COMENIUS UNIVERSITY IN BRATISLAVA
FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS

Distribution of information under conditions of uncertainty

Diploma Thesis

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FACULTY OF MATHEMATICS, PHYSICS AND INFORMATICS
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DISTRIBUTION OF INFORMATION UNDER CONDITIONS OF UNCERTAINTY

Diploma Thesis

Study programme:	Cognitive Science (Single degree study, master II. deg., full time form)
Field of Study:	2503 Cognitive Science
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Title: Distribution of information under conditions of uncertainty

Aim: The comparison of anthropological and psychological methods used for research in distribution of information

Annotation: 1. Our aim is to support an importance of cultural context for cognitive research with previous experiments.
2. We will introduce the cultural consensus theory as a method of cultural anthropology
3. Consequently, we will compare the cultural consensus model as an anthropological method with the cognitive diagnostic model as a psychological method applied on data concerning opinions about wolves.

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ZADANIE ZÁVEREČNEJ PRÁCE

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Názov: Distribution of information under conditions of uncertainty
Šírenie informácii v podmienkach neistoty

Cieľ: Porovnanie antropologických a psychologických modelov pri zisťovaní distribúcie informácií

Anotácia: 1. Naším cieľom je podporiť dôležitosť kultúrneho kontextu pre výskum kognície predchádzajúcimi experimentmi.
2. Predstavíme teóriu kultúrneho konsenzu ako metódu kultúrnej antropológie.
3. Následne porovnáme model kultúrneho konsenzu ako antropologickú metódu a kognitívno-diagnostický model ako psychologickú metódu pri testovaní dát ohľadom informovanosti o vlkoch.

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DECLARATION

I hereby certify that this diploma thesis is entirely the result of my own work guided by my supervisor and I have faithfully and properly cited all sources used in the thesis.

Date: Signature:

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I would like to express gratitude to my supervisor doc. Mgr. Martin Kanovsky, PhD. for his useful comments, remarks, and engagement throughout the process of composition of this master thesis. His excellent methodological guidance helped me to understand anthropological design on higher level.

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Abstract

V tejto práci sme sa pokúsili priniesť antropológiu a jej metódy do povedomia kognitívnej vedy. Začali sme s prehľadom možných vplyvov kultúry a prostredia na kognitívne procesy, napr. jazyky, ktoré identifikujú pohlavie osôb urýchľujú spoznanie vlastného pohlavia u detí. Bližšie sme vysvetlili koncepty kognitívnej a kultúrnej niky, kultúrnych modelov a sociálne distribuovanej kognície, aby sme ozrejmili zdieľanú kogníciu. Špeciálne sme sa venovali ľudovej biológii ako intuitívnej metóde získavania informácii o prírode and mýtom ako nesprávnym ale efektívnym transportérom vedomostí. Pokračovali sme diskusiou o pozícii antropológie medzi disciplínami kognitívenej vedy a predstavili metódu, ktorá by mohla byť významným prvkom v bližšej spolupráci týchto disciplín - Teória kultúrneho konsenzu (CCT - Cultural consensus theory), ktorá získava konzistentné kultúrne pravdy o istej téme v skupine ľudí. CCT sa používa v etnografických štúdiách, štúdiách názorov a vedomostí, napr. čo si Američania myslia, že je najčastejšia príčina smrti v USA.

Naším cieľom bolo taktiež podnietiť kooperáciu medzi antropologickým a psychologickým výskumom tým, že sme prakticky aplikovali dve ich metódy. Získali sme názory na vlky od 120 poľovníkov, pastierov a ochranárov. Potom sme aplikovali CCT model, ktorý rozdelil participantov na skupiny podľa ich zdieľaných vedomostí a presvedčení. Následne sme aplikovali Kognitívno diagnostický model (CDM - Cognitive diagnosis model), ktorý rozdelil respondentov podľa ich pravdivých a nepravdivých vedomostí, ktoré zdieľali. CDM sa primárne používa na zistenie úrovne zručností u žiakov. Zistili sme, že skupiny, ktoré odhalila analýza sa prekrývajú, a teda jedna skupina konzistentne verí pravdivým informáciám a druhá skupina konzistentne verí nepravdivým informáciám. Taktiež sme sa zaujímali, či zdieľané konsenzy korelujú s profesiami, keďže každá skupina sa na problematiku pozerá z inej perspektívy, avšak táto hypotéza nebola potvrdená.

Kľúčové slová: kultúra, kultúrna antropológia, kognitívna veda, teória kultúrneho konsenzu, kognitívno-diagnostický model, zdieľané vedomosti, ľudová biológia, mýtus

Abstract

In this work we attempted to bring anthropology and its methods back to the spotlight of cognitive science. We begin with an overview of possible influences which cultural and environmental factors could have on cognitive processes; e.g., gender-sensitive language accelerates gender identification in children. We explain concepts of the cognitive and cultural niches, cultural models, and socially distributed cognition in more detail to illuminate shared cognition. We pay particular attention to folkbiology as the intuitive method for gaining information about nature and myths as being incorrect but effective transmitters of information. We continue by discussing the position of anthropology among the disciplines of cognitive science and introduce the method which could represent an important link for closer cooperation between these disciplines - Cultural consensus theory (CCT), which obtains cultural truths about given topics from a group of people. CCT is used for ethnographic studies and studies of opinions or knowledge, e.g., what do Americans think are the most frequent causes of death in the US.

Our aim was also to encourage cooperation between anthropological and psychological research by practical application of two methods. We have interviewed 120 hunters, shepherds, and animal activists about their beliefs about wolves. Then, we applied CCT model on data to divide the participants into groups, according to their shared knowledge and beliefs. Subsequently, we applied Cognitive diagnosis model (CDM) which divided the respondents according to the true or false knowledge they shared. CDM is primarily used for diagnostic feedback on proficiency levels in learners. We have investigated that the groups identified in analysis overlapped, which means that one group consistently believes in truth, while the other group consistently believes in false information. Further, we speculated that shared cultural agreements derived from the CCT assessment will correlate with groups of hunters, shepherds, and animal activists, due to their different perspectives, however, this hypothesis has proved to be unfounded.

Keywords: culture, cultural anthropology, cognitive science, cultural consensus theory, cognitive diagnostic assessment, shared knowledge, folk biology, myth

Foreword

In the first year of my studies I have learned that anthropology belongs to the six core disciplines of cognitive science. However, as I found out later, in academic circles there seems to be a silent agreement that anthropology belongs to the periphery of interest in cognitive science, rather than to its centre. Inspiration for the topic of my diploma thesis came to me during the semester abroad that I have spent in Ljubljana. I devoted my time there to exploration of connections between anthropology and cognitive science. During these months I was also able to do several interviews with a community of women living near Ljubljana, whose perception of nature I found fascinating and worthy of deeper inquiry. As I grew more acquainted with anthropological methods, I came to believe that this much-neglected academic discipline – if approached from the right angle – can turn into a surprisingly valuable fount of information and reveal new grounds of comparison.

Great number of my extracurricular activities and interests consist of environmental and educational projects – therefore it was not unexpected that after reading a book about Slovak wild animals I became fascinated by wolves. As I was thinking more about the status they have in Slovak culture, I arrived to the conclusion that investigating this topic from scientific perspective would have a high potential of generating interesting results. Wolves-related phrases appear in Slovak language with astonishing frequency: it is said *to be hungry like a wolf / to be hungry so much that one can eat a wolf* (to be very hungry), *to be a wolf-mother* (to be a bad, not caring mother - which is actually contradictory, because there are several cases of feral children raised by wolves, e.g., latests case of "werewolf-boy" was found in Russia ("'Werewolf-boy' - who snarls," 2007)), *to be a lone wolf* (to work and live alone, without friends), *to talk about wolf when it is already behind the stables* (to be speaking about someone who is about to come). Slovakia is also well-known for its chalets and shepherding, which naturally involves dealing with wolves as potential threat for the herd. At some point in history, Slovaks also brought into existence their very own breed of a sheepdog as a natural defender of the flock against the canine predator. Even though worldwide research strongly indicates that wolves normally do not pose a threat to humans, public attitude towards them remains rather negative. In this work, I will focus on several elementary worlf-related beliefs among people who come in contact with them; e.g., hunters, shepherds and animal activists. I hope it might raise the general

public's awareness of Slovak wildlife and thus contribute to changing the unjustifiably negative opinion.

Contents

1 Introduction

In this work we want to argue that anthropology needs to be given a more prominent role in research of cognition as a whole. We aim to propose that the impact of respective cultural settings on cognition must be taken into account and we want to encourage scientists to do more research on cultural topics as well as to use anthropological methods in their research.

In the first part of the thesis we will discuss culture and the significance of its impact on human race. We will start with the evolutional advantage of social learning, which grants us the top position in animal kingdom. Afterwards, we explain several cognitive phenomena which are present in culture and shape our perception and reaction to the external world. Later, we will discuss anthropology as the principal synthesist field concerned with culture and its standing within cognitive science. Finally, we will present an anthropological method - Cultural consensus theory, which looks for shared patterns in a given group of individuals.

In the methodological part we will describe methods and evaluations utilized in this work. Our inquiry into the problematic of popular perception of wolves will provide us with a valuable opportunity to give a demonstration of a cooperation between an anthropological method - Cultural consensus model and a psychological method - and the Cognitive diagnostic model. Ultimately, we will also test our hypothesis of consensus in the context of our group.

In the last two chapters we will reveal our findings and back up our interpretations with similar scientific experiments.

2 Theoretical background

In this chapter we will review several dozens of articles and books about cognition and culture. Firstly, we will explain how human race reached its current position in animal kingdom with utilization of artefacts and narratives. Secondly, we will write about the distribution of knowledge, how it is disseminated and used, and why a group of people is right more often than a single individual. We will pay attention to the phenomenon of myth which contradicts our expectation of pursuit of truth. Later, we will discuss the position of anthropology within cognitive sciences and highlight the importance of content in study of cognitive processes. Especially, for purpose of our topic we will include a section about folkbiology. In the end of the chapter, we will introduce Cultural consensus theory and Cognitive diagnosis assessment.

2.1 Cognitive and cultural niche

"One general law, leading to the advancement of all organic beings, namely, multiply, vary, let the strongest live and the weakest die."

(Darwin, 1909, Chapter VIII)

The human race occupies more habitats than any other species. We owe this success to our cognitive ability to adapt in many diverse environments, while power of our relatively big brains helped us to figure out a unique survival strategy through times (Boyd, Richerson & Henrich, 2011).

Alfred Russel Wallace, co-discoverer of *natural selection*, suggested that human intelligence cannot be interpreted by theory of evolution, as proposed by Charles Darwin, because our ancestors had no use in abstract intelligence. He claims that intelligence is an adaptation to a particular lifestyle, the **cognitive niche**. The cognitive niche is explained by Pinker (2010) as "the ability to overcome the evolutionary fixed defenses of plants and animals by applications of reasoning, including weapons, traps, coordinated driving of game, and detoxification of plants" (p. 8993). Original theory proposed by Tooby and DeVore, as cited in Pinker (2010), states that "organisms evolve at one another's expenses" (p. 8993). It means that plants and animals change to defeat their predators, the stronger link in chain of evolution, hence they develop speed, poisons, manoeuvres… The predators have to adapt as well in order to survive and as a results they also advance weapons to

penetrate the new defences. In short, the predators and preys coevolve through generations in race of more powerful ability for survival. Author thinks that human race evolved to fit this system and to manipulate environment with reasoning and social abilities. The humans have an advantage of operation with mental models (more information on mental models to be found in 2.2.1) which allowed us to invent tools. In brief, it means we can create our defences in real time, while other living creatures need many generations to evolve on biological level (there are also some other animals which can use tools, e.g., chimpanzees, ravens…).

