Dear Reader,

Attached you will find a paper that discusses a reframe of consciousness in the context of evolution. This draft is without any embargo as long as referred to.

As a biologist, personal counsellor and strategist, I am writing a book about the basics of human motivation. In doing so, I came across the little progress of mankind in understanding consciousness. Being a strategist for me a first question was: “What is blocking our progress?”

This is where the paper starts. A query which leads to an unexpected new cognitive frame of consciousness.

After first realizing that the earth isn’t the centre of the universe and after realizing that mankind probably isn’t the centre of creation, this paper suggests that not *we* but the *nervous system* could be the centre of consciousness.

I hope you will enjoy reading it.

Yours sincerely,

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Citation: Dorenbosch, M.M.(2009) The Origin of Consciousness: softening the hard problem. Free essay on internet: draft: 7 Febr. 2009. www.shunyam.com

"THE ORIGIN OF CONSCIOUSNESS"©
"softening the hard problem"©

Draft: 20090207

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Abstract

Consciousness is an intriguing phenomenon. For some reason it conceals its real nature as long as mankind exists. This modest progress could justify the question: "Is the understanding of consciousness really about consciousness itself?" Maybe it is all about the way we look at it? Searching along this line, there is one remarkable aspect in human cognition that possibly could restrain the answer. We all believe to be conscious ourselves. This widespread certainty is discussed in the context of evolution, suggesting that not *we*, but *the nervous system* is conscious.

The approach seems to offer a humble doorstep to the possibility of insight about consciousness, its origin, function, locations and its nature. At the end of the paper the insights are discussed in the context of the hard problem.[2]

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[2] Hard problem: The difficulty to explain mental experiences. Where do they come from?

Conclusions

The main pitfall in understanding consciousness seems our believe to be conscious ourselves. This paper proposes that not we, but our nervous system is conscious. The nervous system has the central task to connect receptor input to proper behavioural output. To this, it needs stable input information. The neurons that decode the ambiguous receptor-input into stable "contrast" seem the candidate building blocks of consciousness.

Activated, these neurons are to compare with the pixels of a contrast decoding "screen" at the input edge of the system. The nervous system uses this "screen" to tune its output on. To do so, it makes use of attention, recognition, learning, steering, routines, etc. Although intertwined, none of these mechanisms seems an essential part of consciousness.

Also, what we perceive as objects, characteristics, interactions, causality etc, could be defined as clusters of associated contrast pixels in the "screen". Beside the pixels no extra conscious layer seems needed. The nervous system uses the clusters of contrast pixels to tune its output on. Also *we* and *self-consciousness* could be regarded as output-features of the nervous system.

The activated screen is to compare with a video, filmed through "our" senses. This places us inevitably in the centre of the film. Maybe this explains why unavoidable think to be consciousness ourselves.

This all doesn't mean that the "Cartesian Theatre" is back.[3] There is no watcher needed. The "screen" itself is to regard as consciousness. To the nervous system, the "screen": describes input together with its output options at one and the same moment.

The nervous system and consciousness probably evolved together from the start ca 650 million years back. To evolution, the neural connections between input and output meant an unexpected possibility to store information in a very fast way. Till then evolution needed several generations to store one item in the DNA-code. This is probably why neural complexity boomed from day one.

Each input-output-connection is to regard as a memory unit. Each unit describes a specific piece of the outside world together with its behavioural consequences. This means that output is defined by the input side. This could explain why consciousness is restricted to input information. We don't experience the output to muscles and glands. This also could explain why we experience a gap between our mind and body. The connection is just there, but we literally are half aware of it.

During the first part of neural evolution, input-output-connections probably were simple reflexes, converting receptor activation directly into behaviour output. Somewhere in evolution, emotion (unconscious "body"-reflex) is inserted halfway this trajectory. This step created the possibility to perceive and learn, independent to direct behavioural output. At the same time this opened the door to behaviour-free thinking and dreaming as we experience to day.

[3] Cartesian theatre (2008) http://en.wikipedia.org/wiki/Cartesian_theater : Metaphor, imagining a tiny theater in the brain in which a little man or woman is sitting, watching a movie that is recorded through our senses.

Putting the nervous system in a central position creates ground to discuss the function, the definition and the unit of consciousness. It also offers a conceptual context to the interaction between consciousness and aspects like learning, steering, thoughts and self-consciousness. Options of bridging the explanatory gap seem promising

Introduction

Consciousness is a strange phenomenon. We all experience it, but no-one seem to know what it is. And on to that, in spite of the many theories, there is hardly any progress in understanding. On the other hand, if evolution is true, the fundamental nature of consciousness should be down-to-earth. This could mean that understanding consciousness probably isn't about consciousness itself, but about human cognition. Realizing this was an invitation to leave the well-known boulevards of common thinking for an of the road tour in search for the basic principles of consciousness.

Human Cognition

In human cognition a central hitch is our incapability to think the unknown, and consciousness is an unknown par excellence. Our brain literally is stuffed with what we learned through consciousness, but there is nothing about the nature of consciousness itself. We simply don't know where we are looking for. The only thing we know is, that we all seem to experience consciousness ourselves.

Maybe as a start, we should accept that we aren't able to define consciousness in a direct way. Our only chance seems, to portray it in terms of the known. Gladly, we aren't alone. In fact we describe almost everything in an indirect way. This ranges from the nature of a black hole to simply the meaning of a word. In all these cases we use two options for understanding. Either we describe the object by its periphery, or we draft the logics of its origin. Here we will follow both tracks.

The paper starts with discussion of the periphery. From that we go to the logics of evolution. In a third part we discuss a number of frequently asked questions about consciousness. We end with a discussion of the explanatory gap, the hard problem itself.

Metaphor and glossary

To those who like a more down to earth approach, a metaphor of consciousness is added at the end, called “Blossom Beach Inc”. Also a short glossary is presented.

Periphery

Periphery is to define as the surroundings that interact with the object at issue. In the case of a black hole the periphery i.e. is about gravitational interactions. In the case of the meaning of words we use related words to describe its meaning to us. A tree becomes a tree to us, by its trunk, branches, leaves and roots.

In case of consciousness, the periphery is to describe by the things we perceive through it, by its neural correlates and by its relation to senses and body. In discussing the periphery we start with the daily experience of consciousness. Subsequently we focus at the position of the nervous system, the different components of consciousness, mechanisms, its nature and its function.

Every day experience,

Consciousness we generally experience as the physical world we're in. Through our senses we automatically perceive the world from the position of the "I". It's like watching a film through the lens of a moving camera. At the same time, we have the feeling that we are the camera man, the leading character and the audience of a film we are playing in. *We* are conscious and the director of our behaviour. We think to steer through thoughts and perception and the brain seems to be the tool to do so. Drives, needs, desires, intentions and thoughts, we all consider as created by our selves[4]

In the every day cognitive frame we think to be conscious ourselves. Not like Descartes' "*I think, so I am*" but rather like "*I am, so I think*". However, when it comes to understanding, neither the position of Descartes nor the every day position brought us the

[4] Dorenbosch, M.M. (2009) How Without Free Will, In prep.

insight in what consciousness really is. To break this spell, we almost certainly have to change our cognitive position on consciousness and a suggestion could be to leave our common and comfortable stand of being the centre of this all.

