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Letter for everyone who is interested in and develops Brain Machine Interfaces

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Dear ladies and gentlemen, dear science lovers,

Brain Machine Interfaces // Brain Computer Interfaces

The brain is probably a biological quantum computer. Simple digitization of a human brain with implantable BCIs is far from being a real upgrade. This is like tying a horse-drawn carriage to a car. Dramatic success will only be achieved when the task is changed. The question is not whether a brain can communicate with machines or the memory can be stored on an external hard disk. Instead, the question is (i) how to optimize and influence the existing (human brain) computer, (ii) which signals are information carriers and (iii) which quantum mechanical processes (e.g. nuclear spins) play a decisive role here. You should employ the best quantum physicists and the best quantum biologists you can have. They are strongly recommended before ten more animal keepers be hired to bring a pig from the reserve.

The competition for the best upgrade of the human brain cannot be won without medical expertise. Whether with or without surgical robots, you need gifted neurosurgeons and neuroscientists who can tell you down to the millimeter which brain region is responsible for what, and doctors with vision who whisper the next upcoming innovations into your ear.

AI will soon overtake humans in most areas of life. However, AI will probably outstrip itself if it is given the chance to merge with biological quantum computers (namely: the human brain) and gradually take over the regiment - and all this without a computer virus.

Let me present some of my ideas regarding Brain Machine/Computer Interfaces here:

(1) Non-invasive Brain Machine Interfaces suitable for everyday use

Without question, the first generation of BCIs will be a blessing for patients with paralysis and other neurological conditions. The benefits still justify the risks associated with the procedure. However, this may change in the future. And when it comes to applications in healthy people, less invasive solutions are urgently needed.

In order to develop brain-machine interfaces that enable a non-invasive connection between humans and computers, and which even a healthy person would be willing to have implanted - say: subcutaneously at the trigonum colli posterior -, a non-invasive measurement technique with high resolution and a trainable neurofeedback system are required. This should not be an attempt to copy »BrainNet« (A multi-person brain-to-brain interface for direct collaboration between brains, Jiang L et. al, 2019), which uses the principle of transcranial magnetic stimulation but the spatial and temporal resolution is in great need of optimization.

So far, the EEG has been used for signal processing. However, the question arises whether other physical principles might even provide better results.

(2) Could Magnetoencephalography (MEG) replace the EEG?

SQUIDS are superconducting quantum interference devices and serve as magnetic field sensors in MEG (Buchner M et al.). Meanwhile mini-sensors have been developed which can measure magnetic field strengths of 1 pico Tesla at room temperature. Instead of looking for signals in the EEG, the magnetic field generated by the brain could provide signals of better resolution. Since the number of commands that a brain-computer interface can reliably distinguish depends on the quality of the signals, it remains to be investigated whether a MEG is superior to the EEG in BCIs (NIST mini sensor measures magnetic activity in human brain, April 2012; https://www.nist.gov/).

(3) Magnetoreception

In 2019, biophysicist Joe Kirschvink at CalTech in Pasadena proved that artificially induced and directionally weak magnetic fields in the micro Tesla range cause an EEG change in about one third of healthy subjects. The strength of the alpha waves decreased, which typically happens when the brain registers a signal. This should not be taken as evidence of human magnetic sense (magnetoreception). For comparison: In this publication signal strengths were used which are 6 log levels higher than the above mentioned sensor technology SQUID is able to measure. Nevertheless, the question arises automatically whether a potential magnetoreception influences information transmission and processing or whether it can be used for this purpose. The work of ETH researcher Christiansen MG and MIT scientist Anikeeva P suggests that magnetoreception could spur the development of new generations of BCIs.

(4) Analysis and use of qEEG/qMEG databases using machine learning, user authentication and the importance of creativity

Quantitative EEG calculates spectra in the resting EEG (spectral analysis with FFT), which contains significantly more information than the conventional EEG. Instead of looking for individual spikes in the EEG, the hit rate for specific signals may increase if spectra are used as an alternative.

Analyze quantitative EEG databases (z-methods) for amplitude, coherence, asymmetry and phase and compare data of the healthy norm population with those of patients with different disease patterns as well as the population with special abilities (top athletes, pianists, composers, artists, scientists, writers, pilots etc.). Machine Learning Tools and AI are essential for a quick and correct analysis. Those who have an elaborated qEEG database, which includes all the above mentioned populations, not only have an enormous diagnostic potential. Just as a human fingerprint can be used for identification, this is potentially also possible with high-resolution qEEG data, so that in a BCI networked world authentication could be performed with the individual EEG fingerprint. The same applies to quantitative magnetoencephalograms (qMEG).