Homo sapiens posses even more unique or highly developed traits which are outstanding in animal kingdom. Apart from using tools, which require at least folk understanding of physics, geometry, biology and psychology, we excel in **cooperation**. A series of cognitive adaptations such a recognition, episodic memory, classification or moral emotions contributed to development of a complex social life. In spite of the fact that a computing power of human brain is tremendous, one cannot learn all information about the environment all by himself. The most important thing for acquiring more knowledge is to learn how to communicate facts further, for instance with speech. Grammatical language is a tool for transmission of knowledge and due to possibility of creating unlimited amount of novel messages, it is a universal tool for communicating any kind information. It multiplies benefits from sharing knowledge by each transfer while causing no losses. This usually occurs within one culture. For example, there is a man accidentally landing on an abandoned island where he finds a much needed herb, which can help to grow any body part back. If he dies without telling someone, this new fact about the environment dies with him and his tribe will not prosper from his discovery. On the other hand, if he manages to communicate it to his clan, the next generation does not have to figure it out on its own but starts at the latest success of the previous generation.

Therefore, the ability to learn from others plays a key role in human adaptation in various environments since the system of information is passing from one generation to another using various ways of communication. This can be called the **cultural niche** - the lifestyle of the humans overpowering other animals with shared knowledge (Boyd et al., 2011).

2.1.1 Characteristics of learning from others

Learning from others is basically an *imitation* of behaviour of another person who learned a certain behaviour from the environment or other person. Mere imitation is less costly than learning, but it results in stagnation. To attain more skills as a population, one has to balance between learning and imitating. If it is cheap and efficient to learn some environmental information, one can learn it on his own, on the other hand, if it is costly, one can choose to imitate instead (Boyd et al., 2011).

Also, a **teacher** is a matter of choice, because less experienced teachers provide less accurate information and inversely, the more skilled is the instructor, the better are chances for evolutional success. A relevant study of only 12-month-old infants showed a preference of more skilled informants over caregivers in novel situations (Sternberg, 2009). All this depends on information quality threshold which determines whose sources we choose. If one is less critical to the content and sources of information he comes into contact with, he is prone to believe and act upon an untruth (Boyd et al., 2011).

There are certain limitations in imitating others. If one has no understanding for the casual connections in particular topic, it can result in copying attributes of behaviour, even if they are aim-irrelevant. This phenomenon in children is called **overimitation**. It appears to be universal human trait and there is no evidence of this behaviour in animals so far. Study of Horner and Whiten (2005) with wild-borne chimpanzees and 3- to 4-year-old children revealed important differences between results of both groups. Chimpanzees and children were showed a situation with a demonstrator using a tool to retrieve a reward from a box. Some of his actions were relevant and some were not. Chimpanzees were able to successfully ignore irrelevant actions if they saw a reward and effectively retrieved the treat. On the contrary, children repeated all the actions without identifying casualties between them. Authors therefore conclude that "imitation may be such an adaptive human strategy that it is often employed at the expense of efficiency" (p.179). Nielsen and Tomaselli (2010) suggest that children's imitation of adults is not a maladaptation which leads to faulty actions, but rather an essential developmental characteristic for transmission of cultural knowledge. More precisely, the exact way how the things are done in certain culture is more important than what is done.

Imitation and action understanding are grounded in a neurophysiological mechanism called the **mirror-neurone** mechanism. "Mirror neurons are a particular class of

visuomotor neurons, originally discovered in area F5 of the monkey premotor cortex, that discharge both when the monkey does a particular action and when it observes another individual (monkey or human) doing a similar action" (Di Pellegrino; Gallese; Rizzolatti, as cited in Rizzolatti & Craighero, 2004, p. 169). Therefore, every time an individual observe an action, the neurones in premotor cortex are activated. They correspond with neural activity spontaneously induced during active action which outcome is known to the observer. Rizzolatti (as cited in Rizzolatti & Craighero, 2004) claims that this is a transformation of visual information into knowledge and also a mediator for understanding actions of other individuals. In a study of guitar chords imitation data, fMRI indicated that while learning new patterns by imitation the new actions might be decompressed to basic motor acts that activate, with help of mirror mechanism, the corresponding motor representations in prefrontal cortex and ventral premotor cortex. The generalisation is however determined by congruence of visual and motor properties of the action. About one-third of mirror neurones in F5 is *strictly congruent* and corresponds in terms of goal of the action (e.g., to grab something), while *broadly congruent* mirror neurones form the rest of the area and do not require observation of strictly the same action. Different studies showed some other features of mirror neurones: it make no difference in intensity of the response if the action is made by human or a monkey; if the object is significant (e.g., food) or not; or if the action is done far or near (Rizzolatti & Craighero, 2004).

2.1.2 Cognitive artefacts

Tools of our ancestors upgraded and multiplied with each generation and nowadays, our everyday activity includes immense amount of artificial devices which if applied enhance our life. Norman (1991) specifies that if these tools operate with information and affect our cognitive processes, they are called *cognitive artefacts* and play an important role in understanding of overall information processing.

At beginning of experiments in cognitive psychology, the emphasis was placed on research of cognitive abilities in individuals measured in laboratories, while impact of situation and social interaction was suppressed. A rebirth occurred only lately within a deeper interest in computer interfaces. Subsequently, a role of artefacts as amplifiers of cognition was reconsidered, since it was discovered they do not change the cognitive ability, rather the nature of the task (Cole, as cited in Norman, 1991). For instance,

checklists help us to not to forget some actions so we do not have to remember them, but it still requires our cognition. Firstly, we need to create the list, then not to forget to consult it and finally also read it and interpret it. Accordingly, we can look at the artefacts from view of observer (system) and personal view of actor. “From the system view, the artefact appears to expand some functional capacity of the task performer. From the personal view, the artefact has replaced the original task with a different task, one that may have radically different cognitive requirements and use radically different cognitive capacities than the original task" (p. 22).

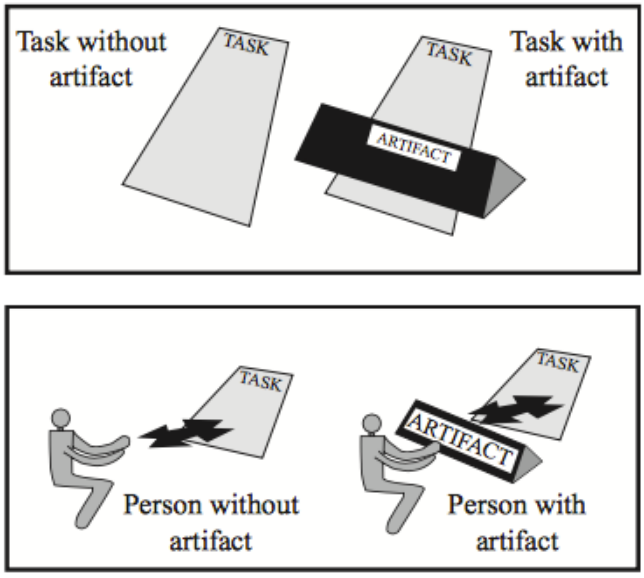

Figure 1. System and Personal point of view on task solve with artefact (Cole, 2003).

Moreover, the construction of checklist prior to the action also impacts the performance because it distributes cognitive effort across time (*precomputation*) and people (*distributed cognition*).

The artefacts are mediators between humans and environment in both ways - we interact with the world and it alters; the world changes and we interpret it (Norman, 1991). Creating and utilisation of artefacts require a cognitive ability of combining conceptual and material structures, where distinctive phenomena are unified to one single view. For example, a queue of people waiting for something is considered as a queue because their bodies in space show certain order which arises a concept of a directed line (trajector). This process is called *conceptual blending* and is also a part of making new cultural models wewill write about in section 2.2.1 (Hutchins, 2005).

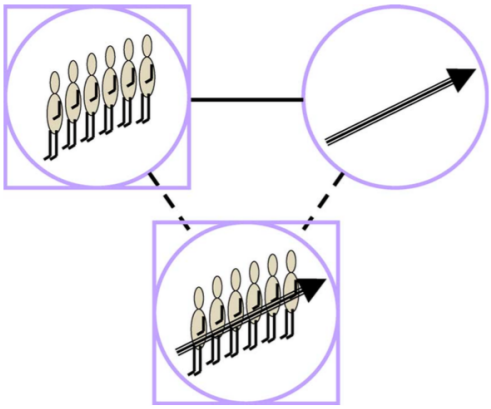

Figure 2. Conceptual blending of trajectory with a line of waiting people (Hutchins, 2005).

It is worth mentioning that cognition is significantly dependant on body in which it operates. The **embodied cognition theory** implies that cognitive abilities spring from interactions of body and environment consisting of artefacts. It was supported by various psychologists claiming in their theories that thoughts cannot be imageless and that cognitive processes are rooted in sensorimotor abilities in child development. Wilson (2002) later supports her statements with a review of the most prominent claims about embodied cognition:

1. *Cognition is situated* - in the real context
2. *Cognition is time pressured* - cognition functions in real time
3. *We off-load cognitive work onto the environment* - we use environment to reduce the operational workload
4. *The environment is part of the cognitive system* - the information flow of mind and its surroundings is too tightly packed to be studied separately.
5. *Cognition is for action* - mind guides the actions of cognitive mechanisms.
6. *Off-line cognition is body based* - activity of the brain stays even if decoupled from environment (p. 626).

These statements are especially important as a support for studying cognition in relationship to a physical body in context and possible implications reach as far as robotics.

To show a practical application of artefacts in contemporary context, we will mention one recent study of cognitive artefacts and their utilisation for effective organization of complex systems, such a hospital. Nemeth (2003) explored a usage of sheets, schedules

and boards in order to operate several departments requesting limited amount of facilities to meliorate highly organised system of acute healthcare. With shared knowledge about situation and willingness to cooperate, the hospital successfully implemented new approach.

2.1.2.1 Cognitive narratology

According to Vygotsky (1978), children at age 4-5 start to master their environment with their practical skills which are accompanied by speech. Firstly, they verbalise their plan and then they act upon it. Author claims that it is a result of forming practical and abstract intelligence. The speech and action are highly connected and the more difficult becomes the action, the more accent is put on speech too. Moreover, in some cases, children were not able to solve the problem if they were not allowed to talk. This is a strong implication towards considering **speech** as a psychological tool, a cognitive artefact.

In addition, story-telling or narration has something to tell to artificial intelligence too. According to Richardson (1998), story as a narrative imagining is a principal instrument for thinking, especially in planning a future, recalling the past or explaining. Hobbs (1990) speculates if imagining, narration and literature have a possible function for programmed cognitive agent embedded in real world. He explains as imagining a certain scenario helps to differentiate, what is to be expected and what is not, similarly to a fiction. When first page introduces a reader to a fantasy world where flying people are not that unusual, the reader is set up to perceive it as normal, expected feature (on the other hand, the flying people are much more disturbing in romantic novels). Narrative is a structured order of events with characters planning and acting on them and so is the cognitive agent.

To summarise, we differ from animals in our ability to operate with mental models and use tools and artefacts, which help us to alter and understand our environment. We have the capacity to create the most effective mental representations for successful function in the environment. Moreover, we share those information to our kind to enable progress for future generations of our culture.

