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Are Better Workers Also Better Humans? On Pharmacological Cognitive Enhancement in the Workplace and Conflicting Societal Domains

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Abstract The article investigates the sociocultural implications of the changing modern workplace and of pharmacological cognitive enhancement (PCE) as a potential adaptive tool from the viewpoint of social niche construction. We will attempt to elucidate some of the sociocultural and technological trends that drive and influence the characteristics of this specific niche, and especially to identify the kind of capabilities and adaptations that are being promoted, and to ascertain the capabilities and potentialities that might become diminished as a result. In this context, we will examine what PCE is, and how and why it might be desirable as a tool for adaptation within the workplace. As human beings are, or at least should be allowed to be, more than merely productive, able-bodied and able-minded workers, we will further examine how adaptation to the workplace niche could result in problems in other domains of modern societal life that require the same or other cognitive capabilities. In this context we will also focus on the concept of responsibility and how it pertains to PCE and the modern workplace niche. This will shed some light on the kind of trends related to workplace niche construction, PCE and capability promotion that we can expect in the future, and on the contexts in which this might be either beneficial or detrimental to the individual as a well-rounded human being, and to other members of society.

Keywords Technological development · Cognitive capabilities · Pharmacological cognitive enhancement · Modern workplace · Bioethics

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Introduction

One of the features that particularly characterize modern capitalist societies in the twenty-first century is the striving and desire to improve performance on various levels. This is evident in both individuals and society as a whole, and concerns everything from aspects of private life to functionality in the workplace, and from digital social networks to the functioning of the economic subsystem. The focus on enhancing performance is also reflected in modern technological development, which both enables and further promotes the goals of doing things more quickly, more efficiently, more productively and offering a wider spectrum of possibilities [1]. Generally speaking, such improvement of individual and societal performance is becoming more and more dependent on the intensive use of cognitive capabilities, as sociocultural production processes and the major challenges that human civilization is facing demand the increasingly intensive use of cognitive capabilities.

As we are seeing growing emphasis placed on performance enhancement, self-improvement, acceleration and intensive use of cognitive capabilities, PCE seems to promise individuals the ability to cope better with this kind of societal environment and demands, with the possibility of enhancing themselves such that they become more successful, more productive and more capable, both as individuals and as members of society. PCE has been investigated to ascertain how it could better enable individuals to pursue their life projects and goals, and how it could enhance societal capabilities, productivity and performance [2–6]. On the other hand, it has also been assessed more critically to evaluate any negative impact it might have on health and wellbeing, distributive justice, solidarity, equality and what threat it might pose to human values and practices that society generally regards as valuable and desirable [7–10].

A somewhat more neglected but nonetheless important area of potential PCE usage is in the modern workplace, more precisely among specific worker populations that are under pressure to increase productivity and performance, whose cognitive capabilities are subjected to increasing strain and on whose cognitive performance the lives of others might depend. PCE in the workplace has occasionally been addressed from the perspective of other ethical, legal and societal implications, for example whether it constitutes a form of cheating and how it might promote coerced usage or could exacerbate working conditions [11]. The interaction between the modern workplace and PCE has not yet been extensively investigated, however. The modern workplace itself has undergone extensive transformations that have reinforced the sociocultural and technological developments briefly outlined above. Furthermore, humans are not only workers; they also have goals, aspirations, obligations and desires in other areas of life and society. Placing increasing and constant demands on them, and fostering specific cognitive capabilities that are valuable in the working environment, can thus affect how they function outside the world of work, and may also have wider impacts on other domains of societal functioning.

As modern neuroscientific research (re)affirms, the human brain, and by extension the mind, is extremely plastic and adaptable, though not to an infinite degree: the impact of the legacy of psychological mechanisms that have emerged during the evolutionary history of the human species shows frequent conflicts with the modern socio-technological environment [12–14]. All the same, the wide range of mental capabilities and the general intelligence of humans have enabled us to adapt to environmental demands and pressures by changing our environments through the use of tools and, over time, increasingly powerful and transformative technologies. Such environmental niche construction transforms the environment to make it better suited to specific human needs, and in turn often gives rise to new adaptive pressures and challenges that require further niche construction in order to adapt and cope [15]. While such adaptations occur over longer timescales and influence genetic evolution, humans are also capable of cultural niche construction. Primarily, this alters our sociocultural environment to allow us to better adapt to specific demands, requirements and challenges – not only those posed by the external environment, but also those posed by human societies. From this viewpoint, we might regard human civilization as a type of cultural niche, composed of and (re)shaped by further social niches, such as the modern workplace. Such niches exert further (sociocultural) pressure on us to adapt in specific directions; through altered behaviour, use of technology, or the establishment of new social patterns. And while practically any use of technology influences and changes the way the human mind functions, human enhancement technologies offer an even more radical possibility – that of adapting human beings directly to specific environments, niches and demands through the technological restructuring of the body, and especially of the brain.