Position of consciousness

If we should not be the centre, who or what could be there instead of us? A good candidate could be the nervous system. As part of our body, the nervous system is the communicational organ par excellence. It has the difficult task to guide the unconscious body through an unknown physical world. To do so, it activates muscles and glands (output) depending on input coming from receptors and stored memory and the input-output-connections that appear profitable, are reinforced for future use (learning),[5]

This simple approach however, creates the possibility of a vast database of input-output-connections within the nervous system. These connections describe the physical world in relation to potential behaviour, and as a consequence, also *we* are in this description. To the nervous system, our body and also our behaviour are part of the physical world outside the receptors.[6]

In conscious terms, the world of the nervous system only exists because of the input-output-connections that are activated. There are two ways to activate; by receptor-input and by input of internal backward loops.[7] [8] During daytime the input of the senses seems

[5] Björn Brembs ,(2007) Aplysia operant conditioning Free University Berlin, http://www.scholarpedia.org/article/Aplysia_operant_conditioning
[6] Proprioception 2009) Wikipedia, http://en.wikipedia.org/wiki/Proprioception
[7] Macnick, S.L., Martinez-Conde, S. (2007). The role of feedback in visual masking and visual processing. Advances in Cognitive Psychology, *vol. 3, no 1-2: 125-152,* http://versita.metapress.com/content/ax751t272743t304/fulltext.pdf
[8] Bogacz, R., Brown, M.W., Giraud-Carrier C. (2000) Frequency-based Error Back-propagation in a Cortical Network. *Proceedings of the IEEE-INNS-ENNS International Joint Conference on Neural Networks, Vol. II*. ISBN 0-7695-0619-4, pp. 211–216.

to prevail, keeping the nervous system (and consciousness) in track with the physical world. During thinking or dreaming, internal loops seem predominant[9]. In all cases the details of consciousness are limited by the detail level of the senses. However, from the evolutionary point, the detail level of the senses will be tuned to the detail level of potential behavioural output.[10]

Defining contrast

To function properly, the nervous system has to recognize input. To do so it needs stable unambiguous neural presentations at the input side of the system. [11] Receptor neurons aren't specific enough for this task. They normally are receptive to a range of related physical or chemical inputs. Also the neurons deeper in the system aren't suitable. Their information contents changes from moment to moment depending on the neurons they connect with. The only candidates left are the neurons at the input-edge of the nervous system, which filter out the ambiguousness of receptor information and translate it into stable unambiguous contrast information.[12] To the nervous system these "contrast decoding neurons" create the "contrast pixels" it has to work with.

However, the contrast-decoding-neurons are just a start. They only are capable to produce "flashes" (electric pulses) in different patterns, but no colour, smell, taste and so on. The system has to translate millions of roughly identical pulses into contrasts which resemble

[9] Ganis, G., Thompson, W. L., & Kosslyn, S. M. (2004). Brain areas underlying visual mental imagery and visual perception: An fMRI study. Cognitive Brain Research, 20: 226 – 241.
[10] Stoytchev, A. (2006). Five Basic Principles of Developmental Robotics. NIPS 2006: Workshop on Grounding Perception, Knowledge and Cognition in Sensori-Motor Experience. Department of Computer Science, Iowa State U.
http://www.ece.iastate.edu/~alexs/papers/NIPS_Workshop_2006/NIPS_Workshop_2006.pdf
[11] Doucette, W., Restrepo, D. (2008) Profound Context-Dependent Plasticity of Mitral Cell Responses in Olfactory Bulb PLoS Biol. 2008 October; 6(10): e258.
[12] Buck.L.B. (2004) Unraveling the sense of smell.
http://nobelprize.org/nobel_prizes/medicine/laureates/2004/buck-lecture.pdf

an unknown physical world. To do so, it uses the information hidden in the pulses and in the spatial distribution of the contrast decoding neurons.[13] [14] [15]

Since the Nervous system doesn't know the outside world, it has to create its own (mental) spectrum of operational contrasts. These self created contrasts we know as colour, smell, taste, touch, sound, feeling, time, etc.. They all refer to the physical world, but none exists as such in the physical world. There are only physical chemical contrasts, no colours, smells, etc.

As a consequence, our conscious perceptions of colours, smell, taste, etc., have to be interpreted as contrasts in the first place. This suggests that the experience of red isn't red as such, but above all not-green and not-blue, but also not-sweet, not-sour, not-fishy, not-loud, etc. The essence is that each contrast is distinctive to all others. Like unique letters of the alphabet make words, the nervous system needs discriminative contrasts to recognize contrast combinations to tune its output on.[16] [17] [18]

Contrast consciousness

To the nervous system, contrast means discriminative input information at the input side of the nervous system[19] [20], in mammals i.e. the outer cortex.[21] [22] This position includes

[13] Gerstner, W., Werner, W.M. (2002) Spiking Neuron Models, Single Neurons, Populations, Plasticity. Cambridge University Press, ISBN 0 521 89079 9 : 40 USD
[14] Davis, K.D., Kiss, H.T., Luo, L, Tasker, R.R., Lozano, A.M. and Dostrovksy, J.O. (1998) Phantom sensations generated by thalamic micro stimulation. Nature, 391:385–387
[15] Ramachandran, V.S., Hirstein, W. (1998) The perception of Phantom limbs: The D.O. Hebb ;ecture. Brain 121, 1603-1630
[16] Malnic, B.,Hirono, J., Sato, T., Buck, L.B. (1999) "Combinatorial Receptor Codes for Odors," Cell 96:713-723.
[17] Buck, L.B., at al, (1999) How Mammals Distinguish Different Odors ScienceDaily. http://www.sciencedaily.com/releases/1999/03/990305071120.htm
[18] Linda B. Buck (2004) Unraveling the sense of smell Nobel Lecture, December 8, 2004, http://nobelprize.org/nobel_prizes/medicine/laureates/2004/buck-lecture.pdf
[19] Ramachandran, V.S. (2003). The Emerging Mind. BBC/Profile Books, London. ISBN 1861973039

several advantages. The information density is high and meanwhile integration of information is possible. Besides at this position there is the option of internal backward looping (i.e. in case of memory retrieval).[7] [10]

Looking from inside the nervous system, the parallel activity of the contrast decoding neurons is to regard as a conscious contrast "screen" at the incoming edge of the system. This "screen", like a video screen, processes the input of all the senses simultaneously. Due to its position, the "screen" is receptive to current receptor input, but also to internal backward looping. The current input regards the physical world, the backward looping the possibility of "re-minding" literally, i.e. in case of search-behaviour, attention, remembering and thinking. In all cases the "screen" however reflects an internal world of contrasts. To the nervous system, and in conscious terms to us, this world is all there is. We literally have to live inside it[23].

Concept-consciousness

To steer, just contrast isn't enough. Within the "screen", the nervous system has to distinguish functional units of interrelated contrasts. Only then, output steering is possible. The nervous system seems to solve this problem by treating simultaneously behaving contrasts, as conceptual units.[24] [25] [26] [27] [8] To find out the significance of such a unit, the

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[20] Kosslyn SM, Flynn RA, Amsterdam JB, Wang G. Components of high-level vision: Cognition. 1990 Mar;34(3):203-77

[21] Doucette, W., Restrepo, D. (2008) Profound Context-Dependent Plasticity of Mitral Cell Responses in Olfactory Bulb. PLoS Biol. 2008 October; 6(10): e258. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2573932

[22] Wesson, D.W., Carey, R.M., Verhagen, J.V., Wachowiak, M. (2008) Rapid encoding and perception of novel odors in the rat. PLoS Biol 6(4): e82. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2288628.

[23] Chudler, E.H. 2008. Sensory Apparatus in: Neuroscience for Kids: Brain Facts and Figures , http://faculty.washington.edu/chudler/facts.html#sensory Receptorcells: Taste 1million, Olfactory 12 million, Retinal 125-150million/eye (1 million ganglion cells,/eye), Tactile in the hand 17.000

[24] Ritz, R. & Sejnowski, T. J. (1997). Synchronous oscillatory activity in sensory systems: new vistas on mechanisms. Current Opinion in Neurobiology, 7, 536-546.

[25] Dopamine (2009) Wikipedia, http://en.wikipedia.org/wiki/Dopamine

nervous system confronts it, more or less randomly, with behavioural output.[28] [29] [30] [31]. It is to compare with a baby that puts everything in its mouth to reveal the significance. The functional units we will call "concepts". In conscious terms we know concepts as objects, characteristics, interaction, causality, coincidence, luck, etc..

The nervous system has many ways to confront concepts with output (i.e. classic and operant conditioning, long-term potentiation). All these mechanisms seem to follow the same principle of the simultaneous activation of neurons.[32] The activation of the input side normally is the result of receptor activity or backward looping (i.e. remembering).

To activate the output side, there are numerous ways. It may be coincidental (i.e. Pavlov), automatically (i.e. Central Program Activators),[5] or as a part of conscious action (i.e. imitation behaviour).

Once the connections between input and output neurons are made, rehearsal will reinforce them and turn them into a preferent route through the brain (learning). The preferent routes we use time after time often become routines. Routines don't need attention as such and probably concept attention is switched of by backward inhibition.

