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Discussion

The language marker hypothesis

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ABSTRACT

According to *the language marker hypothesis* language has provided *homo sapiens* with a rich symbolic system that plays a central role in interpreting signals delivered by our sensory apparatus, in shaping action goals, and in creating a powerful tool for reasoning and inferencing. This view provides an important correction on embodied accounts of language that reduce language to action, perception, emotion and mental simulation. The presence of a language system has, however, also important consequences for perception, action, emotion, and memory. Language stamps signals from perception, action, and emotional systems with rich cognitive markers that transform the role of these signals in the overall cognitive architecture of the human mind. This view does not deny that language is implemented by means of universal principles of neural organization. However, language creates the possibility to generate rich internal models of the world that are shaped and made accessible by the characteristics of a language system. This makes us less dependent on direct action-perception couplings and might even sometimes go at the expense of the veridicality of perception. In cognitive (neuro)science the pendulum has swung from language as the key to understand the organization of the human mind to the perspective that it is a byproduct of perception and action. It is time that it partly swings back again.

Some three decades ago Antonio Damasio launched the so-called *somatic marker hypothesis* (Damasio, 1994). According to his view human cognition, emotion and motivation are highly intertwined in the human brain. Damasio argues that the view that cognition (mental processes) can be segregated from bodily signals, which he describes to Descartes, is wrong[1]. Cognition, seen as operations on purely symbolic representations does not allow us to survive. Cognition needs to be stamped by somatic markers (drives, motives, emotions) to steer its course.

Damasio's view is in stark contrast to an idea that was prominent at the beginning of the cognitive revolution in the sixties and seventies of the last century, namely that a key feature of the human mind is a language of thought with language-like characteristics (e.g., Fodor, 1979). But Damasio's influential view is similar in spirit with ideas advocated by proponents of embodied language and cognition. Although there are many versions of embodied cognition, the common denominator is that the idea of the human mind as analogous to the symbol manipulating operations of the digital computer is deeply flawed (Barsalou, 2008; Pulvermüller, 2013)[2]. Cognition and language are grounded in perception and action and need to be specified according to the formats of these systems. In this context an influential view is that mental operations are imagistic and that conceptual information should be specified in terms of cognitive maps in which conceptual relations are co-determined by spatial coordinates (Buszaki, 2019; Churchland, 2012; Bellmund et al., 2018; Behrens et al., 2018; Hawkins, 2021; for a formal account, see Gärdenfors, 2014). Simulations stamped by features analogous to the spatial and temporal layout of events in the world are core operations of human cognition.

These views are relevant and necessary corrections on an account of the human mind solely in terms of propositional attitudes. Propositional attitudes are mental relations that agents entertain towards sentence-like propositions such as Mary's *believe* and *desire* relations to certain propositions, as in “Mary believes that Paris is the capital of France” and “Mary desires that Raphael Nadal wins the Australian Open”. This idea about mental states is too limited. For instance, imagining and imagery might have visual characteristics that are not merely language-like. Nevertheless, it is an undisputed fact that humans stand out in the animal kingdom by commanding a complex system of natural language.

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[1] In Descartes' Error, 1994, Damasio attributes the cold cognition view to Descartes; but see Draaisma, 2004 for evidence that Damasio interprets Descartes' view incorrectly.

[2] Some of the key findings in the embodied language literature have been hard to replicate (Montero-Melis, van Paridon, Ostarek, & Byland, 2022; Zeelenberg & Pecher, 2016).

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Although there is disagreement about the evolutionary advantages of language (was it selected for communication or for thinking?), it has created enormous potential for both communication and thinking. It has created a 'center of narrative gravity' (Dennett, 1992) or a 'center of cognitive gravity' (Churchland, 2012) in which neural signals related to perception and action will be integrated. The split-brain studies of Michael Gazzaniga and colleagues have found the center of narrative gravity to be largely localized in the left hemisphere (in his words, the left-brain interpreter; Gazzaniga, 2008). This language-based center of narrative gravity makes the coupling between perception and action less direct, and opens a large space for reasoning and inferences. Despite the centrality of language in the make-up of the human mind, its impact on all aspects of human cognition (e.g., perception, action, memory) has been underappreciated in recent decades (cf. Lupyan, 2016; Lupyan & Clark, 2015; Lupyan & Clark, 2016). The *language marker hypothesis* that I propose puts language back at center stage, where it was in the report of the Sloan Foundation (1978) at the start of the cognitive revolution in the seventies of the last century.