The article will explore the sociocultural ramifications of the changing modern workplace and of PCE as a potential adaptive tool from the viewpoint of social niche construction. We will attempt to elucidate some of the sociocultural and technological trends that drive and influence the characteristics of this specific niche, and especially to establish the kind of capabilities and adaptations that are being promoted, and to ascertain the capabilities and potentialities that might become diminished as a result. In this context we will examine what PCE is, and how and why it might be desirable as a tool for adaptation within the workplace. As human beings are, or at least should be allowed to be, more than merely productive, able bodied and able minded workers, we will further examine how adaptation to the workplace niche could result in problems in other domains of modern societal life that require the same or other cognitive capabilities. In this context we will also focus on the concept of responsibility and how it pertains to PCE and the modern workplace niche. This will shed some

light on the kind of trends related to workplace niche construction, PCE and capability promotion that we can expect in the future, and on the contexts in which this might be either beneficial or detrimental to the individual as a well-rounded human being, and to other members of society.

Cognitive Capabilities and the Modern Workplace Niche

In simplified and general terms, we can think of cognitive capabilities as those processes of the mind that we use to acquire and process information and that enable us to act and function in the world. Although there is no comprehensive or definitive list, key cognitive capabilities include perception (recognizing and interpreting sensory stimuli), memory (both short-term and long-term, memory formation and recall), attention (such as sustained concentration on a particular object, action, thought; the ability to manage competing demands), motor capabilities (the ability to mobilize muscles and manipulate objects in specific situations, overall coordination), language (the ability to translate sounds into words and thoughts, conceptualize and interact), visual and spatial capabilities (the ability to process visual stimuli, understand spatial relationships and visualize mental representations), general learning ability, and executive functions (mental flexibility, theory of mind, anticipation, problem-solving, decision-making, working memory, emotional self-regulation, inhibition of impulses). There are also other, even less well-defined mental functions and abilities that are complementary and overlap with those listed above. These include alertness, wakefulness, mood and motivation, willpower, and persistence. In one sense, such capabilities are finite resources that become exhausted with intensive use and require replenishment and regeneration. Many, such as attention and concentration, peak and ebb in approximately 90-min ultradian cycles, after which a break is required to restore their capacity. The individual levels of such capabilities change throughout the biological life cycle, from childhood and a peak in adulthood, to gradual decline in terms of mild cognitive impairment with "normal" aging. They are of course also affected by many factors in the short and long term, such as underlying genetics, specific neurophysiology, nutrition, physical and mental exercise, relaxation and proper sleep, daily activities and stressors, the ability to cope with stress and adapt, and a supportive social environment. As we have noted, the demands of the modern workplace and the growing interaction with information technology in many domains of life place greater demands on cognitive abilities, especially concentration, attention, alertness and wakefulness. Some authors claim that the way we use online technology to access and process information will in the long run decrease our ability to memorize and think deeply, and will weaken cognitive abilities such as concentration, focus, memory and executive functions, including other skills, such as social skills [16]. A study of intensive users of Web 2.0 conducted by Microsoft has shown that our ability to maintain prolonged concentration is actually declining, while our capability to engage in bursts of short, intensive concentration is being strengthened. There are also indications that the ability to ignore ambient distractions decreases when two screens are used simultaneously [17].

The modern workplace, as is the case with most spheres of modern society, is increasingly permeated by a range of technologies that enable improved performance and new capabilities, and that also alter the ways in which workers perform their tasks and in which their cognitive capabilities are utilized by such processes.[1] Among the technological trends are informatization, digitalization, automation, and to some degree, robotization. Many experts claim that we are already in the first stages of second machine age technologies [18] and that industry and business are entering the fourth industrial revolution [19]. This has (at least) a twofold impact on the modern workplace, one direct and the other indirect.