2.2 Culture

"Culture is complex knowledge. It is a set of certain knowledge generally accepted and shared."

(Goodenough, as cited in Trajtelova, 2013, p. 167).

The meaning of term culture is rather inconsistent. In sciences it refers to characteristics of lifestyles in society like habits, preferences in food, architecture, ect. In the western world it is used to describe a person as more or less civilised which comes from german *kulture*. Other meanings are traditional, not modern or unique (Doda, 2005).

One of the most frequent definition comes from Edward B. Tylor, as cited in Doda (2005), who defined culture as "that complex whole which includes knowledge, belief, art, law, morals, customs, and any other capabilities and habits acquired by man as a member of society" (p.84). It means that beliefs and habits of humans are not a result of biology but acquired through life in social group while being exposed to particular cultural tradition. This process in anthropology is called *enculturation* or *acculturation* (acculturation nowadays refer rather to a change due to a foreign culture).

The main characteristics of culture are according to Kottak; Howard & Dunaif-Hattis; Clifton; Scupin & DeCorse, as cited in Doda (2005) these:

- **Culture is all-encompassing** - culture sums up all creations human made, physical or abstract.
- **Culture is general and specific** - all humans live in a culture but as they are diverse so are their cultures.
- **Culture is socially learned** - through forms of socialisation like observation, reward, punishment…
- **Culture is symbolic** - people use words, gestures, sounds, images…, which only represent something else.
- **Culture seizes nature** - culture suppresses biological need in order to follow shared rules.
- **Culture is shared** - some behaviour or thinking is shared among nearly all members of culture as a part of shared experience.
- **Culture is patterned** - each cultural features are interrelated.
- **People use culture creatively** - humans do not always follow all the rules of particular culture.

- **Culture is adaptive and maladaptive** - culture helps people to adapt better in environment but also endanger the members with cultural achievements.
- **Culture is stable and yet it changes** - people hand on the knowledge to other generations but if culture meets another culture it alters.

When it comes to an encounter of two different cultures, there are two possible scenarios: they either denounce and misjudge each other or take for closer inspection in order to truly understand it as a whole. The first scheme is named as *ethnocentrism* and author explains it as "an attitude of taking one's own culture and ways of life as the best and the centre of all and on the other hand, regarding other ethnic groups and cultures as inferior, bad, full of errors, etc. It is the tendency to apply one's own cultural values in judging the behaviour and beliefs of people raised in other cultures" (p. 93-94). This phenomenon is universal within all cultures. The second type of reaction to other culture is called *cultural relativism.* The basic premise behind is that we cannot truly understand the other people if we interpret their behaviour in the light of our own values or beliefs. To comprehend other individuals we need to look at the wider context which surrounds them. Cultural relativism therefore rather respects and appreciates other cultures and their diversity. Anthropologists have to posses this quality, however, they are not supposed approve habits like cannibalism or torture in order to respect also international standards of morality (Doda, 2005).

The ethnocentrism and the cultural relativism are closely connected to our mental representation of the world inside our mind.

2.2.1 Mental models and cultural models

"Nervous systems do not form representations of the world, they can only form representations of interactions with the world."

(Hutchins, 2012, lecture slide)

"**Mental models** are conceived of as a cognitive structure that forms the basis of reasoning, decision making, and, with the limitations also observed in the attitudes literature, behavior." (Jones et al., 2011, page unknown). They are internal representations of external reality which are not available for direct inspection, but strongly influence a structure of contents regarding environment. In other words, a mental models provide a

map for a person, which includes concepts, relations, symbols or descriptions (Hodge, 2006).

Mental models are as unique as every individual, each person therefore creates models with certain limitations according to his or her personal traits. Personal life experiences and understandings of the world are main constructing material which control how we filter new information (Jones et al., 2011). They works like simulation of the world in the mind of he individual (Hodge, 2006). For example, we have a mental model of car functioning which is rather simple or even incorrect since we are not engineers or car mechanics, but it works in our mental world and we operate with it as if it was truth.

Moreover, ability to manipulate thoughts in mind gives us an another evolutionary advantage, when we can learn from our simulations in the mind. It allows us to simulate environment in order to predict an outcome and avoid possible costs (Currie; Dennett, as cited in Hodge, 2006).

According to Levi-Strauss (as cited in Hodge, 2006) there are two types of models: *conscious* and *unconscious*. Conscious models are perceived as norms and transmit social beliefs and norms and unconscious models are manifestations of deeper structures of mind, which if revealed, display possible contrast of ideal image of culture and actual functioning. Caws (as cited in Hodge, 2006) proposed three different types of models:

- *Operational model* - controls individuals interaction in society.
- *Representational model* - describes how subject thinks about state of objects in his environment
- *Explanatory model* - explains the scientific view.

These two divisions confirm that the mental models play an important role in social transmission of knowledge and also rules our perception of our surroundings.

Mental models are not context-universal, rather dynamical and actively responding to changing situation. When people share their experiences, at least to some extent, it results in sharing models as well. “Over time, as a given group of people internalize their shared experiences, cultural meaning is created, which individuals use to perceive and relate to the world around them” (page not stated). It can be called *information pool* carried in minds of individuals within group which links strongly connected elements kept in memory (Jonas et al., 2011). Roy D’Andrade (as cited in Nisbett & Norenzayan, 2002) named these patterns of schemas existing in a system of group which guides many life domains as

cultural model. Correspondingly, *script* is a type of cultural model, which specifies social roles and sequences of behaviours provides a community with less difficult way of everyday life.

Finally, as mentioned above, an important role in creating new cultural models is the conceptual blending were knowledge is adapted to experience. Therefore, we alter our understanding according to experience we have with certain objects and in certain situations.

2.2.2 Myths

"All human cultures, past and present, have myths."

(Hodge, 2006, p.4)

From evolutionary perspective, it looks like our principal goal as humans is survival for which we need to track things in the world around us. Philosophers might argue that our main function in the world is to find the truth, but nature seems to be more interested in what works. Medieval times made us to believe that the Earth is a centre of universe but we still managed to function successfully. Believing in myth has actually benefits like group identity, psychological comfort or cohesion (Hodge, 2006).

Before Levi-Strauss introduced structuralism as a dominant field in anthropology, myth was taken as an abnormality in human thought. He opposed that myths are products of mind not only culture or supernatural reality. According to author, they are governed by the same cognitive function as the other processes and work at the unconscious level. "… a myth is a group of cluster concepts that form a submodel. A submodel is an analogical model that freely interacts with other submodels, thus forming a holistic mental model, or worldview. This worldview is an entire system of submodels of an individual that in turn is shared in large part, reciprocally, with other members of his culture, and thus becomes a mythology" (Hodge, 2006, p. 81).

A goal of cognition also to help us to process sensory information in a way that is best for our survival. Shepard (as cited in Hodge, 2006) claims that our perceptual and representational system was evolutionary build to function in our world, which also confirms the statement of **human-body metaphor** we wrote about in section about cognitive artefacts. For example, we spatially orientate using our body as the axes or get the meaning of the situation from available actions of the body towards object (chair is for

sitting). This analogy gives us opportunity to understand one thing in terms of another one. It is especially important in comprehension of new objects and prediction. Analogical reasoning leads to *anthropomorphism*, which suggests that we treat objects and events as having human characteristics or happen for a reason.

Culture use these cognitive processes to transmit cultural models from generation to generation by social learning and imitation. It starts in child's play where a child imitates those who are considered to be experts in order to create and store mental models. Levi-Strauss and Geertz, as cited in Hodge (2006), implied that "myth and ritual are especially well-suited for the transmission of culturally relevant information and interests because of the shared cognitive mechanisms that they exploit" (p. 119). Boyer (as cited in Hodge, 2006) proposed, that spreading myth is an efficient way to distribute culturally relevant knowledge to a group.

Moreover, it uses a cognitive economy since there are small processing costs for rich inferences. Author suggests that mythical content often violates our expectations by attributing certain feature to object that are not supposed to have them. Hodge also demonstrated it with an example of two sentences:

1. *John owns an orange Volvo.*
2. *I have a tree in my backyard that hears and answers prayers.* (p. 142)

Second proposition was more likely to remember because it violated our expectation about trees. The ability to grab human's attention makes similar statements more likely to be transmitted to other members of group. Moreover, if we claim that a tree can hear and answer the prayers, we move characteristics of human race to another category, trees (anthropomorphism). By this action we increased the inferences of tree which will be used in future.

Boyd believed that we project our mind on environment, when we perceive objects in it as intentional. Biological basis comes from *hyper-active agency detection device* which evolutionary helps our survival. For instance, if we walk in forest and hear bushes rustle we expect that it is a predator, not a wind (as cited in Hodge, 2006). To act according to this superstitious behaviour pattern is economically efficient, because it prepare us to fight or flight. Norman (1983) implies that mental models include also information about certainty people feel about their knowledge. Thus, a person can consider some rule or behaviour as pointless or illogical, yet it seems to work so the action (ritual) is performed.

In conclusion, we can say that myths are pragmatic - both because they are efficient for everyday life and because they are able to rule the society.

2.2.3 Socially distributed cognition

Distributed cognition is a framework for approaching cognition. It differs from the traditional view of cognition, where cognition is about information processing of an individual, when Edwin Hutchins (2000), the author, implies it is more of distributed phenomenon. The theory was established in mid-1980s starting with ideas from two books with almost mirror-symmetrical titles, Mind in Society by Vygotsky and Society of Mind by Minsky. The author of theory reveals three kinds of distribution of cognitive process:

1. across the members of a group.
2. in a coordination between internal and external systems and
3. through time.

Sperber (as cited in Hutchins, 2000) proposed the idea of *an epidemiology of representations,* also called *ecology of belief*. He presented "an analogy in which anthropology is to psychology as epidemiology is to pathology. In the same way that epidemiology addresses the distribution of pathogens in a population, anthropology should treat questions about the distribution of representations in a community" (Hutchins, 2000, p. 3). Shortly, the analogy explains that some ideas are easier to think and communicate, in analogical words - they are more contagious, and therefore easier to spread. This ability to spread is determined by human minds and also prior ecological conditions in the group (Nisbett & Norenzayan, 2002).

The **traditional research** in cognitive science presumes that information processing takes place inside of the individual's brain. The basic framework therefore consists of three-stage cognition model: *perception - cognition - action*. All informations about environment are stored as abstract symbols in memory and cognitive science researches how they are stored and processed. This approach is also called 'reductionist' because it pushes the impact of environment to the back and reasons that "after we have a better understanding of the individual cognizer, we will be able to understand how cognition interacts with the complexity of the environment" (Simon, as cited in Liu, Nersessian & Stasko, 2008, p.1173). One of the famous experiments of this perspective is *the magical*

number seven of Miller which tells us about limitation of our working memory to store 7 ± 2objects (as cited in Liu et al., 2008).

Opposite to this, the **distributed cognition** gives a reason for role of environment as an important aspect in forming cognition. Nersessian claims that cognition is embodied and enculturated in human-artefact interaction, which shifts the approach considering cognitive and cultural processes as autonomic variables to the approach where they are integral to one another (as cited in Liu et al., 2008). It is inevitable that environment provides both benefits and constraints to cognition and behaviour in order to modify it. Hutchins explains tools as instruments helping us to transform difficult tasks into the ones we can resolve by other types of mental manipulations. Therefore, as I mentioned in subchapter about Cognitive artefacts, we achieve something advanced with a tool, but our cognitive skills are not amplified.

