

## Neuroenhancements: Evolution and perspectives

### Neuroenhancements: Evoluzione e prospettive

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#### Abstract

The word “neuroenhancement” indicates the strengthening of those fundamental processes and activities that are considered essential for a normal functioning, such as: memory, attention, problem solving, deductive skills, and so on. With the increasing development of neuroscience, it was believed that a change would come: thanks to the opportunity of observing the brain in vivo, it seemed possible to improve the cognitive functions of human beings. The main pursued changes were basically two: a) the modifications/additions brought by the use of technology could be implanted or stimulated directly in a person’s brain; b) there is a strong will to make those enhancements available to every able-bodied person. Nevertheless, the results shown by the research contradicted the expectations. The pharmacological research is considered suspended, and the effects of the most efficient neuroscientific techniques, as the transcranial magnetic stimulation (TMS), last briefly. Moreover, even moral neuroenhancements, which aim to increase pro- social attitudes and thoughts, are standstill and more and more discussed by neuroscience, philosophy and pedagogy.

Despite those findings, the distribution of these means, most importantly the pharmacological ones, continues growing, and it moreover has a great impact on scholastic literature and practice, contexts in which it is possible to observe their first application and consequences.

La parola neuroenhancement indica il potenziamento di quei processi e attività mentali fondamentali per un funzionamento considerato normale: memoria, attenzione, problem solving, capacità deduttive e così via. Con l’avvento delle neuroscienze si è creduto di arrivare ad una svolta: osservando il cervello in vivo, sembrava possibile potenziare più efficacemente le facoltà cognitive dell’animale uomo. Due i principali cambiamenti apportati: a) le modifiche/aggiunte apportate dalla tecnologia sarebbero impiantate o sollecitate nel cervello di un individuo; b) si vorrebbe che questi miglioramenti fossero disponibili anche per soggetti normodotati. Lo stato della ricerca non è però roseo come era stato auspicato. La ricerca farmacologica può considerarsi bloccata e le tecniche considerate più promettenti, come la stimolazione magnetica transcranica (TMS), hanno risultati di breve durata. Anche i tentativi di potenziamento morale inoltre, ovvero quelli che mirano a stimolare le capacità pro- sociali, sono in uno stato di stasi e ancor di più al centro di dibattito scientifico, filosofico e pedagogico.

L’utilizzo di questi mezzi però, soprattutto di quelli farmacologici, continua ad aumentare ed ha avuto un grande impatto sulla letteratura e sulla pratica scolastica, ambito in cui in concreto si sono potute osservare le prime applicazioni e conseguenze dell’uso degli stessi.

#### Keywords

Neuroenhancements- pharmacological research- TMS- moral neuroenhancements- methylphenidate

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## The block of pharmacological research<sup>1</sup>

Pharmacology was the first discipline in which developments on neuroenhancements seemed promising and endless. The purpose was to make the upgrades available not only to those suffering from any cognitive impairment, but also to people considered able-bodied. The most used drugs now have names that are well known even to those who work in the educational field: methylphenidate, modafinil and amphetamines. On this topic, we can individuate two the main hypotheses: a) the hypothesis of pharmacological optimism, and b) the hypothesis of the prevalence of neuroenhancements (Schleim & Quednow, 2018). The first is based on the assumption that intellectual performance can be improved through the use of drugs, and asserts, moreover, that these drugs are already widely used even by the healthy population. The second hypothesis is based on the belief that their use will increase in the future. Nevertheless, the most recent literature on these two hypotheses presents and corroborates discordant positions. First of all, it is essential to report that there is a talk of a “pharmacological crisis”<sup>2</sup> at least since 2010, and current reports show that the rate of consumption of substances for the purpose of enhancement is low compared to its application as a psychostimulant.

In the golden decades of optimism, one of the most quoted expectations was to find better treatments for those suffering from mental illnesses, and therefore investments by governments were very conspicuous (Pandolfi, 1993).

One of the aims of the re-writing of the DSM V was to identify biomarkers, in particular cerebral ones, that could be reliable footholds for the prediction and treatment of psychiatric disorders. The research focused on various forms of dementia and attention disorders in order to create enhancements also for non-disabled people. Expectations have been largely disappointed, and no reliable biomarker has been found, so much so that the DSM V is based on other criteria, that are not debatable in the present work (for further reading cfr. Kirmayer & Laurence, 2016). Due to these disappointments, pharmaceutical companies and governments have rapidly changed the beneficiaries of their investments.

