The Algorithms of Mindfulness

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Abstract

This paper analyzes notions and models of optimized cognition emerging at the intersections of psychology, neuroscience, and computing. What I somewhat polemically call *the algorithms of mindfulness* describes an ideal that determines algorithmic techniques of the self, geared at emotional resilience and creative cognition. A reframing of rest, exemplified in corporate mindfulness programs and the design of experimental artificial neural networks sits at the heart of this process. Mindfulness trainings provide cues as to this reframing, for they detail each in their own way how intermittent periods of rest are to be recruited to augment our cognitive capacities and combat the effects of stress and information overload. They typically rely on and co-opt neuroscience knowledge about what the brains of North Americans and Europeans do when we rest. Current designs for artificial neural networks draw on the same neuroscience research and incorporate coarse principles of cognition in brains to make machine learning systems more resilient and creative. These algorithmic techniques are primarily conceived to prevent psychopathologies where stress is

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considered the driving force of success. Against this backdrop, I ask how machine learning systems could be employed to unsettle the concept of pathological cognition itself.

Keywords

attention, rest, sleep, information overload, cognitive neuroscience, artificial intelligence

Introduction

In their best-selling book *Peak Performance*, science writers Brad Stulberg and Steve Magness (2017b) refer to a friend who rarely replies to texts, for his employer has "nailed the recipe for stress" (p. 76). When Stulberg and Magness wrote their book, Adam (name changed) was an engineer at Google's self-driving car project and his attention was ever absorbed by projects "where struggle and productive failure aren't consequences *of* the work, but rather the driving forces *behind* it" (p. 76). Yet, according to the authors, Google has meanwhile understood that keeping their employees busy is only half the battle. "Without rest," Stulberg and Magness write, "Google wouldn't end up with innovation. Instead, it'd end up with a workforce that is broken down and burnt out" (p. 76).

Books like *Peak Performance* and Google's Search Inside Yourself (SIY) program described within exemplify a movement toward technological fixes for working at or over capacity in North American and European societies.[1] Corporate mindfulness trainings and meditation apps, for instance, promise to help prevent attentional lapses and detail each in their own way how periods of idleness are to be recruited to combat the effects of stress and information overload. In this context, mindfulness practices are reconceived as techniques of the self that augment cognitive labor. I argue that the rising interest in mindfulness practices is symptomatic of an interest in recruiting *rest* or the flipside of what we know as attention "to task" for enhanced information processing on behalf of the cognitive worker.

In the first part of the paper, I draw on analyses of corporate mindfulness and meditation apps to show how rest is reframed within. This links mindfulness trainings and apps to research on wakeful rest in cognitive neuroscience, which I sketch in the second part of the paper. Thanks to investigations into the brain's so-called *resting state* starting in the 1990s, the brain of cognitive neuroscience has gradually been reconceived as

industrious and never idle. Said research led to a reframing of the resting state as a mode of information processing where our brains not only recharge their cognitive capacities but deviate from the "narrow if-then highway" (Stulberg and Magness 2017b, 88)

Google's artificial intelligence division *DeepMind*, among others, has taken up these ideas and adopted coarse principles of the resting brain to improve the capabilities of their machine learning systems. In the final section of the paper, I elaborate on this algorithmic implementation of rest to show how rest is therein further removed from idleness and reconceived as a mechanism that supposedly augments information processing and keeps the effects of information overload at bay. In contrast to mindfulness trainings and apps, Google DeepMind's developments do not (yet) have an immediate effect on the behavior of individuals. Similar to the Facebook patent applications analyzed by Tero Karppi, these algorithmic models are critical media that process our current realities at the level of discourse: they give us "a set of ideas who the user is, what they do, and who they can become . . ." (Karppi 2020, 49). Ongoing exchanges between computer science and neuroscience hence pass as epistemic experiments, which begin to bleed into psychologies and pedagogies that shape work-lives in North American and European societies. How can we make use of this knowledge in different ways to unsettle the concept of cognitive labor and the user instead of further internalizing the subjectivities that corporate mindfulness and experimental machine learning systems project onto us?