The *language marker hypothesis* claims that language has provided *homo sapiens* with a rich symbolic system that plays a central role in interpreting signals delivered by our sensory apparatus, in shaping action goals, and in creating a powerful tool for reasoning and inferencing. This view provides an important correction to embodied accounts of language. The risk of these accounts is that they try to reduce language to action, perception, emotion and mental simulation (cf Barsalou, 2008; Pulvermüller, 2013). However, interactions between these functions and language is not a one-way street. The presence of a language system has important consequences for perception and action (Lupyan, Abdel Rahman, Boroditsky, & Clark, 2020; Thierry, Athanasopoulos, Wiggett, Dering, & Kuipers, 2009). Language stamps signals from perception, action, and emotional systems with rich cognitive markers that transform the role of these signals in the overall cognitive architecture of the human mind. This is illustrated by findings that words facilitate categorization processes in perception differently than non-language cues by selectively highlighting the stimulus feature that is most diagnostic of the perceived object (Lupyan, 2008, 2012), and they enable abstractions from perceptual token events (mapping of tokens to types; cf. Lupyan & Bergen, 2016)[3].

Additional examples of language markers can be found in other behavioral and neuroimaging studies. In an fMRI study, de Araujo, Rolls, Velazco, Margot, and Cayeux (2005) scanned participants while the authors applied a test odor to the participants' nose. In one condition the test odor was accompanied by the verbal label "body odor", in the other condition by the verbal label "cheddar cheese". They found that the verbal labels had a label-specific modulatory effect on the activation in brain areas that are involved in processing olfactory stimuli. These areas included primary olfactory cortical areas such as the pyriform cortex. Verbal labels are also found to influence perceptual decisions, such as the perception of motion (Francken, Kok, Hagoort, & de Lange, 2014). But in addition to perception, low-level action kinematics can be influenced by verbal information as well. Gentilucci, Benuzzi, Bertolani, Daprati, and Gangitano (2000) asked participants to reach and grasp objects. On these objects words were printed indicating their size, such as "piccolo" (small) or "grande" (large). Although the size of the objects was the same for both verbal labels, the kinematics of the automatic initial phase of reaching-grasping was nevertheless affected by the meaning of the words printed on the objects. This is compelling evidence that language can influence motor control. It is important to realize that the *language marker hypothesis* does not claim that *only* verbal labels (words) can be priors that influence perception and action. Nevertheless, they seem very powerful 'cognitive gadgets' (Dove, 2020; Heyes, 2018) that can influence what were once believed to be low level informationally encapsulated processes (Fodor, 1983)[4].

However, there is much more to language than single words. The power of natural language is based on the design features of the human language system. This system can flexibly combine a relatively small repertoire of lexical elements (e.g., words, or signs in the languages of the deaf) to create a potentially infinite series of novel messages and thoughts. The lexical elements together with the combinatorial machinery create an imaginary space that transcends the influence of direct perception-action cycles. Language provides a symbolic machinery to extend our temporal (e.g. by means of a verb tense system; i.e. grammatical markers for present, past, future) and spatial (e.g. by means of spatial terms) horizon and to go beyond current states of affairs (e.g., by means of counterfactuals, negation, quantification and conditionality). Seuren (2009, in press) points out correctly that in many cases our language-based mental models create virtual realities that have no life outside the mind; that is, they don't refer to the real world. Such mental models "lack actuality but nevertheless … the entities, states of affairs and events occurring in them can be thought and spoken about, and quantified over, with the same ease and naturalness as their counterparts in actual reality are." (Seuren, in press). We can populate our mental models with virtual concepts such as angels, unicorns, the present king of France, green ideas, etc. that have no existence in the external world. Language allows us to create symbolic landscapes that color our internal mental models beyond their embodied characteristics. This is what I have called the *enlanguagement* of the mind, elsewhere referred to as language-augmented thought (Lupyan, 2012). Its effects do not need to be overtly verbal. They can be based on the implicit reasoning skills that are strongly influenced by the properties of our capacity for language.

A paradigmatic case for the implicit nature of certain language markers are the so-called placebo effects. Although some of these effects might be found in other species, to the best of our knowledge they are by far the most powerful in *homo sapiens*. Neuroimaging studies on the effects of placebo treatment for pain have found that a placebo affects the same brain areas that are modulated by medical pain treatment (Petrovic, Kalso, Petersson, & Ingvar, 2002; Wager et al., 2004; Meissner et al., 2011; Benedetti, 2014). Placebo effects are to a large extent based on features that trigger implicit inferences which emulate the effects of drugs with known mechanistic consequences for sensations such as pain (Lupyan et al., 2020). Implicit symbolic markers are thus a powerful instrument to modulate the force of bottom-up external input. Interestingly, degeneration and disconnection of language-relevant regions in the frontal lobes have been found to result in a loss of verbally induced analgesic responses in Alzheimer patients (Benedetti et al., 2006). Impairments of our center for narrative gravity seem to reduce the placebo effects. But the opposite could also be the case. The implicit verbal label (e.g., the word *pain*) might amplify the experience of pain. One way to downregulate the verbal label effect is semantic satiation. Semantic satiation is the phenomenon that many repetitions of a word causes it to temporarily lose meaning (Jakobovits, 1962). The patient will perceive the word *pain* as repeated meaningless sounds. The language marker hypothesis predicts that this will affect the experience of pain. No such