Hutchins states that "it is important to make a fundamental distinction between the cognitive properties of systems composed of individuals manipulating tools and the cognitive properties of individual minds*"* (as cited in Liu et al., 2008, p. 1174). The Traditional cognitive science theory and Distributed cognition theory are still developing and we cannot tell which is more correct yet, only that both approaches are needed for complete understanding of cognition, at least now.

2.2.4 Crowd versus Individual

In 1907 when Vox Populi ("Voice of the people') was an important topic, Sir Francis Galton conducted a breakthrough study about estimating weight of an ox in 787 villagers. Even though none of them guessed the exact weight their averaged estimations differed only in 0,8% from real weight of the ox. At those times it gave an important credit to democracy and also a starting point for more scientific approaches in so called **wisdom of the crowd** (Galton, 1907). The fundamental idea lies in an aggregation of opinions (e.g., with averaging) of group members which eliminates extreme errors. However, the group has to be diverse and have some knowledge about topic or relevant experience. Hueffer et al. (2013) suggest that fulfilling these conditions does not guarantee that this method is a good predictor for certain purpose and it will not be less accurate than prediction by expert.

Another type of human interaction involving cognitive ability is a **collective intelligence**. Levy and Woolley (as cited in Salminen, 2012) described it as a universal,

distributed intelligence, which comes from the cooperation and competition of many individuals as a general ability to accomplish a variety of tasks in a group. The closest non-human behaviour of this kind can be found in swarms of social insects where they use collective intelligence for their highly organised behaviour. Technological equivalent is Wikipedia, where millions of users build the largest encyclopaedia all together and Google which takes judgements of many people to create links between pages and provide very intelligent answers to questions written in search bars. This term is sometimes interchanged with group intelligence which is mainly subject of study for social psychology.

Social tagging mechanism is a novel collaborative technique which helps to explore new information through key words. “Users tag objects with concepts, creating ternary associations between the user, the concept and the object” (Mika, 2007, p. 6). The most significant difference from normal searching through search engines (e.g., Google) is that social tags work as social cues left by other people to guide them through a new topic. In other words, they work like a navigation in a system of information which facilitates understanding. The studies however showed that this works better for exploratory search, while traditional search is more effective for people looking for information in their domain of expertise (Kang et al., 2010).

To summarise, we presented culture as a group of people sharing the same knowledge and values. They operate in the world by manipulating their mental models and participate in a group by handling their cultural models. These shared representations of the world play key role in successful survival, because they distribute knowledge among other group members.

2.3 Cognitive anthropology

“Every anthropos is at the same time an anthropologist.“

(Landmann, as cited in Trajtelova, 2013, p. 10)

Anthropology evolved as a discipline aiming to discover what human was in past and what is now. A connection between changing environment through the time and changing human race is indisputable. This relationship goes both ways - homo sapiens as a product and a producer of the culture at the same time. As a result, we can say that people think, solve problems, organise thoughts or use knowledge differently according to their

environment or society. Here emerges a connection between cognitive aspects of humans and culture which has to be taken as a part of anthropology, more precisely cognitive anthropology. Initially, in 1950s, it came out as a compound of linguistic and sociocultural anthropology and as a promising link between humanistic and scientific world. “The goal of cognitive anthropology is in explaining signs, structures and nature of socially acquired knowledge; and in interpreting particular cultural forms” (Trajtelova, 2013, p.11).

Typical methods of anthropology are field research, interview, interpretation and participant observation. The most problematic approach is the interpretation of acquired data, because there are usually no scientifically valid measurements which could be applied in many different cultures. As an example, Barrett (1996) mentioned two different ethnographic studies of a Mexican village which resulted in two very unalike interpretations of the situation in the village. A respected anthropologist, Robert Redfield, conducted a fieldwork study in Tepoztlan, Mexico and described it as a village with a happy community life that everybody enjoys. Another anthropologist with good reputation, Oscar Lewis, came to the same village 17 years later and found out that community is actually malfunctioning, people quarrel a lot and commit crimes. This studies are together called *Redfield-Lewis controversy*, because the difference between their results could not be caused by 17 years long gap, rather the perspectives which researchers used in fieldwork - Redfield was looking for pleasing factors, while Lewis for displeasing. Another case is described by Murphy, as cited in Trajtelova (2013), who presents his own experience as an example: “Now we all understand that an observer is part of what he is observing; my wife and me were not studying a group of Indians but a group of Indians surrounding two American anthropologists. And we were looking at them with eyes which were influenced by their meanings and ways of perception; they became part of our subjectivity” (p.224). After this and other disagreements in findings, the credibility of ethnographic studies was lowered. Anthropology, however, reacted with developing a methodology we are going to mention later to prevent such failures.

2.3.1 Cognitive anthropology within cognitive science

"Psychology would study how people think and cognitive anthropology would study what people think."

(D'Andrade, as cited in Bender, 2010, p. 375)

The quote above was stated as a suggestion of satisfactory division of work for psychology and cognitive anthropology at the beginning of Cognitive Science Society. Cognitive science's main subject for exploration is cognition and its processes. In order to have a complete picture about it from all perspectives it was necessary to interconnect different disciplines - philosophy, linguistics, anthropology, neuroscience, artificial intelligence and psychology. Anthropology presented impact of culture and environment on cognitive processes, but it concerned mostly shared knowledge (Cole, 2003).

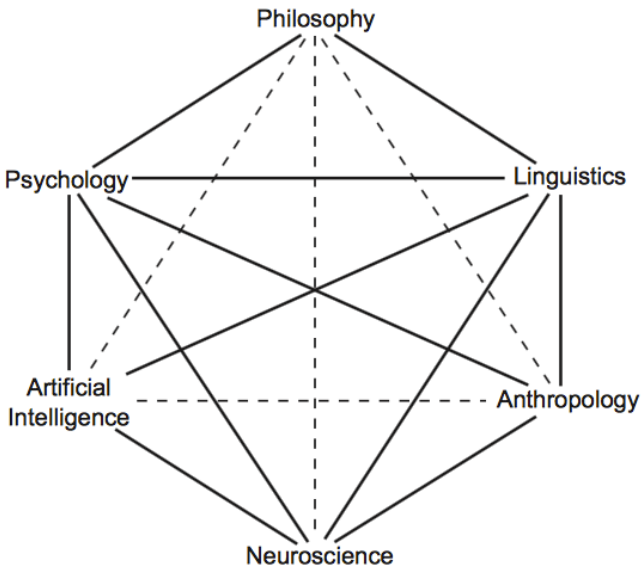

Figure 3. Gardner's hexagon of interconnectedness of Cognitive science disciplines. Broken lines show weak connection and unbroken lines show strong connections between each of them (Cole, 2003)

Cognitive Anthropology appeared to be a perfect complement to variety of perspectives on cognition at the beginning, but shortly after it turned out to be almost incompatible. Bender et al. (2010) sharply distinguishes a contrast where psychology mostly tests university undergraduates in laboratory conditions and anthropology seeks for real-world relevance. Principal presupposition of cognitive science is that "cognitive processes (which are assumed to be invariant across individuals and cultures) can be

separated from the content processed (which is assumed to be variable). This assumption, however, is increasingly contradicted by cross-cultural findings, which reveal that content and process may interact in complex ways*"* (Beller, Bender & Medin, 2012). Therefore, the generalisations must be demonstrated especially on cross-cultural comparisons, not only on college students in western world. The results of cognitive psychology might be or might be not correct at large sample but they need to be tested if they fit the rest of humanity.

On the other hand, psychology can criticise anthropology for a lack of proof for presented claims and prevalence of qualitative data which sounds more like fairytales to postmodernists (Bender et al., 2010). Anthropological data are often unidentified which makes it more difficult to replicate or even verify. Sometimes, the only thing we can say about them is that there was certain phenomenon presented in the particular group 10 years ago. Anthropology provides a cultural version of mental models, but it is disputable if they are mental models of ideal informant or it is a distributed knowledge, which cannot be reduced to one mind. Therefore, to make claims about individuals, it is necessary to include also individuals as a unit to analysis (Medin & Atran, 1999).

Cognitive anthropology is also less represented on annual meetings and in textbooks because its research is held back by methods. It requires transport to often peripheral part of the world, time for settling down, learning new language, gaining trust, interpretation of data, ect. All these constraints play against a potential improvement in position of anthropology in cognitive science because it cannot compete with amount of findings in psychology.

A role of anthropology in past years was rather taken as an opposing element which held other sciences back. The exploration of cultural differences can be truly taken as a step back from a pursuit of mostly universal processes, patterns, behaviours…, until the rest of cognitive sciences do not accept it as a sort of complementary agenda. "Considering culture is not just a nice thing—it is essential for the future health of cognitive science in general and cognitive psychology in particular" (reviewer, as cited in Bender, 2010, p. 378). If we retrieve data for various aspects of cognition only from the undergraduates, as I mentioned above, we have to be cautious with drawing too general conclusions.

Still, the author doubts if cognitive processes are universal at all: "If the processor is not universal, why should processes be? If the brain is organized by experience, and

experience is organized by culture, should we then not expect that culture is a formative force in cognitive processes?" (Bender, 2010, p.380). This leads us to a conflicting point of importance of content of examined cognitive processes.

2.3.1.1 Content of cognitive processes

This section shortly introduces several studies implying that content of cognitive actions has an influential impact on results in different disciplines, such as linguistics, psychology, neuroscience or philosophy. Most of the studies compare participants from different environments to underline the importance of real-world data.

Linguistics: In order to work with ideas and meanings, we need to know how to operate with words, to use language. Language is tightly connected with culture and often culture-specific. Lera Boroditsky (2011) mentions several studies conducted on account of how language affects thoughts. Her study of aboriginal community in Australia revealed a very unique ability to tell cardinal directions in every moment and at almost any place due to language. Pormpuraaw, the aboriginal language, has no words for left and right, but use north, south, east and west instead. Different thinking about space is also more likely to be connected to different perception of time. Research team from University of Aberdeen, Scotland, UK pointed out dissimilarities in showing future and past among English speakers and Aymara (language spoken in Andes) speakers. Opposite to English speakers, Aymara speakers according to their language showed future behind them. This is can be connected to perspective of ego - if we consider ourselves as passively facing moving time or actively moving through space (Lleras et al., 2014).

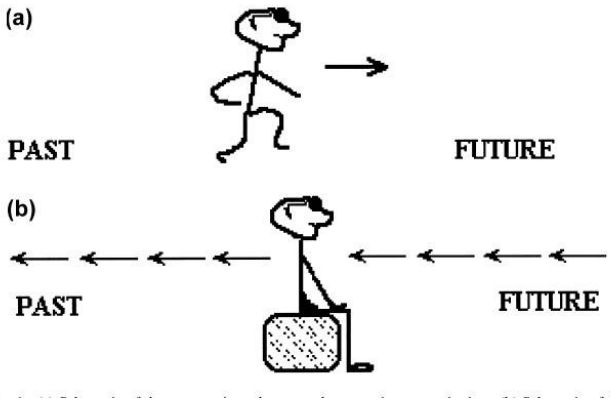

Figure 4. Two types of perception of time according to Boroditsky's study (Boroditsky, 2000).