The approach of neuroscientists and neurosurgeons is occasionally biased and results from the fact that they either only work with healthy subjects or only with patients. Phenomena such as creativity or extraordinary talents are still too rarely or unsystematically examined. Neurophysiological data of such individuals would also be important. Depending on the selected ability, both characteristic and highly individual features may be found.

(5) Biocompatible Cyborgs

If you do not want to leave the cyborg path, it is undoubtedly necessary to think about biocompatible electronic components. In my science fiction story »The Compostable Robot« (original: »Der kompostierbare Roboter«), for example, I mentioned graphene as my preferred material. Rejection reactions and infections are commonplace with artificial implants. Modern future materials will never completely prevent this problem, or at least mitigate it. For example, graphene magnetic field sensors are already available (Pisana S et al.). https://rapidot.de/der-kompostierbare-roboter/

(6) Device-independent information transfer via quantum entanglement of magnetically active cells? Quantum biology is trend-setting

The emerging field of quantum biology contributes to a better understanding of all biological processes at the microscopic level. Quantum biological effects have been well studied in migratory birds, among others, to find a physical explanation for their magnetoreception. This is one of the reasons why the QuantumBird project was created (https://www.quantumbirds.eu).

Migratory birds have a light-dependent magnetic compass, the mechanism of which is thought to involve radical pairs formed photochemically in cryptochrome proteins in the retina. Hiscock HG et al explain (i) new insights into radical pair magnetoreception, (ii) suggest ways in which the performance of the compass could have been optimized by evolution, (iii) may provide the beginnings of an explanation for the magnetic disorientation of migratory birds exposed to anthropogenic electromagnetic noise, and (iv) suggest that radical pair magnetoreception may be more of a quantum biology phenomenon than previously realized. Cryptochromes are not only found in the plant world and migratory birds. Studies in mice show that cryptochromes are responsible for the normal functioning of the circadian clock. The extent to which other functions in mammals are possible is a subject of research (Horst G et al.).

The publication by Sjulstok E et al. summarizes well the extent to which quantum effects are important for biological life: from photosynthesis to cellular respiration, from DNA repair to magnetic field sensing. In all processes in which electron transfer takes place, quantum biological modeling and experiments will provide valuable results. Knowledge in the field of quantum biology will improve, accelerate and optimize the development of quantum computers. The application is therefore not limited to living systems, but also to modern brain machine interfaces and, of course, AI.

The team Tamulis&Grigalavicius assumes that the occurrence of two additional quantum entangled excited states even leads to faster growth and self-replication of minimal living cells. They also examined quantum entangled logic gates. Modeled systems consist of two prebiotic nuclei that become building blocks for new forms of artificial cells, including magnetically active cells. These quantum features are particularly evident in supersensitive light-harvesting systems such as in photosynthesis and photoreceptors.

An AI equipped with artificial magnetically active cells could theoretically communicate with conspecific AIs as well as with living beings capable of telepathy. All these findings will have a massive impact on the development of medical diagnostic and therapeutic procedures. It can be assumed that the application possibilities will one day extend to brain-machine interfaces.

Unfortunately the author Arthur C. Clarke in his novel »The City and the Stars« left open on which biophysical bases the telepathy of the inhabitants of Lys is based. Currently, thought transmission is only possible with »technical« support at great expense. A device-independent exchange of thoughts requires the existence of suitable physiological receivers and transmitters with sufficiently high transmission power or sensitivity. Neither the anatomical substrate nor the physiological correlate for this are known today. A telepathic communication device in the quantum mechanical brain would presumably be based on the principle of quantum entanglement, tunneling and coherence.

If quantum biological effects allow for device-independent information transfer, an implantable brain machine interface may be even unnecessary. Instead, we would have to develop non-invasive amplification mechanisms that would be as easy to operate as headphones or a headset.

... a lot more to discuss

- It is not clear whether neuronal activity creates consciousness or whether neuronal activity is merely an expression of the action of a consciousness ...

- Would a quantum biological memory really needs an ordinary external hard disk?

- Quantum-biological information transfer could control external computers independently of devices ...

I am at your disposal in case of questions - in the distant future, contact via BCI :-). I wish you much success, so that as many patients as possible can be helped.

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With best regards, September 19, 2020

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