Mindfulness, Incorporated

In two articles published in 2018, a group of researchers who subscribe to conducting contemplative neuroscience voiced their concerns regarding the ongoing muddling of the ancient Buddhist practice of mindfulness through corporate programs and apps. The authors write that many of the practices that undergird mindfulness "arose in religious and spiritual contexts where the motivations and goals for what could and would be achieved through meditation differed greatly from secular Western notions of health, well-being, and flourishing" (Van Dam et al. 2018b, 68). Even if reliable measures of "flourishing" and "well-being" could be attained, it would remain unclear, from a psychological standpoint, whether the practices conceived as mindfulness trainings are well-suited to attaining such high-level goals.

Theirs is a rebuttal to an ongoing commodification of mindfulness practices, which finds support also in their own fields. For instance, neuroscientist Alissa Mrazek and colleagues argue that apps provide "an

unprecedented opportunity to deliver high-quality training to an increasingly internet-connected global audience" (Mrazek et al. 2019, 81). They emphasize the reach and seamlessness of apps in comparison to classic, place-based psychiatric therapy, which is becoming ever more important in workplaces that are primarily or entirely digital and screen-based.

In general, the two camps do not disagree about the value of mindfulness practices, yet they are divided over the question whether mindfulness should be reconceived to neatly fit into the packed schedules of North American and European executives and white-collar workers. "With the current use of umbrella terms," the contemplative neuroscientists write, "a 5-minute meditation exercise from a popular phone application might be treated the same as a 3-month meditation retreat (both labeled as meditation) and a self-report questionnaire might be equated with the characteristics of someone who has spent decades practicing a particular type of meditation (both labeled as mindfulness)" (Van Dam et al. 2018a, 38). Contemplative neuroscientists are concerned that mindfulness might turn into a mere technological fix for the problems that creative economies and digital cultures have wrought.

In this context, mindfulness trainings and apps sit next to digital detox programs (Beattie and Cassidy 2020; Sutton 2020), conceived to counter the effects of affective bonds introduced through the patents, policies, and business models of digital platforms (Baym, Wagman, and Persaud 2020). Apps promise to alleviate the effects of "how our cognitive capacities are captured and modulated on these platforms at the level of affective flow" (Karppi 2018, 10-11). In contrast to digital detox programs, however, mindfulness trainings and apps are typically designed to allow for affective bonds to be sustained. The very same devices that first induce digital distractions are employed to support changes in behavior and promise "attention by design" (Jablonsky forthcoming).[2]

Corporate mindfulness trainings pursue similar objectives and reconceive mindfulness as a behavioral technique. For instance, *Workfulness*, the corporate well-being program of Scandinavian telecommunication company Telenor, has been developed for companies that seek to create a healthy digital working environment by reducing digital distractions in the workplace: it "aims at refocusing the employees' attention to more constructive behavior" (Guyard and Kaun 2018, 543-44). Central to Google's mindfulness strategy—which is prominently featured in Stulberg and Magness's book—is their own *SIY* program. SIY supposedly supports employees in sustaining peak performance by strengthening their "ability to stay present and be aware of what's happening as it's happening" (Search Inside

Yourself Leadership Institute 2019). Ruchika Sikri, Google's Well-being Learning Strategy Lead, explains these tactics by comparing the mind to a snow globe:

> We're constantly shaking it with information overload, distractions and task switching. This results in reduced clarity of our priorities and a lack of focus. By practicing a brief meditation (as short as five minutes!)—we can let the "snow'' settle and see things more clearly and vividly. Clarity of mind can help us prioritize what's important, solve problems better, figure out new strategies or uncover issues we may have ignored. (Parcerisa 2019)

Google's SIY, Telenor's Workfulness, and other corporate programs position mindfulness as an intermittent mode of rest, which departs from traditional understandings of rest as the cessation of labor or nonactivity. They emphasize intellectual flexibility and emotional resilience in workplaces, digital and analog (Cook 2016; Ferguson 2016; Parviainen and Kortelainen 2019). Instead of disconnecting entirely, cognitive workers are called upon to go off-line and regenerate their cognitive capacities to reconnect to the world. What was once a meditation practice that requires years of training is now often recruited to support "fitness for work" (Hull and Pasquale 2018) and has therefore taken on "feats of athleticism" (Gregg 2018).

