The realm of subconscious perception

Exploring the Labyrinth

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We still know very little about a sense whose function we hardly ever notice, but whose dysfunction is immediately problematic

Using Cartesian categories and oversimplifications to study the complex realities of nature, moreover under the false assumption that perceptional phenomena occur mainly within the conscious realm of our cognitive processes, usually gives rise to mistaken conclusions. This can be illustrated by research on the sense of balance, which functions outside our domain of consciousness. This subconscious nature of some of our senses leads us to make errors in evaluating our surroundings and to experience difficulty in objectively assessing perceptional phenomena that lie hidden within our psychic realm. That requires us to stay on our guard against the immanently illusive nature of any cognitive processes that always involve the senses. Warnings of a similar sort have been raised by such great philosophers from various cultures and epochs as Buddha, Parmenides, and Immanuel Kant. The career path of the Austrian scholar Ernst Mach (1838–1916) might serve as an indicative example here: he first took an interest in mechanics, then in high speeds, and then in the sense of balance, to ultimately become... a philosopher.

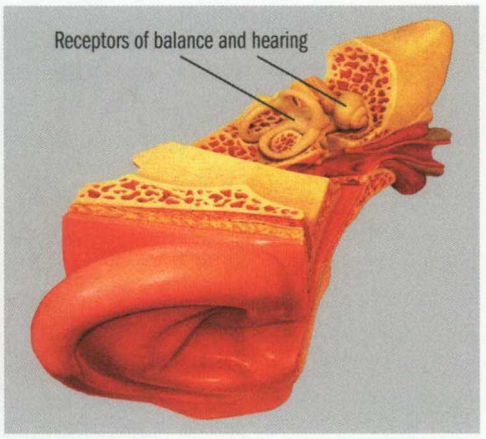
The realm of the subconscious

Functioning entirely within the subconscious realm, the sense of balance is hard to study or diagnose. Paleontologists maintain that, evolutionarily, adopting an upright posture freed up our arms and enabled us to use tools, which in turn stimulated the human brain's development through abstract thought and practical action. The sense of balance, stimulated by bipedalism, therefore contributed immensely to the advancement of our conscious civilization. An effective sense of

Robert Linder, www.sxc.hu

Reality is impermanent. Internal contradictions trigger development. *Panta rhei* – everything is in a state of flux. Information from the senses is processed by the mind – thoughts ascribed to Heraclitus (ca. 540–480 BC), dubbed "the Obscure" by other ancients

The sense of balance functions entirely within the subconscious realm, and moreover the labyrinth organ is concealed deep within the cavities of the skull, making it hard to access, study, and diagnose



University of Strathclyde

balance is crucial for orientation and for the development of anti-gravitational postural reflexes for standing, walking, running, jumping, and other evolutionary advances. Balance is even useful while in sitting or lying position.

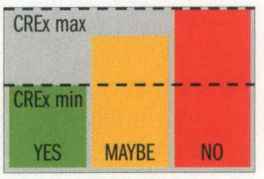
The first anatomical description of the labyrinth (the portion of the inner ear responsible for the sense of balance) was given by the Swiss anatomist Albrecht von Haller in 1786. Nowadays we know that the paired labyrinth organs consist of 6 semicircular canals and four otolith maculae, including some 20,000 hairy nerve cells of a type and number similar to those found in the nearby aural organs. In conjunction with the faculty of vision and the matrix of kinesthetic receptors situated around the body (for the subconscious sensation of tension states in the muscles, tendons, and ligaments, of bone loads, and of joint angles, pressures, and speeds) plus specialized brain centers in the cerebellum and hippocampus, the labyrinth stimulates mental development in childhood, provides a sense of direction, space, and body balance, and aids in reading, communication, and control of the environment, i.e. assisting us in ensuring our safety.

The otoliths are above all sensitive to linear acceleration, while some authors also consider them sensitive to angular acceleration and sometimes to the force of gravity as well. According to NASA research, the otholiths paradoxically provide a more precise - albeit subconscious - sense of linear displacement than the visual clue does. The receptors of the semicircular canals, in turn, are considered sensitive solely to angular acceleration.