The direct impact is that many workplaces are becoming more digitalized and that workers need to use a growing array of information and smart tools. The digital workplace as a general concept "permeates all aspects of working life. It affects technology, physical workplaces and people. Changes made in one area may result in changes in another" [20]. According to a Gartner report, "[t]he Digital Workplace enables new,

[1] This is not an attempt to provide any comprehensive summary of all the characteristics and trends that mark the modern workplace, only those that might be most important in connection with performance enhancement, cognitive abilities and PCE. Furthermore, rather than considering all workplaces and professions, we are also focusing mostly on those professions in which the trends of technologization, acceleration and performance enhancement, and the use of PCE, are most evident or likely.

more effective ways of working; raises employee engagement and agility; and exploits consumer-oriented styles and technologies." [21] Another aspect is that modern ICTs also enable telework and mobile work, which can be carried out from any location where internet access is provided. Around 17% of EU workers are engaged in such work, which can increase flexibility, working time autonomy, productivity and efficiency, but can also lead to longer working hours, an encroachment of work into personal life, and work intensification [22]. In sum, the modern workplace is becoming increasingly hybrid in nature, meaning that workers need to interact increasingly with digital, smart and semi-automated technologies.

As such technologies enable greater productivity, responsiveness, availability and generally higher performance in the workplace, they also raise the bar when it comes to expectations and norms, further accelerating the demands placed on the technology and the workers themselves. Further questions are being raised about the impacts such intensive and prolonged human-machine interaction is having on the human body, and especially the mind.

As we have mentioned, the human mind is fairly plastic. Its flexible nature means that it (temporarily) views the tools that we use as being part of the body (and mind), regardless of whether these are objects, machines, tools or smart information systems, or indeed modes of thinking or of perceiving ourselves and the world [23]. Thus the repeated intensive use of any of these material or immaterial tools means that we are actively transforming our modes of thought, perception and action at the neurophysiological level, and, through the regular and excessive use of cognitive capabilities, we are (over)loading certain capabilities while neglecting (weakening) others [24–26]. What is more, the culture of entrepreneurship and start-ups that has been heavily promoted in recent years places greater demands on workers; with decreased stability and Schumpeterian "creative destruction" [27], many workplaces in older and newer industries are facing increased competition and work demands.

The indirect impact is that the technological trends of digitalization, informatization, automation and robotization have helped bring about far-reaching changes in many industries. Telework and mobile work have also enabled crowdsourced work in which workers are not permanently employed but generally wait for fixed-duration project work that is usually undertaken remotely [22]. Such technological changes are associated with various trends that have led to a substantial reduction of employment for indefinite periods, to the loss of many worker rights and benefits, and to greater uncertainty and anxiety about the duration and permanence of employment. Workers are increasingly responsible for finding and remaining in work; this is also evident in a rising number of self-employed workers, a decision that is not always voluntary.

Another trend enabled by technology that has helped make employment increasingly uncertain and precarious is technological unemployment and the obsolescence of job skills. This is reflected in the emergence of the Internet of Things, in manufacturing and industrial automation, in the (semi-)automation of many tasks in the service and retail sectors, and in further efforts to automate tasks in healthcare, care facilities, hotels and fast-food restaurants [28]. Several analyses also show that further automation is unlikely to result in new jobs requiring the same level of qualifications as those that have become obsolete. Despite promises that new, better and more "interesting" jobs will be constantly created – which to a certain extent is a genuine trend that accompanies the introduction of new work technologies – there are a number of dilemmas. Extensive statistical studies note for example that around 45% of all current professions in the US are threatened by complete automation in the next 20 years [29], as are 25 to 35% of occupations in the next 10–20 years in the UK [30]. Desirable new jobs that are being created are demanding in terms of the expertise, knowledge and skills they require. Numerous other new occupations are more precarious, temporary and insecure, and may involve no or only limited social security benefits such as health and pension insurance, even in factory work. The rise of the company Uber is one example of how professional drivers are facing an increasingly precarious situation, while the advent of self-driving cars and trucks is likely to have even greater disruptive effects.

Retraining workers who have been made redundant is not easy, especially when it is a question of qualifying them for new jobs that require a higher level of expertise, or when the workers are older and less skilled. Assuming further socio-technological acceleration, we may well ask ourselves how often we will need to change careers and acquire new skills in the future. Even cognitive professions with high expertise and skills will probably not be exempt in the long term, as can be seen from comparisons between the work performed by

intelligent systems and for example that done by legal advisors, medical technicians and others [31]. The possibility of partial or complete automation and the rapid substitution of workers in such workplaces, coupled with the (increasing) number of job seekers, will give rise to additional demands and expectations in terms of performance and productivity, increased competition, and a growing need for "presenteeism" – the requirement to come to work even when ill [32]. The cultural niche of the modern workplace is thus characterized by both external and internal pressures, expectations and demands. Socioeconomic trends and employer expectations regarding performance can be high, and we are conditioned, both collectively and individually, to strive to improve ourselves and to enhance our individual (professional) capabilities [33]. Modern workplaces and the way they require us to interact with information technology place considerable demands on our cognitive abilities. The EU-OSHA report on stress at work [32] states that around 22% of EU workers experience stress on average and, although this differs from country to country, feel that they are required to work faster and meet tighter deadlines. Furthermore, the need to constantly function at a high level of performance places an additional burden on mental function: people continue to work past the point of cognitive fatigue and cognitive abilities, see their concentration decline, and should really be resting and/or sleeping. All this can contribute to greater exhaustion, lower attention levels, lack of concentration and sleep, and consequently to an increased risk of errors and accidents at work, and in the long term also to an increased risk for physical and mental health [34].

