

ART ^ NEUROSCIENCES

SEED-12: Noise turns subconscious information into conscious knowledge

0. CONTACT DETAILS

0.1 Surname and first name

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0.3 Let us get to know you a little bit through your participation in websites, blogs, social networks, etc.

www.neuroconsulting.services

<https://www.researchgate.net/profile/Peter-Walla> (researchgate)

<https://scholar.google.com/citations?user=32peME0AAAAJ&hl=en> (google scholar)

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https://de.wikipedia.org/wiki/Peter_Walla

<https://www.newcastle.edu.au/profile/peter-walla>

SFU Podcast: <https://www.youtube.com/watch?v=ID2c9PeYYSO>

Talk on youtube: <https://www.youtube.com/watch?v=r54BAJpuHhI>

<https://www.facebook.com/reel/2171238326568798>

0.4 What is your background and in which institution do you work?

PhD in Neurophysiological Zoology (Vienna University),

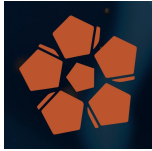
Habilitation1 in Cognitive Neurobiology (Medical University in Vienna),

Habilitation2 in Biological Psychology (Vienna University),

Honorary Neuroscience Professor at the University of Newcastle in Australia (NSW)

I currently work as a Full Neuroscience Professor at Sigmund Freud Private University in Vienna (Austria)

Since September 2020 I am Full Neuroscience Professor at the Faculty of Psychology at the Sigmund Freud Private University in Vienna (Austria) providing academic leadership in Neuroscience. My career began with anatomical and physiological work about photoreceptor cells in spider eyes. While most of this work was done at the Yokohama City University in Japan, where I was trained in the most sophisticated neurophysiology related to single cell recordings I then graduated at the Vienna University, Department of Zoology. After being introduced to the single neuron level I learned all essential skills to enter the world of human brain research. My interests and techniques were formed at the Clinic for Neurology and the Ear-Nose-Throat Clinic at the General Hospital in Vienna as well as at the St. Andrews University in Scotland. My PhD was completed in 1998 with work about human memory functions. At that stage, I already collected 9 authorships on peer-reviewed Neuroscience-publications in journals as highly ranked as Nature. I was already author of several successful grant proposals and broadened my mind through further



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international collaborations. While most of my post-doc time was spent in Vienna I did further trainings at the University of Melbourne, the Howard Florey Institute in Melbourne and the National Neuroscience Facility in Melbourne (Australia). In addition, I spent time at the Marta Kutas Lab and the Larry Squire Lab in San Diego. Since 2007, I have the honour to be awarded with the highest European academic qualification at two different Universities. I am habilitated in Cognitive Neurobiology at the Medical University in Vienna and also in Biological Psychology at the Vienna University. I became Head of the Biological Psychology Unit at the Faculty of Psychology in Vienna and it did not take long until I was asked to become Deputy Head of the Institute for Clinical, Biological and Differential Psychology at the Vienna University. In 2008, I moved to Newcastle (Australia) following an invitation after being short listed regarding the call for a neuroscience-oriented professorship. I convinced the panel of my scientific and social skills and made my way (5 years). From 2014 to 2020 I was Head of the Psychology Department at WEBSTER University in Vienna and since September 2020 I am at Sigmund Freud Private University teaching Neuroscience and Psychopharmacology and heading the Freud CanBeLab (Neuroscience Lab).

Research Expertise

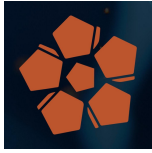
The brain knows more than it admits! Although the spectrum of my previous research is wide there is a clear focus on information processing in the human brain below the level of consciousness (non-conscious information processing). In the end, highest cognitive functions are based on subconscious and unconscious information processing. If we understand those we better understand human behaviour. I am well experienced in Neuroimaging-related research in fields such as memory, language, olfaction, cognition and affection (emotion). My expertise spans from designing brain imaging studies over data analysis to the interpretation of results.