Janice Maturano, a former Vice President and Deputy General Counsel at the American consumer food manufacturer General Mills and founder of *The Institute for Mindful Leadership*, states: "Just as we understand that there are innate capacities of our bodies that can be trained to make us more resilient, flexible and stronger, we now know from neuroscience research that there is universal training we can experience that can cultivate and strengthen our mind's capacities. And, the good news is that it doesn't require any special equipment or a gym membership" (The Institute for Mindful Leadership 2016). That is, rest is not only recruited to regain focus and attention—it allows switching into modes of thought that complement the fast-paced cognitive labor that companies, such as Google, have branded. In Stulberg and Magness's (2017a) words, rest "isn't lazily slothing around; it's an active process in which physical and psychological growth occurs. To reap the benefits of stress, you need to rest."

Corporate mindfulness projects an industrious subject that is never really idle—a mode of subjectivity that is in fact firmly rooted in cognitive neuroscience research on the brain's "resting state" (Callard and Margulies 2010). Stulberg and Magness, for instance, prominently reference the work of neuroscientist Marcus Raichle, who began studying the brain "at rest" in

the 1990s and has since continued this line of research by investigating the brain's "default mode" of operation. This change of perspective—from rest to default mode—is based on a "flipping of contrasts" in the psychology laboratory that occurred in the 1990s (Callard and Margulies 2011).

Rest, Reframed

In 2007, neuroscientists Alexa Morcom and Paul Fletcher (2007) published an article in the highly influential journal *Neuroimage* that lamented the ever-growing interest in what the brain does when we rest. Although a resting subject's brain might well be active, the authors saw no reason why such activity should be conceived as the source of creativity and subjectivity, as some of their fellow neuroscientists would have it. Morcom and Fletcher appeared to be particularly disturbed by the fact that participants were by then increasingly asked to simply rest during experiments.

I myself remember many off-the-record conversations in neuroscience labs from roughly ten years ago, where researchers mocked resting state research as mere experimental laziness. Most experiments I witnessed doing fieldwork in cognitive neuroscience labs had been dominated by problems, instructions, or stimuli defined by the experimenter and executed by the volunteer. Any measurements of mental and cognitive activity— whether via electroencephalography, positron-emissions tomography, or functional magnetic resonance imaging (fMRI)—were typically conducted if and when the volunteer was occupied with an experimental task.

In fact, experimental psychology and neuroscience had since the late nineteenth century been characterized by "an uncanny proximity between subjective responses to a task delivered in the laboratory and one prescribed on the shop floor" (Morrison et al. 2019, 64). Nevertheless, asking volunteers to put their brains "at rest" in the fMRI scanner had always been an important element of brain imaging studies, for brain activity at rest was conceived as "control condition" and thus "the flipside of a range of focused, controlled and externally oriented processes: an image in negative of the aware and externally attentive brain" (Alderson-Day and Callard 2016, 12). In the 1990s, neuroscientists developed a vested interest in distinguishing the components of resting state activity, and initially they simply looked the other way. Instead of subtracting the activities of the brain at rest from what happens when the volunteer's brain is hard at work, they started to search for brain regions that show increased activity during

periods of rest and found a network of brain regions we now know as the "default network."

In this process, what had been considered as mere background noise that tends to obscure the cognitive activity of the brain became the target of analysis—an "an organized, baseline default mode of brain function that is suspended during specific goal-directed behaviors" (Raichle et al. 2001, 676). Crucially, cognitive neuroscientists gave up on the idea that the default mode is bound to extended periods of rest and began to more generally analyze mental processes that had been disregarded by cognitive neuroscientists, for they were considered unrelated to active, cognitive processes, and hard to summon in the laboratory. They developed strategies that would keep volunteers from following the traditional, attentive routines of the psychology lab so that they stay "off task."

