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Between Cognitive Augmentation and Atrophy: AI's Role in Reshaping Human Intelligence

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Abstract: Vestigial organs serve as one of evidence for the theory of evolution, gradually atrophying and disappearing when they no longer contribute to an organism's survival. This principle can also be applied to human consciousness and intelligence, as the brain is a product of an intricate and ancient evolutionary process. While the concept of cognitive atrophy from an evolutionary perspective is less well-defined than physical atrophy, evidence suggests that mental functions deteriorate when they become obsolete. Environmental shifts, lifestyle changes, and evolving social structures all play a vital role in shaping this dynamic process. Organisms tend to attract stability, minimizing conflict and competition tendency that also influences cognitive decline. In this context, the rise of artificial intelligence (AI) may accelerate the atrophy of human cognition. As societies grow increasingly reliant on technology, certain cognitive abilities essential in earlier human history may diminish due to reduced necessity. This paper argues that the rapid development of AI will facilitate mental and cognitive ease, ultimately leading to a decline in human knowledge in the near future.

Keywords: Comfort Zone, Cognitive Atrophy, Critical Thinking, Artificial Intelligance, Human Intelligence.

Introduction

In the shadowy depths of Mexico's water caves, the blind cavefish called Astyanax Mexicanus Forges through eternal darkness, its ancestors' eyes vanished into spectral grooves since long time ago. Evolution, uncaring for nostalgia, suspended what was no longer required. the remaining of a sight relic is fossil of function, but is not a sight tool (Yoshizawa et al., 2010). As we outsource our mental to machines, this biological parable mirrors a question haunting humanity recently: what cognitive relics will future generations inherit?

The concept of vestigiality earlier confined to the appendix's enigmatic whisper or the python's shriveled pelvic spurs has slipped into the concept of cognition. The analogy between biological vestigiality and cognitive decline is based on the concept of "use it or lose it" Just as natural selection favors the degradation of energetically costly traits that no longer offer survival advantages, cognitive functions can atrophy if they are constantly replaced by AI. Darwin (1859) first framed vestigial organs as "mute witnesses to imperfections of nature". Modern thinkers like Gould (1991) reinterpret them as evolutionary scars, shaped by selective pressures. the AI recently assumes roles once reserved for human intellect, such as computer based diagnosis and cities navigating, a provocative analogy emerges. Could mental cognitive facility, like the eyes of cave fish, atrophy when their utility fades? Carr (2020) warned of this in his book (The Shallows), arguing that the convenience of the internet had eroded memory and deep reading. Recently, ascendancy of AI threatens a broader cognitive desertion, a "mental vestigiality" where skills from ethical reasoning to mental arithmetic atrophy, leaving behind neural echoes.

History offers cautionary stories. When the navigators traded GPS by the old method of celestial way finding, their descendants lost the skill to read stars (Lewis, 1994). Similarly, the people of Kenya, once adept at tracking forest sounds, now struggle as smartphone apps mediate their environmental awareness. These cases align with Hebb's (2005) axiom: neurons that fire together wire together. Conversely, disuse weakens synaptic connections—a principle now accelerated by AI's encroachment. Sparrow et al. (2011) reveals this in their seminal "Google Effect": when the humans notice that information can digitally accessible, they forget it quickly, their brains consider the internet as a memory partner. AI, advance further, where the knowledge is stored, curates, and creates from it and decides for it. Bostrom (2014) warns in his publication (Superintelligence), such systems could induce "cognitive outsourcing," where the mental of humans, like the atrophied wings of the flightless kakapo parrot, retain only the ghost of their ancestral intellect.

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In an era increasingly defined by artificial intelligence (AI), the human brain may face a new evolutionary challenge: the risk of technologically facilitated intellectual decline. As AI systems take over more cognitive tasks, from navigation and calculation to decision-making and information retrieval, humans engage less in the mental processes that once shaped intellectual development. This paper explores the concept of cognitive atrophy from an evolutionary perspective, arguing that the increasing reliance on AI may not only replace human cognitive work but also contribute to the long-term erosion of some knowledge systems and intellectual abilities. By examining the environmental and societal changes brought about by the integration of AI, this study aims to raise critical questions about the future of human intelligence, its autonomy, and the unintended consequences of technological progress. This research explores the delicate relationship between AI and human intelligence, emphasizing the nuanced balance between augmentation and atrophy. By analyzing the cognitive and behavioral effects of AI integration, the study aims to demonstrate how AI reshapes human thinking. Ultimately, this study aspires to provide a framework for analyzing a synergistic relationship between humans and AI machines that empowers intellectual capacities rather than undermines.

