

The myth of cognitive enhancement drugs

The debate on biomedical cognitive enhancement has been prodigious, arguably questionably so. The sheer volume of discourse about this prospective technology has led some to wonder whether, for once, the ethical investigation is too far ahead of the technology (e.g. [1]). What is fueling this frenzy of deliberation about such a specific prospective technology? In the context of pharmacological cognitive enhancement (PCE), which have received the bulk of the attention in the associated literature, I argue that a number of key presumptions act to impel this flurry of debate. These can be summarized as follows:

- That evidence exists that certain drugs boost cognition among the cognitively normal.
- That it makes neurological sense to talk about pharmacologically enhancing cognitive abilities separately from non-cognitive facets of our psychology, like mood and motivation.
- That an ethical analysis of cognitive enhancement specifically is therefore pertinent.
- All the more so due to the evidence of widespread and increasing PCE use, especially among students.

As I will illustrate below, some combination of these four presumptions – or, as the title suggests, these four myths – is at the heart of driving this debate. It is the goal of this article to expose these as unwarranted. I will first argue that, in fact, there is no consistent evidence that the cognitive enhancers commonly discussed – such as methylphenidate (Ritalin), mixed amphetamine salts (Adderall) and modafinil (Provigil) – actually augment specifically cognitive capacities among the healthy and non-sleep deprived. I will then provide evidence that these drugs appear to be acting on non-cognitive brain states, and that attempts to separate the cognitive from the non-cognitive (such as mood and motivation) are artificial and neurologically misinformed.

Furthermore, I will argue that maintaining any such artificial divide between PCE and pharmacological non-cognitive enhancement in the name of highlighting the core ethical issues raised by the former, such as using PCE for academic examinations, is unfounded: non-cognitive enhancers that boost subjective states such as confidence and motivation are equally relevant in such contexts. In fact, it is not clear how PCE per se raises any ethical questions that are distinct from some broader neuroenhancement of brain states. I will then argue that a recurring justification for this debate – that the use of PCE is widespread and likely to increase – lacks evidence and is based on scant and unreliable data. Finally, I reflect on some of the costs and implications of these presumptions.

The goal here is not to conclude that the debate itself is unneeded. Instead, the aim is to highlight the need for a less hype-driven conversation that is instead rooted greater conceptual clarity and in the actual empirical evidence for PCE efficacy and prevalence.

Cognitive enhancement in the literature

Before proceeding, it is important to be clear about what exactly is meant by cognitive enhancement in the context of this debate. Here is a term that is often used interchangeably with neuroenhancement – often intentionally so (e.g. [2]) – as well as with terms like “brain doping” and “cosmetic neurology” (e.g. [3]).

Nevertheless, a clear domain for cognitive enhancement is apparent in the literature, and that domain is rooted in that aspect of our psychology associated with the organization and processing of information. It is such traits as perception, attention, understanding, memory, and reasoning that are associated with cognition [4]. Hence in a volume titled *Cognitive Enhancement: An Interdisciplinary Perspective* [5], it is characterized as increasing “information-processing functions such as learning, planning, concept formation, perception, attention, memory, reasoning and problem solving” [6].

Despite the seeming interchangeability of cognitive enhancement with neuroenhancement, Kipke suggests that the latter term often encompasses the enhancement of both cognitive and non-cognitive properties (i.e. mood and motivation related), while cognitive enhancement refers only to specific enhancements that aim to improve cognitive function [7]. Within that framework, PCE can be characterized as one form of cognitive enhancement, and is commonly considered in terms of improving cognitive capacities like attention and memory through the use of pharmacological agents like methylphenidate, Adderall and modafinil [8,9].

While not necessarily articulated in these characterizations of cognitive enhancement, such interventions are designated as actual enhancements only to the extent that they improve capacities in some way other than by repairing or remedying a specific dysfunction. Thus Bostrom and Sandberg elaborate on cognitive enhancement as an intervention that improves the performance of a cognitive subsystem without correcting some specific, identifiable pathology or dysfunction of that subsystem [4]. In that sense, the target of these interventions are cognitively normal individuals, at least to the extent that we can agree on what ‘normal’ currently refers to.

This emphasis on the information processing character of cognition is often put into context by contrasting it with non-cognitive enhancements that impact more subjective brain states like mood and motivation, which are deemed to be a different of kind intervention. Hence, a volume like *Enhancing Human Capacities* [10] dedicates separate sections for cognitive enhancement and mood enhancement. While I will argue that attempts at making a clear cut separation of our information processing faculties from the non-cognitive facets of our psychology are misguided, we can at least move on now with an idea of how cognitive enhancement is generally characterized in the literature. For the purposes of PCE, it is an intervention that aims to pharmacologically boost already healthily functioning information processing faculties, as opposed to more subjective facets of our psychologies, such as our emotions and dispositions.

