twentieth-Century Extraterrestrial Life Debate and the Limits of Science. Cambridge: Cambridge University Press, 1996; Dick, Steven J., and James E. Strick. The Living Universe: NASA and the Development of Astrobiology. New Brunswick, NJ: Rutgers University Press, 2004; Sullivan, Woodruff T., and John A. Baross, eds. Planets and Life: The Emerging Science of Astrobiology. Cambridge: Cambridge University Press, 2007.
[35] Worms, Jean-Claude. "Space and Humans." Humans in Outer Space – Interdisciplinary Odysseys. Eds. Luca Codignola, and Kai-Uwe Schrogl. Vienna: SpringerWienNewYork, 2009. v–xiv. vii.
[36] Jakosky, Bruce M. op. cit. 663.
[37] Pratt, Mary Louise. Imperial Eyes: Travel Writing and Transculturation. London, and New York: Routledge, 1992. 15.
[38] Dick, Steven. "Humanity and Extraterrestrial Life." Proceedings of Life on Mars. What Are the Implications? Eds. John M. Logsdon, Bridget R. Ziegelaar, and Anne Marie Burns. 26 Nov. 1996, Washington D.C. Washington DC: Space Policy Institute George Washington University, 1997; Codignola, Luca. "Future Encounters: Learning from the Past?" Humans in Outer Space – Interdisciplinary Odysseys. Eds. Luca Codignola, and Kai-Uwe Schrogl. Vienna: SpringerWienNewYork, 2009. 14–21.
[39] "The Vienna Vision on Humans in Outer Space." Humans in Outer Space – Interdisciplinary Odysseys. Eds. Luca Codignola, and Kai-Uwe Schrogl. Vienna: SpringerWienNewYork, 2009. 227–229. 229.
[40] Concerning cultural encounters and travel literature: Campbell, Mary B. The Witness and the Other World. Exotic European Travel Writing, 400–1600. Ithaca: Cornell University Press, 1988; Porter, Dennis. Haunted Journeys: Desire and Transgression in European Travel Writing. Princeton, NJ: Princeton University Press, 1991; Pratt, Mary Louise. op. cit.; Pagden, Anthony. European Encounters with the New World. From Renaissance to Romanticism. New Haven, CT: Yale University Press, 1993; Elsner, Jas, and Joan-Pau Rubiés. Voyages and Visions: Towards a Cultural History of Travel. London: Reaktion Books, 1999; Bridges, Roy. "Exploration and Travel Outside Europe (1720–1914)." The Cambridge Companion to Travel Writing. Eds. Peter Hulme, and Tim Youngs. Cambridge: Cambridge University Press, 2002; Sell, Jonathan P. A. Rhetoric and Wonder in English Travel Writing, 1560–1613. Aldershot: Ashgate, 2006;

Abulafia, David. The Discovery of Mankind: Atlantic Encounters in the Age of Columbus. New Haven, CT: Yale University Press, 2008.

[41] We can find a new interest in spatiality, the spatial turn. See for example Crang, Mike, and Nigel Thrift, Eds. Thinking Space. London: Routledge, 2000; Schlögel, Karl. Im Raume lesen wir die Zeit: Über Zivilisationsgeschichte und Geopolitik. München, and Vienna: Carl Hanser Verlag, 2003.

[42] Lefebvre, Henri. La production de l'espace. Paris: Anthropos, 1974.

[43] Niebuhr, Carsten. Reisebeschreibung nach Arabien und andern umliegenden Ländern. Copenhagen: Nicolaus Møller, 1774–1837.

[44] Columbus, Christopher. Epistola de Insulis nuper Inventis. Rom: Eucharius Silber, 1493.

[45] Todorov, Tzvetan. La Conquête de l'Amérique. La Question de l'Autre. Paris: Seuil, 1982.

[46] Sonesson, Göran. "Ego Meets Alter. The Meaning of Otherness in Cultural Semiotics." Semiotica 128.3/4 (2000): 537–59; Sonesson, Göran. "The Globalisation of Ego and Alter. An Essay in Cultural Semiotics." Semiotica 148.1/4 (2004): 153–73; Cabak Rédei, Anna. op. cit. 2, 7, 70.

[47] Cabak Rédei, Anna. op. cit.

[48] Katsuragawa, Hoshu. Kratkie vesti o skitanijach v severnych vodach. Moscow: Nauka, 1978.

[49] Said, Edward. Orientalism. London: Routledge & Kegan Paul, 1978.

[50] We will thus not know how to treat them. For an analysis of the moral implications when encountering extra-terrestrial life see Cockell, Charles. "Ethics and Microscopic Extra-Terrestrial Life" (in this volume)

[51] Landfester, Ulrike. op. cit. 105.

[52] For the term "cosmocentric", see Lupisella, Mark. "Astrobiology and Cosmocentrism." Bioastronomy News, IAU Commission 51.10(1) (1998): 1–2 & 8.