How can Human Beings Transgress their Biologically Based Views? [1]

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Abstract
Empirical evidence from developmental psychology and anthropology points out that the human mind is predisposed to conceptualize the world in particular, species-specific ways. These cognitive predispositions lead to universal human commonsense views, often referred to as folk theories. Nevertheless, humans can transgress these views – i.e. they can contradict them with alternative descriptions, they perceive as more accurate – as exemplified in modern sciences. In this paper, I enquire about the cognitive faculties underlying such transgressions. I claim that there are three faculties enabling us to part with these universal commonsense views of the world imposed by our nature. The first is our ability to represent representations – i.e. to form metarepresentations. The second is our ability to produce alternative representations both by explaining a familiar subject matter in terms of the principles governing different conceptual domains than the one that we are predisposed to apply to the subject matter and by directing our mind to new subject matters (for which we have no predisposed conceptual grasp), understanding them in terms of familiar domains. The third, finally, is our ability to give these representations an epistemic orientation.

Key words: Human cognition, Domain-specific knowledge systems, Cognitive predispositions, Folk theories, Cognitive flexibility, Human – nonhuman distinction.

1. Introduction

Human beings – as any other species – are predisposed to interpret their environment in a set of species-specific ways. These predispositions, determining the way we conceptualize about particular aspects of the world – as, for instance, other species, physi-

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cal happenings and other minds – are often referred to as modules or domain-specific knowledge systems by cognitive and evolutionary psychologists (Tooby & Cosmides 1992; Pinker 1997; Carruthers 2006). Those innate domain-specific knowledge systems lead to a set of folk theories we entertain about the world. In this regard, we share a particular 'folk physics', 'folk psychology' and even 'folk biology' with all of humankind. I will refer to these universal human commonsense theories about the world as 'biologically based' or 'biologically determined' views, since they are strongly determined by our genetic constitution.

While all other species on this planet are endowed with such biologically determined views of the world, human beings – I argue – are unique in their ability to transgress them. We are, in other words, able to reject and substitute those beliefs about the world, which are rooted in our particular cognitive nature. Indeed, while other animal species might be able to update and change simple beliefs about their environment through experience (as, for instance, the location of food or even expectations with regards to the behavior of conspecifics), homo sapiens is able to change its *biologically determined core beliefs*, generated by innate cognitive predispositions, as – for instance – the assumptions underlying its uncritical representation of the physical and natural world.

This is what I mean by 'transgressing biologically based views'. It entails not merely belief alteration or update, but a radical shift in the way one views the world and accounts for its phenomena. Einsteinian physics, for example, rejects our deeply grounded intuition that time and space are two absolute, independent entities. The probabilistic nature of quantum mechanics, on the other hand, rejects our intuitions about causality and physical determinism. Human beings, in this regard, transgress their biologically determined views, substituting their intuitive grasps of the world with theories they perceive as better descriptions of the subject matter. An analysis of our ability to 'transgress', in this context, does not pretend to explain creativity in general (what cognitive faculties enable genuine originality), nor can it be reduced to analyzing mere belief change (what enables us to change a belief through experience). It covers the middle ground, asking what enables us to overcome our intuitive grasp of the world, rooted in our cognitive make up.

Several candidates have been proposed for this ability to transgress biologically based representations: mapping across domains, reasoning by analogy, metarepresentational thought, explicit and conscious representation, to name the most important ones. While all these faculties are relevant to the issue at hand, taken individually, however, they fail to account for our ability to transgress our commonsense views and lead to confusion by covering similar faculties from different perspectives. Indeed – as will be explained in greater detail in section 3 and 4 – while mapping across domains and reasoning by analogy enables us to form new representations, our ability to form transgressing representations entails not merely that we produce representations that differ from our biologically based representations, but also that we perceive those representations as more accurate. The cognitive faculty to form explicit or conscious representations or to form metarepresentations, on the other hand, endows us with the ability to compare representations, but taken alone, both fails to produce variation (i.e. provide us with different representations), and – in absence of a sense of truth or epistemic desirability – to assess which representation is more accurate.

Therefore, I propose to go about it the other way around. Instead of fitting salient cognitive faculties to human epistemic achievements – and their characteristic feature of transgression – I reason from the ability to transgress in general and ask what cognitive faculties are required. Doing so, I aim to integrate and complete those proposed cognitive faculties in a framework constituted by the necessary conditions for transgression, providing an unequivocal and sound account of the distinctive human cognitive ability to go beyond and against its biologically based views. What other faculties underlie these faculties, how they evolved or how they are physiologically realized, however, remains beyond the scope of this paper.

2. Innate Predispositions, Universal Commonsense and Transgressing Theories

With the decline of behaviorism and the rise of the cognitive sciences, it has become generally accepted that the human mind is not a blank slate. A growing body of empirical evidence shows that we come equipped with a variety of domain-specific learning mechanisms (Chomsky 1959; Spelke 1991; Baillargeon 1991; Atran 1998). The human mind is, in other words, not a general-purpose computational organ but comprises a variety of special purpose mechanisms dealing with different categories of objects in different ways. In this context, Pinker (1997: 315) argues that we are endowed with mental modules for dealing with objects and forces, animate beings and other humans, artifacts and natural kinds, among other categories. This view is supported by two strands of research: developmental psychology and comparative anthropology. The former shows that infants and young children possess assumptions about different aspects of the world that they could not have gathered from mere induction or conventional learning, while the latter points out that the commonsense or folk theories anchored in these assumptions are shared across all human cultures.