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[26] Schultz, W. (2007), Reward Scholarpedia, 2(3):1652 http://www.scholarpedia.org/article/Reward
[27] Schultz, W. (2007), Reward signals Scholarpedia, 2(6):2184 http://www.scholarpedia.org/article/Reward_signals
[28] Morsella, E. (2005). The function of phenomenal states: Supramodular interaction theory. *Psychological Review*, 112, 1000-1021.
[29] Morsella, E., Krieger, S. C., Rizzo-Fontanesi, S., & Bargh, J. A. (2007). The primary function of consciousness in the nervous system. Annual Review of Biomedical Sciences, 9, 37-40
[30] Brembs Björn (2006) Brains as output/input devices. http://bjoern.brembs.net/e107_plugins/content/content.php?content.39
[31] The modern Search for the enagram. In: Kalat, J. W. (2001). Biological Psychology (7th ed.). Belmont, CA: Wadsworth USA: 366-368. ISBN 0-534-51400-6
[32] Hebbian learning (2008) Wikipedia http://en.wikipedia.org/wiki/Hebbian_learning the fire wire principle

Frequent rehearsal also has another consequence. It concentrates concepts to their most constant contrasts. These characteristics are rehearsed most and will become preferential routes within concept-recognition. These “condensed” concepts are to be seen as definitions we seem to use in recognizing and thinking.

The foregoing suggests, that concept-consciousness is to be seen as a hierarchic level within the contrast “screen”. The implication could be, that within the nervous system no second location is needed to realize concept consciousness. In conscious terms, concepts just are associated contrast pixels. This suggests that only one type of consciousness exists; contrast-consciousness. But that contrast-consciousness only can lead to behaviour in context of defined concepts. Like letters create words, but stay meaningless on their own. Meanwhile we have to realize that such an approach only will work if the system is capable to inhibit the connections with other concepts. To read we need spaces in between the words.

This approach could mean that the rest of the brain has to be seen as a giant switchbox with data processing and output management as main functions. This could possibly explain why it is so difficult to pin down consciousness by the use of the neuro correlates of consciousness. Most neuro correlates will be about tapping input-output-connections somewhere halfway in the switchbox. Indispensable for understanding brain activity according to consciousness, but not an easy way to pin down the core of it. A little bit to compare with the question if the shining of a light is because of the current, the switch, the wire or the light bulb?

Deviation

To function in the long run, the nervous system needs mechanisms to handle unknown and deviating input. Because the nervous system can't look into the future, it is forced to keep potential attention at everything that possibly could deviate. To do so, it needs the "contrast screen" of contrast decoding neurons as permanent radar. Because contrast pixels as such don't deviate, the nervous system only has to regard concept deviation. To do this, among others, it uses so called "reward prediction error" neurons, which only react at deviation.[26] [27] [33] [8] [34]

When deviation is significant, the nervous system has to incorporate it into its database of input-output-connections. This is done in the same way as concept incorporation by simultaneous activity of input and output neurons. During this 'downloading' the nervous system has to keep the new information separated from other existing input output connexions. So, whereas contrast processing is parallel, downloading has to be serial. That's probably why we, in terms of attention, only can focus at one thing at a time. Nonetheless, during downloading, steering has to go on. The nervous system seems to tackle this problem by executing steering exclusively in terms of routines. [35] [27]

Why conscious?

There is a lot of discussion on the function of consciousness. Is it meant to steer, to learn, or just an epiphenomenon without any function? Realizing our reduced consciousness during routines, the function of consciousness can't be steering or recognition of concepts.

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[33] Lesya, Y., Ganushchak, L.Y., Schiller, N.O. (2008) Brain Error–monitoring Activity is Affected by Semantic Relatedness: An Event-related Brain Potentials Study. Journal of Cognitive Neuroscience May 2008, Vol. 20, No. 5,: 927-940

[34] Bogacz, R., Brown, M.W. (2003) Comparison of computational models of familiarity discrimination in the perirhinal cortex. *Hippocampus* 13: 494-524

[35] Mobile phones and driving safety (2009) Wikipedia. http://en.wikipedia.org/wiki/Mobile_phones_and_driving_safety

Within routines we have the ability to process concepts and steer without consciousness. As a metaphor in the 100 m sprint the nervous system of best athletes needs 120 to 160 ms to recognize the starting shot and start,[36] while consciousness needs at least 200 ms to know what we really did.[37] [38] If consciousness was meant for steering, it should be the other way around.

Beside steering there also seems no explicit link with learning. When we look at something very familiar, there often is nothing to learn, nevertheless we are conscious. When consciousness isn't exclusively linked to learning, it neither will be to the creation of concepts, because that's learning too.

Perhaps we have to conclude that consciousness simply is describing contrast, creating the opportunity to the nervous system to recognize, steer and learn within an unknown physical world.

That we hardly are conscious of concepts during routines, doesn't automatically conflict with this approach. Routine seem to suppress concept-consciousness, rather than concept-consciousness, and most likely by backward looping.[7] In this way, the nervous system stays alert at contrast level and can focus at concepts which aren't under control yet.[39] [40]. This also could explain the correlation between consciousness and learning. When concept-consciousness is suppressed in non learning situations, it only will be remain in

[36] Duffy, K (2004) *Beating the Gun or Running Fast.* http://condellpark.com/kd/reactiontime.htm
[37] *Cleeremans, A*., *Sarrazin, J.C.* (2007) Time, action, and consciousness. Human movement science 26(2):180-202.
[38] "Benjamin Libet" (2007) Wikipedia. http://en.wikipedia.org/wiki/Benjamin_Libet
[39] Burr, D.C., Morrone, M.C., Ross, J. (1994) "Selective suppression of the magnocellular visual pathway during saccadic eye-movements" Nature 371 511 – 513
[40] Paus, T., Marrett, S., Worsley, K.J., Evans, A.C. (1995) Extra retinal modulation of cerebral blood flow in the human visual cortex: Implications for saccadic suppression J Neurophysiol 74: 2179-2183

learning situations, falsely suggesting a causal relation. Nevertheless the overall effect is, that consciousness presents a world to learn, in order to perform better next time.

Conscious globe

To the nervous system, consciousness seems a tool to describe input in order to tune output on. Consciousness is to compare with a paining of the nervous system that describes possible output in terms of input, i.e., an apple to eat, a bike to ride, someone to love and "I" to act. This suggests that concepts are to be seen as output features in the first place. [29]. This could mean that the nervous system doesn't see a dog. It just detects millions of associated contrast pixels to take for a walk, or to avoid.

To do this the nervous system constantly arranges incoming contrast into output features. The result is a three-dimensional circum central "screen" as seen through the "eyes" of the senses (receptors). That's probably one of the reasons that we and our body are in the centre of this conscious "screen". Seen from the senses, we are close at hand.

Within the "screen" *we* also are output features to the nervous system, principally not different from any other features shown. The only difference is, that "we", are more perceptive to the output of the nervous system. Nonetheless, to the nervous system every concept in the "screen" stays a non personal "it". To our ego certainly unattractive thought, but to the nervous system "We" "you", and "I", all are output features about which it has to find out what the output should be.

In terms of consciousness, the circum central "screen" is all there is and beside this there is literally nothing else. The real physical world outside the receptors stays unperceivable.

The nervous system only perceives the activity of receptors. This creates a free floating globular individual world, made out of contrast consciousness, featuring conscious concepts, floating in a universe of nothingness. Given the direct dependence to accidental external and internal input (memory), no two conscious worlds will be the same. Within this self created world, the nervous system has to live and learn. To some extend, it is the prisoner of its own creation.

Thoughts and dreams

Also thoughts are to be seen as output features in the "screen", concepts activated by backward looping. Thoughts seem to evolve in situations that combine attention at concept level with the lack of proper output at behaviour level. For example in case of a question, a prohibition, or in case of the famous command "not to think of a pink polar bear".[41] This suggests that thoughts probably are the result of backward looping, activated by the lack of behaviour output at concepts level.