As we have noted previously, human beings are more than just workers, with lives that extend well into other societal domains. Modern informatization and automation technologies are to be found in various societal spheres, for instance in the almost ubiquitous forms of smartphones and tablets. The information technologies that underpin our social interactions, relationships, shopping and especially entertainment, place additional demands on our cognitive capabilities that are similar to those experienced in the transforming workplace. Since social acceleration and a striving for self-improvement and enhanced performance are present in most areas of modern societies, this also means greater overall engagement and activity, fewer opportunities and less time to rest and experience "downtime", and the all too frequent postponement of relaxation and sleep. Such excessive and prolonged cognitive engagement can lead to frequent mental exhaustion and suboptimal cognitive functioning, if insufficient time or opportunity is available for cognitive inactivity, replenishment and regeneration. This pattern, coupled with increased cognitive demands in the workplace, can further worsen cognitive and overall mental performance.

If approached from the viewpoint of suboptimal cognitive function and worker performance in the workplace, however, the individual enhancement of cognitive capabilities can be seen as a legitimate target, at least within the framework of human enhancement and self-improvement. And it is precisely in this context, that is to say with a view to improving individual performance at work, that pharmaceutical cognitive enhancement (PCE) seems to offer an opportunity to enhance suboptimal cognitive function, to boost overall cognitive performance and to better adapt workers to the modern workplace niche in the context of the self-improvement ethos.

Pharmaceutical Cognitive Enhancement in the Modern Workplace

PCE can be defined as the use of pharmaceutical prescription drugs "to improve cognitive function and capacity, where these are not impaired or defective in clinically significant ways / ... / such as attention, understanding, reasoning, learning and memory" ([35], 164). The prescription drugs most commonly used for the purposes of PCE are methylphenidate (MPH) in products such as Ritalin and Concerta, amphetamine salts (AMF) in products such as Adderall, and modafinil (MOD) in products such as Vigil, Provigil and Modiodal [26, 36–39]. Such drugs are central nervous system stimulants: MPH and AMF are generally prescribed for attention-deficit and hyperactivity disorder, while MOD is prescribed for the treatment of narcolepsy. Off-label prescriptions can be issued to address cognition-related problems. For the purposes of PCE, such drugs are usually obtained from "online pharmacies" or third parties, or from a doctor – either by requesting an off-label prescription or by simulating disease symptoms [39]. There are also other pharmaceutical drugs that can be used for similar purposes, for example propranolol, which is prescribed for high blood pressure, and psychedelic drugs such as psilocybin and

LSD[2]. Propranolol can help reduce anxiety and the physical symptoms of fear and nervousness in social situations and at public events. In the context of work it is used for job interviews, presentations and negotiations. Microdoses of illicit psychedelic drugs such as LSD and psilocybin are used to increase work performance and creativity and to improve mood; the results of preliminary studies of volunteers indicate that they "can be an aid for productivity, and can provide relief for treatment-resistant depression" [40].

In some pharmacological studies of healthy subjects, MPH and AMF had small but significant enhancement effects on inhibitory control and short-term episodic memory [41], produced improvements in declarative memory and enhanced the consolidation of memories, while positive effects on executive functions were found in at least some subjects [42, 43]. MPH improved performance in novel and attention-based tasks, and reduced planning latency in more complex tasks [44]. MOD enhanced the enjoyment and performance of tasks connected with spatial working memory, planning and decision making, as well as visual pattern recognition memory following delay [45]. It also improved reaction time, logical reasoning and problem-solving [44]. Furthermore, it improved attention in well-rested individuals, while maintaining wakefulness, memory and executive functions to a significant degree in sleep-deprived individuals as compared to a placebo [46]. Generally all three substances exhibited some improvements in levels of attention in healthy test subjects [42], although it should be noted that the enhancing effects of AMF and MPH are low to moderate and seem to vary according to individuals and specific study settings. AMF also entail some risk of addiction and increased blood pressure, while MPH involve a lower addiction risk and generally benign side effects [46]. A recent meta-analysis of robust studies of MOD conducted between 1990 and 2014 on healthy non-sleep-deprived adults concluded that it appears to consistently enhance attention, executive functions and learning in healthy non-sleep-deprived subjects, without any observed tendencies towards side effects or mood changes [47]. Moreover, MOD has shown enhancement and maintenance of vigilance and wakefulness under conditions of sleep deprivation for up to 60 h, with the fewest side effects of any of the three drugs [48, 49]. On the other hand, it should be noted that other studies have indicated health risks in people with pre-existing medical or psychiatric conditions, and that the effects are not evident or tangible in all individuals and circumstances. Health risks also increase if therapeutic doses are exceeded, and tolerance can develop in such circumstances [34, 50].