In this regard, developmental psychologists, Spelke (1991) and Baillargeon (1991) tested 3 to 8 month old infants on their conception of objects and the physical laws governing them. They concluded that infants expect objects to be impenetrable by each other, to move along continuous trajectories and to be cohesive. Infants also expect objects to move only when caused by an external force. These intuitions underlie the way adults expect objects to behave on a commonsense level. People spontaneously assume that a moving object is impressed with an 'impetus', a force acting upon it, until this force gradually dissipates and the object comes to a rest, its natural state. As Pinker (1997: 320) points out, these assumptions are very persistent. Even students with a background in physics are still inclined to account for moving objects in this notoriously unscientific way.

Anthropological research, on the other hand, shows that the human mind is predisposed to think about fauna and flora in a highly structured way. All cultures appear to divide the natural world in a complex taxonomy that incorporates different groups, each further defined in different levels of subgroups (Atran 1998). This predisposition to classify the organic world according to a complex taxonomy stems from an intuition of a hidden trait or essence that members of the same group share with each other (Pinker 1997: 323). This essentialist approach is at the core of folk biology and invariably develops in children of a certain age (Gelman & Wellman 1991). Other probable candidates for domains of innately constrained representations are: a sense of number and natural geometry (Spelke 2003), a domain for psychology or theory of mind and a domain for language (Pinker 1994, 1997), a domain for facial recognition and a cheater-detection module (Tooby & Cosmides 1992).[2]

While we share some of these cognitive modules and faculties underlying our intuitive grasp of the world, with other nonhuman animals (Spelke 2003: 289), human beings, as pointed out, are unique in their ability to transgress their biologically determined views. Indeed, our intuitive understanding of physical happenings – ascribing an 'impetus' to moving objects, assuming that every object's natural state is at rest, etc. – is contradicted by Newtonian physics and even more so by Einstein's theory of relativity. Similarly, our essentialist categorizing of the organic world is rejected by the theory of evolution, according to which species are not endowed with immutable, internal 'identities', but change over time.

Any theory about human cognition should therefore account for our ability to transgress our biologically induced core intuitions about the world.[3] Over the last two decades, a multitude of theories reasoning from a nativist stance – claiming, as I do, that the human mind possesses a variety of special purpose, domain-specific knowledge systems – have proposed cognitive faculties that enable human beings to conceptualize the world in ways that go beyond and against their innate predispositions. These theories about 'what makes us smart' take up the challenge to reconcile the premise that human cognition is based on innate knowledge systems or modules and the obvious flexibility displayed by the mind in its conceptualizations. Let's have a look at the main proposals.

3. Theories about What Makes us Smart

3.1 Mapping Across Domains

Carey and Spelke (1994) attempt to explain conceptual change in cognitive domains, as evident from the history of science, within a framework of domain-specific cognition. Human minds, they argue, are endowed with innate systems of knowledge, each pertaining to a particular domain – as, for example, other minds, physical objects or number. According to these authors, such domains comprise a distinct set of entities and phenomena (e.g. the innate knowledge system of physics applies to material bodies and their behavior) and a number of core principles (in the case of physical objects: cohesion, continuity and contact). Learning, from this perspective, consists of an enrichment of those core principles through experience. Therefore, a high degree of universality in representations is to be expected in the domains for which humans possess innate core knowledge systems. Nevertheless, scientific theories demonstrate that conceptual change in those domains is both possible and actual (Carey & Spelke 1994:

2 If all of these proposed domains constitute separate and autonomous modules, however, is not the concern of this paper. My only aim is to illustrate the generally accepted claim in cognitive and evolutionary psychology that the human mind is endowed with domain-specific knowledge systems, predisposing it to view particular aspects of the world in a particular way.

3 Piaget's (1963) dialectical process of assimilation and accommodation, in which external elements are assimilated to fit mental structures, on the one hand and mental structures accommodated to fit these elements, on the other hand, is often invoked as a way of transgressing the initial representations the human mind is endowed with. Nevertheless, this process involves a fine-tuning or updating of the initial representations rather than radically overthrowing them. Piaget did, indeed, reason from a developmental perspective not a nativist one. Unaware of the strong empirical evidence pointing at innately constrained cognitive domains he didn't conceive of the process of assimilation and accommodation as a means of going against and beyond biologically determined commonsense views, but as the way in which the child's representations gradually develop.

169). Core principles are overridden and new principles adopted, leading to widely diverging theories.

According to Carey and Spelke (1994: 180), conceptual change in those innate domains is the result of 'mapping across domains'. This happens when the core principles of one system are applied to the set of entities of another system, thereby escaping the principles that naturally – i.e. in virtue of our nature – fit these entities. By devising and using systems of measurement in physics, for example, scientists create a mapping between the core knowledge system of numbers and that of physics. Therefore, the principles governing the behavior of physical bodies are no longer those of cohesion, continuity and contact but the core principles of the system of number – as one to one correspondence, succession and the like.

Mithen (1996) takes on a similar viewpoint from a different perspective. Reasoning from an archaeological background, he attempts to explain the cultural explosion in the transition between the upper and middle Paleolithic (approximately between 60 and 30 000 years ago). According to Mithen, this 'big bang of human culture', featuring the birth of art, religion and complex hunting strategies, is the product of a last, major re-design of the mind in human evolution (153). Whereas our human ancestors evolved encapsulated, domain-specific knowledge systems in areas as social intelligence, natural history or biology and technical intelligence, these specialized intelligences were now no longer working in isolation. The resulting cognitive fluidity or mapping across domains, characteristic of the modern human mind, provides – according to Mithen – the foundation of scientific endeavors and the distinctive human ability to transgress the contents of its innate, domain-specific knowledge systems.