Vestigial Organs

Atrophied organs, often referred to as vestigial organs, have been a topic of interest in evolutionary biology as they provide insight into the history and adaptation of organisms. Vestigial organs are remnants of structures that had significant functions in ancestral species but have lost or changed their original functions due to evolutionary processes (Berry, 1900; Darwin, 1859; Macalister, 1871; Müller, 2002). For instance, the human appendix is a classic example. It is a reduced version of a larger cecum that was used by distant herbivorous ancestors for digesting cellulose (Randal Bollinger et al., 2007; Smith et al., 2013). Another example is the vestigial wings of ostriches, which are not used for flight but may have other functions such as balance or mating displays (Bock, 1959).

This is called Mechanisms of Trait Loss and can occur through various evolutionary mechanisms, including natural selection and genetic drift. For instance, cave-dwelling animals like certain species of fish have lost their eyesight over generations because vision is not advantageous in complete darkness. Instead, these species may develop other heightened senses to navigate and survive (Johnson et al., 2012). Thus, numerous studies have focused on understanding the genetic and developmental pathways involved in the atrophy of organs and have provided insights into how natural selection can favor the loss of a trait when it is no longer useful for survival.

Studies on Cognitive Atrophy

Consciousness is believed to have evolved as an adaptive trait that provided significant survival advantages. The development of consciousness involved a gradual increase in cognitive complexity, enabling better decision-making, problem-solving, and social interaction. This evolutionary path is evident in the progression from simple neural networks in early animals to the highly complex brains of humans and other advanced species (Corballis, 2007; Suzuki, 2022).

While the evolution of consciousness generally involves the development of more complex cognitive functions, there are scenarios where certain cognitive abilities may atrophy or diminish. Feinberg and Mallatt (2016) discuss the ancient origins of consciousness, highlighting how primary consciousness evolved and how certain cognitive abilities can diminish when they are not beneficial for survival. They argue that consciousness likely emerged as a solution to ecological challenges, and as environments change, some aspects of consciousness can become redundant and atrophy . Ginsburg and Jablonka (2019) explore the evolution of subjective experiences and propose that consciousness evolved through stages of increased complexity. They suggest that some forms of primitive consciousness could diminish if the environmental pressures that once required those traits are no longer present . In humans, cognitive atrophy can be linked to various factors, including genetic mutations, environmental changes, and social evolution. For example, as societies have become more complex and technology-dependent, there may be a reduced need for certain survival-based cognitive skills that were crucial in earlier human history.

To sum up: While the concept of the mind and consciousness atrophying from an evolutionary standpoint is less straightforward than physical atrophy, there is evidence that cognitive functions can diminish when they are no longer advantageous. This process is influenced by changes in the environment, lifestyle, and social structures, reflecting the dynamic nature of evolutionary adaptation.

Comfort Zone

In the process of survival, the organism uses more energy for the organ that enables it to survive. In active birds like hummingbirds, the energy consumption of flight muscles is extremely high. Hummingbirds have the highest metabolism of all vertebrates, with their flight muscles consuming up to 60-70% of their total energy intake during flight (C. C. W. Chen & Welch Jr, 2014; Ingersoll & Lentink, 2018). For fish, particularly those that are constantly active like tuna, the muscles involved in swimming also consume a significant portion of the organism's energy. Tuna is known for their continuous swimming, which requires substantial metabolic energy to sustain the high levels of muscle activity needed for their active lifestyle. Studies show that these muscles are highly efficient in utilizing energy, reflecting the evolutionary adaptation to their fast-paced aquatic environment (Graham & Dickson, 2004; Guppy et al., 1979).

