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Free will – an approach from the perspective of neuroscience

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ABSTRACT

Free will designates the possibility of conscious and free choice of the subject, as well as his real possibility to act. The topic has a special medical and social relevance as it is directly connected to how the subject's responsibility (moral, legal, medical) for his own actions are understood, but also the possibility (real or illusory) of intervention in his own life.

Free will has received various philosophical, psychological, legal and interdisciplinary approaches in recent decades. In this article we shall inventory some results from the area of neuroscience that we consider relevant in the analysis of free will, research and clinical studies that highlight various effects caused by voluntary actions, consciously repeated by the subject. Some psychotherapeutic interventions, the process of awareness, learning, attention monitoring, visualization, some forms of meditation, and the changes that these practices produce in the processes of neurogenesis, neuroplasticity and epigenetics, in terms of health and quality of life are analysed.

Since these interventions involve the conscious participation of the subject and his voluntary action, we consider that the discussed results are relevant in the debate on free will. The study also highlights the importance of education and social knowledge, as well as the need to promote participatory prevention and therapy, involving the subject in increasing the quality of life and health, through public messages that emphasize the responsibility of each person for their own choices and actions and the impact they have on his life.

Keywords: free will, conscious participation, neuroplasticity, neurogenesis, epigenetics, placebo, mindfulness, visualization (mental imaging), the impact of spiritual life on health

FREE WILL – SHORT DISCIPLINARY AND INTERDISCIPLINARY THEMATIC INVENTORY

Since the way we understand free will corresponds to real or illusory capacities to decide and act, the topic is of particular importance from an epistemological and practical perspective. The concept has a long philosophical history, starting with Greek antiquity [1, 2]. In recent decades, the concept of free will has been analysed in relation to various concepts, such as the moral [3] and legal [4] responsibility of the subject, but also in connection to educational policies [5] and character cultivation [6], with the performed work [7] and academic excellence [8], being also approached in the evaluation of cultural creations [9]. There have also been approaches to free will as a decision-making process [10,11], in close connection with intentionality

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[12] and the voluntary act [13], but also in connection with other concepts such as determinism, indeterminism and the possibility of choice [14] or with reference to issues concerning consciousness [15] and conscience [16].

In addition to the inevitable ethical discussions about free will [17], there are genetic [18], clinical [19] and interdisciplinary explorations, such as those that juxtapose psychological, neuro-ethical and moral theology radiographs [20]. Finally, there is no shortage of speculative, borderline discussions that place free will in the context of quantum mechanics [21, 22] or artificial intelligence [23], or those that analyse the conditions of possibility for the existence of free will among invertebrates [24].

The PhilPapers philosophical index is evidence of the multitude of perspectives on the analysis of free will in the field of science. Made by a digital community of philosophy specialists, PhilPapers monitors sources in the field of philosophy, including texts from periodicals, journals, books and open access archives, but also from personal web pages belonging to specialists, researchers or academics. PhilPapers represents the largest digital archive of texts in the field of philosophy, with free access to the general public. At the time this article was written (April 15, 2021), PhilPapers contained 2,570,856 classified entries, organized into 5,674 categories, with over 280,000 registered users [25]. In the subcategory "free will and science", this digital inventory offered no fewer than 1016 distinct titles; of these, 13 concern analyses of free will in connection with genetics, 351 in connection with neuroscience, 109 with physics, 426 with psychology, and 103 with other sciences.

Also, the topicality and complexity of the topic can be seen in the numerous attempts to systematize or evaluate free will, recorded in recent years [26-35].

FREE WILL AND INDIVIDUAL AND SOCIAL RELEVANCE

In this vast territory of free will approaches, there are many perspectives. Some of them deny the reality of free will [36], others openly support it [37]. Beyond the many challenging and complex aspects it entails, the topic is important in terms of personal and social life [38]. There are many reasons that support this fact: the need to clarify the moral and legal responsibility for our actions, the real possibility to choose between various options, to be reasonably considered the authors of our own choices and deeds, conscious participation in decisions and actions which are assigned to us socially or in terms of lifestyle [39].

At an individual level, the way free will is understood provides a representation of the real or illusory ability to change the patterns of one's life, to replace unhealthy habits with sanogenic practices. Debating one model or another of understanding free will, scientific information can increase the subject's responsibility for his own choices and actions or, on the contrary, it can relieve him of this responsibility.