Nonetheless, if a person is subjected to internal and external pressures, they may well be more willing to try PCE if they perceive that it might offer them even small potential benefits. In the context of the modern workplace, this potentially means that workers could work more quickly and efficiently, could handle greater workloads or could cope with longer periods of intense work with fewer breaks, distractions and periods of non-activity.

Given the demands and features of the modern workplace niche described above, we might expect PCE drugs to be attractive to at least some workers, who would hope they would then become more competitive, improve their performance and be able to work more intensively and for longer periods, even under conditions of fatigue and exhaustion. Indeed, many experts in PCE have long claimed and assumed that PCE is used in occupations of high cognitive intensity, in which safety and human lives depend on high levels of attention, concentration and wakefulness being maintained, which in many cases involve shift or night work, and in which workers are under significant pressure to perform quickly, take risky decisions and be competitive. These apparently include surgeons, nurses, pilots, professional drivers, firemen and soldiers, as well as air-traffic controllers, programmers, scientists, financial traders and entrepreneurs [26, 36, 37, 51, 52]. Most assumptions about prevalence among workers are based on personal experiences, anecdotal reports and personal observations. There are few empirical surveys on the topic. One is the 2009 DAK insurance survey in Germany, which showed 5% of PCE users among 3000 employees [52]. Another is a 2011 survey of 1145 surgeons at five international conferences, showing that 8.9% have used PCE [53].

Of course, such practices are not entirely new, especially in the domain of work. In the twentieth century, psychoactive drugs were used to improve work

[2] Generally, we can distinguish between three broad and partly overlapping categories of PCE drugs or substances, known as smart drugs, nootropics, cognitive enhancers etc.: (1) prescription drugs (medications) that are used off-label by healthy people; (2) illicit drugs such as cocaine and amphetamines; (3) over-the-counter, commercially available nutritional supplements and products containing caffeine, procognitive substances and plant-based extracts.

performance and endure bad working conditions. In the US, this use of drugs can be traced back to the 1910s and 1920s, when cocaine was used in sectors such as construction, mining and manufacturing [54]. Later, we can observe that various illicit stimulant drugs such as amphetamines and cocaine were used in the 1960s and 1980s by those in occupations that required concentration and wakefulness, e.g. truck drivers, financial traders and executives, as well as by prominent personalities such as the gonzo journalist Hunter J. Thompson and the mathematician Paul Erdos. Some prominent examples can also be found in the military, which often pioneers advances in human performance enhancement: various armies used amphetamines during World War 2, while US combat pilots on long missions took advantage of amphetamines, and later modafinil, to improve cognitive performance [55].

Other supposedly cognition-enhancing substances also exist but are not regulated as prescription drugs. Most modern workplaces are equipped with coffee machines that provide employees with access to caffeine which, depending on the dosage, can have positive and negative effects comparable to PCE. Various energy drinks containing caffeine and taurine are widely available, and many people use the nicotine in cigarettes to improve their concentration and to relax. Many dietary supplements with herbal extracts such as huperzine A, vinpocetine, Bacopa monnieri and gingko biloba claim to have a positive impact on cognition, but their effects are often difficult to gauge and remain largely untested in clinical studies. As cognitive enhancement and smart drugs grow in popularity because of newspaper articles, movies and books, and as human enhancement ideas become more and more mainstream, many internet stores and companies have started to sell their own smart stacks and pills, composed of caffeine, plant extracts, vitamins, and in some cases other procognitive substances such as racetams. These are usually marketed especially at young entrepreneurs, programmers and students. Although such substances may have beneficial effects on cognition in some individuals, only caffeine in higher doses exhibits effects that could be comparable to PCE drugs [56].

Implications of PCE in the Modern Workplace Niche

As we have attempted to illustrate in the previous sections, we can see that various sociocultural and technological factors are already caught up in a reinforcing feedback loop in which considerable pressures to increase performance through the enhancement of cognitive capabilities are applied to the modern workplace and to workers. As the pressures of modern society and technological interaction place additional demands on cognitive capabilities, PCE may eventually come to be seen as an efficient means of coping with increased demands.