In humans, the brain is a major energy consumer. It constitutes about 2% of body weight but uses approximately 20-25% of the body's total energy budget, primarily for processing and transmitting information through electrical signals. This high energy demand is due to the brain's complex functions and constant activity, even during rest (Boyer & Harrington, 2018; Raichle & Gusnard, 2002).

Therefore, because the organism consumes, it must provide more energy to supply the main organ in its body, so it tends to the comfort zone in search of a stable environment in order to adapt and survive. When the organism finds that stable environment, it will provide more energy by consuming less (McGuire et al., 2021; Robbins et al., 2012). Therefore, staying in a comfort zone can sometimes lead to the atrophy of certain organs. For instance, skeletal muscle atrophy can occur when muscles are not used regularly, as seen in animals that reduce their activity levels to conserve energy. This atrophy is driven by molecular and cellular mechanisms that reduce protein synthesis and increase protein degradation in muscles (X. Chen et al., 2023; Fanzani et al., 2012)

From an evolutionary perspective, the concept of seeking comfort zones can be understood as an initial survival mechanism. Early humans likely benefited from conserving energy and avoiding unnecessary risks, enhancing their survival odds. However, in modern contexts, this behavior may have unintended negative consequences.

Research suggests that avoiding challenging situations can prevent the development of new skills and the ability to adapt to changes, ultimately diminishing mental agility and resilience. Over time, this can lead to reduced cognitive function and overall mental capacity (Fullerton et al., 2021; Greve, 2023; Mahdiani & Ungar, 2021).

From an anthropological perspective, early humans tried to alleviate the burden of thinking and decision-making by creating social games that helped them survive with minimal cost. This was achieved through collective cultures, kinship values, religious practices, and rituals. All these "games" enabled individuals to live within a hard community that aided in decision-making and framed knowledge through ready-made answers provided by faith and belief within a unified collective framework. While these cultures have the positive aspect of creating a comfort zone and certainty for individuals, they also confine them to a traditional, stagnant environment that neither develops nor progresses. This stagnation can be observed in primitive societies and the human struggle in transitioning from traditional societies to modernity and technology era.

For instance, Durkheim explores how religious beliefs and practices create social cohesion and provide guidelines for behavior (Durkheim, 1995). As Frazer suggested, these societies relied on shared rituals and myths to understand and control the world around them, making collective decisions based on these beliefs (Frazer, 1983). While Lucien Lévy-Bruhl believed that in "primitive" societies, collective decision-making was heavily influenced by communal beliefs and myths, which guided their understanding of the world and their actions (Levy-Bruhl, Lucien & Clare, 2018). Strauss sees in many societies, decisions are made collectively or guided by community elders or leaders. This communal approach can distribute responsibility and reduce individual stress. In some indigenous cultures, decision-making is a communal process, where elders or a council provide guidance based on collective wisdom and experience (Levi-Strauss, 1966). Weber examines how religious beliefs, particularly Protestantism, influenced social norms and economic behaviors (Weber & Kalberg, 2013). Geertz discusses the symbolic and cultural frameworks that influence human behavior and decision-making (Clifford Geertz, 2017). Bourdieu's work explores how social structures, including traditions and norms, shape individual behavior and practice (Bourdieu, 2020). Goody examines how social norms and traditions around marriage and family structure shape societal organization (Goody, 1976).

Critical Thinking and Decision-Making:

Artificial Intelligence (AI) is rapidly transforming multiple sectors by automating processes, optimizing decision-making, and providing data-driven insights. While AI's influence on enhancing critical thinking and decision-making is substantial, there is growing concern over the future consequences of an over-reliance on AI by the human mind. Recently, Deep learning machine programs are capable of adapting to unexpected situations. The emergence of self-driving cars might be the most timely example (Csikszentmihalyi, 2016), though the ‘autocorrect’ features on our smartphones also prove useful on a smaller scale. However, unlike human beings, AI is programmed to make decisions without affective and cognitive restraints. Some even argue that machines are better poised to maximize positive outcomes because they are bound to precise utilitarian algorithms. Recent surveys indicate that machine learning programs could replace up to 30% of work hours could be automated, with significant changes in sectors like manufacturing, retail, and food services by 2030 (Ellingrud et al., 2024). As AI systems become more advanced and integrated into the workforce, there is a need to reskill and adapt to the human workforce. This transition poses challenges as it requires ongoing education and adaptation to new technologies, which can be demanding and may lead to gaps in knowledge and skills if not managed effectively (Rawas, 2024).