One study highlights this influence of scientific discourse on free will in subjects' self-report of addiction [40]. The scientific information supporting a diminution of free will in the case of alcohol-dependent subjects is noted; by emphasizing the neurological imbalance and deterministic aspects of addiction, they indirectly support a decrease in the possibilities available to addicted subjects of the choices they make and of their actions. On the other hand, ethical or moral approaches to alcoholism present the behaviours of alcoholics as the result of their choices, the evolution of the situation still depending on the decisions of the subjects. After noting these differences at the level of public discourse, the study emphasizes that scientific information about the real or illusory possibility of choosing behaviours can change the self-perception of addictive subjects. A discourse that minimizes the possibilities of conscious and free choices and voluntary actions can intensify the self-deprecation and stigmatization of addictive people, fuelled by the awareness of their own deficiencies in decision-making, by the acceptance of the lack of self-control [40].

In our opinion, in addition to the research aiming at conceptual aspects or theoretical, legal, psychological or interdisciplinary models, free will can also be evaluated through a series of results and discoveries in the field of clinical neuroscience. We refer here to those that concern neuroplasticity, neurogenesis or epigenetics, but also to those that take into account the placebo phenomenon, the changes induced by cognitive-behavioural psychotherapy and the experience of spiritual life.

SELF-INDUCED NEUROPLASTICITY

Neuroplasticity targets a wide spectrum of processes, being highlighted in some mammalian species [41] and in humans [42]. It accompanies the usual developmental stages of a healthy brain, but it also includes the adaptive or maladaptive structural and functional changes in brain tissue that occur throughout life as a result of experiences (sensory input), being also responsible for changes in reception and processing of experience data [43].

Neuroplasticity is present today in a wide spectrum of therapeutic interventions, from those highlighted by Edward Taub, in post stroke recovery [44], to those aiming to identify molecular targets to improve plasticity in neurodegenerative diseases [45]. Regarding synaptic plasticity, for example, PubMed indicates a total of more than 66,000 entries since 2009, with more than 3000 articles registered annually [46]. Research and clinical studies that have explored neuroplasticity show encouraging results in Alzheimer's disease, in the case of spinal cord injuries, in apraxia or in post-stroke motor rehabilitation [47]. In another register, the adoption of sanogenic behaviours, such as regular physical exercise and healthy eating, improves neural adaptation processes [48].

In various forms, in situations of this kind, at the core of the intervention, there is the conscious action of the subject, the observable neural effects being, most often, the result of a voluntarily repeated exercise. For example, adopting healthy behaviours helps increase the production of brain-derived neurotrophic factor (BDNF). It is well known that BDNF levels influence cognitive function and that in some conditions, such as severe depression [49,50], Alzheimer's [51] or type II diabetes [52], BDNF levels are low. The impact of daily practice is evident in sports, as moderate physical exercise, even for as little as 30 minutes, has effects on BDNF levels [53], contributing to increased selective attention [54] and learning abilities [55], also causing structural brain changes [56].

INTERVENTIONS FOR NEUROGENESIS STIMULATION

In the matter of free will, the findings that highlight the influence of voluntary actions and behaviours on neurogenesis are also relevant. Located in the hippocampus and dentate gyrus [57], the processes of new neuron formation by differentiation of neural stem cells have also been highlighted in adults [58]. Neurogenesis is of particular importance, having a regenerative potential [59]. And in the case of these processes, there are situations where the will, involvement and conscious action of the subjects prove decisive.

Some studies show that choosing a social environment [60] or diversifying experiences and enriching the living environment can stimulate neurogenesis [61]. Other examples are provided by studies targeting cognitive-behavioural interventions to improve the stress response. Effects of stress on cellular processes, dendritic architecture and growth factor levels are known [62]. The impact of stress is extensive, affecting the transmission of signals in the nervous system and its connections, the processes of neurogenesis [63] and neuroplasticity [64], but also the general clinical picture [65]. Cognitive-behavioural interventions to improve the stress response [66] are relevant in the discussion about free will, because they produce a change through a set of actions in which patients participate consciously. For example, intermittent fasting [67], exercise [68, 69] and diet [70] can stimulate processes of neurogenesis. Also, there are some studies that announce the beneficial impact of coping strategies in the regulation of neurogenesis processes, a fact first highlighted in monkeys [71], but also discussed in humans [72].