The result is blatant to anyone dealing with these substances: they are the same since the Seventies. This does not mean that the known and investigated molecules offer no other challenges. Amphetamine, for example, is still widely used and tested to better understand the mechanisms behind particular action of the human and animal brain. Moreover, many studies on the use of these substances in the treatment of attention deficit hyperactivity disorder (ADHD) that are now available, should make academics reflect and re-evaluate the issue.

A recent meta-analysis by the Cochrane group has discovered that most trials in this specific sector have been and are at high risk of bias, and that they bring empirical evidence of very low quality. These trials, we read, should last longer and concentrate more on acquiring data on side effects and prolonged use (Punja et al., 2016 regarding children and adolescents; Boesen, Saiz et al. 2017 for the diagnosis of ADHD and treatment with amphetamines in adults).

Recent literature has also reported that many of these already tested substances have very limited and uncertain effects on damaged cognitive functions (de Jongh, 2017).

The difficulties in investigating enhancements focused at treating symptoms of recognized mental illnesses are therefore still considerable/enormous. The obstacles of the research on the use by healthy individuals of these substances are even more: it is not so straightforward that the substances that can benefit some functions of a person suffering from a pathology can give also good results on the same functions on those who are not affected by that pathology (Schleim, 2014). As previously stated, it is more difficult to develop substances that can enhance a healthy

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1 Il manoscritto è il risultato di un lavoro collettivo degli autori, il cui specifico contributo è da riferirsi come segue: Margot Zanetti paragrafi 1,2 e 3; Francesco Peluso Cassese paragrafo 4 e Conclusioni

2 <https://www.nature.com/news/2011/110614/full/news.2011.367.html>.

individual than to find them for an “ill” individual. The assumptions underlying the hypothesis of pharmacological optimism are therefore denied.

For what concerns the spread of these drugs, an aspect must be emphasized: even if their production is constantly increasing, this is not related to a growth in their use for the purpose of enhancing. As a matter of fact, it seems that the increase in the number of amphetamines, modafinil, and methylphenidate is mainly due to an increase in ADHD diagnoses (Bachmann, 2015).

Moreover, it is curious to notice that the increasing warning literature about their use does not correspond to their less widespread and more considered use.

There are not enough data that can show the augmented use of these substances as cognitive enhancements by able-bodied people. Therefore, the hypothesis of the prevalence of enhancements is, at least for the moment, to be set aside, too.

## **2. The other neuroenhancements: methods of brain stimulation**

One of the most promising methods of enhancement is electromagnetic brain stimulation. As it is known, brain stimulation for the purpose of improving mental functions and decreasing neurological and psychiatric symptoms has a long history.

From electroshock, namely, using its technical name, the electroconvulsive therapy (ECT), made known in particular by films and literature, new forms of stimulation have been devised, and ECT itself has undergone several changes (it should be noted that it is still used). The literature that studied its effects provided the basis for the development of new techniques, which are considered to give excellent results. The studies were solicited also by the success of neuroimaging techniques, which allowed us to identify the neural bases of some cognitive functions.

Direct current transcranial stimulation (tDCS), guided by neuroimaging techniques, has brought interesting results in enhancing memory, attention, and learning in able-bodied individuals (Coffman et al., 2014). The actual benefits deriving from this technique are of short duration, nevertheless, the given progress needs, at least, to be reported. Specifically, the tDCS has shown that it can enhance reading skills in subjects suffering from dyslexia, and it is hoped to be able to suggest and actualize treatments for those who suffer from this learning disability – currently, adults are being studied (Turkeltaub, Benson et al., 2012). The side effects seem few and not very intense, and the combination of different techniques allows a better performance when each of them is used with other techniques. Scientists who seek to improve these means hope to use them, for example, to improve attention and vigilance both in healthy individuals (workers who might need them), and in those suffering from different deficits (Parasuraman & Galster, 2013). It is also stated that these stimulation methods are much more effective than the pharmacological ones and, since they have very few side effects and are cheaper, they could be combined with or replace them (Kuo et al., 2017).

Transcranial magnetic stimulation (TMS) is used to increase or decrease cortical excitability. It is possible to obtain different effects by modifying the frequency of impulses, especially on motor learning, tasks that involve the use of attention, memory, and language. Even also in this case, experimentations are both on able-bodied subjects and on people suffering from pathologies (Luber & Lisanby, 2014). The possible relationship between TMS and Hebbian learning<sup>3</sup> has also been investigated. The hypothesis is that the TMS alters the properties of neural networks precisely through this connectionist theory.