Furthermore, Boroditsky and her student disclosed how language influences eyewitness memory in English, Spanish and Japanese speakers. Since Spanish and Japanese usually avoid mentioning a culprit in case of accidental events, they are less likely to remember agent of action. Language and its ability to tell the gender of person spoken about has a significant impact on children's ability to figure out what is their own sex. Alexander Guiora, as cited in Boroditsky (2011), researched that children speaking language which differentiates between men and women were able to recognise their own gender about a year earlier than children speaking without these marking signs. In order to measure clearer data, there were many experiments about testing language and its impact on results. Bent-Martinez, as cited in Boroditsky (2011), revealed that cognitive performance does exhibit differences caused by language of test in bicultural bilinguals. This, however, goes both ways and therefore, we can control what people think by changing the way they speak. For instance, teaching people a new name for colour consequently changes their ability to discriminate colours (Boroditsky, 2011).

Psychology: Another typical culture-determining trait is its geographical location. The most famous controversies come from comparison of individualism of the West and collectivism of the East. Studies showed that Asians are less likely to fall for *attribution error* - people tend to overemphasise personality-related factors in other people, but underemphasise it in themselves and rather see it in context. In tests about categorisation, Americans categorise according to the level of matching category (e.g., cow and chicken are both animals) while Asians look for relationship between objects (e.g., cow eats grass). Heejung Kim, as cited in Winnerman (2006), conducted a study with practical implications to mixed culture environments. She tested western way of verbalising thoughts while solving a problem and silent thinking typical for Eastern culture because she, as a foreign student, felt pushed by culture to speak up during classes. Results demonstrated that speaking and not-speaking group solved the problem just as well, but forcing Asian-American students to express themselves orally lowered their performance (Winnerman, 2006).

Neuroscience: "An intrinsic property of the human central nervous system is the lifelong ability for structural and functional brain reorganization" (Pascual-Leone, as cited in May, 2011, p. 475). These structural and functional changes (also called *plasticity*)

adjust an adult brain to changes in external environment. The course of change can be both maladaptive and beneficial and the level of reorganisation is influenced by genetic and personal experience of outer world. Many studies support structural changes in brain after severe lesions, but change could be seen also in longitudinal studies on learning and memory. Maguire et al. (2000) studied brains of London taxi drivers, as humans with extensive navigation experience, and control subjects with MRI. Results revealed that taxi drivers have significantly enlarged posterior hippocampi in comparison to the control group, while the volume positively correlated with the amount of time they spent in this profession. "These data are in accordance with the idea that the posterior hippocampus stores a spatial representation of the environment and can expand regionally to accommodate elaboration of this representation in people with a high dependence on navigational skills" (May, 2011, p. 4398). Lee, Miyasato and Clayton (1998) researched changes in hippocampus in birds while they extensively used their spatial abilities. As a conclusion, they discovered that increased hippocampal volume correlated seasonally with periods of considerably higher usage of this ability.

Philosophy: "Psychologists have demonstrated that the basic presumption that the mind is separate from the world is one of the most definitive achievements of childhood development. By the age of three, more or less—there is a good deal of controversy—toddlers understand that mental states can explain behavior" (p.5). This phenomenon is described in *theory of mind* which used to be considered as a universal psychological construct until anthropology proved differently across cultures. Typical experiment, *False belief task*, shows how experimenter hides a toy in front of child's mother, then mother leaves and experimenter changes the position of the toy. The children watching this scenario are asked where the mother should look for the toy. Younger children point the second place, because they do not distinguish between themselves and other people in terms of inner thoughts, while older ones pick the first, because they know that mother cannot know what experimenter did. At this point children understand that what people think can be different from what actually happened in the real world. Farther, Luhrmann (2011) identifies six different theories of mind across the world:

a. *The Euro-American modern secular theory of mind* - thoughts do not leave the mind to act in the world, however, emotions have power to make person ill.

b. *The Euro-American modern supernaturalist theory of mind* - a boundary of mind and world is permeable for god.

c. *The opacity of mind theory* - typical for South Pacific and Melanesia - they refuse to deduce what one thinks unless he utters it and also, the mind is permeable for spirits.

d. *The transparency of language theory* - typical for Central America - language includes more words for describing outer world and vocabulary for inner processes is near non-existent.

e. *The mind control theory* - typical for Thailand - thoughts can wander in the world and act on other minds.

f. *Perspectivism* - typical for Amazonians - a picture of the world depends on the perspective one takes on it, it is like mind can migrate from body to body (including bodies of animals).

According to these examples, "the anthropological suspicion that the inferred theory of mind is both universal and culturally particular" (Luhrmann, 2011, p.6) seems to be worth of deeper examination.

2.3.2 Categorisation

Categorisation is a principal phenomenon studied in cultural anthropology. It assumes that the main differences between cultures are caused but different approaches to knowing and clustering the world.

"A theory of categorisation is presented in which knowledge of causal relationships between category features is represented in terms of asymmetric and probabilistic causal mechanisms" (Rehder, 2003). Objects belong to categories in extent they show features which are expected according to casual knowledge. This ability helps humans to control their environment and react to external events.

The features of categories vary according to their current weight or importance to categorisation. Research on the use of categories identified 3 phenomena associated with Osherson (as cited in Anderson, 2011) *similarity-coverage model*:

- *Similarity* - Two kinds seen as similar often share a previously unknown characteristic, in comparison to two kinds that are taxonomically more distant.

- *Typicality* - More typical members have more features in common in comparison to less typical members of the group.
- *Diversity* - We tend to ascribe a feature to the whole category when told that two taxonomically distant category members share that feature, than if we are told that two taxonomically similar category members share a feature (if cow and horse have a property P, then all mammals have the property P, if cow and hedgehog have a property P, then all mammals have the property P - we consider second scenario as a stronger argument, because cow and horse are too similar and it adds only little information).

The way we classify our environment and the objects in it is in cultural anthropology called folk taxonomy. It is our personal analysis and interpretation of relations in the world. We classify living and non-living thing according to their function or appearance with our inborn cognitive ability to distinguish characteristic features. (Trajtelova, 2013).

2.3.2.1 Folkbiology

Through human history, people lived and still live in close connection with plants and animals. Naturally, human cognition was shaped by this relationship in order to survive, but how do they understand flora and fauna and how these understandings change with more experience? These are the questions of folkbiology or naive biology, which brings together contributions of anthropology and psychology.

Anthropology unveils rich folkbiological thoughts within context and analyses entire folkbiological system of categories. However, it is limited in use of informal names for plants and animals and possibility of unrepresentative sample. There is a need to use field methods in laboratories and apply laboratory methods in the field. Ethnoscience already researched a great deal of folkbiological taxonomy, but less the categories used in this reasoning. Some psychologists presume that inductive reasoning is one of the most important benefits of categorisation. We make predictions and inferences as a process of generalisation so for example we do not have to encounter all dogs to infer a general principle that dogs bark (Medin & Atran, 1999).

Experiments in folkbiology pay a lot of attention to what living kinds surround the group, what are the term for them, what is the relation between them… Sometimes, different cultures use different names for plants and animals. Whether they do or not, it is

natural to ask what is the principle which determines it. For instance, it could be influenced by relevance to human or size. Scientific taxonomy provides a standard and heuristics for creating a research questions and also as a comparison to cross-cultural results. If the system is different from the scientific one, it is important to look for an abstract structure that it represents and ranks which place various kinds at the same level (Medin & Atran, 1999).

The principal question in folkbiology is if categories are constructed or recognised. *Intellectualist view* sees nature consisted of 'chunks' that impose themselves on minds. As a result, the scientific species and kinds are often corresponding with cross-cultural findings. *Utilitarian view* suggests that folk taxonomic system are shaped by goals and belief within a culture. The third alternative is a *compound* of these two approaches where the differences can be more pronounced in structure and use of categories such a class than in species level. In other words, we use categories like tree or bird more differently than oak or robin (Medin & Atran, 1999).

In conclusion, folkbiology describes a structure of knowledge we believe about nature. Our personal view can differ from scientific one, because we trust also the information we have no proof of, just because they fit to our model of the world.

To summarise, the position of anthropology within cognitive science is rather unsteady, since both sides lack communication and will to cooperate, because of critical disagreement in approaches. We proposed several ideas, which could meliorate this relationship. We also mentioned several studies from the rest of cognitive science disciplines to support the importance of content in cognitive processes. Then we wrote about categorisation as an approach to understanding the world with closer look on folkbiology which is a relevant topic for our research about wolves.

2.4 Cultural Consensus

"Culture is the set of learned and shared beliefs and behaviors, and cultural beliefs are the normative beliefs of a group."

(Weller, 2007, p.339)

Each discipline has specialised methods for its purposes. Surveys describe variations in population, experiments test hypothesis and ethnographic fieldwork explores novel

environments. The latter technique is demanding in time, quality of sampling, making generalisations or comparisons. Unlike psychology or cognitive science, anthropology is looking for specifics of each cultural group and hesitate to generalise about humankind as a whole. However, in order to identified more complex features, anthropology had to start working with sample of informants rather than just individuals (Gatewood, 2012).

2.4.1 History of Cultural Consensus

One of the first approaches was *Cultural consensus theory* (CCT). CCT was presented in 1980s as a design for estimation of "culturally correct" answers in groups with some shared knowledge and a degree to which group members report these answers (Weller, 2007). This model is sometimes called as "test theory without an answer key" or "wisdom of the crowds". It can be taken literally. One of the authors of the theory, William Batchelder, describes an example of assistant, who lost the answer key for test in quantum physics he was supposed to give to students. Since he had no idea what are the correct answers he could apply CCT and obtain culturally correct answers to evaluate test (UCI Media Services, 2013).

A few years before CCT was formally introduced in research, Dawes (1977) measured height of participants with rating scales instead of ruler. He claimed that "the numbers obtained from rating scales do not represent empirical relational systems in the sense that relationships among the numbers imply corresponding relationships in the systems*"* (p. 267). He gave 5 different rating scales referring to height to 25 men to mark estimation of height of the other men from the group. Firstly, he averaged the ratings and compared to real numbers - the average of real height of each person. The correlation was from .88 to . 94. Secondly, he factor analysed the intercorrelation between scales and this correlation with real height raised up to .98. Factor analysis is a statistical method which identifies clusters of related items (factors) in tests. It reduces a number and detects structure of variables.

The key idea behind the CCT is that there is a certain level of intracultural variability which determines proficiency of group members while the shared knowledge connects all fundamentally important information together which results in cultural consensus.

Romney, Weller & Batchelder (1986, as cited in Gatewood, 2012) created in 1986 a formal version of cultural consensus model for open-ended and multiple-choice questions

and informal Cultural consensus model which can accommodate ranked, interval and ratio-scaled data.

2.4.2 Application of Cultural Consensus

"The typical data structure for a CCT model consists of the responses of N respondents to M items on some response scale, e.g., true/false, ordinal, or continuous*"* (p. 151). Similiarly to Item Response Theory (IRT), CCT also operates with respondent proficiency and item difficulty, but does not need to know the correct answers, which is especially helpful for ethnographic studies (Anders & Batchelder, 2015). There are three basic rules to be followed in order to use CCT:

1. Respondents need to answer questions without consulting it with other members.
2. All questions should range around a single topic and do not vary in difficulty.
3. There must be a certain level of agreement in answers, a response pattern (scree plot) (Weller, 2007).

One can argue that simple majority rule can also provide an answer key, but CCT operates with less participants (which is common for ethnographic studies) and other parameters to support the culturally correct responses.