The goal of these experimental strategies gradually changed, from identifying brain regions that are active when we rest to creating the conditions where volunteers' minds could stray. The underlying cognitive activity is now variously referred to as self-generated, task-independent, stimulus-independent, unconstrained, or spontaneous thought. The rising interest in these phenomena and the brain's default mode was based on the idea that "conscious experience is relatively more dependent on the individual's concerns, preoccupations and hopes (i.e., self-generated), rather than immediate perceptual input (i.e., perceptually generated)" (Callard et al. 2013, 1).[3] The described, experimental shifts in brain imaging have since contributed to the idea that brains are, in fact, entirely unrestful and allowed for a default mode phenomenology to emerge.

Default Mode Phenomenology

In 2010, resting state forerunner Marcus Raichle (Raichle) published a paper on the brain's "dark energy." The metaphor latched onto the similar concept of dark energy in physics, which allows one to speak about phenomena that cannot be reliably measured or explained, although its effects can be observed. The metaphor was introduced as an auxiliary hypothesis to explain why the expansion of our universe keeps on accelerating; in neuroscience, it helped explain why the brain remains active when the demands of the environment abate.

The dark energy metaphor grasped the growing interest in the contents of self-generated mental activity, which researchers had largely ignored—also since experimenters technically need the help of volunteers to know when it occurs and catch their mind wandering.[4] In the process of mind wandering,

memories are recalled for simulations of the future based on experiences in the past, which is why we sometimes imagine lying on a pristine beach while staring into gray, postindustrial landscapes that whizz by the windows of a commuter train.[5]

More than fantasy and (day) dreaming, mind wandering has been linked to the process of drifting away and interrupting whatever activity had been carried out before. In psychology, it had been conceptualized as task-unrelated since laboratory practices "have repeatedly assumed that experimental subjects must have some task to wander *from*" (Morrison et al. 2019, 67). The so-called executive failure theory, for instance, postulates that mind wandering amounts to a loss of focus and control over our mental activity (McVay and Kane 2010). Psychologists Jennifer McVay and Michael Kane offered that mind wanderers are characteristically unable to stay on task, unconsciously drift away and fail to return their attention to the outside world, and unable to take notice of their mental absence. What is to be avoided, from this perspective, is getting lost in one's thoughts, whether these are positively connotated as in daydreaming, negatively connotated as in depressive rumination, or entirely erratic as in psychotic episodes (Wotruba et al. 2014).

Yet, the differentiation between highly valued attentiveness and pathological introversion has been complicated throughout the last two decades. The fact that humans are mind wandering up to 50 percent of their waking life alone speaks against the cognitive insignificance or any pathological character of mind wandering per se. Proponents of the "perceptual decoupling" hypothesis suggest that mind wandering is characteristic of a cognitive state where we attend to normally sub- or nonconscious processes that occupy parts of our brain throughout the day and not only when we rest (Baird et al. 2014; Hove et al. 2016). That is, neuroscientists meanwhile believe that mind wandering might be indicative of a subconscious, yet system-critical mode of information processing, which occupies our attention whenever we indulge in our thoughts, but generally benefits our ability to keep fixed and "on task" (Shepherd 2019).

Uncontrolled mind wandering is billed as the source of cognitive pathologies such as attention deficit hyperactivity disorder, autism, depressive rumination, schizophrenia, and obsessive thought (Tang, Hölzel, and Posner 2015). If mind wandering is voluntary, however, it is linked to creative thinking, imagining the future, social problem-solving, memory consolidation, and a general openness to new experiences (Beaty et al. 2018; Murphy et al. 2018). In this case, mind wandering amounts to a particularly vivid form of "off-line thought" (Smallwood and Schooler 2015) or "off-line

perception" (Fazekas, Nanay, and Pearson 2021). In other words, a phenomenological ambiguity sits at the heart of the concept: mind wandering is considered a source of pathology if it cannot be controlled, but it can be beneficial and productive if it is "goal-directed" (Christoff et al. 2016).