Presumption #1: Cognitive enhancement drugs already exist

As stated above, much of the debate in the literature on PCE presumes that these drugs exist, and that their effects on our psychology are specifically cognitive in nature. Take this declaration by Buchanan: “Drugs designed to treat the symptoms of Alzheimer’s dementia (including Aricept), to treat attention deficit disorder with hyperactivity (including Ritalin and Adderall), and to treat narcolepsy (Provigil) have all been shown to improve cognitive function in the cognitively normal” [11].

Similarly, Savulescu asserts: “Already, drugs are being used to improve cognitive performance in the normal range. Modafinil is a new class of drug originally developed for narcolepsy... It improves executive function, wakefulness, and working memory” [12]. Speaking of Adderall and Ritalin, Greely et al. note that “these drugs increase executive functions in patients and most healthy normal people,

improving their abilities to focus their attention, manipulate information in working memory and flexibly control their responses” [13].

These are deemed uncontroversial proclamations, so much so that they often go unreferenced. Here I argue that even in instances where empirical support is cited, the overall evidence is far from conclusive that these drugs actually improve cognitive function in the cognitively normal.

For instance, a survey of more than fifty experiments on the effects of drugs that treat ADHD on a wide array of cognitive functions – such as memory and executive function – among healthy young adults found a roughly even mixture of significant enhancement effects and null effects [14]. This was particularly prevalent in the case of the stimulants’ impact on working memory. Moreover, all of the null results the review uncovered were part of studies reporting on multiple tasks. The fact that all studies that measured effects on single-task experiments found an enhancing effect suggests that at least some single-task studies with null results have gone unreported [14].

This should serve as a reminder that the empirical evidence for cognitive enhancement suffers from the same problems facing experimental psychology and clinical trial research in general. Most studies on cognitive enhancement are too small and underpowered to find anything but large effects [15]. It is also impossible to gauge how many null results go unreported since these studies are not normally registered in advance.

So what does the evidence from systematic reviews and meta-analyses actually suggest? One such review suggests that expectations regarding the effectiveness of methylphenidate (Ritalin) and modafinil (Provigil) exceed their actual effects [16]. With regard to Ritalin, the reviewers were not able to provide sufficient evidence of positive effects in healthy individuals from objective tests. While the reviewers reported some positive effects on cognition from modafinil, they stressed that these remained equivocal and more studies were necessary.

In regards to modafinil specifically, Chamberlain et al. [17] reviewed studies in which the Cambridge Neuropsychological Test Automated Battery [18] had been used to assess its effects on patients and healthy control participants. They found that its use among healthy participants showed no effects on sustained attention or attentional set shifting. On five measures for which sufficient data from previous studies were available, they found no evidence overall for significant effects of modafinil among healthy participants.

Likewise, Farah et al. note that while there is clear evidence that modafinil improves executive function and memory for sleep-deprived individuals, perhaps making it a kind of performance maintainer, findings are mixed with well-rested adults, including occasional cases of impairing effects [15]. Notably, two recent studies not covered by these reviews found no evidence that modafinil boosts cognition, but that it actually slows down response time, potentially also hindering creative thinking [19,20].

Another review concluded that while studies in non-ADHD adults suggest these substances may improve retention of previously acquired information and possibly facilitate memory consolidation, they do not promote the acquisition of new information, and may actually impair performance on tasks that require adaptation, flexibility and planning [21].

As for the effects of acetylcholinesterase inhibitors such as donepezil (Aricept), mentioned by Buchanan above, a systematic review found that “the few existing studies, mostly about donepezil, provide no

consistent evidence for a neuroenhancement effect” [22]. In fact, two of the studies surveyed reported transient negative effects on episodic memory [23, 24].

Regarding mixed amphetamine salts (Adderall), a study examining its effects on 13 different measures of cognitive performance – including intelligence, scholastic achievement, inhibitory control, episodic memory and working memory – failed to find any evidence of reliable enhancement among healthy participants [25]. The study is notable for avoiding the insufficient statistical power of similar, previous studies, using a sample size that would allow for 95% power to detect any medium-sized effects on any single measure.

More generally, there is some evidence that while these substances can augment cognition in subjects with low baseline capacities, these effects disappear among subjects with higher baseline performance, and may even lead to a deterioration in performance [26]. Similar findings were reported by a review from the British Academy of Medical Sciences. While some drugs were reported to improve cognition in impaired individuals, the evidence for any enhancement among healthy individuals was found to be very limited, normally being observed only in laboratory conditions, not everyday life [27].