Without denying the complexity of the brain, the combination of input with the lack of output could be the base of concept-consciousness in general. Not only in case of thoughts, but also regarding direct receptor input, dreams and delusions. [42] [43] [44] [45] In other words, when proper routine is lacking, activated neurons will compete backwards along their associated connections, to find a suitable (i.e. resembling) concept to send their

[41] White Bear Phenomenon (2009) Wikipedia, http://en.wikipedia.org/wiki/White_Bear_Phenomenon
[42] Daniel J. Simons (2007) Inattentional blindness. Scholarpedia, 2(5):3244. http://www.scholarpedia.org/article/Inattentional_blindness
[43] Simons DJ, and Rensink RA (2005). Change blindness: Past, present, and future. Trends in Cognitive Sciences, 9: 16-20
[44] Sachs, O. (2003) What the blind see. www.fortunecity.com/emachines/e11/86/blind.html
[45] Koch, C., Tononi, G. (2008) Can Machines Be Conscious? Part of IEEE Spectrum's SPECIAL REPORT: THE SINGULARITY First Published June 2008 http://www.spectrum.ieee.org/jun08/6278

output to. In terms of consciousness this back propagation will lead to the conscious perception of things and probably also to attention.

On the other hand, in case of routines, attention seems to be switched off at concept level (or stays inhibited). That's why we will not consciously recognize these concepts even though contrast shifting is going on (inattentional blindness). [46] [47] In absence of attention we don't perceive a black spot or something like that. There simply is no conscious attention at all. So "normal" concept-consciousness, but also consciousness of thoughts and dreams, could be the effect of switching on attention at concept level. The end result of competing output features, all lacking proper routine-output.

Being in the "screen"

As mentioned before, within the "screen", also *we* seem to be output features. Maybe this could explain why consciousness seems to have no function to us, neither to our behaviour.[48] To relate the function of a painting as a whole (i.e. artistic value) to the things it visualizes (i.e. landscape, buildings, animals) seldom will lead to a satisfying answer.

In the same way, consciousness will have no special meaning to the objects it displays. The objects are there because of consciousness, but that is probably all.

The "screen" we are part of, is to be seen as an attempt of the nervous system to arrange these contrast in terms of output possibilities. However, by being in the centre, we automatically start to think that we perceive all this. We think that our thoughts are

[46] Daniel J. Simons (2007) Inattentional blindness. Scholarpedia, 2(5):3244

[48] Gulick, R..van (2004) Consciousness
http://plato.stanford.edu/archives/fall2008/entries/consciousness/

identical to the being of the picture as a whole. We have to wonder what thinking and "being" actually could mean. From the position of the nervous system "thinking", "being", and also "consciousness" probably are three words for a rather identical significance. Meaning something as "observance of presence". To the nervous system one of the text balloons in the "screen", not principally different from others.

"I"

The real hitch in cognitive position seems the thought or the word "I", to almost everybody the central part of their lives. To the nervous system probably no more than a text balloon containing the word "I". The nervous system unavoidable has to paint us in the centre. Of course, this central part is extra sensitive to output, but this doesn't make it the creator of the "screen". So, we probably have to see our thoughts as "I am" or, "to be consciousness ourselves" as output possibilities to which the nervous system has to find the right output, nothing less and probably nothing more.

When we define the conscious "screen" as the thoughts of the person in the centre, Descartes with his "I think, so I am" was as right as he could be. However when we accept the possibility that not we, but the nervous system could be the initiator of the experience, than "I think, so I am" will change into "Consciousness creates me" leaving humble room for realizing that the picture is bigger than we thought.

The origin

Logics

When we want evolution to share its secrets concerning consciousness, we at least have to attend the following questions:

1) What could have been the evolutionary prologue and premiere of consciousness?
2) When did the conscious “light” go on?
3) What created the way we experience consciousness?

Maybe the answers can give a possible evolutionary context to the previous chapters and provide insight in how a simple start of consciousness could have led to complex phenomena as feelings thoughts, dreams and self-awareness?

Prologue and Premiere

Assuming that there is a relation between consciousness and evolution, a question to start is: where do both meet? A possible meeting point could be, that both regard the interaction of biological systems with their environment. Biological systems interact with their environment in terms of responses. To do so, they need tools to identify physio-chemical stimuli, to process them and to convert them into proper behaviour. Evolution is about the effectiveness of these mechanisms and in some way consciousness seems to be too.

The biological tools to identify stimuli are called receptors. Biological receptors normally are at the molecular cell level and specific to their own range of stimuli. When activated, receptors produce instructions to the cell they are part of, leading to distinct cell behaviour.

Unicellular evolution needed about 2 to 3 billion years to find its way through this complex network of impulses and responses.[49] To consciousness it is essential, that all unicellular communication happens at the level of the cell body and that the impulse-response-tracks, as such, leave no long lasting traces within the cell.

About 1 to 1,5 billion years ago, when the first multi cellular organisms evolved, the mechanism of the receptors could roughly stay the same, but receptor cells now had to communicate across cell borders. Evolution offered two major solutions to this problem. One uses hormones as messenger, the other electric pulses (i.e. nervous system).

Almost all plants follow the first route. They communicate by phytohormones. Like in unicellular organisms, these communication-tracks leave no long lasting traces as such. Animals on the other hand, use both solutions. In the case of the nervous system, communication creates a stable path of neural connections between receptor cells and the muscles and glands.

The discovery of the neural connection not only offered a fast communication opportunity. It also opened a vast delta of new evolutionary opportunities. It became possible to store information in a very fast way (neuro database). Simple rehearsing appeared sufficient to store output in term of incoming information. Until then, for more than 3 billion years, DNA was the only possibility, needing many generations to store a new item. At the same time it became easy to recognize targets by their forerunning indicators (sound meant food, Pavlov). Also recognition of changes became simple,

[49] Timeline of evolution (2009) http://en.wikipedia.org/wiki/Timeline_of_evolution

because by definition, existing neural connections already describes the known environment.

However, to benefit these advantages, the animals had to solve one problem. Electric pulses contain almost no information about the nature of the stimulus itself. To tackle this, animals had to keep the receptive range of their receptors small, and even more important, they had to keep input information separated as long as needed for adequate interpretation. A little bit like the post handling by postal services.

Referring to current primitive animals, it probably was 650 million years back that everything in evolution was ready for the discovery of the neuron. Receptive cells and multi cellular organisms already existed, as well as electric conductive tissue, cell secretion, synapses and contracting myocytes.[50] [51] [52] [53] [54] [55] [56].

The first neurons probably looked like the multi functional nerve cells we see in Hydra (Cnidarians).[57] These "receptor neurons" combined receptor activity, interpretation, integration, communication- and motor-neuron-tasks within one and the same cell body. To enlarge the information contents, the system had to divide the different tasks over individual specialized neurons. For example, by setting apart the motor task in individual motor-neurons, it became possible to restrict muscle tasks to a specific combination of

[50] Leys, S.P., Rohksar, D.S., Degnan, B.M., (2005) Sponges. Curr Biol.;15(4):R114-5.
[51] Sponge (2008) Wikipedia. http://en.wikipedia.org/wiki/Sponge#Cell_types
[52] Braun, F.J., Hegeman, P., (1999),Two light-activated Conductances in the eye of the green Alga Volvox certeri. Biophysical Journal, Vol 76: 1668-1678
[53] Solitary chemosensory cells (2008) http://en.wikipedia.org/wiki/Solitary_chemosensory_cells
[54] Leys, S.P., Mackie, G.O., Meech, R.W. (1999) Impulse conduction in a sponge Journal of Experimental Biology. Vol 202, Issue 9 1139-1150,
[55] Emes, R.D., Pocklington, A.J., Anderson, C.N., Bayes, A., Collins, M.O., Vickers, C.A., Croning, M.D., Malik, B.R. Choudhary, J.S., Armstrong, J.D., Grant, S.G. (2008) Evolutionary expansion and anatomical specialization of synapse proteome complexity. Nat Neurosci. 11(7):799-806.
[56]: Jékely, G., Colombelli, J., Hausen, H., Guy, K., Stelzer, E., Nédélec, F.; Arendt, D.(2008) Mechanism of phototaxis in marine zooplankton. Nature 456(7220):395-9
[57] Koizumi, O. (2002) Developmental neurobiology of hydra, a model animal of cnidarians. Can. J. Zool. 80: 1678–1689

receptor inputs. For instance running away when movement and shadow is spotted simultaneously (danger). The advantage of high information content forced the nervous system to invent all kind of specialized neurons and modules. For instance receptor cells, contrast decoding cells, switchbox- and memory-modules, motor neurons and long distance communication cells. The invention of the neuron is to be seen the evolutionary kick start to the animal kingdom, as well as an invitation to the involvement of consciousness.