Another tool belonging to this family is Deep Brain Stimulation (DBS), which is used, for example, to soothe motor disorders caused by Parkinson’s disease. It has been noted that this

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3 The neurons that discharge simultaneously connect together. Repeated stimulation of specific neurons slowly leads to the formation of a “cell assembly” that can act as a closed system, once the stimulation has ceased, thus prolonging learning.

type of stimulation, which is rather invasive, when aimed at the medial temporal lobe can enhance memory and learning (Suthana & Fried, 2014).

Lastly, it was decided to mention the possibility of using cognitive exercise methods to stimulate structural and functional brain changes able to lead to enhancements. These techniques seem to implement the stimulation ones that have been just illustrated (Shah et al. 2017).

Therefore, the purely neuroscientific perspective appears to be much more promising than the pharmacological ones (Clark & Parasuraman, 2013), not only because its techniques reveal to be, at least to a small extent, effective, but also because it has been successfully experimented the interaction between different means, too, creating what is called “multimodal neuroenhancement”, which consists in combinations between neuroimaging and neurofeedback, between transcranial stimulation, neuroimaging and cognitive training. Surely, there is a lack of common protocols for the application of these technologies, and there are no common methods for performing and reporting measurements. These, therefore, represent the aspirations of sector experts.

### **3. Moral neuroenhancements**

The enhancements described above aim to improve primary cognitive functions. However, researchers and scholars from different disciplines wondered if these were functions worthy of improvement. They argue that the real imperative is not to improve the abilities more closely related to the prefrontal cortex, but rather those dependent also on emotional circuits. Nowadays, it is known that the divisions operated by philosophers for centuries, those between rationality and emotionality, can be defined as outdated (Damasio, 1995). As a matter of fact, emotions and the affective system of human beings have proved to be fundamental for rationality and moral action.

Starting from this perspective, therefore, humanity would benefit mainly from more widespread pro-social and moral attitudes, rather than from individuals with more efficient mnemonic or attentive capacities for performative purposes. Ingmar Persson, Julian Savulescu, Thomas Douglas, and David DeGrazia are the authors who have been most interested in investigating this topic, albeit with differing opinions regarding some aspects.

As they explain, the problems start from the definitions: what is meant by morality? Is identifiable, in the brain, a unified cognitive/emotional system responsible for the formation and implementation of moral judgments? Let's just think about the role of emotions, for example: their importance has been discovered only recently, and we are far from understanding its complexity.

There are several suggestions on methods that can be applied to implement moral judgment: namely, administration of neurohormones such as oxytocin (combined with psychological therapies), alteration of testosterone and serotonin levels to decrease aggression and at the same time increase the desire for cooperate (Crockett, 2014), and, moreover, transcranial magnetic stimulation.

The use of these techniques and deep brain stimulation aims to reduce the impulsive tendencies in psychopaths, as well as to treat addictions and implement self-control (Glenn & Raine, 2008). It therefore seems that this type of enhancements, when successful, could improve the quality of life of individuals and societies, since it is able to help in the treatment (and re-education?) of those subjects that are considered today not able to be rehabilitated or difficult to treat, regardless they are children or adults.

Moral neuroenhancements, however, should be distinguished from mere methods of behavioural control. They are defined as “any change in the moral agent A, made possible or significantly facilitated in some way by the application of a neurotechnology that makes A a better moral agent” (Earp, Douglas, Savulescu, 2018) and have such ethical criteria that are

fundamental to consider them truly moral. Assuming that they must be taken voluntarily: (a) the drug or technology in question must be used as an aid intervention or in addition to more traditional forms of moral learning, so that (b) they allow conscious and committed reflection only facilitated (not caused!) by their use. (c) Drugs and technologies must have been tested in such a way that there is a detailed risk-benefit report.

Lastly, moral enhancement can be considered of two types. The first is called “direct” and it is considered as something that aims at inculcating directly contents, values, motivations and behaviours. The second, or “indirect”, attempts instead to make people more reliable when they autonomously produce more correct moral reasoning, without specifying how these should be (Earp, Douglas, Savulescu, 2018).

This second type is considered to be better for several reasons. To begin with, how can an act be considered “moral” if it has not been chosen in a non-autonomous way? The dialectic between different ideas must not be destroyed by a single thought. Only in this way it is possible to improve ourselves as humankind, without, on the one hand, neglecting the fact that there exist no contents that are always fair and, on the other hand, defining concepts like “moral”, “right”, “beneficial” etc., which are extremely arbitrary.