At this point it is clear that, given the evidence, it does not seem justifiable to state, as some of the authors quoted above so confidently have, that there are genuine cognitive enhancing drugs out there at the moment. Perhaps the evidence suggests, given the more obvious impact these drugs have on sleep-deprived individuals, that they act as “performance maintainers”, as has been recently suggested [28]. But among healthy, non-sleep deprived individuals, whether it’s Aricept, Ritalin, Adderall or Provigil, the evidence for enhancement from systematic reviews is not promising. Authors that cite one or two studies that report an enhancing effect is insufficient to justify their claims about these drugs.

To that extent, the first presumption partially driving this debate – that there is conclusive evidence these drugs enhance cognition amongst the cognitively normal – appears to be a myth indeed.

Presumption #2: Cognitive enhancement is separable from non-cognitive enhancement

This lack of consistent evidence highlighted above is difficult to reconcile with anecdotal reports from healthy individuals who insist that, at the very least, *something* about these drugs seems to make them study better or work harder. What are we to make of this? In this section I argue that these drugs appear to be acting, if at all, on non-cognitive brain states. This will help illustrate a further point: in the context of enhancement via pharmacological means, it is misleading to characterize the cognitive as separate or separable from the non-cognitive.

A study mentioned above is notable for measuring the subjective effects of Adderall [25]. It found that participants tended to *believe* their performance was enhanced when using the drug, compared to when on a placebo. Similarly for modafinil, while it is not clear that it actually improves objective performance, it appears to induce the subjective impression of better functioning [29], with some evidence that it may induce a sense of overconfidence [30], all the more so in individuals who have been sleep deprived for 64 hours [31]. In fact, one notable study found that administering modafinil to healthy young volunteers who were not sleep deprived had no effect on cognitive performance, but was associated with significant changes in mood [32].

Findings like these have led Farah and colleagues to suggest that it may be the non-cognitive effects of these drugs that are actually enhancing performance [15].

Consider these quotes from university students who have used prescription stimulant drugs for nonmedical purposes [33]:

“Everything seems better, and more doable.”

“When I’m not on it I’m usually pretty relaxed about things. [. . .] When I’m on it it’s like more of a sense of urgency.”

“It just got to where I felt like if I was staring at something I just couldn’t take my eyes away from it—it made studying more interesting.”

“You start to feel such a connection to what you’re working on. It’s almost like you fall in love with it—there’s nothing else you’d rather be doing!”

Given these descriptions, Vrecko questions just how cognitive cognitive enhancement really is [33]. Based on his findings, he has identified four recurring non-cognitive themes related to subjects’ experiences with these drugs. He calls them: “feeling up”, “drivenness”, “interestedness”, and “enjoyment.” Each of these refer to affective and motivational states presumably induced by stimulant drugs.

This suggests that even if there is no evidence that these drugs enhance cognition per se, they may still be inducing certain moods and motivational states in users that enable them to make the most of their standard, unenhanced cognitive capacities.

If so, it seems misleading to continue categorizing these drugs as forms of PCE. But even if new evidence were to conclusively show that they do objectively enhance cognition, I want to argue that it is neuroscientifically uninformed, if not also conceptually confused, to discuss the cognitive as separate from the non-cognitive. It is not clear what it would mean to selectively modify cognition pharmacologically but not mood, or vice versa. Superficially at least, it would seem that pharmacological interventions that improve mood may imply boosting motivation, which can surely affect how we utilize our cognitive abilities. Similarly, augmenting cognition to become more focused or mindful may entail feeling more serene or better more generally [6].

More specifically, neuroscientific and psychological research suggests that these two facets of our psychology are deeply intertwined, with emotion affecting cognition, and vice versa. For instance, when we are sad, concentration can be more difficult and we become more selective in what we recall [34]. Similarly, the emotional importance of an event impacts strongly on whether it is consolidated into episodic memory or not [35]. Likewise, feared stimuli (e.g. the sight of a snake) has a significantly enhancing effect on how rapidly we can detect it, with emotions more generally playing a crucial role in driving attention [36]. These examples serve to illustrate the integrated nature of the cognitive and non-cognitive aspects of our psychologies.

Ultimately, the idea that we can pharmacologically alter the cognitive but not the non-cognitive can make sense only through a simplistic understanding of how the brain works, with the limbic system functionally specializing in processing emotion and the cerebral cortex dedicated to cognitive capacities. The reality is more complex than this “one-area/one function” viewpoint [37]. The picture emerging from connectivity data suggests a far more integrative system [38]. Even regions that were once thought to be purely affective in their specialization, such as the amygdala, hypothalamus and nucleus

accumbens, appear to function more as connectivity hubs, integrating information from all over the brain rather than merely processing emotion [37]. For instance, while the amygdala is normally described in terms of affective functions, it is also closely linked to cognitive capacities such as associative learning and attention [39].