Glows of being

The second question was, when in evolution conscious perception could have started? From the start every connection between a neuron and a muscle cell is to consider as a data-unit. This unit describes an output possibility (response) in terms of input contrast (receptor neuron activity). When activated, together the active units reflect the behaviour of the animal as well as the world the animal is living in.

This suggests that a description of the outside world became possible from the very first moment primitive receptor-neurons started to cooperate with muscle cells and glands.[58].[59] From that moment, for the first time in evolution, input could be encoded in terms of behaviour, or better in terms of control.

At the start, detecting of input probably included the behavioural reflexes at the very same time. To primitive animals we have to understand perception in terms of reflexive doing, like an eye blink or a startle reflex. To us, however, detecting often means emotions, but

[58] Parker, G. H. (1922) Taste, smell and allied senses in the vertebrates. pp. 192, 1922. http://www.archive.org/stream/smelltasteallied00parkuoft/smelltasteallied00parkuoft_djvu.txt
[59] Erickson RP (1982) The across fiber pattern theory:An organizing principle for molar neural function. Contrib Sens. Physiol 6:79-110

seldom direct behaviour. Somewhere in evolution, animals evolved the capability to keep body behaviour on hold. So, to higher evolved animals we have to understand perception in terms of being (emotion) and at the same time, in terms holding the possibility of doing in stock. “Reflexing” became “reflecting”.

To experience this, language can be an unexpected hurdle. Words, as such, can be seen as a substitute for real perceiving. Deliberately suppressing language during perceiving brings back the original bodily experiences, as well as the possible output options. Without words, a table no longer is a tabletop with legs. It becomes something we are emotionally related to because of our mutual history (memory). At the same time it becomes an output feature. An object you can put things on and that helps you to keep things within reach. So, in many ways consciousness isn’t about the world outside, but about what is happening inside the nervous system. This ranges from receptor activity, along emotions, to planning of behavioural responses. Meanwhile it is about perceiving on the different cognitive levels: contrast, concepts, words, emotions and possibilities of action.

Does this answer the question when did the light go on? The answer is; “probably not”. In terms of consciousness we still don’t know the difference between active receptor neurons, active input-output-connections, detecting, perceiving and experiencing. What we know is, that description of the world most likely became possible from the moment that input-output-connection evolved. First, as very simple descriptions in terms of a few contrasts, but later on in evolution, more and more complex. Going back along this evolutional path from the way we experience consciousness to day, consciousness could have started at that very moment 650 million years back when the first primitive receptor

neurons came together with the first primitive muscles cells. But this interpretation of course, is light-years away from solid proof or what so ever.

Towards complexity

From the simple start, how could consciousness become as complex as we experience it? To answer this, we will enface the possible evolutionary grounds of the mind body interactions, emotions, thoughts and dreams.

Before we do so, we have to recall the notion that perceiving and maybe also consciousness, started as simple reflexes that connected a receptor activity with muscles or glands. A potential next step could have been that intermediate neurons started to control these reflexes by means of their own receptor input. A swallow reflex i.e. only became possible when taste as well as consistency were meeting the receptor standards.[5] By this, the nervous system also obtained an instrument to control the reliability of receptor input. Things only exist if confirmed by activity of other receptors. Even still, we use this mechanism to strengthen neural connections.[60]

When complexity and input increased, mechanisms as attention and also all kinds of inhibition[61] [62] became indispensable to keep things at speed and to avoid overload and short-circuiting[63].

[60], Eichenbaum, H. (2008), Memory, Scholarpedia, 3(3):1747 http://www.scholarpedia.org/article/Memory
[61] Jonas, P.,Buzsaki, G. (2007) Neural inhibition. Scholarpedia, 2(9):3286
[62] Macknik, S.L., Martinez-Conde, S., (2007) The role of feedback in visual masking and visual processing, Advances in Cognitive Psychology, Volume 3, no 1-2, 125-152, (http://versita.metapress.com/content/ax751t272743t304/fulltext.pdf)
[63] Phillips, W.A. & Singer, W. (1997). In search of common foundations for cortical computation. Behavioral and Brain Sciences 20 (4): 657-722

Given the continuing selection pressure, specialisation within the nervous system had to keep up with it. Groups of input-output-connections started to behave as cooperating modules, leading to brains we see in many higher animals. However, also in higher animals, the input-output-connections still seem the basic design according to input processing and behavioural output.[64].

Mind and Body

With input-output-connections as basic design, the nervous system has a logistic problem. At the same time, every unit contains input as well as output information. In order to be operational, the system has to "choose" whether the unit encodes for the outside world (input) or for inside action of muscle and gland (output).

Given the way we experience consciousness, the evolutionary choice seems to have fallen on the input side. This isn't so surprising as such, because input encodes for enemies, food and safety (the independent variable) while the output is fully depended on input (dependent variable). However, in the meantime, to survive not the input but adequate output is essential [65] [66] [67] ("Shoot First, than talk"). To solve this second problem, the nervous system uses preceding indicators to describe the real impact, creating time to react (i.e. seeing, smelling or hearing can predict food and danger).

[64] Kerszber, M. (2003) Genes, Neurons and Codes : Remarks on Biological Communication., BioEssays 95, 14529-34. . (http://www.snv.jussieu.fr/~wmkersz/Papers/GeNeCode.pdf)
[65] Geary, D.C.(2005) The Motivation to Control and the Origin of Mind: Exploring the Life–Mind Joint Point in the Tree of Knowledge System. Journal of Clinical Pyschology, 61(1), 21–46. http://web.missouri.edu/~gearyd/JCP05%5Bfinal%5D05.pdf
[66] Geary, D.C. (2005) Evolution of Brain, Cognition, and General Intelligence:: Books. Language: English; ISBN-10: 1591471818; ISBN-13: 978-1591471813
[67]. Ross, D.A., Martin, A.(2006) Bookreview: The Origin of Mind: Evolution of Brain, Cognition, and General Intelligence, by David C. Geary. Am J Psychiatry 163:9, September 2006 1652-1653 http://web.missouri.edu/~gearyd/files/American%20Journal%20of%20Psychiatry%20%5B2006%5D.pdf

The single sided choice for input, may explain why we experience a gap between our mental processes (mind & input) and the behaviour of our body (output to muscles and glands). We only experience what is coming from the senses. The instructions to the body are completely unconscious. These instructions we only experience indirectly and afterwards, when our senses trace the result of it. This leaves us with the strange experience of the gap between mind and body. It's like driving in a car with no steering wheel, which nonetheless seems to interact with our thoughts.

We literally seem half conscious. The missing part is formed by the instructions to the body, muscles and glands. In some way this resembles ordinary reflexes like the eye blink reflex. Also in those cases we can experience the input side of the reflex. From this point it becomes understandable, why emotional thoughts can call in tears. These thoughts could be seen as the unconscious but direct instruction to the tear glands to do so.

Real time emotions

As described until now, the database only can store input information when the related output behaviour is going on at the very same moment (fire-wire principle). This system can't integrate events that are apart in time. A suspect looking person yesterday, isn't to connect to a burglary today. So, the nervous system needed a possibility to store input free of behavioural output. At the same time, of course, it needed a possibility to recollect this information when needed at a later moment.

At some moment, evolution seems to have solved this problem by linking input to emotion. Emotion is to define as an unconscious body reflex to input.[68] Not to confuse with the conscious part of emotions, which we will describe as feelings.

Especially emotion was a very suitable candidate, because it directly precedes actual behaviour in time.[69] By linking input exclusively to "emotion-reflexes", it can be stored without further behavioural consequences. The recollection afterwards became possible by using associative connections between memory data. Forming of these associative connections could easily become part of input detection and storage (fire wire principle). New input automatically triggers look-a-likes in the nervous system.[70] [71] By this, it became possible to recall the information along the associative traces. In seeing today the burglary, the nervous system starts to activate related information, including the yesterday suspect.