SELF-DIRECTED EPIGENETICS

The field of epigenetics provides results worth considering in the free will debate for the same reason. It is about the methylation/demethylation processes of DNA, the acetylation/deacetylation of proteins (mainly histones), the activity of microRNAs (miRNAs) that accompany the modification of gene expressions and the functions that these genes encode. In these cases as well, there is evidence regarding self-induced plasticities, through conscious effort, through voluntary actions.

An example in this case is provided by the studies evaluating the improvement of the epigenetic effects of stress through cognitive-behavioural interventions. It is known that exposure to stress in the early period of life can produce changes in gene expression, at the level of methylation processes [73, 74]. Some studies highlight how maternal behaviour and the social environment influence the stress response in mice [75] and how attachment can ameliorate the epigenetics of the stress response in humans, in young adults [76]. Cognitive reframing (cognitive reappraisal), cognitive-behavioural psychotherapy [77] or other psychotherapeutic interventions [78], but also simple behavioural changes, such as choosing a sanogenic living environment and a healthy diet [79] or regular physical exercise [80], can significantly influence gene expression. It is about the regulation of genetic expressions (down-shifting or up-shifting) that modify correlative physiological mechanisms, improving the quality of life [81]. In particular, changes in life patterns can influence the decrease in pro-inflammatory expression and even the conserved transcriptional response to adversity – which includes the expression of the genes involved in the inflammatory and infectious response [82], a fact that contributes to improving health [83].

In the discussion of free will, studies that signal the influence of chronic stress [84] on telomere plasticity [85] and thus the impact on lifespan are also significant. And in this case, therapeutic interventions to improve the stress response prove effective. It is not only about the early periods of life, when telomere plasticity seems to be under the influence of maternal attachment [86], but also about conscious actions, voluntarily repeated by adult patients, actions that can produce significant changes. The method of multisystem resilience (multisystem resiliency) [87], for example, aims at emotional regulation, strengthening social connections and adopting healthy behaviours, these beneficially influencing telomere plasticity. One study showed that the intervention applied to a group of adults, aged 45 - 90 years, caused a slight increase in telomere length and a decrease in the intensity of the depressive episodes [88]. Other studies show a telomere plasticity in adulthood through healthy routines [89-92].

Along with epigenetics, new processes of epigenetic-transgenerational nature, which can interfere with the decision-making process [93], feeding deterministic perspectives at the scientific level and at the level of the general public, are also under discussion [94]. However, we believe that the mentioned studies convincingly show that we can increase the conscious and active involvement in the preservation of one's own health and that there are ways of prevention and possibilities of therapeutic intervention directed to epigenetic responses [95].

SPONTANEOUS REMISSIONS, PLACEBOS AND PERSONAL FACTORS

The study of the placebo phenomenon and those that follow spontaneous remissions provide arguments in favour of free will, arguments which claim that our own choices and actions influence our lives and health.

The placebo phenomenon [96] has registered an increased presence in the scientific approaches of the last decades [97]. Studies show varying degrees of effectiveness of this effect in improving stress response and post-surgery recovery [98], in migraines [99] and anxiety [100], in rheumatoid arthritis [101] and in carpal tunnel syndrome [102], in fibromyalgia [103], in cases of allergies [104], chronic pain [105] and duodenal ulcer [106], but also in depression [107] and cancer [108]. For example, a meta-analysis indicates a placebo efficacy rate of 29%, compared to 36% in the case of classical medical interventions [109].

In recent years, approaches that propose genetic investigations of placebo-responders have emerged. It is about the area called placebome, which inventories the genomic particularities of the patients who respond to placebo and the therapeutic possibilities that arise [110]. One of the acknowledged authors in this field warned, at the end of an older study, that the existence of the placebo effect suggests the expansion of "the conception of human capabilities" [111].

We include here the growing scientific interest in spontaneous remissions as well. It is about some case studies [112-115] and meta-analyses [116-119], which affirm the need for scientific clarification studies regarding the role of subjective aspects, such as prayer [120] or other psychological factors [121] in the process of spontaneous remission.

Studies on the effectiveness of the placebo effect or on the conditions of possibility for spontaneous remission are worth considering in the evaluation of free will, since we are dealing with a process in which compliance, belief in the beneficial effect of the treatment [122], higher organized beliefs are decisive, data of knowledge [123], faith and religious practice [124].