Likewise, brain regions commonly viewed as purely cognitive areas, such as the lateral prefrontal cortex (LPFC), also appear to play more integrative roles rather than being specialized in cognition. For example, functional studies of the LPFC suggest that emotion and cognition are strongly integrated there [38, 40]. In fact, evidence from monkey studies show the LPFC integrates not just cognition and emotion, but motivation as well [41, 42].

Overall, the emerging picture from neuroscience suggests a dynamic interplay between interconnected neural systems involved in non-cognitive and cognitive functions [43]. While this more nuanced understanding of brain processes suggests that the notion of purely enhancing cognition pharmacologically is neurologically misinformed, it does help make sense of individuals' subjective experiences with these drugs. The relationship between how we utilize our attention and working memory is bundled up with how, say, interesting and enjoyable we perceive what we are doing to be. Alter this latter subjective component (as these drugs appear to), and it may well indirectly impact how we use and feel about our standard cognitive abilities.

Nevertheless, it might be argued that artificially separating cognitive capacities from subjective states in the context of enhancement is worthwhile. For instance, Hildt [6] argues that an ethical analysis separately dedicated to cognitive enhancement and mood enhancement is helpful because of the significant differences in the contexts in which these are sought, such as the aims motivating their use, and the consequences entailed by each. Unlike mood enhancement, it might be argued, PCE is more likely to be sought in the context of academic or professional settings, with an aim of being a better performer in a competitive setting. This would in turn have important consequences for our schooling systems and, ultimately, the workforce and economy. Hence, an emphasis on the ethical implications of PCE specifically, it can be argued, is warranted. In the next section, I argue that it isn't.

Presumption #3: There are ethical issues that are uniquely raised by cognitive enhancements

This presumption is often implicit in the literature. The widespread use of the term cognitive enhancement in the debate suggests that the ethical issues raised by these pharmacological interventions are in some way unique [7]. Or at least that PCE raises them more intensely somehow, compared to the non-cognitive enhancement of mood or motivation.

Hence, Bostrom and Sandberg specify that cognitive enhancement raises ethical issues by interacting with notions of authenticity, the good life, and the role of medicine [4]. Goodman questions how cognition-enhancing drugs might be construed (or misconstrued) as cheating or diminishing of our personal accomplishments [44]. Cakic reviews the ethical and pragmatic implications of cognitive enhancing drugs in academia [3]. In all three cases, and many more (e.g. [5, 45-47]), why is the concern focused on cognitive enhancement specifically?¹

¹ Of course there may be several other reasons for this focus on PCE compared to other forms of neuroenhancement. An anonymous reviewer of this article suggests that PCE is more closely related to issues such as productivity or efficiency, which are perhaps less controversial to discuss than the issues raised by mood

Note first that it is not being suggested that these authors claim that cognitive enhancement necessarily stands as uniquely interesting or different in the ethical questions it raises. But rather, this seems to be the overall implication coming from the associated literature. Suggestive evidence for this is reflected in the 821,000 results Google Scholar uncovers when searching for “cognitive enhancement”, compared to the 186,000 under “mood enhancement”.

As noted above, Hildt suggests that it is because of the unique contexts, reasons and consequences posed by cognitive enhancement in particular, as opposed to non-cognitive enhancement, that has resulted in this somewhat special attention [6]. And yet, it is not clear that these reasons hold up when we investigate the specific recurring ethical issues of these two types of enhancement.

To demonstrate this, let’s examine these ethical issues and see if perhaps cognitive enhancement raises different ones, or raises them in a particular way worthy of special attention.

To an extent, such an analysis has been carried out by Kipke, who has identified nine recurring ethical issues, demonstrating how these overlap in similarly relevant ways whether discussing cognitive or non-cognitive enhancement [7]. These are: efficacy and safety; personal authenticity; quality of happiness; development of character and self-awareness; accountability of achievement; fairness in competition; social pressure; changes in values and the idea of humankind.

I will not go through each of these in turn, but to illustrate, we can ask whether authenticity is an issue that is relevant only to one domain of psychological enhancement in a unique way. Bostrom and Sandberg question whether making cognitive abilities for sale in the form of a pill would make them somehow less genuine [4]. Yet this same question certainly seems equally relevant when considering mood enhancement [48]. Is a cheerful mood induced by a pill a less genuine expression of oneself? The goal here is not to answer these questions, but to show that they apply to the prospect of enhancing cognitive and non-cognitive traits equally.