In the context of human enhancement, PCE was originally regarded primarily in terms of its liberating and emancipatory potential, with the goal of making us smarter and happier by expanding the range of our capabilities [2, 57]. In the context of neoliberal capitalist societies, however, such tools and practices are rapidly integrated and co-opted with a view to enhancing individuals as production units to improve system performance and make it more successful, to increase the "biological and intellectual capital" of a company's human resources, and thereby also serving to further accumulate profits [58]. And while society as a whole and individuals as citizens and consumers could certainly benefit from the lower costs and increased savings that are associated with higher cognitive performance in the workplace [26, 59], individual workers may also find themselves facing additional risks, responsibilities and possibly diminished opportunities.

Assessments of PCE substances have often revolved around their efficacy and safety. While most of the studies described above showed mild to moderate beneficial effects on various aspects of cognition in some individuals, practically all such studies explored only limited and short-term use. No studies of the effects of long-term use have been conducted, so any potentially adverse effects on health are unknown, which could see worker health jeopardized in the long run. The performance of cognitive abilities usually follows an inverted U-curve relationship between the dose and its effects, which means that increasing stimulation of a capability beyond the peak causes an eventual decline [60]. Enhancing one cognitive capability can also result in other capabilities being diminished. This implies that work performance in a specific setting or task could be enhanced, but may be diminished in tasks that require different capabilities. Furthermore, individuals who already function naturally at a high level of cognitive performance may find their abilities diminished rather than enhanced [61]. All of this means that workers who wish to engage in PCE need to have extensive knowledge of the drugs, their effects, their own neurophysiological characteristics, and the specific

demands of their workplace, yet most PCE users self-administer such drugs.

Although PCE drugs can enhance cognitive function in healthy people and improve cognition when a person is tired or suffering fatigue, they can also lead to a person overestimating their abilities or result in unrealistic expectations, thereby bringing about precisely the errors, misjudgements and accidents that the drugs were meant to prevent [34]. If a worker is found to have been using PCE drugs without a prescription in such circumstances, then responsibility will shift to him or her even if the benefits of increased productivity benefited their employer. And those PCE drugs used most often by healthy workers without a prescription are illegal in most countries, which could mean additional sanctions.

Given the current regulatory frameworks, it is unlikely that any of the PCE drugs will be approved for enhancement purposes in healthy people. Consequently, few workplaces, with the exception of the military and perhaps of medical, emergency or disaster relief organizations, will officially endorse the use of PCE. Usage will therefore be at the discretion of individual workers when it comes to autonomous enhancement. The argument put forward by pro-enhancement advocates is that a rational, informed individual who wishes to self-improve through technological means, and who does so by weighing up the costs and benefits of such actions, should be allowed to make their own decisions. On the other hand, anti-enhancement arguments also refer to the various socioeconomic pressures and unequal relationships in modern societies that might coerce individuals into enhancement against their will, especially when employers can draw on a large and increasingly global pool of workers thanks to practices such as crowdsourcing [62]. When some workers start to use PCE and are able to increase their performance beyond the current norm, this raises expectations in general, with the result that other workers could be gently coerced into improving their own performance in order to keep up, using whatever means necessary. As discussed above, pressures regarding performance and the conditions of employment are already on the increase, and at least some workers are already struggling to remain competitive in the current workplace and job market. Additional stress and pressure on workers who need to take on a second job or who experience problems in their domestic lives could further increase the need to use PCE to enable them to cope with their everyday obligations and activities.

Due to the lack of empirical studies of worker populations, it is currently possible only to guess at personal motivations for PCE use in the workplace in the light of the wider socioeconomic and technological factors discussed above. The circumstances that exist in a specific workplace are also important: high levels of competitiveness, responsibility for the lives of other people, shift and night work, working conditions that are generally stressful and demanding etc. There are also specific personality factors that might make individuals more likely to use PCE at work. Some individuals may be using PCE to self-treat an undiagnosed attention-deficit disorder or other form of cognitive deficit [63], or as an attempt to mitigate a general sense of being overburdened or needing to achieve standards that exceed the individual's actual or perceived capabilities. Personality traits can also play a role, such as a tendency to postpone obligations, anxiety connected to work tasks, low levels of intrinsic motivation, low perception of one's capabilities, little internalization of negative societal attitudes to drug use, as well as high levels of competitiveness and ambition [64]. Again, some of these characteristics may be associated with undiagnosed psychological disorders such as depression and anxiety. One specific category of worker is the aging individual who may be experiencing mild cognitive impairment and decreased mental flexibility and adaptability. Faced with the demands of the modern workplace and other socioeconomic pressures, such individuals may also be more likely to use PCE in order to maintain or even increase their performance.