Labyrinth model

Inquiry into how the labyrinth functions was stimulated by a desire to explain the observed fact that paralysis patients, when set upright for the first time following spinal injury, intuitively tilt their head to the side or rear. The present author's own bioflow model, Combined Rotational Exposure (CREx), represents an attempt at modeling the directional sensitivity of the membranous labyrinth. Better knowledge of how directional orientation affects labyrinth function may open up new possibilities, e.g. about the most favorable positioning of a hypersensitive individual's head while swinging. The concept of the CREx model involves summing up the relative values of each of the six semicircular canals' exposure to a momentary head rotation vector, standardizing the maximal output value to 1. As a simplification I assumed that all the semicircular canals retain their angular orientations but are located at the head's central point, that the head's momentary axis of rotation runs through that point, and that the head is "severed" or unconnected, enabling it to rotate freely around its central, arbitrarily oriented axis. As a measure of the elementary exposure of a given canal, I adopted the standard model of the cosine of the angle between the current vector of rotation and the normal vector to the canal's plane.

Under this model, the conventional head gestures used for a gradated series of expressions, running from acceptance through uncertainty to negation, correlates with the gradated summary exposure of the semicircular canals: the gestures YES, MAYBE, and NO show rising CREx values of 0.5, 0.8, and 1, respectively. The head gestures utilize the individual canals directionally sensitive to such stimulation across the labyrinth's entire available active range of rotational sensitivity. The intermediate expression MAYBE also shows an intermediate CREx level, which seems to evidence that cultural processes are closely linked to biology. The submaximal exposure seen for rotational oscillations around the head's vertical axis, in turn, is related to safety, as a higher definition of rotational control around this axis aids in precise head positioning and eye movement, facilitating more efficient scanning of the environment.



Maciej Pokora

CREx values for conventional head gestures

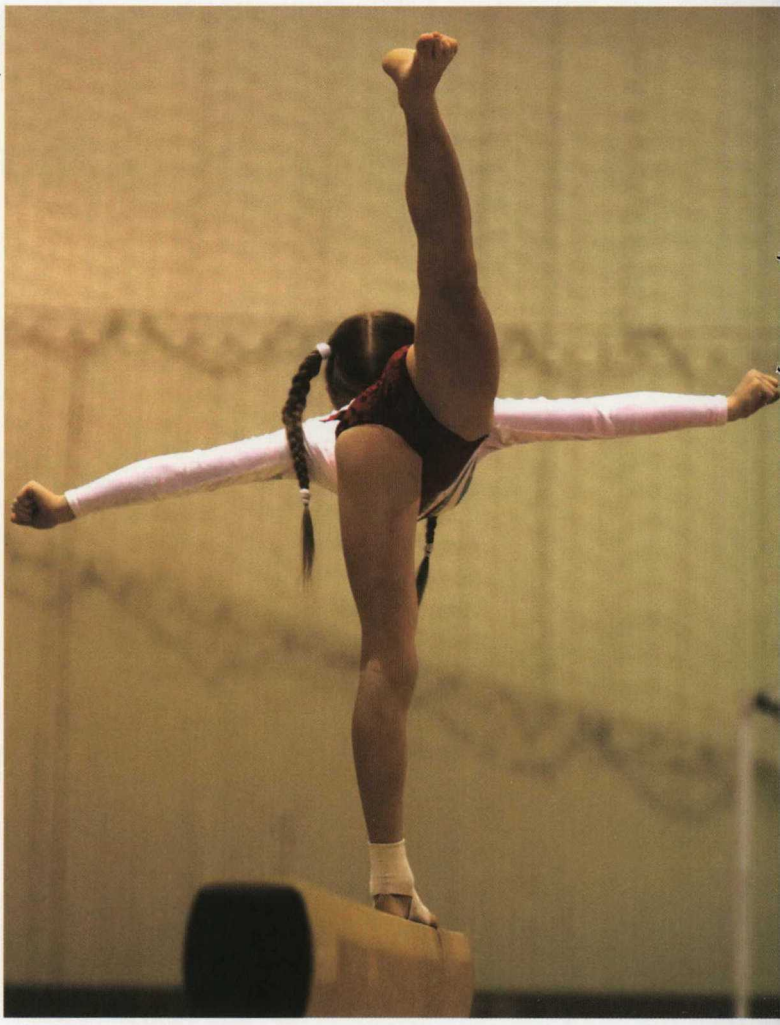
It is perhaps for similar reasons that this rotational side-to-side head gesture is typically associated with the expression NO, with negating something, as we then put ourselves at risk of attack. I have suggested the hypothesis that negation has thus preserved an evolutionarily advantageous reflex in our ancestors to prudently scan the situation left and right, an action that itself eventually became a synonym for the word NO. The fact that the Greeks and Bulgarians use head gestures otherwise merely confirms that there is an exception to every rule.