To the nervous system the connection to emotion was a mayor advantage. From now on, it could store information at any time wanted, without further behavioural costs. Consequently all input-information in the (memory) system got an emotional label.[72] [73] [74] [75] This labelling at the same time launches two totally new advantages. Firstly, the

[68] Wiliam James (2009) Wikipedia. http://en.wikipedia.org/wiki/William_JamesEmotion
[69] James-Lange theory (2009) Wikipedia. http://en.wikipedia.org/wiki/James-Lange_theory
[70] Van Heuven, W.J.B., Dijkstra, A.F.J., Grainger, J., & Schriefers, H.J. (2001). Shared neighborhood effects in masked orthographic priming. Psychonomic Bulletin and Review, 8 (1), 96-101.
[71] Van Heuven, W.J.B., Schriefers, H., Dijkstra, T., Hagoort, P. (2008) Language Conflict in the Bilingual Brain. Cerebral Cortex 2008 18(11):2706-2716
[72] Damasio, A.R., Tranel, D. & Damasio, H. (1991). "Somatic markers and the guidance of behaviour: theory and preliminary testing" (pp. 217-229). In H.S. Levin, H.M. Eisenberg & A.L. Benton (Eds.). Frontal lobe function and dysfunction. New York: Oxford University Press
[73] Damasio, A.R. (1994). Descartes' Error: emotion, reason, and the human brain. New York: Grosset/Putnam.
[74] Damasio somatic Hypothesis markers (2009) Wikipedia. http://en.wikipedia.org/wiki/Somatic_markers_hypothesis
[75] Dunn BD, Dalgleish T, Lawrence A (2006), "The somatic marker hypothesis: A critical evaluation" Neuroscience and Biobehavioural Reviews 30(2):239-271

nervous system can use the labels as weights of interest. The bigger the body reaction (emotion), the bigger the interest. Secondly, emotion is very easy to integrate. Organisms just have one body, so simultaneous activated emotions will integrate automatically. That's probably why we are able to have an immediate opinion about new and completely unknown persons or situations. The body simply adds up the emotional body reactions of the parts the nervous system recognizes unconsciously. This integrated reaction we perceive as a feeling. It feels good or otherwise, often without knowing the reason.

Thoughts and dreams

The link between inputs and emotion opened a total new phenomenon in evolution. It became possible to activate the neuro database free from the physical world and behavioural consequences, forcing the entry to the world of thinking and dreaming.

Earlier we already mentioned the possibility of backwards looping, especially when no proper output is available. Being free of behavioural output and having the possibility of backward looping creates the option of mind travelling. An option without restrictions, but with virtual perceiving, emotions and the inner intentions to speak. Creating a private world, a complete free virtual world, build out of input-output-connections formed in the past. A virtual world with virtual colours, always a little bit behind in time with reality because of the processing time. A virtual world that quickly embraces the physical world, as soon as attention turns to the real input of senses. An individual world in which probably every animal is living. Probably no animal will have a sense of its virtuality. Only to us, human beings, the creation offered the opportunity to be witness of this miracle of evolution.

Discussion

The main questions

In the previous parts we discussed the periphery and evolutionary logics of consciousness. In this third part we will confront the results with the main questions being about consciousness.[76] We start with the question about the little progress according to the hard problem. What is holding us back? From that, we go to questions about who is conscious, the function of consciousness, the location, inattentional blindness and why consciousness always seems 100%. After that we try a definition and discuss the questions about steering, learning, emotions, thoughts and dreams. The discussion is ended by applying the insights in context of the explanatory gap itself. To create a solitary readable discussion, some doubling with previous text isn't avoidable.

Understanding

We started this paper with this question. What is holding us back? To answer, we turned away from consciousness and towards two possible roadblocks of cognition.

The first barrier seems that we lack any information about consciousness itself. Like a camera, consciousness records everything except itself. A related pitfall seems complexity. The complexity of the brain provokes the suggestion, that understanding complexity is understanding consciousness. This could be the case, but on the other hand also complexity is perceived through consciousness, with the implications mentioned above.

[76] Seth, A.K., Izhikevich, E., Reeke, G.N., Edelman, G.M. (2006) Theories and measures of consciousness: An extended framework. PNAS, vol.103, no.28 : 10799-10804 http://www.pnas.org/content/103/28/10799.full.pdf

Probably the second point encloses the real core of stagnation. This seems to be the fact that we all have the impression to be conscious ourselves. It is probably this notion that kept all doors closed to consciousness since man started to think about it. An illustration to this is the one-liner of Descartes. “I think so I am”. A fantastic ego-boost to mankind, but probably also the ultimate rabbit hole to science and all others who would like to find out. To find a way out, the paper investigates the possibility that not we but the nervous system could be the centre of consciousness.

Self-consciousness and I

The possibility that not we, but the nervous system could the centre of consciousness, creates an unexpected chance to unravel the Gordian entanglement we seem to be caught in. However a consequence is, that we have to face the possibility that we are part of consciousness ourselves. Surely an important part, but nevertheless just one of the parts the nervous system uses to tune its output on. Furthermore, also our thoughts, dreams and self-consciousness, have to be regarded as output features of the nervous system. This doesn’t make those experiences less true, but we have to realize that none of them is in charge of consciousness itself.

Function

The notion that our experiences could be output features of the nervous system, offers a new context to the function of consciousness. Till now, attempts to pin down this function never ended satisfactorily.[77] To redefine the context, we first have to realize that the nervous system has the difficult task to guide an unconscious body through a world the nervous system can’t perceive in a direct way. To do this it needs stable contrast

[77] Consciousness (2009) Wikipedia. http://en.wikipedia.org/wiki/Consciousness#Functions

information at the input side of the system. To consciousness this seems sufficient because beyond contrast consciousness, no extra consciousness is needed to recognize concepts. Of course, on to that, conscious contrasts need to resemble the physio-chemical contrasts outside the senses and they have to be connectable to the output side of the system. The paper shows that the input-output-approach of the nervous system meets well with these requirements. This suggests that the function of consciousness is restricted to the displaying of stable input contrast information to the nervous system.

Location

To find the location of consciousness is far from easy. Nobody knows what consciousness is, so searching for its location is far from easy. It is like looking for the location that creates light, if the light bulb goes out, whenever we demolish the bulb, the wires or the switch. Which part should be the location? In this example, consciousness is the result of a process[78]. On the other hand, when we consider consciousness as stable information during processing, then the range of suitable locations, seems to be restricted to the incoming edges of the nervous system (in mammals the outer cortex). This is the only location where unambiguous input information is available together with stability. The only neurons fit to this task, are what we called the "contrast decoding neurons". These are the neurons that translate the ambiguous signals from the receptors neurons, in stable contrast information. This suggests that contrast-consciousness could be located there, and because we already defined concept-consciousness (objects) in terms of contrast consciousness, no extra location is needed.

[78] Pavel Ortinski; Kimford J. (2004) Neuronal Mechanisms of Conscious Awareness. Meador Arch Neurol 61: 1017-1020.

As a consequence the pixels that create consciousness will be scattered across the outer cortex. Contrast-consciousness will be spread conform the incoming sensorial information, concept-consciousness conform its contrast-associations.[78] [79] Realizing that input-output-connections are fundamental to the system, this could mean that also memory will follow these scattered patterns no matter what the animal species will be.

Always 100%

One remarkable aspect of consciousness is that it always seems 100%. Loosing one of our senses is a terrible experience, but strangely enough it doesn't make us less conscious. In some way consciousness stays 100%. When we define consciousness as the summated effect of the activated contrast-decoding-neurons, we should expect to feel less conscious loosing a sense. However, when we realize that beside the active input neurons, there is absolutely nothing, then consciousness has to be 100% at all times. This also could explain why it is so difficult to describe a unit of consciousness. When we describe a unit as the effect of an activated contrast decoding neuron, we still have to relate to the 100% of the input at the very moment. At the same time this means, that even when there is just one contrast decoding neuron active, we still will be 100% conscious, This opens a way to imagine how consciousness could have emerged, somewhere, half a billion years ago.

Inattentional and change blindness

It also could explain a totally other feature of consciousness, our inability to distinguish input differences at contrast level. Contrast-pixels don't differ. They are "there" or "non-existent". They are like individual letters in a word, having no meaning on their own.