0.5 Gender

I am male

0.6 Age range

51 - 60



1. ESSENTIAL DIMENSION

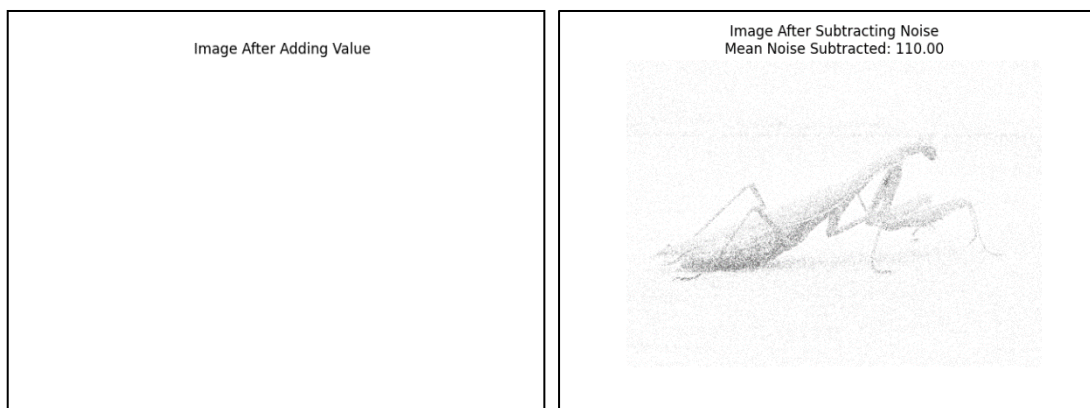
1.1 Seed name

Adding noise turns subconscious information into conscious knowledge: Neuroscience and Stochastic Resonance

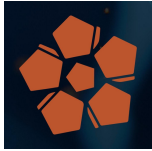
1.2 Seed summary

The pursuit of a comprehensive understanding of human consciousness is a long-standing endeavor. A multitude of disciplines have sought to elucidate and define consciousness, with a particular emphasis on its etiology. What is the cause of consciousness? One particularly eye-opening idea is that humans attempt to identify the source of consciousness by leveraging their own cognitive processes, as if something is attempting to elucidate itself. The results of brain-imaging experiments indicate that the brain processes a considerable amount of information outside conscious awareness of the organism in question. Perhaps, the majority of decision-making, thinking and planning processes originate from non-conscious brain functions. Nevertheless, consciousness is a tangible phenomenon, and its intrinsic nature is both intriguing and challenging to ascertain. The present concept is meant to offer a new idea about how to approach the topic of consciousness, while also providing a distinct visualization that could be demonstrated in the frame of the Ars Electronica Event in Linz.

The concept is founded upon a physical (mathematical) phenomenon known as stochastic resonance. Without delving into the specifics, it is relatively straightforward to grasp one of its implications, which is employed here to introduce a novel approach regarding the potential for non-conscious information within the human brain to become conscious through the introduction of noise. The above-mentioned visualization is able to show that a completely white image is transformed into an image depicting a recognizable object, merely by the introduction of noise (see figure below).



Similarly, information in the human brain that is processed below the threshold of consciousness could become conscious within a neural network by the



introduction of noise. The introduction of noise could originate from one or more of the well-known activating neural networks with their nuclei being located in the brainstem and their axons connecting to various cortical regions. It must be acknowledged that this is merely a theoretical and somewhat superficial concept. Nevertheless, its innovative nature may assist in exploring novel avenues in the search for the origins of consciousness.

1.3 Metaphor

Imagine the shoes you are wearing suddenly begin to ask themselves where they are actually coming from and how come they experience self-reflection. Our brain knows more than it admits to our consciousness, but the fact that it tries to explain itself remains a fantastic mystery.

1.4 Keywords

Consciousness, non-consciousness, stochastic resonance, noise, threshold, neuroscience

1.5 Scientific field (general)

Neurosciences

1.6 Scientific subfield (specific)

Neurophysiology

2. ADDITIONAL DIMENSIONS

2.1 SYNAESTHETIC DIMENSION

This dimension seeks to associate certain sensory characteristics to the seed.

2.1.1 What colours does this seed suggest to you?

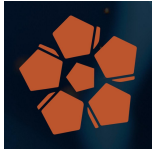
Absolutely red.

2.1.2 What sounds or music does this seed inspire you?

For the content of this seed it has to be noise.

2.1.3 What aromas would you associate with this seed?

Musk and sandalwood.



2.1.4 What flavours does this seed avoke in you?

Somehow a combination of bitter and sweet.

2.2 EMOTIONAL DIMENSION

This dimension seeks to explore the personal meaning of the seed.

2.2.1 What was your motivation to dedicate yourself to this field of research?

What are your personal reason to suggest this seed?

No doubt, better understanding how our conscious capacity works is of very general interest. My decades-long academic work finally allows to contribute this better understanding and the present concept is a fascinating approach.

2.2.2 What metaphysical reflections does this seed provoke in you?

As already emphasised above, it is extremely interesting to realise that our brain tries to explain itself. Following the absolutely fantastic statement: "I always thought that the brain is the most fantastic organ in my body until I realised who is telling me that"! I am highly motivated to think about this. Due to my education in Biology, Medicine and Psychology, I do have the honour to scientifically approach the topic of human consciousness. I am extremely thankful for this opportunity.

2.2.3 What ethical reflection or challenges would you associate with this seed?

The most prominent challenge might be to accept that most of our actions are actually planned by our non-consciousness brain processes.