We could point to at least four types of workers who might be more likely to take advantage of PCE: (1) The undiagnosed worker who suffers from some type of cognitive disorder but has not sought medical attention. In this case PCE use could be considered a form of self-treatment to address a medical or psychiatric condition. (2) The coping worker who is struggling to keep up with performance demands at the workplace. In this case the individual's average or normal capabilities are becoming insufficient to keep up with the norm, either due to internal or external pressures. (3) The aging worker who is starting to lag behind in terms of work performance due to cognitive decline and rapid changes in workplace processes and technology. PCE use in this case could be seen as either self-therapy to ameliorate the effects of degenerative aging or as self enhancement of average aging capabilities in an attempt to keep up with younger workers. (4) The competitive worker who wishes to gain

an additional competitive advantage in order to advance despite the fact that her or his capabilities are adequate to satisfy current work standards. PCE use in this case could be seen as self-enhancement for the purpose of increasing work performance.

However, these categories are not necessarily mutually exclusive, so one worker could also move from one category into another over time. For example, a competitive worker who keeps working beyond the norm might eventually develop cognitive problems which would make him an undiagnosed worker. And all types of worker eventually become aging workers.

In the workplace context, questions of access, fairness and equality have tended to be examined so as to establish whether those who have better resources, knowledge and connections regarding PCE drug acquisition would be in a privileged position that would further increase inequality, or whether the state should provide subsidized access for those unable to afford PCE [2, 36]. However, these issues also raise the question of whether individual workers are able to use PCE drugs and experience the positive effects they hope for given their neurophysiology. As we have noted, individuals have different neurophysiological features that influence the way in which they respond to PCE drugs. Some people have existing medical conditions – for example mental disorders or a tendency towards seizures or high blood pressure – that would make PCE use dangerous on account of its negative side effects. Other people might not notice any effects, or may even experience negative effects. Such workers would then be at a significant disadvantage both at the workplace and in the job market, which in a certain sense would render them disabled as compared with current conditions [9]. On the other hand, one argument in favor of PCE is that people with a lower but still normal level of cognitive ability could use PCE to become more competitive in the job market and in the workplace.

Responsibility, Conflicting Societal Domains and the Future Workplace Niche

The above sections have outlined some of the major trends that are shaping the workplace niche and aligning social relationships in this context. These changing configurations of the workplace are associated with specific patterns of worker and indeed employer responsibility. This link with responsibility can be examined at the individual and at the collective level.

From an individual viewpoint, workers have a responsibility towards their employers to effectively perform their tasks and obligations at the workplace, and strive to improve themselves in terms of such aspects as recognition, career progression or higher income. PCE use could advance some of these aspects. On the other hand, workers are also responsible for maintaining their health and wellbeing in the long term; in this context the short- or long-term adverse health effects of PCE use could lead to the development of illnesses and chronic conditions. In occupations in which the health and safety of other people are at stake, such as surgeons or drivers, it is conceivable that workers might be obliged to take PCE in specific conditions that would ensure greater safety of the worker and others [65]. If PCE is used for prolonged periods of increasing fatigue and ongoing sleep deprivation or low-quality sleep, however, mistakes and errors could lead to material damage and human injury.

At a collective level, workers could be seen as responsible for not using PCE drugs and thereby constantly raising workload norms so as not to increase the likelihood of other workers being gently coerced into following suit. Employers could be made responsible for guaranteeing humane and proper working conditions, including normal workloads and performance demands, in order to ensure the long-term health and wellbeing of their workers. As workers who suffer chronic stress in the workplace are more likely to become a public health problem that is borne collectively, such costs should not be externalized if they have contributed to company growth and profit. Finally, there is also the question of whether pharmaceutical companies and policymakers might be responsible for researching and developing more effective and safer PCE drugs if such drugs are becoming increasingly normalized and sought-after due to the promotion of their use, or if far-reaching sociocultural and regulatory interventions could prove more effective in changing current work-related trends.

While externalities due to the possible long-term negative health effects should be carefully evaluated on the individual and aggregate level, a second potential implication is equally important and warrants careful assessment. PCE does indeed reinforce the feedback loop between the increasing demands on professional performance and individual values, attitudes,

expectations and norms. While workplace and PCE trends do indeed raise demands in terms of human efficiency and competitiveness, there are also other human capacities and capabilities that are socially valuable and desirable, such as cooperation and solidarity, empathy and emotional connectedness.