Kieran Fox, one of the currently most prolific researchers in the field of contemplative neuroscience, explains this phenomenological ambiguity of mind wandering in an interview with *ALIUS Bulletin*:

> I don't think of mind-wandering as a conscious state—I think of these processes as more or less ongoing, below the level of awareness, competing with other inputs and signals in the brain for our attention. We can tune in and pay attention to them, or not, and sometimes the thoughts will be strong enough or emotionally salient enough to grab our attention even when we don't want them to. I think of the stream of inner thought in a way similar to other perceptual channels; for instance, you are constantly receiving a stream of auditory information, even when you're asleep, but your brain is very good at blocking out probably 99% of this information as totally irrelevant, and you never become conscious of it . . . . I suspect the brain is constantly generating thoughts, imagery, and so on at a "subthreshold" level as well, and noticing it is more a matter of this content catching our attention and becoming illuminated by our conscious awareness than of entering a particular conscious state where mind-wandering then starts or is allowed to take place. (Fox and Koroma 2018, 4)

In general, this reframing of mind wandering as a form of subconscious information processing is a welcomed de-pathologizing gesture. It liberates self-generated mental activity from the stigma that emerged thanks to task-focused experimentation in psychology labs and links it to the concept of system maintenance via the metaphor of a default mode.

At the same time, this reframing suggests putting the burden of managing attention on the individual. In the context of trainings and apps, mindfulness is reconceived as a behavioral technique that regenerates *and* recalibrates attention. An emphasis is placed on training minds and bodies to gain attentional and affective control under conditions of information overload. That is, rest is co-opted to support working at or over capacity and reframed according to the idea that the subconscious mind never rests. The brief and intermittent periods of rest that mindfulness-based interventions permit offer respite from or sustain attention, yet they also promise to facilitate access to alternative modes of thinking.

Once considered an antidote to mind wandering, contemplative neuroscience now suggests that mindfulness can help "steer people away from

the negative biases that we see in mental illness, and instead nudge them toward positive, constructive, and creative patterns of thinking" (Fox and Koroma 2018, 11). A remarkable passage in Stulberg and Magness's (2017b) book *Peak Performance* captures this transformation of unproductive rest into an "Other" mode of information processing extraordinarily well:

> Our subconscious mind functions in an entirely different manner than our conscious mind. It breaks from the pattern of linear thinking and works much more randomly, pulling information from parts of our brain that are inaccessible when we're consciously working on something. It is in these parts of the brain, in the vast forests bordering the narrow "if-then" highway that our conscious mind runs on, where our creative ideas lie . . . it's only when we turn off the conscious mind, shifting into a state of rest, that insights from the subconscious mind surface.

Drawing on the idea of a default mode, Stulberg and Magness link focus and undivided attention to the execution of mundane tasks and a narrow "if-then" highway. What they carve out—metaphorically—is a space of play that is buried below and which can only be consciously accessed when we actively go off-line and put our brains at rest. In this context, rest is reconceived as a mechanism that supports resilient and creative information processing—in both brains and large-scale technical systems.

Algorithmic Modulations of Attention

Adam, the restless Google engineer who rarely replies to texts, is only one of many examples presented in Stulberg and Magness's (2017a) book; and yet he is a very memorable one, since Adam was at that time wholly immersed "in the brains and guts of a car . . . to teach an inanimate object moving at 70 miles per hour to differentiate between a stray plastic bag and a stray deer." This is to say that Adam and Google's prototype self-driving car essentially face the same problem: neither Adam nor self-driving cars have the opportunity to escape their informationally dense environments. They are called upon to sustain attention to task while being confronted with an endless stream of information that threatens to overwhelm their cognitive capacities.

Without necessarily taking account of ongoing exchanges between cognitive neuroscience and machine learning, *Peak Performance* draws attention to the slippages that characterize current research in both fields. For instance, Google DeepMind speaks of a "virtuous circle" between

neuroscience and AI, "whereby AI researchers use ideas from neuroscience to build new technology, and neuroscientists learn from the behaviour of artificial agents to better interpret biological brains" (Hassabis, Summerfield, and Botvinick 2017).