With the head tilted laterally, micro-movement testing in the sagittal plane showed that the estimated CREx value may increase by up to 20%. Tilting the head sideways, thereby altering the visual vertical/horizontal stereotype important for visual support of anti-gravitational reflexes, therefore helps post spinal injury patients to develop new balance mechanisms more quickly. This also shows that the adoption of such a position by individuals carrying shaky loads, and sometimes also by children, may not be motivated solely by seeking counterbalance, given the position's probable advantages for labyrinth function. The CREx model's consistency with such behavioral stereotypes, both in neuromotor deficits and in the norm, seems to confirm its choice of modeling procedure and simplifying assumptions.

These results have piqued the interest of such specialists as Prof. Dan Merfeld (Harvard University) and Prof. Nicholas Wade (Dundee University, Scotland). Dr. Stuart Smith, following a lecture on CREx at University College Dublin, came to Warsaw to team up in developing diagnostic and therapeutic methods for fall-prone individuals. Such labyrinth dysfunction is increasingly appearing also in young individuals, perhaps a consequence of their increasing use of cell phones. It turned out that Dr. Smith, investigating the directional characteristics of the otoliths during his post-doc at NASA Ames Research Center in California, had in fact made use of a dyslexia diagnosis system developed at the Institute of Biocybernetics and Biomedical Engineering, Polish Academy of Sciences, by the team of Assoc. Prof. Jan Ober.

Although the sense of balance facilitated human evolution by freeing up our arms, it was not actually recognized as one of the senses until the 20th century. It replaced as the "6th sense" the even less explored intuition (receptor(s) of subtle outer signalling), which was therefore duly shifted down on our senses' list. The existence of the sense of balance is not contested anymore, while this intuition still remains in question.

Raphael Goetter



A well-functioning sense of balance is crucial for orientation and developing anti-gravitational postural reflexes for standing and walking, as well as other evolutionary advances like running, jumping, dancing, swimming, and diving

Patently wrong

While the anatomical term "labyrinth" originally derives from the inner ear's maze-like structure, the organ's name might also be considered in reference to its role in assisting us in our endless quest to navigate, error-free, the tricky "maze" of the world around us, so fraught with potential blunders and missteps. One such insidious error was the source of a certain confusion involving a patent for a flow-inertia gauge of inclination and acceleration that developed out of my research on the biological labyrinth. The patent's main claim relates to increasing the sensitivity of such a

device - a tube shaped as a convex arc filled with liquid and a gas bubble. While devices of this sort have been known for centuries, no one before 1997 had patented the special feature that such a sensor exhibits greater sensitivity when tilted sideways.