Questions of authenticity link to issues of personal accomplishment. Goodman asks whether the use of cognitive enhancing drugs unnaturally cheapens accomplishments [44]. But it is difficult to see why this might be an issue specific to cognition and not to other aspects of our psychology.² As Kipke points out, if someone improves their social and communicative skills through a mood enhancer and ends up accomplishing something great (say, peace between two warring nations), the same question of attributability arises [7]. It is not clear that the question of attributing accomplishments is only relevant when cognitive power is used to find solutions, as opposed to non-cognitive skills, like having a friendly disposition or being in an empathic state of mind.

Kipke also questions whether cognitive enhancers pose a particular problem for fairness in competition (and social justice more generally) in a way that non-cognitive enhancers don’t [7]. Are social opportunities primarily determined by cognitive abilities? Authors often focus on pharmacologically augmented IQs as a key example that may lead to unfairness in, say, securing a job. But competition over such opportunities surely extends beyond solely cognitive capacities. True, a successful

enhancement. These, for instance, may evoke more politically problematic topics like “getting high” or the war on drugs.

² Again, the argument is not that the author necessarily thinks that this issue is only relevant for cognitive enhancers. Rather, the goal here is to indict that this seems to be the suggestion coming out of the overall literature.

professional life requires cognitive skills, but also social, communicative and emotional skills. In fact, individuals who lack self-confidence, self-control, or empathy don't tend to have much success – at least, these more non-cognitive traits appear crucial to success [49, 50]. In that sense, if issues regarding fairness are threatened by cognitive enhancers, non-cognitive enhancers pose a similar threat.

Interestingly, Kipke highlights one specific area where cognitive enhancement might warrant special focus: academic exams. Here, as opposed to competition for professional opportunities where emotional and social skills play an important role, what is tested appears to be mainly propositional knowledge – i.e. things that rely purely on cognitive capacities like memory, understanding, comprehension, etc. This leads Kipke to conclude that this is a unique area where cognitive enhancements specifically raise issues regarding the integrity of exam results.

I disagree. As we have seen, to the extent that Ritalin, Adderall and modafinil are non-cognitive enhancers, these drugs can be used to enhance the mood and motivation necessary for effective study, allowing users to gain a pharmacologically-induced advantage over others in an exam setting. And while exams purportedly only test our cognitive skills, in reality they also challenge our ability to remain calm under stress and to keep motivated and confident. A pharmacologically-induced sense of confidence and drivenness can go a long way in helping someone in an exam setting to make the most of what they already know.

And so, it is not clear why cognitive enhancement in particular receives such singular attention in the bioethics literature: the ethical issues it raises are largely the same as those raised by non-cognitive enhancers – indeed, as I have argued, most authors are actually referring to non-cognitive enhancers when debating the ethics of cognitive enhancers. To that extent, it appears that there is a kind of exceptionalism in the literature being unduly attributed to cognitive enhancement drugs. In the same way that genetic exceptionalism holds genetic information as special, requiring perhaps a unique handling compared to other types of medical information, the trend highlighted here suggests an implicit kind of cognitive enhancement exceptionalism that is, I have argued, uncalled for.

Presumption #4: There is evidence that PCE is increasingly in use

A common introductory remark in a paper on PCE is that such enhancements are increasingly in use, especially amongst student. For instance, the often cited paper by Greely et al. starts off by asserting: “Today, on university campuses around the world, students are striking deals to buy and sell prescription drugs such as Adderall and Ritalin — not to get high, but to get higher grades, to provide an edge over their fellow students or to increase in some measurable way their capacity for learning” [13].

Similarly, Cakic notes the (then) lack of ethical examination of “academic doping”, despite “the widespread non-medical use of psychostimulants such as methylphenidate across universities for the purposes of enhancing concentration” [3]. Likewise Turner and Sahakian ask how society should react given “the growing evidence, particularly from the United States, that pharmaceuticals are being both prescribed and illegally consumed by university students to maintain supernormal levels of concentration in the run-up to exams, with the suggestion that this trend will eventually encompass younger children” [51].

This starting premise of such discourses suggests a certain urgency to this debate, reflecting what looks like an emerging epidemic that is being largely ignored, potentially at society's peril. But what is the

actual evidence for this alleged trend? Here I argue that the studies and surveys regularly cited in these papers are either unreliable, or do not actually reflect what the authors are claiming.