This parallelization of human and machine in cognitive science, computing, and public discourse goes back to mid-twentieth century, North American social science, and the concept of information overload (Levine 2017). Nick Levine traces it to the work of American psychologist James Grier Miller and his article "Information Input Overload and Psychopathology," which was published by the *American Journal of Psychiatry* in 1960. Central to Grier Miller's theory is that living systems have limited channel capacity to process incoming information and that pathological behavior likely results from failures in the communication of internal subsystems. Very much in the tradition of cybernetics, Grier Miller applied his theory to systems from the microscopic to the sociological, from the neuron to the corporation.

Grier Miller's universalist understanding of information overload became characteristic of 1960s and early 1970s complex systems theory that was largely indifferent to the fundamental disparity of human and machine. For instance, social scientist and artificial intelligence forerunner Herbert Simon (1971) observed that information overload "creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it" (p. 41). Throughout the 1980s and 1990s, the concept leaked into management science and became the dominant element of an emerging public discourse on the dangers that accompany the data deluge as well as the proliferation of gadgets, screens, and user interfaces.

The idea of finite cognitive bandwidth is now firmly embedded in both the neurosciences and computing. Neuro-psychologists would frame the attendant problem as a "stability-plasticity dilemma" that haunts artificial and biological systems in a similar way (Mermillod, Bugaiska, and Bonin 2013). A pertinent example of a pathology that derives from the stability-plasticity dilemma is "catastrophic forgetting." As a concept, catastrophic forgetting is native to the machine learning domain, but it compares to the traumatic memory loss that humans experience under conditions of shock. Catastrophic forgetting occurs when an artificial neural network is trained on different tasks and "forgets" one task in favor of another. For instance, take a network that is trained to play legacy ATARI games such as Space Invaders and Pac Man. The network will start by trying out random strategies and consecutively "learn" to master Space Invaders by memorizing the

strategies that lead to success in this very game. If the network is trained on Pac Man thereafter, it might completely erase and overwrite its knowledge of Space Invaders.

The problem of catastrophic forgetting has been approached as an issue of algorithmic attention. In contrast to humans, artificial neural networks are not good at differentiating between useful and superfluous knowledge, which is why their attentional capacities need to be carefully managed. Some researchers suggest to force the network into paying "hard attention to task" (Serra et al. 2018), others promote machinic variants of synaptic memory consolidation (Kirkpatrick et al. 2017). These seemingly different strategies have in common that they seek to protect knowledge from being accidentally erased. Attention is figured "as a means of guarding against undesirable synaptic changes" (Lindsay 2020, 16).

Yet, humans remember and forget primarily when they rest, which is why many machine learning researchers resort to insights from resting state and default mode neuroscience. Wakeful rest and sleep are considered to have a double role in the learning process: if we do not need to pay attention to our environment, our brains supposedly "take out the garbage" and purposefully forget to make space for new knowledge. At the same time, we replay experiences from memory to solve problems creatively and store what is important to long term memory (Langille 2019; Lewis, Knoblich, and Poe 2018).

Current designs for artificial neural networks involve mechanisms that reproduce this behavior in very coarse ways—yet, without factoring actual rest into the equation. Researchers discuss mind wandering as a principle of resilient and creative information processing in machine learning (van Vugt 2018) or suggest encoding artificial rest and sleep into their systems (González et al. 2020). In artificial neural networks, rest turns into a mere algorithmic mechanism—after all, artificial neural networks never actually rest.

In the *Scientific American*, physicist/neuroscientist Garrett Kenyon accordingly describes rest in artificial intelligence in similar terms as *Peak Performance* authors Stulberg and Magness's take on mindfulness in corporate settings:

> Sleeplike states in neural networks are very different from the mode your PC enters after some set period of inactivity. A conventional computer that has gone to "sleep" is effectively in suspended animation, with all computational activity frozen in time. And the age-old advice from the IT department to try

> "turning your computer off and then on again" when a PC gets glitchy is tantamount to exposing your machine to a brief period of brain death. That kind of sleep mode would do nothing to settle an unstable neural network. And power cycling would simply reset the network and undo any prior training, effectively giving the network a severe case of amnesia. In neural networks as well as living creatures, a sleeplike state is not inactivity, but a different kind of activity that is crucial to the proper functioning of neurons. (Kenyon 2020)

Such posthumanist rhetorics gradually blur the differences between biological and artificial systems—with the effect that rest is consolidated as yet another form of cognitive labor.