ATTENTION SELF-CONTROL, LEARNING AND AWARENESS

Those studies (evidence-based medicine) regarding cerebral changes determined by the conscious direction of thoughts are also relevant in the inventory of therapeutic possibilities capable of producing self-induced plasticity. For example, proper mental training through deliberate effort can affect pathological brain circuits, causing adaptive alteration. This is the case of some successes obtained through therapeutic interventions in the treatment of OCD (obsessive compulsive disorder) [125], in phobias, anxieties or in post-traumatic syndrome [126].

Therapeutic interventions aimed at controlling conscious mental activity consist in self- or refocusing techniques, methods of increasing awareness [127] or acquiring coping strategies [128], the learning effort being the main vector in increasing resilience and functional neuroadaptation. Basically, the meaning associated with an action reconfigures the effects of that action on the acting subject, to the extent that he is aware of that meaning. For example, one study showed that informing some housekeepers about the beneficial effects of their activities increased the beneficial impact of their work on their health, compared to another group of housekeepers who performed similar activities but were not informed about the sanogenic impact of their work [129]. The subject's conscious participation in the activities they carry out, a mental way to relate to his own actions (mind-set), comes into question in this case as well.

Other studies, in which subjects are asked to increase awareness of an action or learn a new movement, also have relevance to the discussion of free will. For example, the neural map correlative to a visual awareness task has been found to be more extensive, including higher brain centres, in contrast to the brain footprint corresponding to a visual attention task [130,131]. In another study, we find that the brain imprint corresponding to the learning efforts to learn a new movement (accompanied by a conscious effort) differs from the active one in the automatic performance of the same movement [132]. These results bring into discussion learning as a conscious effort to retain some information or to acquire some movements and the qualitative difference that the awareness effort produces at the level of brain networks [133]. Thus, some particularities have also been identified in the case of mathematicians [134] or those who practice meditation [135].

On the other hand, by consciously directing attention to certain stimuli, the subject influences his own perceptions and neural processing of signals. Intentional focusing of attention on certain stimuli in the sensory field causes differential processing of selected signals (event), relative to all other signals (background noise). Voluntary attention modulates neural communication (top-down), causing an increase in the efficiency of processing presynaptic input and postsynaptic response, in the case of the tracked signal, and a decrease in efficiency in the processing of redundant signals, a fact that allows improved reception of selected stimuli (event) relative to background noise [136].

Furthermore, attentively following images can produce measurable physiological effects, with mirror neurons as a possible explanation [137]. Some studies have reported an increase in finger length through training to view suggestive materials [138], but also an improvement in the condition of stroke patients [139] when they watched video materials with specially adapted content.

SELF-INDUCED PLASTICITY THROUGH MENTAL IMAGING

The studies highlighting the impact of thinking and mental imagery on brain functioning hold an important place in the discussion of self-induced plasticity. One of the first studies that inaugurated this field of work proved that merely practising an action mentally produces neural changes similar to those caused by actually performing the action [140,141]. Following this result, other studies have shown the importance of thoughts and mental images on physiology. The mental representation of a movement of the fingers and toes, as well as the tongue, produces activity in the brain regions that govern them [142], and directed imaginal training produces an increase in physical strength [143,144].

Mental visualization (or mental imaging) has been tested with encouraging results in various conditions, with notable results in the healing of post-surgery wounds [145] and the reduction of pain in fibromyalgia [146], in post stroke recovery [147] and in relieving pain caused by cystitis [148], in rehabilitation after a spinal cord injury [149]. There are notable results of mental imaging therapy, showing improvements in the condition of patients with asthma [150] and Parkinson's [151], decreases in stress levels and recurrence conditions in breast cancer [152], improvement in the quality of life of patients with osteoarthritis [153], but also strengthening the state of calm in patients with lung diseases [154].

In these cases, we are dealing with patients who cultivate specific mental images, obtaining significant improvements, a fact that indicates the important impact of thoughts and mental representations on health and life.

MINDFULNESS, RELIGIOUS AND SPIRITUAL EXPERIENCES

The possibility of real interventions likely to produce significant changes in health and life is also supported by studies evaluating mental practices and spiritual experiences.

In the last decade, there have been neuroscientific investigations on various forms of mental self-control, meditative practices such as relaxation response and mindfulness [155], mindfulness based stress reduction – MBSR [156], mind-body therapy [157] and their possible health effects. The results are significant in the treatment of post-traumatic syndrome [158], anxiety [159] and depression [160], in the regulation of cortisol levels [161], in the regulation of blood glucose levels, in patients with type 2 diabetes [162], in the potentiation of neurogenesis [163], but also post transplantation, reducing depression and anxiety and improving the quality of patients' sleep [164].