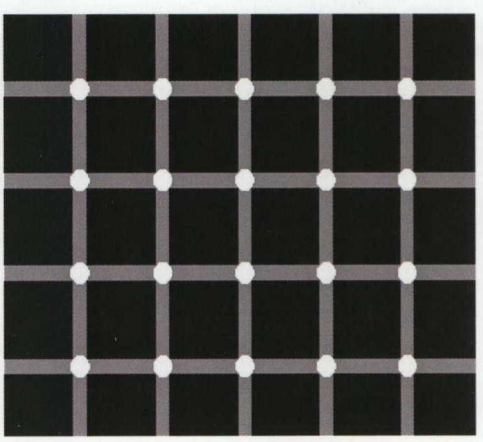
The patent was granted after nearly 7 years, once it was demonstrated that changing the orientation of a known device was indeed something patentable (Pokora M. Patent PL 188317, 2004).

The gas bubble trapped inside such a sensor moves in the direction of acceleration, seemingly violating Newton's third law. It was most likely by overly focusing on this moving bubble that the specialists of a reputable automaker, working independently from me to invent a similar sensor as an air-bag release, drew incorrect markers of direction (running counter to the laws of physics) on the drawings for both their original patent DE 3815938/1988 and in their subsequent US patent. The Polish Patent Office instructed me to remove this annotation from my own patent application, presumably due to confidence in such a prominent brand name and in German technological prowess. It took a simple test to verify the true state of affairs.

How can we avoid making such errors or "wrong turns" without being more aware of their genesis? Neurophysiological research indicates that both under-sufficient and over-sufficient knowledge can be unfavorable to decision making processes. The conclusion is that we should take advantage of what we know, before we know too much. Research with animals, in turn, suggests that survival chances are somewhat greater if decisions - assuming they cannot be made optimally - are made too early rather than too late.

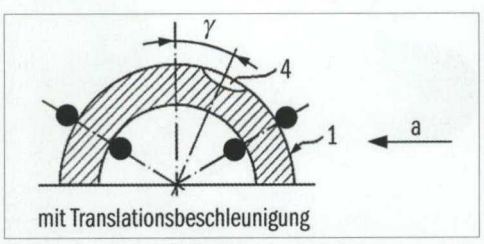
By studying the mechanisms of subconscious mistake-making and recognizing that interpersonal differences are frequently at play, we might glean a better understanding of certain ill-understood phenomena, perhaps even the origin of conflicts. Even individuals who know how to count well will experience difficulty in counting the black dots that appear in peripheral vision on the Hermann grid (modified by Hartline et al. 1956, Baumgartner 1960, Bergen 1993, Lingelbach 1995). This is an example of how unobjective and illusory our perception of reality is. While we are already aware of this and other traits of our physiology, explaining various states of our conscious and subconscious minds remains a challenge for the future. Buddhist philosophy, maintaining that mutually contradictory states can in fact co-occur, is wise: although uneasy for the Western mentality, it helps us understand such things as quantum phenomena.

Elke Lingelbach



The Hermann grid (shown here in the Lingelbach version) illustrates, in black and white, how very unobjective and illusory our "objective" perception of reality can be

Combining knowledge from the fields of biology and technology can lead to new inventions, new diagnostic and therapeutic methods, and sometimes even broader and deeper conclusions of a holistic nature. Given biological entities' high degree of complexity, the Cartesian imperative of categorizing phenomena and the compartmentalized specialization of various fields of research raises the risk of overlooking subtle interactions crucial to proper biosystem function. The simple Hermann-Lingelbach test reminds us of just how very *humane errarum est*... ■



Bayerische Motoren Werke

Under the force of inertia, liquid molecules in a tube are pushed backward by acceleration and, being heavier, they themselves push the lighter gas bubble forward... Or is that the real story?

Drawing from patent DE3815938, caption: "with linear acceleration"

Further reading:

Pokora M. (2009). Link between common YES-MAYBE-NO head gestures and directional properties of human vestibular system. *Abstracts 9th Biosemiotics Gathering*, Prague.

Pokora M. (2008). Hipokinezja - patogenny deficyt motoryki - oraz sposoby i przykłady przeciwdziałania jej [Hypokinesis - Pathogenic Motor Deficiency - and Methods and Examples of its Counteraction]. *Mechanika w Medycynie, 9*, 177-187.