The view that the human mind integrates the content of different domains, underlying Carey and Spelke's (1994) and Mithen's (1996) account, is a recurring theme in the cognitive sciences. According to Fodor (1983), the mind consists of fast, mandatory, encapsulated and domain-specific input systems or modules, on the one hand and a central system which is slow, non-mandatory, non-encapsulated and domain-general, on the other hand. This system integrates the outputs of the modules and provides human cognition with its characteristic holism and creativity. As to the nature of this system, Fodor remains mute, considering it an irresolvable mystery. Carruthers (2006), on the other hand, postulates a massively modular mind. He accounts for its flexibility and creativity by distinguishing between two reasoning systems. The first corresponds to the processing of the modules: it is arranged in parallel and operates swiftly and unconsciously. The second supervenes on the activity of those systems; it is realized by mental rehearsal in general and inner speech in particular and operates more slowly and consciously. It integrates, in other words, the content outputs of the various modules, overriding the results of the first system (254). Boeckx (2010: 128), finally, compares the cognitive ability to cross the boundaries of modules – underlying our rudimentary theories of the world around us – as mixing apples and oranges to form what he calls 'delightful cognitive cocktails'. Like Carruthers, he points at natural language as a content integrator of the different outputs of the modules.

3.2 Analogy and Metaphor

Gentner (2003) argues that higher-order cognition is the product of our capacity for analogy. In this light, our ability to draw abstractions from particulars, to maintain hierarchies of abstraction, to reason outside the current context, to compare and contrast representations and to project further inferences, among other distinctively human abilities, is seen as the product of our ability to learn by analogy. This inborn faculty is, according to Gentner, multiplied by the possession of relational language, which both invites learning relational concepts and provides cognitive stability once they are acquired (195 - 196). Therefore, while we possess – as other animal species – a basic set of cognitive constraints in the form of attentional biases and learning propensities, we also have the possibility to go beyond these biases by means of, what Gentner calls, 'structure-sensitive comparison processes'. In other words, the capacity to detect similarities in abstract relational structures, enables us to make inferences that transgress our innate set of starting knowledge (227 - 228).

This process of abstraction by analogy becomes evident when considered from a different angle: the pervasiveness of metaphor in language. As Lakoff and Johnson (1980) point out, metaphor is not just a device of poetic and rhetorical flourish, nor even a purely linguistic matter, but at the core of our everyday thought and action (3). Language, in this context, is a body of evidence for the way we think, showing us that human thought processes are largely metaphorical. The concept of 'argument', for example, is structured, according to Lakoff and Johnson, by the metaphor 'argument is war'. We call some claims indefensible, we attack weak points of an argument, we can be right on target, demolish an argument and, of course, win or lose it. Similarly, 'time is money': we waste, spend and save time, chores cost time, we invest time in each other and we run out of time (5 - 8).

Furthermore, on a more fundamental level, spatial orientation metaphors organize entire systems of concepts with respect to one another. More is up, less is down (e.g. numbers go up and down), happy is up, sad is down, good is up, bad is down (e.g. it's going downhill or it's going up, he's rising to the top or tumbling to the bottom) virtue is up, depravity is down (e.g. having high or low standards), etc. The same goes for front-back, on-off, in-out, center-periphery and near-far. Similarly, the metaphor of physical objects and substances, structures a whole realm of concepts. As Lakoff and Johnson (1980: 25) point out, this allows us to pick out parts of experiences and treat them as discrete entities or substances. Events, activities, emotions and ideas are conceptualized as entities, allowing us to quantify them (e.g. I feel too much anger), identify aspects (e.g. the ugly side of his personality), identify causes (e.g. the pressure of his responsibility caused him to resign) and set goals (e.g. he went off in search of fame and fortune). Moreover, even our most basic concepts are often metaphorically structured. Our concept of time, for example, is structured by the metaphor of space – e.g.: he arrived at 1:30, worked through the night, looks forward to tomorrow, leaves the past behind, etc. (St Clair 2007; Pinker 2007).[4]

Pinker (2007: 233) argues that the concepts of substance, space, time (rooted in the metaphor of space) and causation (rooted in the metaphor of force) are 'the substrate of our conscious experience'. They are, in other words, the building blocks of our reasoning, giving us the tools to conceptualize about the physical and social world and, most importantly, they are the source of the metaphors by which other spheres of life are comprehended. Metaphors in language, in this regard, are proof of the way our mind co-opts reasoning patterns that are grounded in our innate knowledge systems, to reason about other, abstract domains.

Johnson (2007), in this context, grounds meaning and the nature of abstract thought in image schemas, arising in our perception and bodily movement. Abstract concepts and thought do not constitute a wholly different kind of logic, but are an extension of

4 This, however, does not imply that space and time cannot be represented independently in the brain, merely that they are structured by the brain in a similar fashion (Kemmerer 2005).

spatial-bodily concepts. It is not disembodied, Johnson argues with Lakoff (1980), but structured by our sensorimotor schemas and extended by means of conceptual metaphor (Johnson 2007: 180 - 181). Precisely this ability to extend reasoning patterns, grounded in our innate cognitive architecture or bodily generated schemas – as Lakoff and Johnson (Lakoff & Johnson 1980; Johnson 2007) argue – by conceptual metaphor to abstract domains for which we have no knowledge-system, enables us to grasp the latter in terms of the former. This process, as pointed out, leaves metaphors as a tangible trace in language. For, as Pinker (2007) puts it, language is the mirror of thought.

3.3 Explicit and Conscious Representations

Karmiloff-Smith (1992), studying the human mind from a developmental perspective, argues that we can go beyond domain-specific constraints, by a process called 'representational redescription'. In this process, 'information already present in the form of implicit information *in* the mind, becomes explicit knowledge *to* the mind' (18, her italics). While implicit information is embedded in procedures, isolated from other parts of the cognitive system, merely enabling us to respond to the environment, explicit representations are available to consciousness.