[79] Localized representations of Memory. in: Kalat, etc The modern Search for the enagram. In: Kalat, J. W. (2001). Biological Psychology (7th ed.). Belmont, CA: Wadsworth USA: 364-368. ISBN 0-534-51400-6

This could be the reason why we often don't spot contrast differences when attention is shut down. Without the context of a concept, the system won't be alarmed when meaningless pixels are changing. Unless we fix attention, there will be no way to us to detect these changes. This also could explain why it is so difficult to "Find those 10 differences!" between the two on first sight identical pictures. To find them, beside some other tricks, we have to track every possible concept one after the other. So, unless we explicitly attend at concept level, it is difficult to detect any difference in the world around us, explaining our inborn tendency to inattentional- and change-blindness.[42]

Definition

Discussing the function and content of consciousness, creates the opportunity to try out a definition. According to the previous considerations, as an attempt consciousness could be defined as *the 100% summation of the activity of the current contrast-decoding-neurons*. The fact that we are aware of concepts seems an inconsistency in this definition. But, as we have discussed earlier, concept-consciousness is to define as a coincidental cluster of contrast-consciousness. According to the definition, consciousness seems to stand for the part of the contrast input, which the nervous system filters out to deal with.

Steering and learning

The question is, what could be the role of consciousness in steering and learning? According to what is said before, as a first step, we have to regard the possibility that not we but het nervous system is in charge. The second step could to regard steering and learning as functions of the nervous system, which use contrast consciousness as a substrate.

The nervous system exclusively seems to steer by routine. Because of that, consciousness especially is activated, learning situations. This is when input information isn't recognized right away. This relationship could falsely suggest causality between learning and consciousness.

In both cases the nervous system needs contrast consciousness to function properly. The only difference seems, that in case of routines, consciousness is switched of at concept level (or not switched on), avoiding loss of attention. This means that during these routines even huge differences at concept level will be at risk of not perceiving them.

On the other hand, in case of learning the nervous system has to keep the unknown input in the centre of attention. It possibly has to incorporate new input at concept level. This mechanism also explains why contrast-consciousness has to be parallel and concept-consciousness has to be serial. To recognize deviation, on one hand the nervous system needs a parallel and stable pixel input. On the other hand is has to avoid misconnections during incorporation of new concepts. So, it has to shut down unwanted associations with serial processing as a consequence.

Emotions and feelings

The conscious part of emotions we call feelings. To quote Etienne Bonnot de Condillac (1715-1789, philosopher). «The origin of all consciousness is in the senses».[80] Relying on this philosophic vision, we have to realize that also elusive experiences like a feeling has to start as contrast consciousness, just like smell, colour, taste etc. Think for instance of feelings like pain, hunger, thirst, longing.

[80] Arssleff H (2001) Etienne Bonnot de Condillac: Essay on the Origen of Human Knowledge. Cambridge Texts in the History of Philosophy. Cambridge University press. 2001. 274P ISBN 0-521-58576-7

However, there are three aspects that make feelings to a special category.
First; feelings concern the receptors that monitor the emotional state of the body. They regard not only hunger or longing but also muscle tension, hart beat, skin temperature, etc. We are inclined to experience emotion as an inside world, but to the nervous system the body itself is a world outside its receptors, not largely differently from the world outside the body.
Second; we seem to use feelings as a yardstick of interest. Interest we use to take decisions. Feelings are to be seen as weights we use on our mental weighing scales. In other terms feelings are concept- and contrast consciousness at the same time.
Third: to make it even a greater challenge, feelings are by definition labelled to the concepts that evoke them by reflex, i.e. fear in case of seeing a dangerous snake.
Maybe it is this multi layered complexity that makes feelings such a mysterious and indefinable part of consciousness.

Thoughts, dreams and inner voices

Normally we experience thoughts, including dreams and inner voices, as consciousness at concept level. Thoughts are to be seen as a reaction on current input of contrast. However in routine situations, input of contrast hardly leads to consciousness. This suggests that thoughts concern input that doesn't (completely) fit into existing routines. The nervous system, so to speak, has to deal and wheel in search of a second best fit (neural competition). During this process, the concept information is disconnected from input as well as disconnected from output. Nevertheless the nervous system has to keep it alive. To do so it has many tricks, as backward looping and (working-) memory. This implicates that thoughts are to consider as a preparation on the downloading of new information;

learning. Because the nervous system is input orientated, it can't change output. The only download mechanism is trial and error. That is probably why we reduce speed approaching dangerous situations. By doing so we avoid great harm, and options for a second try. The consequence is that thoughts, dreams and inner voices, can't be about steering. The only possibility is, that they simply represent the fact, that the contrast "screen" isn't shut down because the system has to adjust its database at concept level.

Mind the gap

Deduction and intuition

As a last chapter we will discuss the most difficult question, the body mind problem,[81] also called "the hard problem"[82] or "explanatory gap".[83] [84] To do so, we define this question as follows: How can a subjective mental experience be the result of an objective activity of the nervous system? To unravel this old mystery, we at least have to understand the most obscure part; the mental experience. In doing this, we will start with five very contra intuitive deductions. After that, we will return to our common intuition about body and mind.

The first contra intuitive deduction

As described a mental experience contains two components; contrast-consciousness and concept-consciousness. In the paper we showed that concept-consciousness is to regard as an association of contrast consciousness. The consequence is that all consciousness, including a mental experience, basically is contrast consciousness. This leads to the contra intuitive consequence that consciousness of concepts, like objects, thoughts, attention, planning, inner speech etc., doesn't play an essential role in this deduction.

This second contra intuitive deduction.

The fact that mental experiences are build out of contrast consciousness has another contra intuitive consequence. Contrast is without meaning. Meaning refers to output and as

[81] Taylor, J.G. (2007) Mind-body problem. http://www.scholarpedia.org/article/Mind-body_problem
[82] The Conscious Mind: In Search of a Fundamental Theory (1996). Oxford University Press. hardcover: ISBN 0-19-511789-1
[83] Levine, J. (1983) Materialism and qualia: The explanatory gap. Pacific Philosophy Quarterly 64:354
[84] Lormand. E. (2006) *Philosophical Review* Vol. 113 No. 3, July 2004. (published June 8, 2006) The Explanatory Stopgap

stated, output is a privilege to concept recognition. This reduces the core of a mental experience to a collection of meaningless contrasts. Something, which some may recognize from gazing at nothing for a while. This includes that also feelings aren't essential in this discussion.

The third contra intuitive deduction.

The third contra intuitive aspect is that within the nervous system there is nobody to experience. So no-one is gazing out, and neither is the nervous system. To the nervous system, contrast is just the part of its system, which stands for activated contrast decoding neurons at its input edge. This suggests that a mental experience isn't about perceiving contrast. It only can be about "being" the contrast itself. This deduces a mental experience, in a matter of speaking, to a cluster meaningless pixels of "being". In other words; it is not about "seeing" the world, but about "being" the world.

The fourth contra intuitive deduction.

Also a contra intuitive is the fact, that a mental experience isn't the summation of pixels of "being". Because being is a quality of the system as a whole and because outside these pixels in terms of consciousness there is nothing, consciousness is always 100%. Consciousness is independent of the absolute number of pixels. As stated before, even one isolated pixel of contrast-consciousness would create 100% consciousness to the regarding organism. This means that a mental experience is to consider as the effect of all contrast pixels, being 100% conscious, whatever the number of pixels will be.

The fifth and last contra intuitive deduction

The last contra intuitivity is the notion that “being” isn’t about connection. It rather is about disconnection. Neural activity only is possible after downloading the input. The neuron uses the disconnection to process this information at neural level. At the level of the contrast decoding neurons, the system can only be aware of the outside world as long as these neurons are active to the system and disconnected with the outside world. This position of the active contrast-decoding-neurons, offers the system the possibility to reconstruct the outside physical world in terms of internal being.

First intuitivity

To a neuron, “to be” means behaving by conforming to its genetic cell instructions. To a contrast decoding neuron, this means something like: “Wait till there is enough input from the receptor neurons. Then you can go free and if you don’t, you risk being deleted”. Firing is “being a neuron”. To some this will sound like anthropocentric childish talking and they are right. Nevertheless, it could be the essence of all mental experiences. *Neural activity during disconnection* could be in the heart of the explanatory gap and the heart of experiencing.