2.2.4 What aesthetic dimensions does this seed suggest to you?

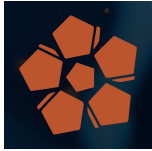
Interestingly, noise does not contain any signal (information) and yet it could be the solution to generating conscious awareness.

2.3 PROCEDURAL DIMENSION

This dimension seeks to explore the scientific processes that are usually followed when investigating this topic.

2.3.1 Description of the research process

It is challenging to conceptualize that the fundamental basis for human beings to per-ceive a distinct, vibrant image of our surrounding environment is the alteration of ion concentrations along cellular membranes. However, that is the current state in



the Natural Sciences. Ions, as charged particles, can passively or via some kind of selective support (this is well understood) flow through specific channels in the membranes of nerve cells. Due to their negative or positive charge, the flowing in and out of a nerve cell changes the membrane's potential. This can be quantified in a manner analogous to the measurement of battery potential by a voltmeter. The respective gained knowledge has enabled the creation of psychotropic substances that are capable of modifying emotional states, including the ability to alter feelings such as those experienced with antidepressants. Additionally, these substances can induce unusual perceptions. The effect of these chemical substances is merely to influence the potential changes. The scientific process to investigate the idea that adding noise lifts up sub-threshold information into the stream of consciousness has to include research on that level. Brain Imaging with Electroencephalography (EEG), in particular Event-related potentials (ERPs), has to be applied to analyse early sensory-evoked brain activities in response to subliminal visual presentations, once stand-alone and once during parallel presentation of noise.

Here is the suggested visualisation in more detail:

Visualisation method: In order to visualise the idea of stochastic resonance to support the generation of consciousness including perception I here decide to use a greyscale image composed of 307.200 pixels as a starting point (640 x 480) (figure 1).

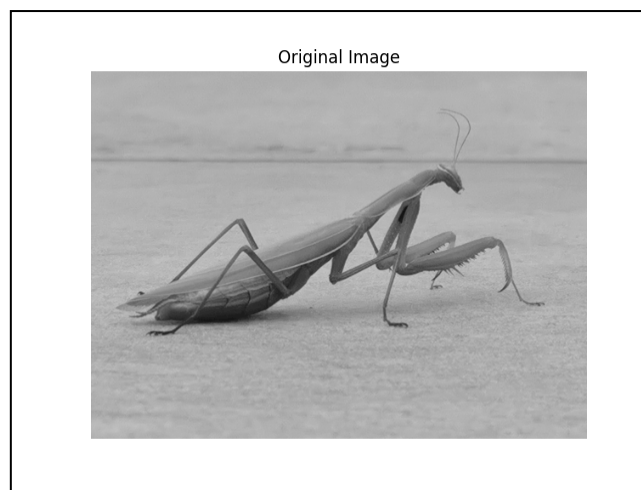
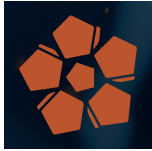


Figure 1: Greyscale image of a praying mantis (*Mantis religiosa*). The image consists of 307.200 pixels, each pixel having a value between 0 (black) and 255 (white). Any value between 0 and 255 reflects a certain grey tone leading to the visible praying mantis (The picture is self-taken in 3712 Maissau, Lower Austria, Austria).

The crucial idea is to understand this “original” image as an actual object in the environment that can be seen. A following procedure shall add a distinct number to all pixel values with the result to finally lift up all values above the threshold-number of 255. This can be achieved by adding the number 255 to all values. What happens is that pixels with the original value 0 (black) are now becoming 255, which is white. The



result is an image without any visible pixels (it's all white) and consequently nothing can be recognised (figure 2).

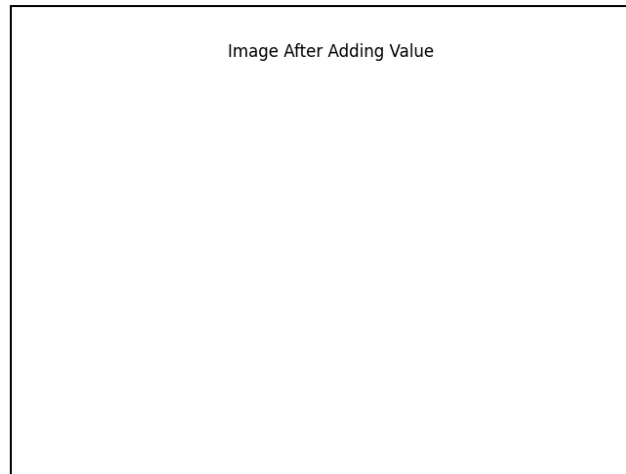


Figure 2: In this picture nothing can be seen, because to each original pixel value (each pixel has a value between 0 and 255) the number 255 was added. Obviously, no pixel value is now below 255 (255 = white) meaning all grey tones (even black) became white. However, each pixel still carries its actual number, which can maximally be 510 (original 255 plus the added number 255).