In this regard, the innate, intuitive grasp of objects and the physical laws governing them – which Spelke (1991) and Baillargeon (1991) discovered in infants – are present, according to Karmiloff-Smith, in the form of procedures triggering responses to environmental stimuli. They are implicit representations. When this embedded information becomes accessible through the process of representational redescription, children become – in the words of Karmiloff-Smith – 'little theorists' (78). The core principles (i.e. cohesion, continuity and contact) are now represented explicitly, encoded in a format usable outside normal input/output relations and available to verbal explanation. Karmiloff-Smith argues that this does not happen exclusively through conventional learning by acquiring the representations in linguistic form from parents and educators. While some of the representations might be acquired this way, other theory building occurs by this internal process of representational redescription. The human mind is, in other words, endowed with a mechanism that can bring implicit representations to consciousness, taking them as objects of cognitive attention and therefore enabling it to manipulate them. This, Karmiloff-Smith concludes, permits the mind to extend well beyond its environment and underlies its distinctive creativity (192 - 193).

Similarly, in recent work, Carey (2009), invokes the mechanism of 'Quinean bootstrapping' to account for the conceptualization of genuinely new representations. According to Carey, new and 'richer' representations can arise out of representations with more limited expressive power. Invoking the case of a child's acquisition of the concepts of natural number – which exceeds the content of the core knowledge-systems at our disposition – she argues that memorization of the counting sequence by rote, eventually enables children to correlate these number words with matching number sets, making them 'cardinal principle knowers'. In this regard, the acquisition of number words making numerical values explicitly represented, provides the child with a richer representational medium than the core knowledge systems it started out with.

According to Karmiloff-Smith (1992), explicit representations are intrinsically linked to conscious accessibility. Schacter (1989) draws a distinction between implicit and explicit along this line with regards to memory and elaborates on it. Memories, he argues, are implicit when they facilitate performance on a particular task that does not require conscious recollection of previous experiences and explicit when performance does require conscious recollection. Consciousness, in this context, refers to 'a person's ongoing awareness of specific mental activity' (356). Therefore, explicit representations are representations of which the beholder is *aware*. In virtue of this awareness, he or she explicitly represents this representation. This brings us to the final proposal of human kind's ability to go beyond its commonsense theories.

3.4 Metarepresentational Thought

A metarepresentation is a representation of a representation. We can, however, distinguish between two different kinds of metarepresentation. The first comes from psychology and refers to the possession of a theory of mind. In this perspective, a person holds a metarepresentation by representing another person's representation. For example, Mary holds a metarepresentation when she sees Tom looking for his coat in the closet and infers that he believes his coat is in the closet. Doing so, she forms a representation of Tom's belief or representation, i.e. the coat is in the closet. The second kind of metarepresentation refers to a representation of *one's own* representations.[5] This is the kind of metarepresentation relevant to the question 'what makes us smart'. According to Stanovich (2004), the possession of the ability to represent one's own representations is what separates human from nonhuman animals. It gives rise to the self-critical stances that are a unique aspect of human cognition (1264). It enables us, in other words, to form beliefs about our own beliefs. How reliable are they, on what are they grounded, etc?

Sperber (2000) agrees with Stanovich that the ability to form metarepresentations is one of the distinctive human cognitive abilities. Just as echolocation for bats, he argues, the capacity to metarepresent is both unique to humans and crucial in explaining their behavior (117). While animals may have some rudimentary capacity to metarepresent in the psychological use of the term (e.g. detecting that a conspecific wants to mate or fight), these forms of metarepresentation, according to Sperber, lack both compositionality and recursion. They can only metarepresent a short and fixed list of representations. Humans, on the other hand, can metarepresent an unlimited amount of representations. According to Sperber, this requires a whole new level of cognition. The mental ability to represent does, indeed, not imply the ability to represent those representations. They would remain hidden to the beholder, unless there is something that renders them tractable and therefore cognitively accessible (118 - 121).

According to Dennett (2000), this something is provided by the encoding of representations in language or other tangible media of representation (e.g. drawings, writings, etc.). The obvious route to true, genuine metarepresentation – in this case, the self-conscious representing of one's own representations, which Dennett calls 'thinking about thinking', not to be confused with the representation of another person's beliefs (cf. first kind of metarepresentations) – he argues, is from the outside in. It begins with overt use of public symbols – i.e. the acquisition of natural language – and creates practices that can later be internalized, providing us with the necessary tools to think about thinking (21). Indeed, our possession of a medium in which representations can be couched (as natural language provides us with), enables us to form, what Dennett calls, 'florid representations' as opposed to 'pastel representations'. While the latter are merely unconscious guides to behavior, the former are deliberate, knowing

5 It is very plausible that the ability to metarepresent in this second sense evolved from the previously acquired ability to metarepresent in the psychological sense – i.e. the possession of a theory of mind. Selective pressure on social intelligence is, as Mithen (1996) points out, suspected to be the motor behind the evolution of human intelligence. A discussion on the origin of our ability to metarepresent, however, is beyond the scope of this paper.

and even self-conscious ways of representing. In the terminology of Karmiloff-Smith (1992), they are explicit representations. Those florid representations, then, according to Dennett (2000), are truly metarepresentational in kind, prompting him to exclaim: 'no florid representation without metarepresentation' (19).

4. Necessary Conditions for Transgressing

While all of the proposed accounts of what distinguishes human cognition with its characteristic flexibility and non-encapsulation – underlying its ability to transgress innately grounded core intuitions about the world – are important aspects of human cognition, I argue that taken individually they cannot account for it. Furthermore, they lead to confusion by highlighting similar faculties from different angles and depicting them in a different terminology. In order to bring this incompleteness to light and dispose of the terminological confusion, I propose to reverse the sequence of reasoning. Rather than analyzing human cognition and fitting salient faculties to our ability to produce theories which depart from our innate predispositions, I will take this ability to transgress our biologically based views as the starting point, analyzing what faculties are required to achieve this.