It is this reframing of rest that fueled the hype around brief and intermittent mindfulness exercises as a source of psychological resilience and creativity. Corporate mindfulness trainings subsume the Buddhist practice of mindfulness meditation to the logics of psychological resilience and thus reflect "a disturbing utilitarianism—a partial adoption of asceticism that is actually the antithesis of productivity's insatiable appetite for self-enhancement" (Gregg 2018, 122). Recent experiments in machine learning and artificial intelligence contribute to this reframing of rest as a cognitive technology. Against this backdrop, I would like to conclude by focusing on the question of what it would take to escape these logics of necessity: can machine learning systems be employed to experiment with alternative cognitive subjectivities?

Conclusion

The current prominence of mindfulness trainings and apps suggests that North Americans and Europeans increasingly think about mindfulness, and about their lives more generally, in algorithmic terms. Technologies play an important part in this process: as Ruckenstein and Schüll (2017) observe: apps, trackers, and new, device-based pedagogies "bring machinic agency to bear on human ways of defining, categorizing, and knowing life" (p. 269). At the same time, machine learning researchers experiment with implementing coarse principles of cognition in the human brain in artificial neural networks and thus prepare the ground for selling these as generative models of how humans perceive and learn. Whereas the algorithmic modeling of cognitive processes is conceived to augment artificial intelligence, neural networks, or neuromorphic devices supposedly further our understanding of cognition in the brain.

In other words, both contemporary neuroscience and neuroscience-inspired machine learning research appear to close in on algorithmic understandings of cognition in humans and machines. The related—by now rather speculative—transpositions are not always and inherently problematic. Yet, in their current form, they invite us to think about cognition primarily as a problem of preventing pathology. This tendency is exacerbated in neuroscience-inspired, artificial neural networks. They provide working models of cognitive labor under conditions of overload and lend themselves well to experiments with technological fixes for the effects of working at or over capacity.

Yet, Adam's issues with work–life balance and the difficulties that (Google's) driverless cars have with differentiating between plastic bags and stray deer appear comparable only within an information processing framework that presupposes the inevitability of overload. While these techniques and technologies may help alleviate its effects of working at or over capacity, they simultaneously burden the worker, and the worker alone with managing overload—and thus reframe rest as yet another form of labor. Current exchanges between cognitive neuroscience and cognitive computing suggest that "there is no idle time, either for human or non-human actors," as media historian Markus Krajewski (2018) writes in his book *The Server*. "A human servant is never physiologically inactive. The same applies to a machine: as soon as it goes idle, it turns to maintenance tasks, attending to its own treatment and care" (p. 346).

If we want to think beyond this reframing of rest as cognitive labor, we need to situate and historicize the underlying epistemology. The current interest in determining the algorithms of mindfulness is rooted in a reorientation toward nonconscious cognitive processes in North American and European cognitive neuroscience since the 1990s. It gradually drew attention to patterns of infrastructural activity in the brain and thus aligned our understanding of biological cognition with contemporary paradigms of information processing, exemplified in cloud computing (Bruder 2019).

Thinking about humans as information processors, however, implies neither that we gear our entire lives toward managing overload that is imposed nor that the search for algorithms of mindfulness needs to turn into an endeavor of relentless optimization. The knowledge that contemporary neuroscience produces, and that machine learning research selectively perpetuates, lends itself well to unsettling old dichotomies, such as those between attention and distraction or between task and rest. Rather than resorting to this knowledge only to overcome pathologies that derive from our social and informational environments, it might aid in exposing the

frameworks that naturalize overload and define the inability, or unwilling-ness, to succumb to it as pathological.

