"Update on Positive Psychology". Berlin July 12th and 13th, 2014

The Fellow Human Being As A Blessing
- A Neurobiological Perspective

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Successful interpersonal relationships are of paramount importance for the biological systems of the human body and thus for the health of human beings. Psychosomatic Medicine has already known this for decades but during recent years this insight has also found its way into modern neuroscience. This paper sets out to provide an overview of some recent neuroscientific findings that show how a newly formed field of modern brain research, the so called "social neurosciences", can further a deeper understanding of the human psyche.

1. The influence of social experience on the activity of genes.

Let us start with a brief look at what genes are. Even today, the genome often is still depicted solely as an autonomous system that single-handedly determines all biological processes. This is a lopsided view, as genes, in fact, are not autistic actors at all. On the contrary, the activity of genes is regulated by numerous, from the perspective of the gene, external stimuli. Among the stimuli that influence gene regulation are not only nutrition, the extent of our sporting activities, or the quality of our ecological environment, but also what kind of interpersonal relationships we experience. All social experience, whether pleasant or not, is constantly evaluated by the limbic system in our brain and translated into biological responses. As the activity patterns of numerous neurotransmitter systems continuously change in response to what we experience, the brain, if you will, converts psychology into biology every minute we are out and about socially.

Numerous studies have shown that social experience has effects on regulatory sequences in many genes. The experience of stress activates stress genes such as the CRH gene. If we're exposed to "good" stress, that is, if we're confronted with challenges we can manage, this not only activates stress genes but also genes for nerve growth factors. Unhealthy stress, on the

other hand, especially traumatic experiences, where humans become victims of violence in conjunction with a total loss of control, activates gene cascades that can result in the demise of nerve cells.

Genes are not only regulated by social experience "right here, right now". Numerous studies from recent years have shown that social experience can influence also the accessibility of genes, thus affecting gene activity in the medium and long run. This is where so called "epigenetic" mechanisms come into play: cells can block or unblock, i.e. make accessible, a gene's regulatory sequences or "gene switch", for the long-term, by attaching side groups, usually methyl residues. Such so-called "epigenetic" modifications can become induced also by social experiences. Michael Meaney's research group was able to show that the regulatory sequences of the glucocorticoid receptor gene are epigenetically blocked in newborn mammals – and we humans are mammals, too. The glucocorticoid receptor gene is an important anti-stress gene that is instrumental in an organism's ability to downregulate, that is, quiet down the stress axis again after it has been activated. As already mentioned, in newborn mammals – humans included – the genetic switch in this important antistress gene is blocked. The antistress gene only becomes unblocked, that is enabled, by the stimuli acting on the newborn during maternal care. Evolution has apparently worked in such a way that small mammals only become capable of calming down their stress system once they have de facto experienced a protective environment. Studies by Moshe Szyf and his colleagues have shown that in suicidal adults who were victims of childhood abuse the epigenetic blockades of the mentioned anti-stress gene had only been insufficiently removed. Persons whose epigenetic blocks in the region of the regulatory sequences of the glucocorticoid receptor gene have not been properly removed during childhood and adolescence, apparently carry a higher risk for depression.

In summary, it can be concluded that genes are not autistic but are molecular communicators, if you will, that react to stimuli from the organism's social environment.

2. The vital importance of interpersonal affection: the neuronal motivation system

Modern neuroscience not only teaches us that the experience of social relationships really has biological effects. We also know *what kind of relationship experiences* humans need to stay biologically energetic and healthy. A number of studies show that experiencing interpersonal

affection and social support activates biological systems that ensure that we feel vigorous and enjoy life.

In an elegant study, French and Italian researchers generated so called "knock-out" mice with a disabled endogenous opioid system. The all-female research group inactivated the μ opioid receptor gene in these mice. Wild-type newborn mice react with ultrasonic isolation cries if separated from their mother. The investigators' hypothesis was that the mother's presence had the effect of an opiate on the pups. Newborn mice *without* a functioning endogenous opioid system indeed do not react with the typical vocalizations but remain relatively calm when separated from their mother. Maternal closeness is apparently embodied in the pups' opioid system. In another study, this time in adult humans, persons suffering from experimentally induced pain not only showed a significant subjective reduction of their pain but also a massive production of beta-endorphin, an important endogenous opioid, in response to social affection.