In analogy to consciousness, the threshold of a pixel value of 255 can be understood as the threshold between consciousness and non-conscious information. All different pixel-values of the now white image (figure 2) still carry their original pattern, but all are now above 255, which is why we cannot see anything but white.

Now, stochastic resonance comes into play. In 1981, Benzi et al. (1981) published a letter explaining the effect, which they named “stochastic resonance”. They found that noise isn’t necessarily detrimental (especially in non-linear systems), but instead can actually increase the signal-to-noise ratio in a system. While the original explanation is rather complex and very mathematical, the authors pointed out that their newly described phenomenon is likely to have interesting applications (Benzi et al., 1981). In this theoretical paper, the application is to define the notion that for a brain that contains most information below the consciousness level adding noise can make this non-conscious information cross a threshold to become conscious. The idea that the human brain mostly contains information below the level of awareness was strongly promoted by Sigmund Freud (1915, 1923). Meanwhile, since the advent of brain imaging technology numerous studies demonstrated that the human brain indeed processes information outside consciousness (e.g. Pavlevchev et al., 2022; Walla?et al., 2022). Even self-referential processing could be shown to take place outside consciousness (Walla et al., 2007, 2008).

The crucial process finally is to add noise (random numbers added to each and every pixel) to the white image presented in figure 2. If one does this, the results vary depending on the number range chosen for the random number generator. See some results below in figure 3.

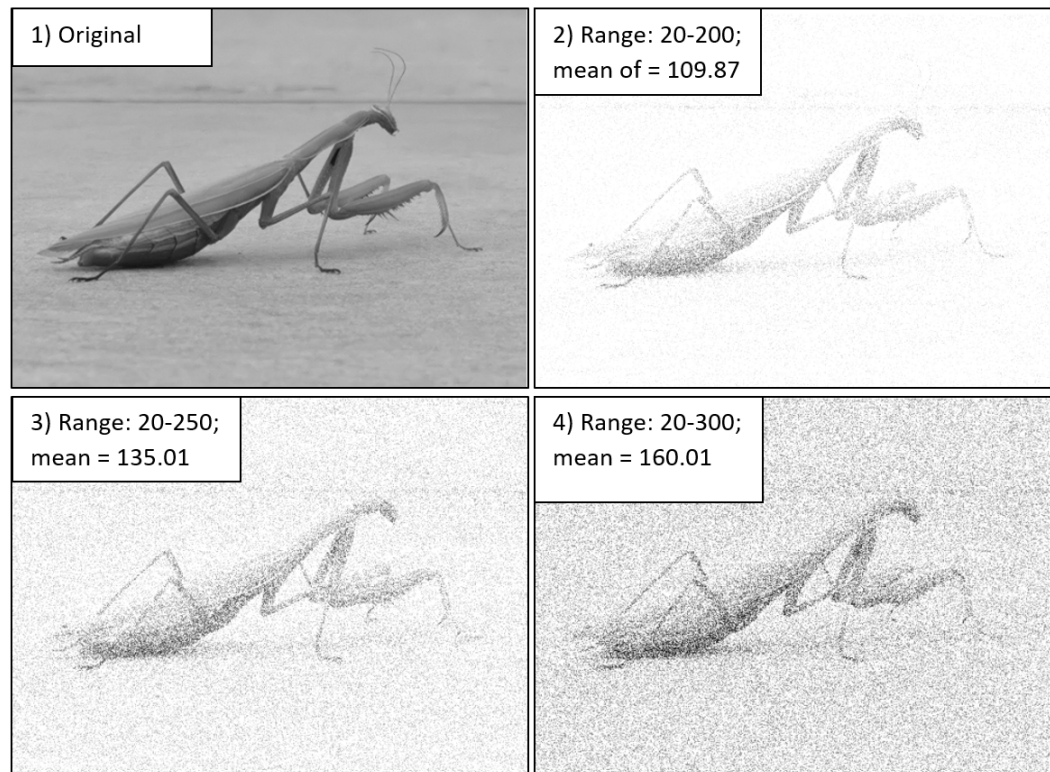
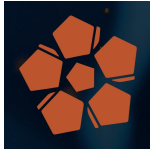


Figure 3: The praying mantis can be seen, only as a result of adding “noise”. Noise was defined as random numbers between a range from 20 to 200 (top right), 20 to 250 (bottom left) and from 20 to 300 (bottom right). Every single pixel value got one such random number added, which results in the fact that enough pixels get values below 255 so that the mantis can be seen, even though the basis was a completely white image.

Research in the here proposed field is meant to combine the idea of primarily non-conscious information providing most dominant input for our actions with the physics concept of stochastic resonance in order to explain that every-now-and-then humans become aware of what their brains decide mainly outside awareness.