My aim, in other words, is to uncover the necessary and jointly sufficient conditions for transgression. Based on this analysis, I will then point out that the proposed cognitive faculties of 'what makes us smart' are not sufficient to account for this ability to transgress. My analysis, in this regard, takes a non-empirical approach, since its goal is to elucidate what is necessary for transgression in general, not merely how humans achieve this cognitive feat. Otherwise put, I consider the task at hand and ask what is logically presupposed to achieve this. This 'external' analysis, uncovering the necessary and jointly sufficient conditions to form transgressing representations, will then yield a framework in which the current (empirical) accounts of cognitive faculties that 'make us smart' can be integrated and completed where necessary. This, I hope, will provide us with a more complete and unequivocal account of the distinctively human ability to transgress the core intuitions it holds in virtue of its cognitive nature.

For exposition's sake, I will illustrate my argument with a thought experiment. My use of a thought experiment, in this regard, is not necessary but serves an illustrative purpose. Its goal is to provide the reader with a vivid and clear illustration of what it takes to transgress biologically based views of the world. I could, in other words, bypass the story-telling in my analysis. In my opinion, however, the following thought experiment both enhances the clarity of an otherwise rather abstract exposition and enables the reader to engage intuitively with the matter at hand. This approach, I hope, will render my analysis more tangible and, therefore, more engaging.

4.1 E.T.s on an Icy Planet

Imagine extraterrestrial organisms living on a planet at some constant distance from a star, their sun. The planet revolves in such a way around its axis and around the star that the same side is always exposed to the light, while the other is always couched in darkness. Our extraterrestrials live on the side exposed to the sunlight and heat and, therefore, in constant daylight. Furthermore, there are no climatic changes whatsoever: the temperature remains constant at 5° Celsius and the sun is never obscured by clouds. The landscape of this planet is filled with huge ice caps. Because the temperature is always above melting point, those ice caps are slowly melting. How the ice got there in the first place can, of course, for the purposes of this thought-experiment, be ignored.

The extraterrestrial organisms, let's call them E.T.s, are endowed with a sense of vision. Furthermore, they possess a concept of time and causality similar to ours. Based on this input (vision of ice becoming water) and their cognitive architecture (predisposition to situate this event in time and look for a causal explanation), they are predisposed to think that ice has an inherent quality of becoming water over a certain amount of time. This representation or belief is, in other words, part of their folk physics. Not once, given the climatic conditions of this planet, has this expectation been violated. However, over time a bright E.T. comes up with an alternative explanation: it is not the inherent nature of ice that causes it to become water, but it is the sun which causes ice to become water. My question now is, what cognitive faculties does it take to allow for this radical transgression of the commonsense representation of the E.T.s? How, in other words, can our bright E.T. come up with this 'Copernican revolution', given its input (vision) and conceptualization faculties (a notion of time in which melting takes place and a notion of causality)?

4.2 What Cognitive Faculties would E.T. Need to Transgress its Commonsense View?

First of all, since transgressing its commonsense view not only implies that this view is substituted by an alternative view, but that the latter is perceived as 'better' or epistemically more desirable than the former, our E.T. would have to represent both its commonsense view – i.e. ice becomes water because of its inherent nature, and its transgressing view – i.e. ice becomes water because of the sun, in order to compare both. If this representation is implicit – i.e. not represented itself – merely underlying its expectations, E.T. will never be able to assert that one representation is better than the other, nor even be aware of the two distinct representations for that matter.

Furthermore, E.T. would need an epistemic goal, a disposition to look for truth or an accurate description of its external environment, in this case the transformation of ice into water. Without this epistemic goal, transgression is not possible. Indeed, remember that transgression entails not merely a shift in belief – which could occur without the cognitive creature being aware of it and without an epistemic orientation – but a perception of the transgressing representation as 'better' than the commonsense view, entailing a comparison of both representations in virtue of an epistemic goal.

Thirdly, short of divine inspiration, E.T. must come up with a different representation based on the input it receives and the conceptual tools it possesses. As I have outlined, it possesses a visual input: it sees the ice, the water and the sun and it has a conceptual architecture representing these entities in a framework of time and causality. This has led it to believe that ice becomes water *because* of its own nature over a certain amount of *time*. In order to produce the alternative representation that properties of the sun, instead of the ice itself, cause the ice to become water over a certain period of time, it has to combine the representations drawn from its visual and conceptual resources in a different way. In this case, the causal connection between the perceptual input of ice and water has to be attributed to a foreign element, the sun, instead of ice, the object of transformation itself.

This ability to recombine elements from input and conceptualization into a new representation further requires that E.T. not only represents its commonsense representation and its transgressing representation as such, but represents the parts of this representation as well. It has to hold the representation of 'ice', 'water' and 'causation in virtue of' as separate conceptual building blocks in its mind. This allows E.T. to divorce its representation of 'causing to become water', from its representation of 'the nature of ice', on the one hand and to form a new representation by reassembling elements from its input (ice, water, sun) and elements from its conceptual resources (in this case, the causal connection), on the other hand. Indeed, since it represented the parts of its commonsense representation, driving the proverbial wedge in between them, these parts can now be reattached with another element it represents (i.e. the sun).

Finally, E.T. will need a way to assess that its new representation (i.e. ice becomes water because of properties of the sun) is preferable in terms of its epistemic goal (i.e. truth or accuracy of description) than its previous commonsense representation (i.e. ice becomes water because of properties of the ice itself). To make this assessment, E.T. needs two things: data demarcating both representations and epistemic criteria in virtue of which one representation accounts for the demarcating data in a better way (in terms of the epistemic goal that is) than the other.