The opioid system is not the only biological system that reacts to interpersonal affection. Four year old children, who exchange small caresses with their mothers, react with an increase in their endogenous oxytocin levels. Oxytocin, which was discovered many years ago as a hormone relevant during childbirth, also is a highly potent "mind-altering" drug as many recent publications have shown. It attenuates the stress response, lowers blood pressure and increases the readiness to behave empathically and cooperatively. As already mentioned, four-year olds with a normal social biography react with a clear increase in their endogenous oxytocin levels after tender interaction with their mothers. Children, on the other hand, who during their first 12 to 16 months of life have lived in an infant nursery under conditions of neglect, show a clearly reduced response capacity of their oxytocin system even years later. Early experiences of social neglect apparently leave a sort of biological scar in humans' oxytocin system.

The most important vigor-related transmitter in humans is dopamine, which is produced by the so called mesolimbic system in the midbrain. Because it elicits pleasant feelings, dopamine has also come to be known as "happiness hormone" in lay publications. In fact, addictive drugs such as alcohol, nicotine or cocaine do not unfold their disastrous addictive effetcs *per se* but by inducing the release of dopamine. The ability of dopamine to trigger pleasant feelings is the reason why any behavior and experience that is tied to the release of dopamine has a motivating effect on human behavior. Just being in eye contact with a sympathetic other person activates the dopamine system. One of the most important insights

of modern neuroscience is that interpersonal recognition, affection and the experience of social appreciation activate the endogenous reward system, represented by the dopamine, opioid, and the oxytocin system.

All sentient beings seek pleasurable feelings, an insight we owe to Charles Darwin. Sigmund Freund adopted Darwin's realization and later called it the "Lustprinzip" ("pleasure principle"). This is the reason why humans intuitively seek experiences that activate their dopamine, opioid, or oxytocin system. One possibility of activating these systems and thus experience pleasurable sentiments, consists in obtaining caring human affection, social recognition and appreciation. Humans are willing to go out on a limb to reach this goal. Not least, it is this goal that drives us humans to go to work. At this point, let me mention that sports and music, like social acceptance, are also able to activate the human motivation system.

In summary, the results from numerous investigations document that social recognition and attachment are, from a neurobiological standpoint, most desirable for humans. Thomas Insel, director of the National Institute of Mental Health (NIMH), ironically likened social bonding to a sort of addiction in humans. Humans crave social recognition and connectedness but this, in no way, implies that humans are by nature morally "good". As a matter of fact, humans are willing to not only do good but also bad things to reach their goal of social inclusion. This prominently shows in unattached young men who crave nothing more than social appreciation and to belong. If a society cannot provide adequate opportunities to their young people, e.g. in the form of institutions of education, recreational offers, sports facilities or participation in meaningful social projects, then these young people may instead turn to fanatical-religious or radical political groups or join criminal gangs in their desire to be part of a community.

Studies have shown that an adequate degree of social recognition plays a big role in workplace health. If effort and reward at work do not balance out, i.e. if a so called „Effort-Reward-Imbalance" exists, the proportion of those with stress-related health problems, be it orthopedic problems, nervous dysfunction, disordered sleep, gastrointestinal complaints or heart diseases, increases.

Meta-analyses from recent years have shown that social connectedness not only has a significant influence on health but also on the life span of humans. Abstaining from alcohol and tobacco, exercising or losing weight all have an effect on the probability of a long life but even more so does social attachment – the effect of social connectedness is higher than that of

all of the other factors, as studies impressively demonstrate. The reason for this are not humanitarian convictions but is the structure of the human brain which is geared towards good social relationships.

3. **The neurobiological foundation of intuitive understanding and empathy: the mirror neuron system**

The human brain not only requires social recognition but evolution has equipped humans with a neurobiological tool without which mutual understanding, empathy and, consequently, social connectedness, could hardly be achieved: the mirror neuron system. This system was discovered by an Italian research group around Giacomo Rizzolatti. One could characterize the mirror neuron system as a neuronal resonance system. A tuning fork, which is struck and caused to vibrate, can induce a second tuning fork to vibrate via the sound waves it emits. In other words, it causes the second tuning fork to resonate. In principle, a very similar process can also occur between two human brains. Certain aspects of a brain's state can be related to a second brain – through language or body language. Numerous experiments have convincingly demonstrated this.

Young guitar students were placed into a functional magnetic resonance imaging scanner. The young test persons observed the movements of their guitar instructor's hand on a screen. The students who lie in the scanner see how the teacher's hand repeatedly plays a specific chord on the guitar's fretboard. While watching this, not only the visual cortex in the observers' brain becomes active - as expected -, but motor neurons are co-activated as well. Even though the observing students do not move their hands, motor networks that would be capable of making the hand move show a mirror-like co-activation. One could say that the viewers' brains are simulating the observed action. This way, their brains probably make the observing students gain a sort of comprehension of the observed activity. When the students are asked to memorize the chord they are about to see, so as to later be able to play it on the guitar themselves, then the mirror reaction becomes stronger the very moment they are watching.