Consider the two pieces of evidence cited by Greely et al. for the prevalence of cognitive enhancement use on US campuses. The first one surveyed stimulant use in 119 US colleges, reporting prevalence rates between 0% and 25% [52]. While the prevalence of 25% was found in only one out of the 119 colleges surveyed, with only 3 colleges reporting rates over 15% – the median estimate being only 3% – Greely and colleagues positioned the findings to conclude: “On some campuses, up to 25% of students had used [stimulants] in the past year”. While technically true, this rendering of the survey results is also misleading and sensationalist.

The second piece of evidence, widely used in other papers to bolster this fourth presumption, is an online poll of 1400 *Nature* readers that found one in five respondents claimed they had used drugs for non-medical reasons to stimulate their focus, concentration or memory [53]. Needless to say, an online poll of a science journal’s readers is not an accurate representation of enhancement use in a population, not to mention the credibility of online polls as a research method more generally.

Another regularly cited survey used to support this presumption found that 16.6% of 283 students in one US college (MCLA) had used methylphenidate for non-medical purposes [54].

Bush cites this finding as part of the evidence for healthy individuals using stimulants to maximize their alertness and maintain extended periods of wakefulness [55]. Warren and colleagues cite it as evidence that 16% of students at *some* US universities take prescription medication as study aids [56]. Other authors cite the survey to the same end [57, 58].

All this despite the 16% figure being based on student responses inside *one* university answering this question: “Have you ever taken Ritalin for fun (non-medical purposes)?” Keeping in mind the question refers to *ever* taking Ritalin, as opposed to regularly using it, the survey is also only concerned with the recreational (“fun”) use of Ritalin, not cognitive enhancement. As Lucke et al. [2] point out, the one mention of Ritalin being used as a ‘study aid’ is in the report’s discussion: “Personal communications with students at MCLA suggest that methylphenidate is sometimes used as a study aid for ‘pulling all-nighters’” [54]. This does not justify using the 16% figure as being indicative in any way of cognitive enhancement use among students in the US generally, let alone that the trend is increasing.

If anything, and if we are to be as equally selective about the evidence we cite, the trend with methylphenidate at least appears to be falling, with the number of college students in the US admitting to using Ritalin steadily declining from 5.7% in 2002, to 3.9% in 2006 [59]. As for how often stimulants are used, a survey of 3639 undergraduates at one US university found that while 6% of student used prescription stimulants nonmedically in the last year, only 1% had done so on more than 10 or more occasions in that year, and only 2% had done so in the last month [60]. This suggests that use of these drugs is sporadic and infrequent.

It is worth stressing that these surveys rarely ask about the use of these drugs for cognitive enhancement purposes specifically. However, more recent surveys in Germany and the UK have investigated the use of these drugs specifically for cognitive enhancement purposes, and reflect far more modest use patterns [8, 61, 62,]. In the case of Germany, life time prevalence use of methylphenidate and amphetamines for cognitive enhancement purposes in pupils was 1.55 % and in

students 0.78%, with last year and last month prevalence rates being significantly lower[61]. Another three studies of German university teachers also showed a very low prevalence rate for the use of these drugs [62]. In the case of university students in the UK and Ireland, a majority of those surveyed were unaware and/or uninterested in putative PCEs[8]. For methylphenidate and Adderall, current users and regular past users made up less than 1% of the study sample, respectively. Modafinil had a higher rate of current users at 3.9%. Interestingly, the survey suggests that students may be quite resilient to pressures to use these drugs, given the contrast between the level of awareness and interest in PCE (about one third of those sampled), and the comparably far lower levels of consistent use of putative PCE. While this contrast may be due to the lack of availability of these drugs, it is also possibly a reflection of the fact that one time users find that they don't make any remarkable difference to their academic performance, and hence do not pursue their continued use.

Despite this, it may be argued that it is still worth discussing the implications of the possibility that this trend will increase with time. It is, after all, a new trend and it would be reasonable to expect it to grow as these drugs become more effective and/or readily available. But it is important at this stage to position this trend within its historical context.

One of the problems with relatively new terms like cognitive and neuro-enhancement is that they imply the emergence of a new phenomenon. But this is not the case. To a large extent, the bioethical debate on cognitive enhancement continues to ignore the fact that many stimulant drugs that are now illegal were previously developed for therapeutic purposes and were later used by healthy individuals for enhancement purposes [2]. For instance, the early amphetamine Bzedrine – which, like modafinil was initially approved as a treatment for narcolepsy in 1937 – was used by university students to “aid the time-honoured practice of last minute ‘cramming’ for exams” [63]. The year before its approval for narcolepsy a study published in *The Lancet* reported an increase of approximately 8 per cent on intelligent test scores among patients administered the drug [64]. As amphetamines became more widely available and began to be sold as mild antidepressants, they were also advertised as enhancing mental performance. By the late 1960s, just before amphetamine distribution became legally restricted, the estimated non-medical use of stimulants was comparable to 2002 [63].