How can be evaluated, therefore, those enhancements that can hypothetically be used in educational and rehabilitative treatments?

Another important question to ask is: what is better to increase and what to decrease? Would making everyone more empathetic be really profitable? Logically not. Many professionals, for example, would face enormous obstacles. But not only that. Particularly sensitive people would suffer from a further increase in these faculties, and, moreover, it seems that empathy could be the cause of serious bias in moral reasoning (Prinz, 2011) and even counterproductive.

It goes without saying that the real results to expect after these “upgrades” are different depending on the person and the context. It should be an improvement of the conscious or unconscious ability of identifying the moments in which it would be more appropriate to empathize and allow consequent behaviours to manifest (and vice versa, the ability to suppress this mechanism). The fundamental importance of the educational context and of classical and non-classical pedagogical methods, as a basic foundation for the enhancements to actually work, cannot therefore be ignored: the aim is to facilitate, not to determine a reasoning or moral action (Earp, Sandberg and Savulescu, 2016). Therefore, it is strongly suggested using mindfulness techniques, teaching philosophy from childhood, and applying particular game laboratories.

Currently, the main focus lays on means other than the ones that do not require the use of drugs, probably because these have always been the same for years: their use is cited as a test-bed with children and young people with ADHD, and transcranial brain stimulation methods are reported just to reiterate again that the pharmacological research is blocked. Furthermore, there are discussions on their ethics, on the distinction between healthy and pathological, on the struggle between bioconservatives and transhumanists.

After having examined the methods which have been implemented and those which are hoped, it just remains to figure out what the present reality is, especially in school classrooms and in those contexts where an educational intervention is required. The educational approach is still considered essential even for future discoveries.

#### **4. Methylphenidate and amphetamines: the concrete “enhancements” that teachers face**

There is no doubt that methylphenidate and its compounds are the most common drugs among those that can be considered as enhancements. As it is prescribed for what is considered a real psychological distress, the ethical debate about it has not acquired any particular significance. As a matter of fact, since ADHD, like many of the mental illnesses, often presents diagnostic comorbidities, such as oppositional defiant disorder, but also affective and social deficits, some psychiatrists encourage the use of this drug as the only method to alleviate symptoms, and

to be the only one able to manage the child at school and at home.

Leaving aside the possible criticisms that could be made about this prospect, like for example, the lack of real informed consent given to families on the possible side effects of the drug and its long-term use (Storebø, Pedersen et al., 2018), it can be highlighted that Italy, on this regard, is a positive model. Not only the diagnoses and prescriptions did not follow the European trend of continuous increase, but a special register was established to monitor the phenomenon and the spread of the drug. Nevertheless, in 2016, people assuming methylphenidate or atomoxetine (which is an alternative drug, noradrenaline re-cap instead of serotonin) amounted to 3696, and the average age was 10, 7 years<sup>4</sup>. Of extreme male preponderance, this number and, above all, the age of the users cannot be ignored, especially if we consider that, even if is slight compared to the rest of Europe, the increase in prescriptions exists.

Although these drugs are not prescribed as cognitive enhancements, and they are not, as advocated by some of the scientists mentioned above, prescribed to able-bodied children to perform a surplus of potential, one could try to use this spread as a test-bed. One might ask, for example, if specific pedagogical learning methods have been devised to support the use of therapies. It would also be interesting to understand if teachers are aware of what the use of these drugs entails, and which consequences it has on their own way of thinking, and the one of their students. If the answers to these questions are mostly negative, as it will be briefly seen below, the logical consequence is to take a step back from the dream of becoming all “transhuman”.

Regarding the methodologies, different ones have been elaborated from a psychological perspective (e.g., Vanzin, 2018). There are official sites that deal specifically with this disadvantage, but pedagogical interventions and observations do not stand out.

It is possible to find generic recommendations or even suggestions based on the observation of a single student diagnosed with ADHD (Hamilton, Astramovich, 2016).

The mentioned strategies refer more often to the greater need for positive reinforcement, to find occupations that involve the motor aspect, to teach communication techniques, and to assign tasks of shorter duration.