In this case, our bright E.T. could have noticed that when casting shade over the ice, the ice stopped melting (remember the constant temperature on the planet in the exposure of the sun is 5° C; when the sunrays are blocked, however, the temperature tumbles to – 5° C).[6] This leaves the choice of sticking to the old representation while accommodating the new finding (i.e. ice becomes water because of properties of the ice itself, however, shaded ice does not become water) or accommodating these findings in the new representation (i.e. ice becomes water because of some properties of the sun, therefore, when the sunlight is blocked, so are those properties of the sun, which causes their causal effect to vanish).[7] How can E.T. assess that the latter representation fits its epistemic goal better?

To make this assessment, E.T. would need an epistemic orientation. Such an orientation is provided by a set of values or criteria which can rank different representations on a scale determined by its epistemic goal (i.e. a scale ranking from less to more accuracy of description). Those values, in this case, could be explanatory scope (the latter representation explains more since it offers a causal reason why non-shaded ice does not become water, whereas the former does not), simplicity (rather than attributing causal powers to one state of ice – i.e. non-shaded ice – and not to another – i.e. shaded ice – E.T. can attribute an unchanging causal power to the sun) and coherence (while the commonsense representation entails that the nature of ice both causes and does not cause it to melt depending on it being shaded or not, the transgressing representation does not harbor such a contradiction).[8]

4.3 Framework of Necessary Cognitive Faculties for Transgressing

There seem to be three major cognitive faculties in play for E.T. to come up with a transgressing representation of what turns ice into water. The first is the ability to represent representations and their parts. Indeed, in order to compare both representations, E.T. needs to represent both. Furthermore, it has to represent the different parts

6 Let's assume that there isn't anything casting a constant shadow on the ice caps and the effect of shade on ice, therefore, was never revealed before.

7 Typically, these data will be at the start of the exploration leading to a new representation, fuelling the doubt and directing the conceptual recombination of the available building blocks. This account, however, is not a chronological account of how new representations are typically formed. Its sole aim is to provide us with a clear overview of what cognitive operations are needed to transgress a representation anchored in innate pre-dispositions.

8 Those values are human epistemic values. Transgression, however, does by no means entail the application of these particular values or criteria, merely the possession of an epistemic orientation – i.e. an epistemic goal and criteria realizing this goal.

of this representation separately. In this case, 'ice becomes water', 'because of', 'qualities belonging to ice'. This, as pointed out, is necessary for E.T. to recombine these parts in a different fashion allowing it to conceptualize a different explanation of the subject matter (cf. second condition).

A second necessary condition for E.T. to come up with a representation transgressing its commonsense representation, is the possession of a way to recombine the information it gathers through its visual input and the conceptual resources at its disposition into a new representation. Indeed, as pointed out, E.T.'s new representation has to be composed out of elements it gathers from its input and the conceptual tools it possesses. Since representations don't materialize out of thin air, any new representation has to be accounted for in terms of the information that can be drawn from the world and the ways this information can be processed.

A third and final necessary condition, is the possession of an epistemic goal and epistemic values or criteria. Without an epistemic goal, a view of what makes a representation desirable, as truth or accuracy of description, one cannot propose alternative representations which are perceived as epistemically more desirable. This goal or ideal is, indeed, necessary to provide an axis on which different representations can be compared. Necessary but not sufficient, however. For this comparison to take place, there need to be epistemic values or criteria determining the relative proximity of the two representations with regards to this ideal. A disposition to look for true representations is, indeed, vacuous without some criteria that make a representation more or less truthful.

In the case of our bright E.T., those values were explanatory value, simplicity and coherence. As pointed out, it could only apply those after integrating demarcating data into the equation. This however, since it was gathered by its visual input, can be accounted for by the previous faculty enabling it to represent information gathered from its input and to recombine it with representations drawn from its conceptual framework. Moreover, one can imagine a case in which there would be no need for empirical data demarcating both representations, one representation being preferable merely in virtue of epistemic values. For instance, when two representations account for the same phenomenon, but one does so in a more parsimonious way, this representation can be seen as better, yielding to Occam's razor, satisfying the value of simplicity. The better representation, in this case, would typically contain less elements, not needing additional data but, in the contrary, erasing data from the equation.

Without this last, crucial condition, i.e. the possession of an epistemic value system, alternative representations would be but random proposals, with nothing to determine whether one representation is more desirable than another. Indeed, the very concept of transgression presupposes the existence of such a system. A representation can only be perceived as transgressing commonsense when it is perceived as more desirable than its commonsense counterpart. For our E.T.s, just as for us, this increased desirability comes from a sense of increased accuracy or truthfulness. In this context, except for extreme cases of scientific relativism, it is commonly accepted that scientific accounts present us with better descriptions of the world than uncritical commonsense assumptions. They are either considered as more truthful (scientific realism) or at least more useful (instrumentalism).

5. Integrating Human Cognitive Faculties in the Framework

5.1 Representing the Representation and its Parts

As pointed out, in order to compare two representations we need to represent those representations. If our representations are merely implicit, underlying our behavior without us representing the representations themselves, how could we assert that one representation is more accurate than the other? Moreover, as pointed out, if representations cannot be carved up in different parts, each represented individually, we have no means of representing the subject matter differently, by recombining the different parts.