[3] A related issue is that of linguistic relativity, also known as the Sapir–Whorf hypothesis. According to this hypothesis the structure of a particular language affects its speakers' perception or cognition. This essay focuses on general effects of language. It doesn't address how these effects might differ as a consequence of language diversity.

[4] A key characteristic of Fodorian Modularity (Fodor, 1983) is informational encapsulation. To safeguard the veridicality and the speed of perception, input modules should be closed to influences from higher level cognition. Studies such as the one by de Araujo, Rolls, Velazco, Margot, and Cayeux (2005) indicate that input modules are less encapsulated than claimed by Fodor. Moreover, Fodor's prime example for informational encapsulation is the Müller-Lyer illusion. I have always found it somewhat ironical that a non-veridical percept was the example *par excellence* in defense of an account that should safeguard the veridicality of perception.

evidence is currently available, but testing this prediction can give us some further insights into the role of language markers on the perception of pain.

Let me further illustrate the power of implicit language-based reasoning with a case described in Suzanne O'Sullivan's marvelous book "It's all in your head: true stories of imaginary illnesses" (O'Sullivan, 2015). Linda had noticed a small lump on the right side of her head, which upon medical examination turned out to be a harmless lipoma. This diagnosis, however, did not stop Linda worrying that something serious was going on in her brain. Soon she developed symptoms on the right side of her body, such as weakness of the right arm and leg, further amplifying her belief that her brain was seriously affected by the lump in her skin. What Linda didn't know is that the right hemisphere controls the left side of the body and, therefore, the symptoms that she experienced just could not be caused by a right hemisphere brain damage. Her chain of reasoning created somatic symptoms that were inconsistent with how our brain controls our body. Although such reasoning does not require overt verbalization and can be largely implicit, it seems to depend on declarative knowledge, which is conceptual and propositional in nature. Language and reasoning are thus not just harmless afterthoughts without causal power, as some have argued (e.g., Lamme, 2010), but they can influence our perceptions, actions and bodily sensations. They have causal efficacy in the interaction with the other faculties of the mind[5].

In the tradition of Kant and Helmholtz, recent accounts of human cognition see the brain as a prediction machine (Clark, 2016; Hohwy, 2013). We interact with the world on the basis of internal generative models. These models are confronted with the sensory data transduced through the eyes, ears and other sensory organs. In case of a mismatch between prediction and evidence, a prediction error occurs, and our internal models are sometimes but not always updated. Hence, bottom-up sensory signals are the feedback on the internal models of the world. Innate predispositions and experiential statistics generate the expectations that determine our perceptual inferences. A nice example is the hollow face illusion (Gregory, 1980; see https://michaelbach.de/ot/fcs-hollowFace/index.html). This illusion is that we are usually unable to perceive a rotating hollow mask as hollow. Instead, we perceive it as convex, with the nose and lips sticking out, despite visual cues that suggest concavity. Top-down predictions guide our perceptual experience. The prediction machine account presupposes a substantial brain-internal computational contribution. In fact, there is neurophysiological evidence supporting this presupposition. For instance, in the visual system the afferent projections that travel from the retina via the lateral geniculate and thalamus to the primary visual cortex comprise only a small percentage of all excitatory synapses, in the order of 5–10% (Douglas & Martin, 2007). This suggests that to a large extent the brain is minding its own business. Part of this business is the generation of internal models of the world, including the causal inferences of sensory input.