Remaining in the Italian context, it is interesting to notice that one of the places where more space is given to the link between boys with ADHD and school, is the AIFA page, in which are given, for each symptom considered typical of this disease, specific management suggestions. Since the means are mainly of a clear educational-pedagogical type, and not psychological, there could be an interesting challenge for pedagogy to develop methods that take into account the findings of the “sister disciplines”, and that can implement the pedagogical specificity that actually seems to be still needed.

In fact, if several suggestions are given, and today many people talk about ADHD and children with the need for support, teachers cannot define themselves ready to face the complexities of management that all these differences entail in a classroom.

A recent Australian study has brought interesting results regarding this aspect. The aim of the research was to understand if teachers had ambiguous thoughts or attitudes towards their students with ADHD, or if they lived in a positive and simultaneously negative way the teaching to the students. It turned out that the teachers who knew this psychic distress best had more positive attitudes and behaviours towards them, but they presented more ambivalent basic beliefs than the colleagues who knew less (Anderson, Watt, Shanley, 2017). It would be extremely important to understand how these ambiguities are perceived by students. As a matter of fact, this is the attempt made by some Finnish researchers who have investigated the perception of teachers' behaviour by children with ADHD. The data emerged are discouraging, especially for a state considered pioneering in the educational field as Finland. The behaviours of the teachers towards these students have been perceived by them as disproportionate, traumatizing, negligent and unfair (Honkasilta, Vehkakosky, Vehmas, 2016). Of course, this is the point of view

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4 The ADHD national register can be consulted:  
[http://old.iss.it/binary/adhd/cont/Registro\\_nazionale\\_dell\\_ADHD\\_2007\\_2016.pdf](http://old.iss.it/binary/adhd/cont/Registro_nazionale_dell_ADHD_2007_2016.pdf)

of adolescents, who often, with diagnoses or not, do not like the reproach or the obligation to adhere to some rules. However, educators should be interested in understanding the reactions they provoke, especially in children whom it is more difficult to teach to. The dangers of negative labelling cannot be underestimated (Zanetti, 2018).

Is it desirable to give these drugs, or similar, to able-bodied children when at the moment it is difficult to manage even those who, according to doctors, need them? Could research on new educational methods of empowerment be more appropriate than those carried out by hard sciences?

## **Conclusions**

Despite the greatest hopes of companies and governments, that have invested especially in pharmacological research, the possibility of enhancing cognitive faculties of able-bodied and non-able individuals is still far. Pharmacology has shown that it is more difficult to find substances that empower the able-bodied children, than to discover others to soothe or implement the faculties of those suffering from mental illness.

Neurosciences, on the other hand, propose methods whose effectiveness, although brief, seem to be proven for both categories, so much so that some researchers even hope to replace some drugs with different types of transcranial stimulation.

It is interesting to notice that, even in this case, the importance of other strategies to apply in conjunction with stimulations is not denied.

Another line of research on enhancements considered more appropriate to ask if improving human beings from a moral point of view could bring more benefits, making reasoning skills more efficient, but also providing a better autonomy on emotional systems, which depend also on a greater awareness of the same. Paradoxically, this approach presents more obstacles than the previous ones: not only the pathways and brain processes underlying the moral reasoning and the influences that emotions have on these are not clear, but, moreover, the meaning of the word “moral” is also debatable. The methods investigated for this purpose are of the same kind of those used for the implementation of primary cognitive faculties, and, again, it is particularly mentioned the use of drugs, such as methylphenidate and derivatives, to increase pro-social capacities.

These authors, too, come to the conclusion that there actually is a block in the research-field in this sense, and, therefore, they propose the use of educational strategies, such as teaching philosophy from childhood, and mindfulness paths. Once again, the need for introducing more pedagogical paradigms is recalled, whether they are understood as alternative methods, or as a necessary background to allow the upgrades to work.

In conclusion, it seemed appropriate to mention and figure out the real current situation, where amphetamines and methylphenidate are the most common prescribed drugs, and children and young people are the first consumers, due to the diagnosis of ADHD and the subsequent prescriptions of medicines.

It has been wondered, perhaps too arbitrarily, if this could be a test of what would happen if more drugs or treatments of different types were widespread. Although, in this case, they are children with a diagnosis who do not take substances for the sole purpose of enhancing, observing what happens in the classrooms can be inspirational and offer new challenges to pedagogy. As a matter of fact, methods of a purely pedagogical matrix do not seem to stand out in support of the proposed therapies, despite their need is, more or less, strongly hoped.

Since science admits that it has not achieved the results it aimed for yet, and that there are no safe and efficient methods as desired, pedagogy could regain its proper space.

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