Karmiloff-Smith (1992) argues that we have the ability to bring implicit representations to consciousness, representing them explicitly. Explicit, in this sense, means available to conscious awareness.[9] The question remains however what exactly is available? Dienes and Perner (1999) distinguish different kinds – or as I would put it: degrees – of explicitness. Just the content of a representation can be represented explicitly (the cat is on the mat), both the content and the attitude can be represented (knowing or believing that the cat is on the mat) and finally the content, the attitude and the holder of the representation can be represented (it is me who believes the cat is on the mat) (737). Nevertheless, they argue, under a common understanding of the term 'conscious', a representation counts as conscious only when its content, the attitude and the holder or self can be represented consciously (740). How, indeed, can one be said to be aware of having the representation 'the cat is on the mat', without being aware that one knows, sees or believes this and that, quite obviously, it is oneself who holds this representation? An explicit representation – in the sense of consciously available representation – therefore, is a representation of oneself representing a content in virtue of a certain attitude. It is thinking about thinking, as Dennett (2000: 21) puts it, it is thoroughly metarepresentational in kind.[10]

In this sense, Karmiloff-Smith's (1992) explicit representations and Stanovich's (2004), Sperber's (2000) and Dennett's (2000) metarepresentations refer to one and the same ability of representing one's own representations.[11] They are representations of a higher order because their object is a representation and not something external to the mind. This higher-order cognition, representing the representations we hold in virtue of our biological nature (i.e. our senses and cognitive architecture), is a first major step to transgressing the commonsense beliefs we hold. As Stanovich (2004) points out, this ability is distinctively human. While other animals might be able to metarepresent to a certain degree in the psychological use of the term (cf. 3.2 Metarepresentational thought), they cannot be said to represent their own representations. They do not, in Dennett's (2000) terms, think about thinking.

Moreover, when representing one's own representations, the parts of these representations are necessarily represented as well, for how are we going to represent the vi-

9 At least in its ultimate stage, because Karmiloff-Smith conjectures about several stages of gradually increasing explicitness.

10 Metarepresentational in the sense of representing one's own beliefs, not representing someone else's beliefs or possessing a theory of mind (cf. different kinds outlined above – § 3.4 Metarepresentational thought).

11 This does, however, not entail that they agree on which faculties underlie the ability to form metarepresentations, merely that all these accounts point at the ability to represent one's own representations. The question which faculty underlies the human ability to form metarepresentations or how this faculty evolved, is beyond the scope of this paper.

sual representation 'the cat is on the mat', without being able to represent 'cat', 'mat' and 'on' as separate aspects of this representation? Indeed, while, for example, the implicit visual representation 'the clouds are dark' will simply trigger the instinctive reaction of an organism to seek hiding for the coming rain, its explicit counterpart 'the clouds are dark, therefore it will rain', obviously requires us to represent all elements gathered from input: clouds, dark and the inference from conceptualization: 'therefore it will rain', individually.

Dennett (2000) argues that those "florid representations" are couched in natural language, Karmiloff-Smith (1992: 15) points at the redescription of implicit representations in different representational formats that are ultimately available to verbal report. Explicit representations, in both accounts, therefore, can in principle be encoded in natural language[12], a system which constructs representations based on the combination of explicit units of meaning. This provides an explanation why, when we represent explicitly, we necessarily do so by representing the parts explicitly. Indeed, either natural language itself functions as the system in which representations can be couched and therefore made explicit, as Dennett suggests, or these representations are encoded in a format close enough to natural languages to be verbalizable, which entails this format shares its basic structure with language, as Karmiloff-Smith suggests. This aspect of explicit representation underlies the possibility of reassembling those separately tagged elements in different configurations, as I will discuss under the next heading.

5.2 Variation Through Recombination

Merely representing representations does not by itself enable us to transgress our commonsense views. This requires a cognitive faculty that can produce variation. Since we cannot access different ways of drawing input from the world or different ways of conceptualizing this input, we can only come up with alternative representations by recombining elements we gather from input and from our conceptual modules in different ways, to form – as Boeckx (2010: 128) calls it – 'delightful cognitive cocktails'. We can both explain a familiar subject matter in terms of the principles governing different conceptual domains than the one that we are predisposed to apply to the subject matter and direct our mind to new subject matters (for which we have no predisposed conceptual grasp), understanding them in terms of familiar domains.

This ability, referred to as 'mapping across domains' or 'reasoning by analogy' enables us to apply our sense of number to the domain of space and time, representing delimited parts of space and stretches of time in numbers or to apply our module for reasoning about animate creatures to inanimate objects, investing rocks, trees and the like with spiritual essences, as is done in animistic religions. Furthermore, it enables us, or rather Harvey in this case, to conceive of the heart as some sort of mechanical, pump-like device or Bohr to view the structure of an atom as that of a solar system (De Cruz & De Smedt 2007) and even more fundamentally, to view time in terms of space or causation in terms of force, as St. Clair (2007) and Pinker (2007) point out. It allows us, in other words, to think differently about subject matters and to think about different subject matters than the ones we are predisposed to think about.

12 Karmiloff-Smith (1992: 22-23), however, allows for levels of explicitness of representations which are not yet available to verbalisability. She does therefore not reduce consciousness to verbal reportability. However, at the ultimate level of explicitness the representation is encoded into a format which, she hypothesizes, is close enough to natural language for easy translation into communicable form.

Language, according to Lakoff, Johnson (1980) and Pinker (2007), provides us with tangible proof of these cognitive operations. This ability to produce variation by recombination becomes evident, when we look at language's compositional character. By recombining words to form new sentences, there are indeed no limits to the amount of sentences with distinct meaning we can create. This implies that there are no limits to the amount of representations the human mind can come up with. We can, in other words, endlessly recombine those building blocks we gather from perception and conceptualization into new representations. Moreover, our ability to extend representations to previously unknown domains is evident when we look at the metaphorical character of language. As shown by Lakoff and Johnson (Lakoff & Johnson 1980; Johnson 2007) our language is pervaded by metaphors, pointing at our ability to map body-based, sensory-motor source domains – i.e. innate reasoning patterns – onto new abstract target domains, by means of conceptual metaphor (Johnson 2007: 177).

5.3 Epistemic Value System

As argued above, without an epistemic value system – i.e. an epistemic goal and values or criteria for realizing this goal – there can be no transgression of biologically based views, since this entails not only the substitution of commonsense views with alternative ones, but also the perception of the latter as epistemically better than the former. Therefore, the human mind has to possess an epistemic goal and epistemic values in order to rise above its uncritical assumptions.