The CCT operates in two types of model:

The formal Cultural Consensus Model (CCM) first roughly calculates individual competencies of informants and then the answers with confidence for each of them. This model assumes that participants respond the questions with correct answer or guess without bias - similar to flipping a coin. "The model identifies certain parameters involved in the answering process: the competency of each individual, the number of response categories, and the proportion of culturally correct answers in each response category" (p. 344). The cultural competence is expertise of each respondent according to the set of questions and is derived from proportion of identical matches between all pairs of informants. This score, however has to be corrected for guessing. For instance, if pigeons would be answering true-false test by pecking their beaks, their score would be around 50% even with 0% competency. The corrected score can be easily calculated with doubling the number of proportion of correct answers minus 1.0. In pigeon case we would get 2 x 0.5 - 1.0 = 0.0 competence. Similarly, the same thing has to be done with proportion of matching answers between respondents. Alternative method to the match coefficient can be

the covariance method, which is sensitive to the proportion of true/yes answers. However, both methods are inaccurate in case there is the response bias present - the respondents do not answer with preference in yes or no. The cultural competence is shown in a result of factoring a corrected agreement matrix. “Cultural competence estimates are provided by a principal axis (minimum residual) factoring method that solves for the unknown main diagonal values of the matrix. The competence scores appear as factor loadings on the first factor” (p. 346). To determine the competence of each individual, we need to examine the ratio of the first and second eigenvalues, which need to be 3:1 to indicate one dimensional solution. It means that there is only one series of responses existing in the data. Consequently, the culturally correct answers are approximated by weighting the answers of individuals by their proficiency scores. “The likelihood of each possible answer to each question is considered and calculated as the sum of the likelihood that each person gave a correct answer” (p. 346). In general, the majority response is the answer with the highest likelihood but in some cases even the minority responses can be the correct ones (Weller, 2007).

Early application of the formal model was conducted by Boster (1986) on manioc horticulturalists - people who were taking care of cassava trees in Peru. Author was looking for pattern in transmission of knowledge about these trees while concentrating on agreements in identification, exchange of varieties and kinship. Apart from successful application CCM, he found out that knowledge about varieties is well shared among other women within one kin but less with other women. However, the sharing outside of kin is sufficient for reaching overall consensus. The deviations from cultural consensus in variety identification could be caused by uneven distribution of learning opportunities, since knowledge about physical world is more likely to be learned from direct experience and abstract domains from other people’s descriptions. “In concrete domains, one would expect greater variability in attribute description than in identification, whereas in abstract domains, one would expect greater variability in identification than in attribute description” (p. 434).

The informal version of CCM is considered to be a factor analysis of people with fewer implications about data. There is no need to correct the answers from guessing, because the competence scores reveal how the answers of each individual agree with those in group. “An agreement matrix is factored and the competence scores are used to weight

the responses of each individual (by multiplication) and then are summed together" (p. 347). Still, the eigenvalue check is necessary (Weller, 2007).

One of **the earliest applications of informal model** was done by authors Romney, Batchelder and Weller in 1987 where they asked students about death causes and compared to mortality statistics. The comparison proved the validity of model approximation (Weller, 2007).

Nowadays, the application of CCM is mostly in ethnographic studies (e.g., determination folk medical beliefs, syntax of an exotic language, actual relationships in a social group, ect.), also in aggregating forecasts from different experts (e.g., about weather or elections) and pooling judge's rankings in competitions (e.g., ballroom dance, box, gymnastics, ect.). Finally, it is also used for determination of what really happened in crime scene from eyewitness reports (UCI Media Services, 2013).

To summarise, CCT is an approach to measurement of shared knowledge in a group of informants. It takes into account the proficiency, the difficulty and the distortion of answers in order to measure latent trait of items.

2.5 Summary of theory

In this chapter, we went through many aspects of environment and culture to demonstrate their effect on cognition.

The first section dealt with our ability to operate in environment. We use our language and imitation to convey information to other members, which enhances mutual cooperation. Cognitive processes help us to solve problems in real time to overpower predator or even other persons. We do not have to learn everything by ourselves, because of our innate ability to mimic behaviour and advanced communication skills. Our unique abstract intelligence allows us to manipulate the environment and objects in it with lower cost which subsequently improves our position in animal kingdom. Since we operate in different habitats, our cognition is shaped by environment-specific strategies we use for effective way of life.

The second part explained our internal manipulations - mental models - and their ability to spread across the population. Mental models are inner representations of the world which influence our behaviour and behaviour of those they share them. Human race

is highly dependant on cooperation within its kind and sharing information is an efficient way how to manage a group of people, e. g., with norms which are generally accepted and any violation against them is punished. Also, we can say that the more opinions we have, the closer we are to solution, because when we blend many different judgements, we eliminate the extreme views. Our cognition therefore use also other minds to understand the world and share those working ones further, because it is effective.

In the third part, we described the position of cultural anthropology within cognitive science, as a discipline which places impact of environment on the first position in pursuit of knowing the cognition. It is criticised for unverifiable data, which holds the overall research back. We mentioned several studies about importance of content in research of cognitive processes to support inevitable presence of anthropology in cognitive science.

In the fourth section, we introduced Cultural consensus theory (CCT), which is widely used in ethnographic studies as a method "without an answer key". The CCT derives a culturally shared truth from a group of people, which have a decent knowledge about a given topic. We advocated for its practical utilization in different context.

3 Methods and materials

In this chapter we will define our goals and the methods and materials we used in order to achieve them. For gathering data in our research we have developed a questionnaire. In the following chapter we discuss how we have developed and administered the questionnaire, describe the participants and data collection. Since questions of the questionnaire are dichotomous, we will also provide the correct answers according to literature.

3.1 Aims

In the theoretical part we have argued that anthropological approach is necessary for cognitive research, and in this part we will give a demonstration of a successful cooperation between an anthropological and psychological methods.

We will apply Cultural consensus model (CCM) we have described in previous chapter to demonstrate applicability of anthropological method and Cognitive Diagnosis Model (CDM), which as a psychological method will provide us with an interpretation of CCM data.

Our main goal is to research the distribution of information about wolves in a group of respondents.

3.1.1 Hypothesis

We expect that Cultural consensus model (CCM) will result in three different cultural matches corresponding with three groups of participants. The groups vary in their perspective given by profession and for that reason we expect it will result in a consistently different set of answers.

3.2 Questionnaire

As the tool for collecting data we created a questionnaire containing 7 dichotomous questions about the life of wolves. At the beginning, subjects were asked about their profession: whether they are hunters, shepherds or animal activists. We were also interested in how many years they have worked on their position and how many wolves they

encountered during this time. Subsequently, we inquired about opinions or beliefs about certain behaviours of wolves where the only possible answers were "Yes" or "No".

The questions were based mostly on academic books about wild animals in Slovakia. They dealt with hunting practices of the wolf, mating patterns and (aggressive) behaviour of the animal population. Although the recommended amount of questions is 20 for high consensus data, we compensated our 7 dichotomous questions by involving 120 respondents. The ratio of correct-incorrect answers was 2:5. The original Slovak and English versions can be found in Appendices.

The correct answers according to literature are following:

1. I believe that a pack of wolves attacks human more often than a lone wolf.

   No: In Slovakia we registered 2 wolf attacks on human and both of them were infected with rabies. Also, most of the fatal wolf attacks in the world have involved rabies. Since rabid animals normally stay alone (outside the pack) and lack the natural fear of humans which allows them to behave aggressively, we can conclude that a lone wolf attacks human more often than a pack of wolves.

2. I believe that in a pack of wolves only leading pair may mate.

   No: In the ideal pack, when there were no deaths, only the alpha pair is mating, but if there were any losses, a compensation is needed and therefore also other wolves in the pack may mate.

3. I believe that in areas without big preys the packs are small or wolves live alone.

   Yes: Distribution of packs or lone wolves is determined by the amount of prey.

4. I believe that a wolf after reaching its prey always attacks the neck.

   No: Wolves use all possible methods to catch the prey and they attack on legs too. We cannot say they always bite neck first.

5. I believe that some packs are specialised in hunting of domestic animals.

   Yes: If they are easy to catch, the pack will come back for more prey. Moreover, it is relatively common that she-wolf would train her cubs to hunt on sheep.

6. I believe that a wolf can significantly endanger the number of deers.

   No: Since the number of wolves is limited, they are incapable of seriously endangering the kind. Moreover, the compensation in natality would solve this situation by breeding more young.

7. I believe that wolf can overgrowth in its amount.

No: The wolf is a wild animal which needs a relatively big area in order to hunt, therefore its number is limited to these conditions (Linnell et al., 2002; Findo & Kajba, 2014).

The questionnaire was available online for 34 days in March and April 2015. The data was collected online, through phone calls or in person. We posted a web link with basic information about the research in social media and specialized webpages or looked for participants in databases.

3.2.1 Participants

We have collected 120 responses from 86 hunters, 28 animal activists and 6 shepherds. They all differed in number of years of practice as well as in estimated amount of wolves near workplace. The participants were from different parts of Slovakia and different backgrounds, which supported anthropological approach, which avoids uniformity, rather seeks culture-dependant variability.

3.3 Evaluation

Firstly, in order to find possible matches we tested the data with CCM; and then with CDA in order to define the discrete proficiency of each participant. Secondly, we compared the groups that believed in one consistent set of answers obtained from CCM with the groups believing in truth or untruth according to the correct answers obtained from CDA.

3.3.1 Cultural Consensus Model

CCM presented Bayesian estimate through Markov Chain Monte Carlo method (Anders & Batchedler, 2015). We have used three chains with 20 000 iterations for each and 2 000 adaptive steps. The match of model and the data was evaluated with Gelman-Rubin diagnosis (Gelman & Rubin, 1992). The values of convergence are excellent if they are smaller than 1.05 and acceptable if they are smaller than 1.10. In our model we sought for Omega value, which would divide respondents to groups.

3.3.2 Cognitive Diagnostic Assessment

The traditional educational assessments are frequently rooted in Item Response Theory (IRT). They identify student's score on a single proficiency continuum which determines if student possesses the trait of interest. "Such scores can then be used for a variety of purposes, such as identifying a student's level of proficiency, differentiating passing from non-passing students, selecting candidates for a program, admitting students to a college, or determining the recipients of scholarships" (de la Tore, 2014, p. 89). One of these evaluations is Cognitive Diagnostic Assessment (CDA). It provides diagnostic feedback on mastery level of learners when it combines theories of cognition and statistical models to test levels of certain skills (Jang, 2008). Therefore, we selected CDA to use it as a complementary method for interpretation of our CCT model data. It will provide us with a distribution of correct answers for each respondent.

Since CDA is primarily diagnostic, it needs to be embedded in statistics which derives information from data. Such a model is called Cognitive Diagnosis Model (CDM). It measures latent variables of respondents as they are discrete values, therefore the informants either have the ability or not. Unlike CCT, CDM has to have the answer keys, because it tests if the respondents are knowledgable and who knows the correct answers. We extracted correct answers from available literature as stated in 2.2.1.1 Development of questionnaire and use it as set of scientifically correct answers.

The mathematical estimate of CDM was implemented in CDM package (de la Torre, 2011) as Expectation Maximisation (EM) algorithm. EM algorithm converged after 284 iterations. We used generalised DINA model for dichotomous data. The consistency of model and data was evaluated according to the absolute fitness of model (Chen, de la Torre & Zhang, 2013) and S-X2 statistics for dichotomous data (Orlando & Thissen, 2003).

4 Results

In this chapter we will present our findings from application of models on data. The combination of models revealed an interesting phenomenon which needs to be explained in further studies.