Interestingly, later studies showed that any perceived improvement in cognitive ability was due to these earlier stimulants' capacity to increase confidence and drivenness [63]. In that sense, they may be all the more similar to the drugs currently under discussion, which, as I have argued, appear to impact mood and motivation rather than cognitive performance amongst the healthy.

The point here is not to suggest that therefore there is nothing new to discuss. But, given the poor data at hand, and given that we have reason to believe this is not a new trend diverging from the historical abuse of stimulants, the urgency entailed by the presumption of mass and increasing use of these drugs certainly needs to be tempered.

The cost of hype

I have argued that the four common presumptions underlying much of the debate on PCE do not really hold up to scrutiny. The evidence for cognitive enhancing drugs boosting cognition amongst healthy users is, at best, inconsistent. Moreover, it is not clear that it is possible to pharmacologically boost cognition, without impacting mood, and vice versa – in fact, the drugs discussed appear to be mainly impacting the latter. Given this, and given that, as I have argued, cognitive and non-cognitive

enhancement raise the same ethical issues despite being artificially separated in the literature, the specific focus on PCE is difficult to justify and is indeed confusing. Finally, it's not clear at all that these drugs are being used in large or increasing numbers.

It may be cautioned that these conclusions risk encouraging readers to dismiss the topic as a negligible issue for neuroethics and drug policy [65]. However, exposing these presumptions as unwarranted is not to say that there is nothing to debate. On the one hand, how emerging technologies might impact our perception and appreciation of things like accomplishments, authenticity, justice and risk is a discussion that is worth having without the need for the hype and confusion entailed by the four presumptions critiqued here. On the other, while the evidence for the efficacy and prevalence of these drugs as examples of PCE is limited, they may still be boosting performance either by inducing moods conducive to work or study, or by enhancing motivation itself. Even under such a non-cognitive characterization of their effects, this may still warrant worthwhile ethical inquiry, and has indeed recently done so [28, 66].

As things stand, however, what these conclusions suggest is that the literature suffers from poor conceptual clarity along with a clear misalignment between empirical research findings and the bioethical debate. It's a misalignment that threatens the credibility of bioethics as an approach to these ethical issues, but more importantly it poses potential harms to the broader public due to the current relationship between the academic literature and media reporting on this topic.

The evidence for that relationship is compelling. A study of media reporting on neuroenhancement analyzed 142 newspaper articles between 2008 and 2011 and found that 94% portrayed neuroenhancement as common, increasingly in use, or both [67]. And while 95% mentioned at least one possible benefit of these substances, only 58% mentioned any possible risks or side effects. More to the point, the primary sources for these claims were based on overenthusiastic reports by bioethicists and neuroscientists in the academic literature.

There is also some evidence of circular reporting, whereby the media references academic papers and academic papers reference the media. To illustrate an instance of the latter trend, a paper published in the *International Journal of Neuropsychopharmacology* cites an informal poll that was published in Cambridge University's student newspaper *Varsity* as evidence that PCE use is widespread [68]. And yet it is precisely such papers that claim "an unprecedented rise in the use of PCEs" (68, p.563) that arguably feed media reports.

Given the relationship between the media and academia on this topic, bioethicists may unwittingly be advertising the use of these drugs by suggesting the existence of a considerable, seemingly inevitable trend, thereby potentially indirectly coercing the public and especially students by increasing feelings of a permanent competitive struggle [69]. Indeed, this sentiment was reflected in a study on stakeholder perspectives on media coverage of cognitive enhancement [70]. As one student put it, commenting on media coverage of the non-medical use of methylphenidate: "I don't know why but it made me want to try Ritalin."

What this suggests, again based on the relationship between media reports and claims in the academic literature, is that bioethics may end up being complicit in fostering the very trend it is meant to be merely debating. The overall outcome risks increasing and normalizing the use of these substances despite a lack of evidence for their efficacy and safety.

This ultimately increases the risk of public policy being poorly informed [67]. The literature, in conjunction with media reporting on the topic, unduly pressures society to take a premature stance: if these drugs work and they are in increasing use, we are required to resolve whatever ambivalence we feel towards these interventions and arrive at some regulatory conclusion. And there clearly is a sense of ambivalence here [71,72]. The fact that there is such prodigious debate on how to think and respond to PCE reflects some degree of feeling conflicted about these interventions – otherwise, they would not be deemed worthy of so much debate. Yet we know that when people are conflicted, they seek to resolve this dissonance even at the cost of highly motivated reasoning [72,73]. Acknowledging the fact that these drugs promise very little to no improvement among healthy non-sleep deprived individuals can go a long way in encouraging a less polarized debate based on a more grounded assessment of the actual evidence.