If, as I suggested earlier, the reframing of mind wandering as subcon-scious information processing is a de-pathologizing gesture, this gesture may also be understood as losing interest in perpetuating the notion of psychopathology more generally. Could machine learning systems support this process? In *Cloud Ethics*, Amoore (2020) writes that algorithms "cannot be controlled via a limit point at the threshold of madness because the essence of their logic is to generate that threshold, to adapt and to modulate it over time" (p. 110). Machine learning algorithms internalize and exhibit significant aspects of the rationalities that undergird them—they "are never far from their conjoined histories with psychosis, neurosis, trauma, and the imagination of the brain as a system" (p. 114; see also Halpern 2014). At the same time, they generate new forms and models of what is considered normal and abnormal, precisely because they merely internalize some coarse principles and fragmentary sets of data that can only ever be partial. Machine learning systems do not—in a traditional way—understand what they are modeling and therefore potentially and acciden-tally unsettle the very rationalities they were made to internalize.

I believe that studying and experimenting with these systems can con-tribute to thinking beyond currently paradigmatic epistemologies of machine learning, and toward diversifying or queering related, in North American and European neuro-psychologies. The flipping of contrasts that created an opening for de-pathologizing mind wandering might be a good model for algorithmically unsettling the idea of pathological cognition. This process demands continuous and recurring engagement with the technical-ities of algorithmic systems and the knowledge practices they implement—"continual, careful, collective, and always partial reinscriptions of a cultural-technical situation in which we all find ourselves" (Philip, Irani, and Dourish 2012, 5).

Author's Note

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Notes

1. I am indebted to Michael Fisch who pointed me toward the significance of working over capacity. In *An Anthropology of the Machine*, Fisch (2019) discusses the significance of "finessing the interval" for a system working over capacity, such as the Tokyo Commuter Train network. Human brains and commuter trains make for unlikely bed fellows, but it is this metaphorical parallelization of human and machine that sits at the heart of this article.
2. In this regard, meditation apps fall into a class of technics that include self-trackers that monitor and automatically intervene in the behavior of individuals (Berg 2017; Schüll 2016), apps or gadgets that "cancel" unwanted frequencies through adding white or pink noise (Hagood 2019), or cognitive devices that override corporeal senses and biological functions, as Chia (2019) offers, "through an imagined master code to program the mind" (p. 6). Further, one might want to include pharmacological cognitive enhancement with drugs such as Adderall and Modafinil, which have been particularly prominent among students and academics (Coveney, Gabe, and Williams 2011; Vargo and Petróczi 2016; Vrecko 2015), and the microdosing of classic psychedelics, which has gained traction among creative workers as well as in the traditional (white) middle class (Johnstad 2018). An interdisciplinary group of researchers from the University of California and the University of Alabama found that users experienced positive effects on sociability and "praised microdosing for its ability to increase productivity and satisfaction at their work, which is often a primary concern among the middle class. They reported being more focused, creative,

and energetic, especially on the days of and after microdosing" (Webb, Copes, and Hendricks 2019, 37). Psychologists Vince Polito and Richard Stevenson (2019), however, observed that the positive effects reported by microdosers are often accompanied by and occlude a tendency toward absorption and neuroticism.

3. Following Callard and colleagues (2013), I will from now on refer to this class of phenomena as self-generated mental activity and only use one of the alternative terms in case I refer to a specific aspect of self-generated mental activity.

4. Experienced mindfulness practitioners appear to be able to "change the relationship with the resting state and experience the stream of stimulus-independent mental content in an adaptive way" (Vago and Zeidan 2016, 97). Their capacity to tell when their mind begins to wander provides experimenters with a cue to start monitoring the interactions of large-scale brain systems when mind wandering is deliberate and goal-directed.

5. Unconstrained thought has therefore also been compared to film editing, with the hippocampus—a central element of the default mode network—as editor: it directs the cuts that essentially determine how individuals remember specific events and conceive of experience as episodes in time (Ben-Yakov and Henson 2018). The minds of people with hippocampal damage provide a model of where such processes fail. They appear to wander primarily in the present, which means that mind wandering does not occur more or less often than in healthy individuals, but it apparently lacks "flexible, episodic, and scene-based" qualities. Instead, mind wandering appears "abstract, semanticized, verbal"—and thus entirely similar to ways of thinking that many of us have been trained to enforce on the job (McCormick et al. 2018).

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