4.1 Questionnaire evaluation

We tested our questions for their informative value and after factor saturation analysis, we decided to omit question n. 2. “I believe that in a pack of wolves only leading pair mates”. It showed low factor saturation (-0.24 in first dimension and 0.004 in second dimension) and also negative discrimination, which means that respondents with worse latent ability will score better and vice versa. For more consistent results, it is allowed to skip such questions in evaluation.

4.2 Cultural consensus model evaluation

CCT model found out that is a consistency in responses, more precisely, there are two patterns of answers. In Appendix 3. we show bayesian posterior estimation of Omega, value of sigma (standard deviation), value of R-hat (Gelman-Rubin diagnostics) and approximated value of sigma. Sigma value divides the respondents into two groups with consistent set of replies they provided in the questionnaire.

4.3 Cognitive diagnosis model evaluation

CDM estimates the proficiency of respondents according to their knowledge of correct answers. We tested 120 participants for their knowledge or ignorance about wolves. For purposes of our study, we used discrete values to differentiate if a participant has or has not the ability.

Tables 1, 2 and 3 indicate that the model has an acceptable match with data:

Table 1. Global tests are not significant, therefore we do not reject the null hypothesis of the consistency of model and data.

Test of Global Model Fit		
type	value	p
max(X2)	5.702	0.254
abs(fcor)	0.222	0.122

Table 2. 'Jackknife' estimations of MADcor, MADaQ3 and SRMSR are under recommended values 0.08.

	jk_est	jk_se
MADcor	0.044	0.019
SRMSR	0.071	0.026
100*MADRESIDCOV	1.096	0.425
MADQ3	0.080	0.024
MADaQ3	0.063	0.032

Table 3. All statistics of matching items are not significant therefore we do not reject the null hypothesis of their consistency with data.

item	S-X2	df	p	RMSEA	p.holm
X.1svorka	2.600	3	0.457	0.000	1.000
X.2samot	2.293	3	0.514	0.000	1.000
X.3krk	4.096	3	0.251	0.055	1.000
X.4domace	0.400	3	0.940	0.000	1.000
X.5pokles	2.748	3	0.432	0.000	1.000
X.6premnoz	7.512	3	0.057	0.112	0.343

Since CCM revealed two-dimensional structure of information, we have four discrete classes of knowledge: 00, 10, 01 and 11. Average difficulty in first dimension is -1.264 and in second dimension it is 0.713. Therefore, to have the knowledge of second dimension is

more difficult. As a result, we interpret 00 and 10 as ignorance and 01 and 11 as knowledge. Appendix 4. shows the estimated knowledge of each respondent according to the maximum likelihood.

4.4 Complementarity of models

We compared two groups which CCM identified as distinctive according to a consistency in set of answers with the results of CDM, which also divided participants into two groups according to ignorance or knowledge related to wolves. For demonstration, we used first ten participants and compared their score in Tab. 4. The complete data can be found in Appendix 5.

Tab. 4. The first 10 participants shows a high correlation of groups derived from application of CCM and CDM

Participant	Groups according to CCM (approximated Omega)	Groups according to CDM (knowledge - 1 and ignorance - 2)	Match in groups
1	1	1	1
2	2	1	0
3	2	2	1
4	2	2	1
5	2	2	1
6	2	2	1
7	1	1	1
8	2	2	1
9	2	2	1
10	2	2	1

In the comparison of results of CCM and CDM we can clearly see that two subgroups of CCM can be with help of CDM explained as follows:

- The first subgroup of CCM is represented by respondents with true knowledge about wolves.
- The second subgroup of CCM is represented by respondents with false informations, yet consistent.

Since the value of Omega was approximated, the possible inconsistency in matches can be caused by borderline values.

We can conclude that these two groups are more distinctive in question n. 2 “I believe that in areas without big preys the packs are small or wolves live alone.” and less in question n. 5 “I believe that a wolf can significantly endanger an amount of deers.” (Fig. 5)

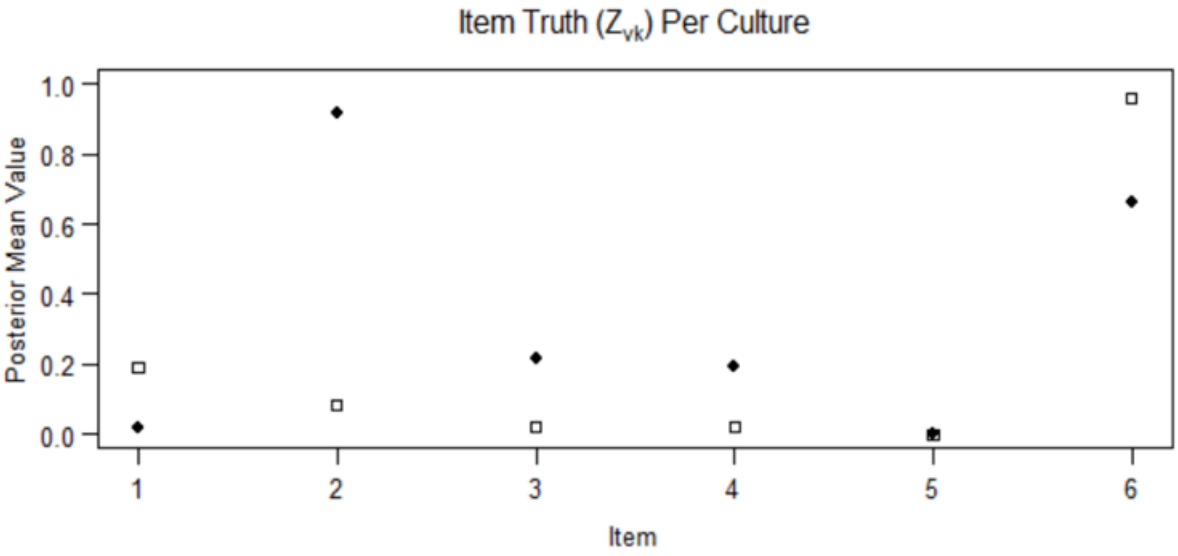

Figure 5. The questions show different values of truth for two groups with consistent set of answers defined by CCM.

The principal finding of our work is that these groups are connected. The tetrachoric correlation of two groups from CCM result and two groups from CDM result is 0.9689 (SE= 0.01951).

4.5 Hypothesis evaluation

We have presumed that the different work-related perspective of participants will result in a distinctive consensus in knowledge about wolves. However, this assumption was not confirmed, because there was no significant correlation between two groups with consistent set of answers and any of professions.

We were thinking that the key difference might be in the years of practice of participant, but logic regression showed that there is no significant difference (odds ratio for respondents with more than 10 years of experience with wolves is 1.00, 95% CI is 0.48 - 2.10).

5 Discussion

Biology as a science collects information about environment in a different way than people. We learn efficiently and therefore we choose that which is easier to learn; what provides us with the most information for the lowest cost; i.e. what is relevant. As a result, the structure of our knowledge depends on the environment and actions that we perform in it. Our ancestors used to believe that sleeping with a wolf's head under the pillow cures insomnia or that pinching one's chest with a wolf fang puts off death (Menatory, 2005). We do not need these pieces of information for our survival, yet we tend remember them to supplement our structure of knowledge regarding wolves, regardless of their incorrectness.

Our study shows the structure of information in 120 Slovaks, who come into contact with wolves. We applied the anthropological model of cultural consensus in order to determine characteristic features of this structure and discovered that there are two groups with consistent beliefs about the given topic. In order to determine which group of participants is correct, we applied Cognitive diagnosis model. The two groups identified in CCM matched with the two groups recognised in CDM. Our hypothesis predicted that the groups which in their responses shared consensus would correspond with the professional groups. This was not confirmed, as there was no significant correlation between profession and consensus. Afterwards we assumed that consensus might be determined by experience, more precisely, more years of experience would lead to more correct answers. This presumption was not confirmed either.

Our findings emphasize the importance of cooperation between cognitive psychology and cognitive anthropology in data collection and evaluation.

The participants were from different parts of Slovakia and different backgrounds, which supported anthropological approach, which avoids uniformity and seeks culture-dependant variability instead; thusly we advocated for anthropological approach which examines very distinctive groups across the world. As we have already discussed in previous chapter about anthropological position within cognitive science, this uniformity of participants is one of the main objections anthropology has towards psychological research: it omits cultural differences.

Furthermore, we applied psychological model of Cognitive diagnosis to illustrate asuch collaboration in practice. Cultural consensus model tests if there is a systematic

structure and cultural consensus in shared knowledge of a group, but cannot state if the piece of information is true. On the other hand, Cognitive diagnosis detects if there are shared truths in knowledge of participants, but it does not identify whether it is consistent or systematic. As we can see, these two models are complementary and useful in research of distributed information.

However, anthropology attempts to interpret these findings in the context they have been studied. Since our data was also collected online, there is no possibility to interact with participants and understand their attitudes from direct observation. A field research is therefore necessary for a more complete investigation of cognitive phenomena.

Conclusion

In this work, we attempted to defend the unsteady position of anthropology within cognitive science. We supported our argument with theory and practical application of anthropological and psychological methods on real data.

Our cognitive abilities are greatly shaped by cultural and environmental factors. Since we daily respond to different phenomena in our surroundings, our cognition is shaped for best possible reaction to them. The composition of the individual's accumulated knowledge is determined mainly by the efficiency of acquired information. Therefore, we believe those pieces of information which are effective for our survival, independently of whether they are true or not. Anthropology examines these environment-dependent specifics in different cultural contexts. It aims to account for variability in cognitive studies instead of creating generalisations too readily. This leads to a lower emphasis on methodology, since each culture demands a specific approach. As a result, this discipline finds itself on the periphery of cognitive sciences. However, with many studies done about the influence of content in cognitive processes we mentioned in our work, we believe that Anthropology needs to become a complementary approach which will provide the research in cognitive science with new phenomena to explore and data to interpret.

We endorsed the idea of successful cooperation between anthropology and psychology through the combination of Cultural consensus model and Cognitive diagnosis model. Our results showed, that 120 Slovak hunters, shepherds and animal activists share two distinct sets of information, where one corresponds with scientific reality and the other does not. In order to gain deeper understanding of the possible causes , we need to apply more anthropological methods, e.g., direct observation or more elaborate interview.

We hope that our work will encourage scientists to conduct more cooperative works between anthropology and the rest of cognitive sciences.

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Appendices

Appendix 1: **Slovak version of the questionnaire**

Dobrý deň,

volám sa Jana Kováčiková, študujem Kognitívnu vedu na Fakulte matemariky, fyziky a informatiky, UK a práve píšem svoju diplomovú prácu na tému Získanie a šírenie informácii v podmienkach neistoty. Mojím cieľom je preskúmať proces, akým si usporiadavame informácie do zmysluplných celkov na vzorke populácie, ktorá sa vo svojej praxi stretáva s vlkmi. Veľká vďaka za Vašu ochotu zúčastniť sa.

Pozícia: poľovník ochranár pastier

Roky praxe na tejto pozícii: _____ rokov

Odhadovaný počet vlkov v revíri / oblasti, kde pracujete: _____ kusov

Odpoveď zakrúžkujte:

Myslím si, že svorka vlkov zaútočí na človeka častejšie ako osamotený vlk.

ÁNO NIE

Myslím si, že vo svorke vlkov sa vždy rozmnožuje iba vodcovský pár.

ÁNO NIE

Myslím si, že v oblastiach bez výskytu veľkej koristi sú svorky malé, prípadne jedinci žijú samotárskym spôsobom života.