A study showed the effectiveness of an 8-week mindfulness-based stress reduction program (MBSR) in 49 breast cancer patients and 10 prostate cancer patients, all at an early stage. The program included relaxation periods, meditation techniques practiced daily at home. Measurements, made before and after surgery, revealed changes in endocrine, immune and autonomic parameters, salivary cortisol levels, immune cell counts, blood pressure and heart rate [165].

Other results point out that the MBSR program can contribute to the improvement of the quality of life [166], causing a reduction in the level of stress in patients with various forms of cancer [167]. In some cases, the effectiveness of the intervention is rapid, if we take into account the conclusions of another study, which highlighted, after only 8 hours of meditation practice, changes in the inflammatory mechanisms (decrease in the level of interleukin-8, a pro-inflammatory cytokine) [168].

Numerous other results refer to other spiritual practices. We have in mind here the “Mother Teresa Effect”, highlighted by David McClelland [169], which signals the change of the immune response as a result of an experience which has a spiritual content, but also the therapeutic effects of compassion [170-172]. In this case, the studies that identify distinct brain imprints and psycho-emotional effects from various spiritual or religious practices, highlighted by Andrew Newberg in neurotheology research [173,174], are also relevant.

The conclusions of the meta-analyses carried out by Harold Koenig, in the studies regarding the therapeutic effects of religious or spiritual life, are also remarkable. In one of these large meta-analyses, evaluating 1200 medical studies published between 1872 and 2000, and 2100 studies published between 2000 and 2010, strong correlations between religion/spirituality and various aspects of health are highlighted [175]. Operating a rigorous selection that took into account criteria of scientific probity, experimental design and correctness of data analysis, the meta-analysis provided a scientific x-ray of the relationship between religious life and health, at the level of 2010. The conclusions of the meta-analysis indicate a significant beneficial impact of spiritual and religious life practices in coronary diseases, arterial hypertension, cerebral-vascular diseases, Alzheimer's disease and dementia, in the regulation of immune function and endocrine function, in the evolution of cancer, in the quality of mobility (mobility and capacities physical) and health and life expectancy [175]. In addition, spiritual life has a beneficial impact in shaping the response to stress, in cultivating positive emotions, in well-being, in cultivating hope and optimism, in strengthening the sense of a meaningful life, in increasing self-esteem, in positive character traits, at the same time reducing the incidence of depression and suicide, anxiety and substance abuse, delinquency and marital instability [175].

Another meta-analysis, led by the same physician [176], assessed the link between spiritual/religious life (R/S) and mental health captured by scientific studies published in specialized journals over a 20-year period between 1990 and 2010. Original research on religion, religiosity, spirituality and related terms published in the top 25% of psychiatry and neurology journals, according to the 2010 ISI index rankings, was examined. In percentage terms, 72.1% of the analysed research showed a positive relationship between the level of religious/spiritual involvement and a lower presence of mental disorders. All studies on dementia, suicide and stress disorders found a positive association of R/S, 79% of them found that R/S correlated with lower depression and 67% of them with lower substance abuse [177].

Other approaches go even further, forcing new territories, targeting possible effects of mental activity on neurogenesis and DNA expression [178] or the epigenetic impact of the relaxation response [179]. A significant example is a study of the changes brought about by a meditative practice that focused on the meaning of life. The practitioners recorded - after 6 hours of daily meditation, during 3 months spent in retreat - important changes in immune cells, a decrease in negative affectivity, increased telomerase activity, increased telomere length and an increased longevity of immune cells [180].

Even though the detailed analysis of such results is just beginning [181-183], we believe that studies of this kind remain significant for discussions of the real possibilities of choice and life change, discussed with reference to free will.

CONCLUSIONS

Debates about free will bring into question various philosophical and psychological concepts and nuances. In addition to these considerations, clinical studies and experimental research in the field of neuroscience provide significant results that deserve attention in the evaluation of free will. The stake is precious, as we are dealing with the possibility of deliberate, conscious intervention in the plan of personal life. The briefly inventoried research indicates various possibilities of involving the subject, which can alleviate suffering, contribute to the recovery or development of some skills, can stimulate positive emotionality and can change patterns of thought and action, contributing considerably to the improvement of the quality of life.

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