A positive shift

These concerns serve as arguments for a more critical approach rooted in better empirical, conceptual and ethical research. To an extent, there are an increasing number of such calls in the literature. For instance, Mohamed [74] calls for larger surveys on diverse populations to determine the motives and attitudes behind stimulant misuse, as well as greater dialogue between researchers, clinicians, parents, teachers and regulatory bodies in the evaluation of putative PCEs. Pustovrh and Mali similarly stress the need for more empirical investigations on user populations in different sociocultural contexts as well as societal debates on how to address the issue [9]. Racine and colleagues highlight broader sociological and normative presumptions in the associated literature and call for a greater awareness and explicit acknowledgement of them and how they relate to speculation on this topic [75].

These more recent calls reflect a positive shift in the literature, and there is some evidence that empirical investigations are responding to such calls. For instance, recent surveys have analyzed the various drivers behind individuals' willingness to use putative PCEs and have identified several factors that increased that willingness [62, 76]. Amongst those were greater inclinations to use PCE when their enhancing effect was expected to be powerful, when more of one's peers used them, and when one suffers from academic procrastination. Newer surveys, especially in Europe and Australia, now also ask about the use of these drugs for the purpose of cognitive enhancement specifically, as opposed to their off-label use more generally [8, 61, 62, 77].

Getting clearer about cognitive enhancement

These welcome additions to the literature mark a more fruitful approach that will hopefully prove useful in formulating appropriate policy responses to the prospect of PCE. On the other hand, it is clear that despite over a decade of intensive debate on this topic, the conceptual groundwork for discussing cognitive enhancement remains muddled – something evidenced by the fact that, as I've argued here, the cognitive enhancement literature does not even appear to be discussing drugs that specifically impact cognition to begin with.

Getting clearer about the nature of cognitive enhancement will be key to interpreting the implications of future empirical findings appropriately. As suggested above, aside from their potential impact on mood and motivation, these drugs may be better characterized as performance maintainers, rather than enhancers. However, there are possible objections to such a suggestion that reflect ongoing conceptual complications.

For instance, one may counter that, if these drugs work by impairing the process of fatigue so as to allow users to maintain their otherwise standard cognitive performance over longer periods than normal, what does that say about the nature of enhancement? Might this nevertheless be a form of enhancement – that is, the enhancement of how long one can consistently utilize one’s unenhanced cognition for? Similarly, if a mood is enhanced so that one feels highly motivated to use their otherwise standard cognitive capacities, but for hours on end, might this justifiably qualify as an example of cognitive enhancement, despite cognitive functioning not technically being boosted? One the other hand, is one’s ability to remain highly focused on a task a reflection of enhanced motivation or enhanced attention? How might it be possible to tease these two apart? These questions point to the need for more thought given to the nature of the relationship between cognition, mood, and motivation, and more broadly on how enhancement and performance maintenance relate.

As things stand, the term cognitive enhancement mistakenly implies that certain substances can work to enhance cognitive capacities generally and without any tradeoffs [75], and in that sense it plays right into the very hype highlighted here. Moreover, the overlap between cognitive and non-cognitive enhancement makes any reliance on this term too narrow and restrictive. It may be that we ought to do away with the term cognitive enhancement in this context entirely.

However, while ‘neuroenhancement’ is increasingly employed to encompass both domains of our psychology, it is also potentially misleading in that it suggests our aim is to improve the functioning of neurons rather than the associated mental or psychological properties – which is presumably the actual aim behind such enhancements. In reality, it may be that we can best enhance certain aspects of our psychological properties by actually diminishing the functioning of certain neurons or areas in the brain [78]. On the other hand, terms like ‘mental enhancement’ and ‘psycho-enhancement’ – which perhaps better capture what is actually being referred to in these discussions – are rarely used, possibly because the connotations of words like ‘mental’ and ‘psycho’ may comically suggest boosting insanity in some way. Perhaps ‘mind enhancement’ or ‘psychological enhancement’, while the latter is arguably overlong, offer a more appropriate rendering of what these interventions refer to and aim to achieve.

Such riddles of nomenclature aside, what is clear is that a better, more nuanced debate will require more precision about what exactly is being referred to when discussing enhancements of this kind. That, along with an appropriately skeptical appreciation of the evidence on efficacy and prevalence, can move things forward more productively.

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