The brain is a prediction machine in humans as well as in other species. Nevertheless, through language the chain of causal inferences is much more extended in humans compared to other species. The language marker hypothesis states that our uniquely human language capacity provides *homo sapiens* with additional machinery for the creation of rich internal models. It supports the molding of the "blooming buzzing confusion" (James, 1890) of internal neural signals in the format of the internal language-based center of narrative gravity. Our language capacity provides the cognitive toolkit with the possibility to create rich generative models of the world. We don't have direct access to the world itself. Instead we "only have direct access to the events at the nerves, that is, we sense the effects, never the external objects" (Helmholtz, 1867). But linguistic instructions can determine how and where we look for sensory evidence. Our eye gaze is directed by linguistic information that creates a search light for engaging with the world as transduced through our sensory apparatus (Altmann & Kamide, 1999; Heyselaar, Peeters, & Hagoort, 2020; Yarbus, 1967). A nice example is provided in an elegant study of Bock, Irwin, Davidson, and Levelt (2003). These authors asked participants to inspect a clock and tell the time in a digital or analog format, while their eye gaze was measured. They found that their eye gaze was largely determined by the linguistic structure of the expressions. In the digital clock condition, their eyes first fixated the hour, and then the minutes in line with the order of mentioning (e.g., *ten twentyfive*). In the analog clock condition it was exactly the opposite as a consequence of the order of mentioning (e.g., *twentyfive past ten*). The authors call this "seeing for saying"[6]. How we speak has a strong effect on how we guide our eyes to sample the world.

We already saw that the strong expectations based on our internal models can go at the expense of the veridicality of perception. Is this effect amplified by language? The answer seems to be yes. Etcoff, Ekman, Magee, and Frank (2000) presented participants with facial expressions based on real emotions and fake emotions. Real and fake emotions differ in subtle facial expressions, due to the involvement of different facial muscles (Duchenne de Boulogne & Cuthbertson, 1990). Most people find it hard to see the differences. Etcoff and colleagues found that healthy controls and patients with a right hemisphere lesion were at chance in distinguishing facial expressions for real and fake emotions. In contrast, aphasic patients scored well above chance (73% correct). A reduction in the availability of language-based markers in the aphasic patients increased the reliance on sensory cues and hence improved the veridicality of perception.

Veridicality of perception is, however, not a major target of our cognitive skill set. I concur with Buszaki (2019) "that the brain's main function is not veridical perception and representation of the objective world with its mostly meaningless details, but to learn from the consequences of the brain's actions about those aspects of the environment that matter for particular goals, such as reduction of hunger." (p.61; see also Frith, 2007). Cognitive control is further needed for the selection of the relevant actions.

In this context, language acts in two different directions. On the one hand, it has an inward directionality, in that it allows us to have conscious access to parts of our internal models (Jackendoff, 2007); that is, it can make us aware of the neocortically based declarative knowledge that is a key component of some of our internal models. The outward direction of language enables us to externalize our internal models. Our language markers are negotiated between the members of a language community. In this way, internal models can be shared with other members of the community, and become socially shared models. This provides common ground for joint action (Clark, 1996) and knowledge accumulation, a major game changer in our evolutionary history. Since language is a biocultural hybrid (Evans & Levinson, 2009), our internal models will be shaped by external influences from the conventionalized use of language. It results in the social alignment of people in the form of religions, ideologies, myths, and science (Harari, 2012). But also, in how speakers and listeners align in conversations, and in what a listener infers from the speaker's utterance. For instance, it is found that in conversations with their physician patients interpret the same message very differently dependent on how it is packaged into words. When the patient hears that with a specific treatment there is a 90% chance of survival, this leads to a very different reaction than the message that there is a 10% chance of death (Kahneman, 2011; Kahneman & Tversky, 1979). Same information, but packaged in a different way. This is only one

[5] In addition language creates and maintains the elaborate structures of human social institutions (cf. Searle, 2010).

[6] The expression "seeing for saying" is inspired by Slobin's thinking-for-speaking hypothesis (Slobin, 1987). According to this hypothesis the speaker has to direct her attention to those aspects of objects and events that need to be grammatically specified in the to-be-produced linguistic utterance within the given language.

example among many. Language matters, the concomitant non-verbal communication signals (co-speech gestures, eye gaze, body language) matter. How information is packaged in multimodal language will co-determine the effectiveness of medical treatments and many other aspects of human life.

In short, the language marker hypothesis does not dispute that the origins of language and language development are largely grounded in perception and action. But on top of it there is its relatively independent contribution to the cognitive architecture of the human mind. This contribution might feed back into non-linguistic cognitive and perceptual systems. Cross-species comparisons of perception, action and memory should not ignore the possible role of language in these domains in the case of *homo sapiens*. This does not contradict that language is implemented by means of universal principles of neural organization. However, the internal models that these allow us to create are shaped and made accessible by the characteristics of a linguistic system. In cognitive (neuro)science the pendulum has swung from language as the key to understanding the organization of the human mind to the perspective that it is a byproduct of perception and action. It is time that it partly swings back again.

Data availability

No data was used for the research described in the article.

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