ÁNO NIE

Myslím si, že vlk po dostihnutí koristi vždy zautočí na krk.

ÁNO NIE

Myslím si, že niektoré svorky sa špecializujú na lov domácich zvierat.

ÁNO NIE

Myslím si, že lov sŕn a jeleňov vlkom má za následok ich rapídny pokles až ohrozenie druhu.

ÁNO NIE

Myslím si, že sa vlk môže premnožiť.

ÁNO NIE

Appendix 2: **English version of the questionnaire**

Dear participant,

my name is Jana Kovacikova, I study Cognitive science on Faculty of mathematics, physics and informatics, Comenius university in Bratislava and I am currently writing my Master thesis about Acquiring and spreading information under uncertainty. My aim is to research the process how we organize informations to meaningful units in participants dealing with wolves.

Thank you for you participation.

Position: Hunter Shepherd Animal activist

Years on this position: _____

Estimated amount of wolves in you area: ____

Mark your answer:

I believe that a pack of wolves attacks human more often than a lone wolf.

YES NO

I believe that in a pack of wolves only leading pair mates.

YES NO

I believe that in areas without big preys the packs are small or wolves live alone.

YES NO

I believe that a wolf after reaching prey always attacks its neck.

YES NO

I believe that some packs are specialised on hunting of domestic animals.

YES NO

I believe that a wolf can significantly endanger an amount of deers.

YES NO

I believe that wolf can overgrowth in its amount.

YES NO

Appendix 3: **Bayesian posterior estimate of Omega, value of sigma (standard deviation), value of R-hat and approximated value of sigma for each participant.**

	mu	sd	Rhat	
Om[1]	1.337	0.473	1.010	1
Om[2]	1.610	0.488	1.023	2
Om[3]	1.667	0.471	1.017	2
Om[4]	1.712	0.453	1.087	2
Om[5]	1.608	0.488	1.027	2
Om[6]	1.621	0.485	1.038	2
Om[7]	1.448	0.497	1.031	1
Om[8]	1.734	0.442	1.018	2
Om[9]	1.614	0.487	1.039	2
Om[10]	1.706	0.455	1.074	2
Om[11]	1.455	0.498	1.034	1
Om[12]	1.708	0.455	1.093	2
Om[13]	1.350	0.477	1.001	1
Om[14]	1.715	0.452	1.092	2
Om[15]	1.469	0.499	1.011	1
Om[16]	1.279	0.449	1.000	1
Om[17]	1.530	0.499	1.029	2
Om[18]	1.391	0.488	1.011	1
Om[19]	1.458	0.498	1.027	1
Om[20]	1.356	0.479	1.000	1
Om[21]	1.591	0.492	1.005	2
Om[22]	1.475	0.499	1.014	1
Om[23]	1.707	0.455	1.098	2
Om[24]	1.733	0.442	1.022	2
Om[25]	1.454	0.498	1.028	1
Om[26]	1.412	0.492	1.019	1
Om[27]	1.604	0.489	1.014	2
Om[28]	1.728	0.445	1.014	2
Om[29]	1.393	0.488	1.017	1
Om[30]	1.286	0.452	1.002	1
Om[31]	1.216	0.412	1.010	1
Om[32]	1.388	0.487	1.020	1

Om[33]	1.727	0.445	1.016	2
Om[34]	1.328	0.469	1.003	1
Om[35]	1.608	0.488	1.059	2
Om[36]	1.256	0.437	1.003	1
Om[37]	1.252	0.434	1.007	1
Om[38]	1.485	0.500	1.012	1
Om[39]	1.387	0.487	1.017	1
Om[40]	1.257	0.437	1.004	1
Om[41]	1.430	0.495	1.010	1
Om[42]	1.517	0.500	1.025	2
Om[43]	1.400	0.490	1.018	1
Om[44]	1.329	0.470	1.004	1
Om[45]	1.355	0.478	1.000	1
Om[46]	1.442	0.497	1.008	1
Om[47]	1.620	0.485	1.038	2
Om[48]	1.439	0.496	1.008	1
Om[49]	1.480	0.500	1.011	1
Om[50]	1.696	0.460	1.083	2
Om[51]	1.731	0.444	1.019	2
Om[52]	1.250	0.433	1.002	1
Om[53]	1.445	0.497	1.008	1
Om[54]	1.609	0.488	1.013	2
Om[55]	1.443	0.497	1.003	1
Om[56]	1.705	0.456	1.085	2
Om[57]	1.615	0.487	1.062	2
Om[58]	1.696	0.460	1.098	2
Om[59]	1.350	0.477	1.000	1
Om[60]	1.464	0.499	1.034	1
Om[61]	1.383	0.486	1.003	1
Om[62]	1.586	0.493	1.011	2
Om[63]	1.392	0.488	1.014	1
Om[64]	1.418	0.493	1.004	1
Om[65]	1.434	0.496	1.007	1
Om[66]	1.399	0.490	1.014	1
Om[67]	1.476	0.499	1.012	1

Om[68]	1.647	0.478	1.020	2
Om[69]	1.250	0.433	1.010	1
Om[70]	1.668	0.471	1.024	2
Om[71]	1.407	0.491	1.016	1
Om[72]	1.661	0.474	1.018	2
Om[73]	1.592	0.491	1.010	2
Om[74]	1.606	0.489	1.002	2
Om[75]	1.440	0.496	1.006	1
Om[76]	1.725	0.446	1.023	2
Om[77]	1.598	0.490	1.055	2
Om[78]	1.390	0.488	1.017	1
Om[79]	1.720	0.449	1.018	2
Om[80]	1.436	0.496	1.008	1
Om[81]	1.582	0.493	1.014	2
Om[82]	1.400	0.490	1.016	1
Om[83]	1.435	0.496	1.030	1
Om[84]	1.643	0.479	1.020	2
Om[85]	1.732	0.443	1.022	2
Om[86]	1.261	0.439	1.002	1
Om[87]	1.251	0.434	1.000	1
Om[88]	1.257	0.437	1.001	1
Om[89]	1.620	0.485	1.045	2
Om[90]	1.695	0.460	1.079	2
Om[91]	1.615	0.487	1.040	2
Om[92]	1.255	0.436	1.001	1
Om[93]	1.656	0.475	1.016	2
Om[94]	1.464	0.499	1.008	1
Om[95]	1.395	0.489	1.015	1
Om[96]	1.206	0.404	1.010	1
Om[97]	1.248	0.432	1.003	1
Om[98]	1.462	0.499	1.015	1
Om[99]	1.617	0.486	1.046	2
Om[100]	1.341	0.474	1.004	1
Om[101]	1.590	0.492	1.049	2
Om[102]	1.618	0.486	1.042	2

Om[103]	1.447	0.497	1.006	1
Om[104]	1.253	0.435	1.000	1
Om[105]	1.605	0.489	1.004	2
Om[106]	1.711	0.453	1.077	2
Om[107]	1.251	0.434	1.000	1
Om[108]	1.600	0.490	1.057	2
Om[109]	1.491	0.500	1.001	1
Om[110]	1.213	0.409	1.007	1
Om[111]	1.612	0.487	1.045	2
Om[112]	1.617	0.486	1.033	2
Om[113]	1.372	0.483	1.010	1
Om[114]	1.695	0.460	1.081	2
Om[115]	1.706	0.455	1.069	2
Om[116]	1.252	0.434	1.000	1
Om[117]	1.325	0.468	1.002	1
Om[118]	1.608	0.488	1.053	2
Om[119]	1.706	0.456	1.099	2
Om[120]	1.705	0.456	1.076	2

Appendix 4. **Two dimensional structure of knowledge derived from CDA - maximum likelihood for first and second dimension.**

MLE1	MLE2
1	1
0	1
0	0
1	0
1	0
1	0
1	1
0	0
1	0
1	0
1	1
1	0
0	1
1	0
0	1
0	1
1	1
0	1
1	1
1	1
1	0
0	1
1	0
0	0
1	1
0	1
0	1
0	0
1	1

0	1
1	1
1	1
0	0
1	1
1	0
1	1
1	1
0	1
1	1
1	1
0	1
0	1
1	1
1	1
1	1
0	1
1	0
0	1
0	1
1	0
0	0
1	1
0	1
0	0
0	1
1	0
0	0
1	0
1	1
1	1
1	1

0	1
1	1
0	1
0	1
1	1
1	1
0	0
1	1
0	0
1	1
0	0
0	1
1	0
0	1
0	0
1	0
1	1
0	0
0	1
0	1
1	1
0	1
0	0
0	0
1	1
1	1
1	1
1	0
1	0
1	0
1	1
0	1

0	1
1	1
1	1
1	1
1	0
1	0
1	1
1	0
1	0
0	1
1	1
1	0
1	0
1	1
1	1
1	0
1	1
1	1
1	0
0	1
1	0
1	0
1	1
1	1
1	1
1	0
1	0

Appendix 5: **The correlation of two results of CCM and CDM for each participant.**

Participants	Groups according to CCM (approximated Omega)	Groups according to CDM (knowledge - 1 and ignorance - 2)	Match in groups
1	1	1	1
2	2	1	0
3	2	2	1
4	2	2	1
5	2	2	1
6	2	2	1
7	1	1	1
8	2	2	1
9	2	2	1
10	2	2	1
11	1	1	1
12	2	2	1
13	1	1	1
14	2	2	1
15	1	1	1
16	1	1	1
17	2	1	0
18	1	1	1
19	1	1	1
20	1	1	1
21	2	2	1
22	1	1	1
23	2	2	1
24	2	2	1
25	1	1	1
26	1	1	1
27	2	1	0
28	2	2	1
29	1	1	1

30	1	1	1
31	1	1	1
32	1	1	1
33	2	2	1
34	1	1	1
35	2	2	1
36	1	1	1
37	1	1	1
38	1	1	1
39	1	1	1
40	1	1	1
41	1	1	1
42	2	1	0
43	1	1	1
44	1	1	1
45	1	1	1
46	1	1	1
47	2	2	1
48	1	1	1
49	1	1	1
50	2	2	1
51	2	2	1
52	1	1	1
53	1	1	1
54	2	2	1
55	1	1	1
56	2	2	1
57	2	2	1
58	2	2	1
59	1	1	1
60	1	1	1
61	1	1	1
62	2	1	0

63	1	1	1
64	1	1	1
65	1	1	1
66	1	1	1
67	1	1	1
68	2	2	1
69	1	1	1
70	2	2	1
71	1	1	1
72	2	2	1
73	2	1	0
74	2	2	1
75	1	1	1
76	2	2	1
77	2	2	1
78	1	1	1
79	2	2	1
80	1	1	1
81	2	1	0
82	1	1	1
83	1	1	1
84	2	2	1
85	2	2	1
86	1	1	1
87	1	1	1
88	1	1	1
89	2	2	1
90	2	2	1
91	2	2	1
92	1	1	1
93	2	1	0
94	1	1	1
95	1	1	1

96	1	1	1
97	1	1	1
98	1	2	0
99	2	2	1
100	1	1	1
101	2	2	1
102	2	2	1
103	1	1	1
104	1	1	1
105	2	2	1
106	2	2	1
107	1	1	1
108	2	1	0
109	1	2	0
110	1	1	1
111	2	1	0
112	2	2	1
113	1	1	1
114	2	2	1
115	2	2	1
116	1	1	1
117	1	1	1
118	2	1	0
119	2	2	1
120	2	2	1