Neuronal mirror reactions can not only be observed in the area of the motor system but also in the limbic system. As the brain itself feels no pain, neurosurgical procedures on epileptic patients can be performed under local anesthesia in conscious patients. The Canadian neurosurgeon William Hutchison took advantage of this particular situation to examine nerve cells in the anterior cingulated cortex (ACC) – with consent from the patients and the

(relevant) local ethics board. He examined neurons that belong to the so called pain matrix in the human brain. William Hutchison's group identified nerve cells in the area of the ACC that always reacted when the experimenter quickly pricked the patient's finger pad with a mini lancet. However, the same pain-activated nerve cells in the ACC also discharged when the patient himself did not suffer any pain but when he observed how the experimenter pricked his/her own finger pad with the lancet. Tania Singer and colleagues used functional magnetic resonance imaging (also known as nuclear spin tomography) to confirm William Hutchison's findings: neuronal networks in the pain matrix, which encompasses parts of the ACC but, additionally, parts of the insula as well, react not only to pain we experience ourselves but also to pain we observe.

Additional experiments by Tania Singer show that the brain's readiness to let its own pain matrix resonate in response to the pain observed in another person, is reduced if the observed other person previously behaved unfairly towards other fellow human beings. Female observers show a significantly reduced mirror reaction in the insula region when they watch how pain is inflicted on persons who have previously acted unfairly. Male observers show an even stronger decrease in their neurobiological empathy reaction than women. Experiments like these explain why the leaders of nations who intend to ready their own people for war, spread information that aims at dehumanizing the people in the country they want to wage war against. The empathy barrier which would prevent normal humans from hurting others can be overcome by creating the reasonably convincing impression – e.g. via mass media – that those who are the target of an intended aggressive intervention behaved unfairly.

Let us briefly sum this up: Mirror neurons are nerve cells that not only become active if onelself acts or feels something. They also react when a person merely observes or witnesses another human acting or feeling something. Mirror neurons convert an observation into an internal personal experience. They create an internal simulation in the observer, if you will. This way, mirror neurons let us intuitively understand what other humans are doing or feeling. But there's more. Mirror neurons also prime tendencies for executing actions to which they respond. Moreover, mirror neurons are the biological foundation for the phenomenon of emotional contagion: they can, so to say, infect us with other humans' emotional states.

Against this backdrop, it becomes clear that the mirror neuron system is of enormous importance for the physician-patient relationship, and of downright paramount importance in psychotherapy. On one hand, the therapist's "charisma" generates effects of contagion, because doctors and therapists invariably trigger resonance in their patients – whether they

want it or not. On the other hand, the therapist also feels a resonance that the patient induces in him. Mirror neurons are the neurobiological substrate of the effect we know as counter-transference. The resonance induced in himself allows the therapist to intuitively understand his patient. However, the therapist adds something to his/her resonance: He/she has a kind of "vision" of the patient. The patient, on the other hand, perceives how he/she is mirrored by the therapist. The "vision" of the therapist has consequences; it may act as a self-fulfilling prophecy. In some cases, the therapist's process of comprehension even precedes that of the patient. Sigmund Freud was the first to recognize this. In 1912 he wrote: The psychoanalyst "must turn his own unconscious like a receptive organ towards the transmitting unconscious of the patient. He must adjust himself to the patient as a telephone receiver [is adjusted to the transmitting microphone]. Just as the receiver converts back into sound waves the electric oscillations in the telephone line which were set up by sound waves, so the doctor's unconscious is able, from the derivatives of the unconscious which are communicated to him, to reconstruct that unconscious, which has determined the patient's free associations."

4. The neurobiology of aggression

While Sigmund Freud's genius is undisputed, we must realize that modern neurobiology is unable to confirm all of his concepts. Especially the aggression drive ("Aggressionstrieb") Freud postulated could not be substantiated. Directing unprovoked aggression towards others is unrewarding from the perspective of the motivation systems in the human brain, which I talked about at the beginning. In this sense, modern neurobiology agrees with Charles Darwin who did not posit an aggression instinct but described human aggression as a - while biologically founded - yet (merely) reactive behavioral program. Inflicting pain is the most reliable trigger for aggression in all mammals including humans. If you step across another human's pain threshold, you will provoke aggression or depression.

Naomi Eisenberger, an American neuroscientist, realized that parts of the pain matrix in the human brain, especially the anterior cingulated cortex ACC, not only react to pain that is physically inflicted but also to social rejection and humiliation. The pain matrix clearly reacts more sensitively to an acute experience of social exclusion in humans who generally have had little social support in their lives compared to persons embedded in strong social networks. Furthermore, it is interesting that our brains' pain matrix not only responds when we

experience social rejection ourselves but also when we observe how others are (being) excluded – which brings us back to the (previously mentioned) mirror mechanism.