The importance of these is most evident in other spheres of human life, such as family and friendship, neighborhood and community, civil society and polity. However, excessive emphasis on (cognitive) performance is likely to diminish their legitimacy and social appreciation, changing what is perceived as "valuable" models of behaviour. Bioethicists have long discussed the implications of PCE interventions when it comes to understanding the self and definitions of normalcy. This discussion stressed that diversities of culture, wealth and economic status dictate to a large extent what constitutes a "normal" healthy brain, meaning that it is difficult to envisage a common 'standard' to describe normal human cognition ([66], 117) or to determine which cognitive function should be considered most valuable. For example, some of the desired effects of PCE drugs move individuals closer to the autistic, introverted part of the spectrum of human psychology, and the risks of addiction cannot be ignored.

Moreover, raising performance-related work norms and pressuring workers to perform under ever more stressful and fatigueing conditions can cause such norms and expectations to spill over into other societal domains. One potential option in this regard is to widen the spectrum of diagnosis so that new drugs and therapies can be developed and prescribed to treat conditions that were not previously thought of as illnesses. This trend towards medicalisation and normalization [67] may mean that, as people use PCE increasingly widely to enable them to cope with difficult working conditions, we may eventually reach a point where that which is currently regarded as normal cognitive exhaustion due to overwork would constitute a pathological disorder that needs to be treated by prescribing PCE or other drugs rather than simply rest and regeneration.

The possible emergence of such pathological disorders raises many new ethical issues, so the risk of pathological (social) disorders needs to be weighed against the possible benefits of using PCE. The effects on the social integration of workers should also be considered, as reduced time for rest and regeneration is likely to shorten the time available for expression, affection and bonding. The implication of such shifts in human behaviour goes far beyond the challenging and pressing issue of the potential, harmful effects on workers themselves or others, and affects the way we understand and perceive the social domains in which we live, their relative importance and the norms that govern them.

Under such circumstances, regulation and public policy continue to play a crucial role in governing the diffusion and use of PCE with a view to reducing the human costs of trial and error and to taking advantage of societal learning processes. "As individuals we will need to put our values in order, but we will also need to devise policies, and in some cases perhaps new institutions, to help ensure that those values are realized" ([68], 12). Empirical evidence is fundamental to designing such policies and institutions so that policy approaches can be informed by evidence [69] and grounded in a robust public discussion about the premises and framework of PCE, its drivers and its consequences.

Conclusion

The wider sociocultural, economic and technological trends are shaping the modern workplace niche with the result that workers are under increasing pressure to improve their performance and work for longer periods and at greater intensity under conditions of exhaustion and cognitive fatigue rather than getting the rest and sleep they need to replenish and regenerate their energies. This is further exacerbated by the fact that such practices are spilling over into other societal domains, and by changes in employment opportunities and job security, which are being eroded by informatization and automation.

These trends generate strong social pressure that promotes certain cognitive capabilities, personality characteristics and practices in the workplace and beyond, while others are being used and valued less.

Under such circumstances, it could become more attractive to use PCE regardless of whether such drugs can deliver only small or negligible effects, and even if they entail a risk of negative health effects in the long term.

Within this framework, PCE could play an equally important role as part of a reinforcing loop that would raise work norms and create the conditions for work under ever more stressful and fatigueing demands. The predominance of performance-related capacities and

capabilities could worsen the already fragile balance between the different spheres of social life and enable the further "colonization" of efficiency and performance-related values, attitudes, expectations and norms in such important domains as family and friendship, in which human capacities and capabilities such as cooperation and solidarity, empathy and emotional connectedness are socially valuable and desirable.

This narrow view of human behaviour has implications for the significance of responsibility, too. From this perspective, responsibility is essentially equated with efficiency and effectiveness, and with the conservation and augmentation of bodily capacities to prolong this optimized, productive behaviour over time. Yet personal qualities such as empathy are critical prerequisites for assuming responsibility for others that constitute an all-important part of this notion [70]. Failing to acknowledge the importance of this different set of qualities limits our conceptual understanding of responsibility and our grasp of how responsibility relations develop in social processes.

In summary, the cultural and behavioural significance of PCE in the workplace appears at least as important as the concerns about the health of enhancement users and about the distributional effects of the widespread diffusion of PCE. To assess this dimension, a broader view of PCE needs to be taken, one that inevitably includes aspects of subjectivity, priorities (social and individual), values and preferences in the picture. Nonetheless, the logic of *balanced integration* between the different societal domains, as well as the differentiated positions and roles individuals have within and across such domains, can serve as a valuable and broadly applicable principle when it comes to framing the inevitable debates and decisions on PCE and cognitive enhancement management and policy in the workplace.

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