Second intuitivity

As stated, contrast consciousness is just “being contrast”. It is being unambiguous and stable decoding of receptor input. To create a mental experience the system has to select aggregated contrast to tune its output behaviour on. This output induces feedback by means of new input, creating concept-consciousness and meaning. In this way more and more concepts will be defined, step by step expanding recognition within mental experiences.

Third intuitivity

However, to create meaning, the nervous system needs a mechanism to "judge" for good or bad. To do so, it can use an inheritance from the unicellular evolution, which are hormones. Hormonal messages can range from bonding instructions to flight instructions. Like unicellular organisms, neurons also communicate with excretion of hormone. On one hand, hormones are suitable to reinforcement of neural bonding (i.e. by dopamine) for instance in case of positive physio-chemical feedback. On the other hand, they are also suited to discourage bonding when feedback is negative (stress hormones). This creates the possibility to arrange incoming contrasts and concepts along an axis of favourability, creating room for meaning and feeling within our mental experiences.

Fourth intuivity

Till now "being" only is defined at the level contrast-consciousness. To upgrade to concept level, the nervous system needs to create time and space to process concept information. For instance, by keeping the pixels of the concept activated in search for proper output, even when the real input is gone already. To do this, it seems to use mechanisms like backwards looping and memory retrieval. These mechanisms keep the concept active in disconnection and create the possibility of "being" at concept level.

Fifth intuivity

So a mental experience seems "being contrast" as well as "being concept" more or less at the same time. When we rehearse all steps starting with physio-chemical input, then consciousness begins with the physical chemical reactions within the receptor neuron. Because of that the receptor neuron will start to fire, leading to activation at the level of the contrast decoding neurons. These stable pixels of information seem to be the core of

consciousness. However to us, not these pixels but the end products count. That's probably why we would describe a mental experience in terms of recognition, feelings and meaning. Within the mental experience, we perceive contrast-consciousness as a parallel stream of consciousness, concept-consciousness on the other hand as a neatly continuing but nevertheless discrete serial slide show of recognized output features.

The "disconnection in processing" could also explain why it will be difficult to create conscious robots. Electronics don't process in disconnection in the way individual cells or groups of cells do. We don't know what technology will bring in the future, but up till now evolution created inside our own nervous system the only place for us, where there is time and space to be.

Acknowledgements

I dedicate this paper to my father for his gentle but often repeated question:

"Do you understand, my boy…?"

I like to thank all who dared to share their findings for free on the internet. Also I thank my friends who were willing to go through the drafts we shared. Special gratitude goes to Shunyam E.M.L. van Steveninck [85] for her indispensable, spiritual and intellectual support and constant challenge during the creation of the paper.

[85] Painter and acknowledged enlightened master, www.shunyam.com

Metaphor

"BLOSSOM BEACH INC." Flower Int. Trade Company: a metaphor to the nervous system and consciousness.

Introduction:

- Blossom Beach is a very big international trade company (the body of the organism)
- It sells all kinds of flowers all over the world (body behaviour)
- It has a small management team (nervous system)
- In the team there are three mandated experts: flowers, market and weather (contrast decoding neurons)
- Each expert has its own advisers, inside and outside the company (receptors)
- On Sunday the team isn't there (unconscious)
- The rest of the week they all three have to be in the board room (potential contrast consciousness)
- The company starts selling when all three raise their hand (3 contrast pixels = concept consciousness)
- Successful combinations are labelled and repeated (memory reinforcement & dopamine)
- These combinations become standard procedure and need no special attention (unconscious routine)
- One day there only is a unknown flower-variety available (unknown input)
- The flower expert (contrast consciousness) can't raise its hand automatically (start of attention)
- The team needs and extra board meeting and maybe an extra flower expert. (consciousness regained)
- The meeting is about the best look-a-like flower from the past (memory retrieval)
- The team copies the output according to that flower and all raise there hands (conscious choice)
- Selling starts as usual, however almost nothing is sold (negative feedback "de-inforcement")
- So, a second meeting is needed, resulting in a second attempt etc...

The company behaviour follows "trial and error" till it ends successfully (reinforcement) or with no result, firing the flower expert. (de-inforcement at concept level, or ignoring the contra indicating of some contrast decoding neurons).

What could be consciousness in this metaphor?

- The confrontation of unknown input with existing procedures? (neural feedback?)
- The flower expert not knowing what to do? (passive contract decoding neuron within the neural team?)
- The invitation to an extra board meeting? (enhanced neuronal activation?)
- The board meeting itself (associating contrast decoding neurons?)
- The search for look-a-likes? (or amplifying the neural input or of lowering doorstep levels?)
- Just the experts being woken up because of the trade jam (not inhibited at concept level)
- Just one expert not fallen in sleep despite of routines (idem not inhibited at contrast level)

Our view is that, even if there is just the presence of one expert the company is conscious (contrast consciousness). However the company is unable to act (no concept

consciousness). So at company level consciousness is about the being of an expert raising its hand.

How to define the being of an expert in conscious terms?
- Just sitting in its chair? (inactive contrast decoding neuron)
- Taking (extra) information in from its advisors? (contrast decoding cell, downloading receptor input)
- Processing the information from its advisors? (disconnected processing but without firing?)
- Raising his hand, independent of the presence of the others? (disconnected processing firing into the system?)

Our view is that only in the last case the company could be conscious. However the company only can act, when it treats the single expert's hand raising as a (miss-) concept. To the work floor, this concept will be an unworkable instruction. So they will feedback to the board: "Find a solution in terms of company behaviour". The board needs to become conscious again as a team, creating concept consciousness at company level; a mental experience of thinking about a solution.

The conclusion could be that consciousness is about the expert sending unambiguous but stable information into the system whether it fits or not. However in routine situations this expert information will not lead to explicit concept consciousness. Only in case of an information jam the system really gets conscious on concept level (board meeting).

Glossary

- Backward looping: Activating of neurons by internal backwards (recurring) signals in the nervous system. This in contrast with direct forward activation by the input from the senses.
- Cartesian theatre: a metaphor of consciousness, imagining a tiny theater in the brain in which a little man or woman is sitting, watching a movie that is recorded through our eyes, ears etc.. (http://en.wikipedia.org/wiki/Cartesian_theater)
- Change blindness: the phenomenon that a person fails to detect large changes in a visual scene. (http://en.wikipedia.org/wiki/Change_blindness)
- Consciousness: the experience of the being of things.
- Contrast: input referring to contrast in the physical world, which is discriminative and stable in the terms of the nervous system. i.e. colour, tone, taste, tone, touch, etc..
- Contrast pixel: smallest unit of contrast.
- Contrast decoding neuron: neuron that translates the ambiguous signals from its receptors neurons, in stable discriminative input information (contrast).
- Concept: simultaneously behaving associated contrasts with a potential behavioural function. i.e. objects, characteristics, causality, coincidence, (bad-) luck etc.
- Emotion: the unconscious reflex-reaction of the body to the conscious or unconscious recognizing of concept input .
- Feeling: the afterward conscious experience of emotion. The integrated information of the senses that monitor the body state.
- Explanatory gap: the gap between subjective metal experiences and objective physio-chemical activities of the nervous system.
- Fire-wire rule: Neurons that fire together wire together, meaning that their synaptic connections will strengthen (http://en.wikipedia.org/wiki/Hebbian_learning).

- Hard Problem: the difficult problem of explaining the explanatory gap. (http://en.wikipedia.org/wiki/Hard_problem_of_consciousnesss)
- Inattentional blindness: the phenomenon of not being able to see things which are actually there. (http://en.wikipedia.org/wiki/Inattentional_blindness)
- Inhibition: neurons that suppress the stimulation of neighboring neurons.
- Output feature (= concept): related contrasts that are treated as an unit by the nervous system in order to connect them as a whole to certain range of behavioural possibilities (output).
- Receptor: any structure which, on receiving an environmental stimulus, produces an informative signal to the cell of which it is part of.
- Receptor cell or neuron: cell which on receiving an environment stimulus, produces an informative signal to other cells. http://en.wikipedia.org/wiki/Sensory_receptor
- "Screen": the collection of all active contrast decoding neurons at a given point in time.