Let me summarize: For the human brain, social exclusion and humiliation "feel" just like physical pain. This is why social rejection and humiliation cause aggression, just like physical pain does. Interpersonal bonds and social support attenuate the reaction of the pain matrix (and the resulting aggressive tendencies) to an acute experience of exclusion.

Here, I will not go into detail on other important aspects of human aggression which I have covered extensively in my book "The pain threshold". These include, for example, the role of the memory of aggression ("Aggressionsgedächtnis"), the role of displaced aggression ("Verschiebung") and the influence of experiencing violence on a person's tendency to act aggressively him-/herself. At this point, I would simply like to add that underdogs living in countries where extreme poverty collides with immense wealth, experience their situation as social exclusion. We have already learned that social exclusion activates the neuronal pain matrix and promotes violence. Many independently performed studies have in fact demonstrated that a country's homicide rate correlates with the unequal distribution of income and wealth.

From a neurobiological perspective, the ability of humans to control their own aggression can be described as a process that strives to balance a neurobiological "bottom-up drive" against a neurobiological "top-down control". The "bottom-up drive" is embodied in the Corpora amygdalea (fear centers), parts of the Insula, parts of the hypothalamus and the brain stem. Together, these systems represent the "bottom-up drive" of aggression and react whenever humans experience physical or social pain. The so called "frontolimbic loop" forms a central element of the human aggression system. This loop consists of nerve projections that connect the Corpora amygdalea (fear centers) to the prefrontal cortex. Specialized parts of the prefrontal cortex such as the OFC contain networks in which the human brain stores information on what the things we ourselves do look like to our fellow human beings. The basis for the prefrontal cortex's ability to perform this important function, are years and years of a dialog process we call "education". As the existence of the prefrontal cortex proves, teaching children to consider the perspective of other humans is not a project that goes against a child's "nature". On the contrary: whoever fails to invest time and effort into this dialog process, is guilty of compromising proper biological maturation of a child's brain. The

consequence may be juveniles with narcissistic, dissocial or even psychopathological disorders.

5. Summary

Let me conclude by summarizing once again: Social recognition and appreciation are key motivations for human behavior. Humans are willing to not only do good but also bad to reach their goal of belonging socially. Social rejection activates the pain matrix and promotes aggression (or depression). Humans possess a neuronal system for intuitive understanding and empathy. This system, the mirror neuron system, not only lets us intuitively understand what other persons do or feel. It also primes certain (unconscious tendencies for) actions and explains why humans let themselves become infected with the emotional states of their fellow human beings. Because of their prefrontal cortex, humans possess the ability to reflect other persons' perspectives and to control their own aggressive impulses. The process of education is a prerequisite for a sufficient biological maturation of the prefrontal cortex. Good interpersonal relationships are, so the central insight of the "social neurosciences", a critical requirement for the biological well-being of humans.

Books written by the author (see www.amazon.de)

Joachim Bauer: Das Gedächtnis des Körpers. Wie Beziehungen und Lebensstile unsere Gene steuern. (This book shows how social experiences influence gene activities and the architecture of the brain and how this may cause psychiatric disorders)

Joachim Bauer: Warum ich fühle was du fühlst. Intuitive Kommunikation und das Geheimnis der Spiegelneurone. (This book explains the mirror neuron system and its importance for the human ability to intuitively understand what other people do and feel)

Joachim Bauer: Prinzip Menschlichkeit. Warum wir von Natur aus kooperieren. (This book explains from a neurobiological perspective why human cooperate, and why we need social connectedness to preserve our health)

Joachim Bauer: Das kooperative Gene. Evolution als kreativer Prozess. (This book presents an expansion of Darwinian views. While completely rejecting the concepts of creationism and of intelligent design, the book shows how, based on the discoveries of Barbara McClintock and many others after her, modern genetics may explain how novelties develop along evolution)

Joachim Bauer: Lob der Schule. (This reader was written as a kind of guide explaining to parents and teachers how discoveries of modern neuroscience may help to improve teaching and learning in schools)

Joachim Bauer: Schmerzgrenze. Vom Ursprung alltäglicher und globaler Gewalt. (This book gives an overview on the neurobiological basis of human aggression. While rejecting Sigmund Freuds theory of an aggression instinct ("Aggressionstrieb"), Bauer shows that modern neuroscience supports Charlees Darwins view who interpreted aggression as a reactive program.

Joachim Bauer: Arbeit. Warum unser Glück von ihr abhängt und wie sie uns krank macht. (This book analyses both the promoting and the potentially dangerous effects human labor may have of human health.