Such a goal, it bears no doubt, is our predisposition to look for truth. Papineau (2000) argues that the search for truth is an innate drive, much like hunger and the desire for sex. It is, in other words, part of our innate endowment, a product of natural selection increasing our chances to succeed in our practical projects and thereby boosting our biological fitness (202). This drive underlies the remarkable curiosity we exhibit as a species, our hunger for knowledge and our need for justification before adopting a belief. We are, in this regard, cognitively predisposed to judge beliefs in terms of their truthfulness. Truth or the concept of justified beliefs, however, remains vacuous without criteria in terms of which it can be realized or in terms of which these beliefs can be justified.

These criteria are epistemic values. They enable us to compare different representations and infer which one offers the best explanation. Which representation, in other words, approximates 'truth' the most and is most justified to believe. According to Kuhn (1977: 321 - 322), such values include: accuracy (predicting all or most data and explaining away the rest), consistency (both internal and with other relevant and accepted theories), scope (the consequences of a theory should extend as much as possible beyond the data it is required to explain), simplicity (explaining the data as economically as possible) and fruitfulness (degree to which a theory permits to make new predictions).[13] More basically, they boil down to: predictive accuracy (a representation should be confirmed in its predictions by states of the world), coherence (the elements within a representation should not contradict each other, nor should the representation be in contradiction with other representations), scope (a representation should ideally explain all data) and, more controversially, a sense of aesthetics (between two theories explaining the same amount of data in a coherent way, the most elegant formulation – i.e. the most economical one – carries away our preference). Longino (1990: 4) refers

13 Kuhn claims that these five criteria provide the shared basis for acceptance of a theory over another. However, he argues, this shared basis is not sufficient to determine scientific choice, i.e. to eradicate the incommensurability that governs over competing paradigms (Kuhn 1977: 331).

to those criteria as constitutive values. They are values 'by which to judge competing explanations' and are 'generated from an understanding of the goals of science'. They can be contrasted to contextual values, which are 'personal, social and cultural values'. The latter depend on the particular cultural context in which science is conducted, while the former are derived from the very enterprise of scientific enquiry itself.

Carruthers (2006: 347) argues that those epistemic values – i.e. Longino's constitutive values – are most probably innate, for they seem universal to human cultures, from hunter-gatherer societies to western scientific communities. Those values underlie, in other words, not just modern scientific reasoning, but all of human kind's belief forming about the world. Furthermore, Carruthers points out, they are not – at least among hunter-gatherers – explicitly taught. Therefore, these epistemic values must be part of our cognitive endowment, much as our innate drive to search for truth.

I agree with this analysis on a more principled basis. How indeed would humans ever have transgressed their biologically determined scope on the world, were they not already endowed with an epistemic value system inciting them to question their assumptions and look for alternative, *preferred* representations? Without those values or epistemic guidelines there could be no preference for one representation over another and with this lack of preference, there could be no motivation, nor meaning in producing alternative – i.e. transgressing – views. Therefore, just as our predisposition to look for truth, at least some of those values must be anchored in our innate cognitive make-up and cannot be purely cultural products, since culture itself depends on the transgression of our biologically constrained view of the world. Indeed, without the ability to transgress its innately predisposed ways of viewing of the world, humanity would never have entered the cultural realm, in which the world comes to be viewed through a rich tapestry of diverse spatio-temporal perspectives instead of a singular species-specific view.

Furthermore, the claim that epistemic values have an innate basis, is backed by empirical research on simplicity. Lombrozo's (2006: 233 - 235) experiments point at a preference for simpler explanations (i.e. explanations invoking less causes) and the role of simplicity in probabilistic reasoning. Finally, it seems hard to conceive that we are predisposed towards truth without possessing epistemic criteria. Indeed, how could we be endowed with an innate drive to represent the world truthfully, without the necessary tools to respond to this drive?

6. Conclusion

I set out to answer the question of how the human mind can be predisposed to conceptualize the world in a particular set of ways and at the same time be able to overcome these biologically determined views. It appears that there are three main faculties underlying this cognitive feat. The first is our ability to metarepresent, representing the representations we hold and their parts. The second is our ability to produce alternative representations by recombining elements we gather from input and conceptual domains unlimitedly and transferring our modes of representing to other previously unconceptualized domains. The third is our possession of an epistemic value system, enabling us to rank representations with regard to epistemic desirability.

These three abilities are the cornerstones of the human ability to transgress its biologically based view of the world and are therefore the source of the unique cognitive achievements that characterize homo sapiens and distinguish it from all other creatures on this planet. They provide us with the cognitive flexibility that enables us to overcome the outputs of our 'hard-wired modules', parting with our nature into this awe-inspiring diversity of human culture.

This, of course, does not imply that all transgressing theories can be accounted for merely in terms of these three cognitive faculties. Indeed, quite obviously, someone living in 5000 B.C. could not have come up with the theory of relativity. To do this, he or she would have to have stumbled upon a number of crucial astronomic discoveries – not in the least that the earth is round and orbits the sun – developed mathematics to a breath-taking degree of complexity and developed the proper technology for all these astronomic discoveries, at the very least a powerful telescope. Einstein's ability to formulate his transgressing view of the universe, in this light, is not the just the product of his own cognitive abilities but – to a very important extent – of the impressive body of accumulated knowledge he was born into. Indeed, theories do not originate in thin air; they are built upon previous theories, which again are founded on an older set of theories. However, the very possibility of embarking on this chain of theories – transgressing its species-specific set of uncritical representations, as homo sapiens has done – is grounded in this three-fold ability to represent its own representations, to produce alternative representations with the available resources and to give these representations an epistemic orientation.

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