AI has a wide range of transformational applications that affect practically every aspect of our life. In healthcare, AI is revolutionizing medical diagnostics, enabling personalized treatments, and assisting in complex surgical procedures (Beets et al., 2023; Voinea et al., 2024). AI healthcare market is growing at 41.7% annually (1). The transportation sector is witnessing the emergence of autonomous vehicles and intelligent traffic management systems, promising safer and more efficient mobility (Nwakanma et al., 2023). In finance and economics, AI is reshaping algorithmic trading, fraud detection, and economic forecasting, altering the dynamics of global markets (Chang et al., 2023). Moreover, AI is transforming education by offering personalized learning experiences and intelligent tutoring systems, fostering individual growth and enhancing educational outcomes (Gašević et al., 2023).

For instance, A recent survey revealed that nearly 89% of American college students use Chat GPT to complete homework tasks, with 53% using the tool for writing papers. Additionally, 48% of students use Chat GPT during exams and 22% use Chat GPT to generate paper outlines. However, it is worth noting that some students are not only able to successfully complete assignments using Chat GPT but also achieve high scores. Nevertheless, it is difficult for teachers to determine whether students are using Chat GPT (Yu, 2023), which has a negative impact on students' over-reliance on this tool, gradually causing them to lose their ability to think critically, explore, verify, and summarize actively. If this trend continues, it will greatly affect students' learning outcomes and development (Sharma et al., 2022; Zhu et al., 2023).

As consumers, we already rely on a wide range of automated programs to help organize our lives and custom tailor everyday experiences. These programs have become so commonplace that we deploy them almost effortlessly. Some are perhaps more obvious than others. For instance, Google Maps updates live traffic routes to get us promptly to our desired destination. Spotify, Pandora, and iTunes (among others) provide song and artist recommendations that align with our current tastes. The familiar voices of Apple's Siri and Amazon's Alexa are programmed to learn our most frequent

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requests, and in turn, quickly find resources to aid us in planning events and making informed decisions about the future. The list of intelligent programs that we use in our daily lives goes on and on: Online search engines estimate our preferred queries by filling in half-typed words, shopping bots guide us towards products they think we might want to purchase, automated customer service programs facilitate expedient returns and exchanges, video streaming platforms like Netflix suggest films that relate to our interests, and so forth (Csikszentmihalyi, 2016; Vaassen, 2022). The statistics say over 35% of global companies are using AI in areas like customer service and predictive analytics, while 70% of finance firms use AI for trading and fraud detection (Ellingrud et al., 2024; IBM, 2022).

AI has opened up new possibilities across diverse domains, including clinical care (Esteva et al., 2019), education (Božić & Poola, 2023), art and music and design. It has transformed interactions with the broader public, emerging as an influential instrument that effortlessly connects users in a multitude of settings. Unlike predictive AI, which leverages historical data to predict future events, AI could maintain a 'context window' informed by extensive datasets from its pre-training and incorporate human feedback to direct its algorithms. This allows for the synthesis of novel content across multiple modalities—including text, images, audio, programming code, simulations, and videos—that are contextually pertinent. In 2021, the Global GAI Market Size reached USD 7.9 Billion, and it is projected at a Compound Annual Growth Rate (CAGR) of 34.3% from 2022 to 2030, reaching a market size of USD 110.8 Billion by 2030 (Acumen Research and Consulting) (Gupta et al., 2024).

Existing research has identified several autonomy-related issues with AI systems, including ways in which different systems may undermine or constrain human autonomy. AI technologies are already used to dynamically personalize individual's choice environments, to paternalistically nudge, deceive, and even manipulate behavior in unprecedented manners. Increasing differences to algorithmic systems in various decision-making processes raises the question of whether user's choices can be regarded as authentic, and whether this tendency will impoverish our capacity for self-determination. Furthermore, one might ask, given that algorithmic decision- making practices are based on past and group-level data, can they truly be sensitive to a person's capacity to author their own life (Laitinen & Sahlgren, 2021).

Floridi and Cowls conceptualize the issue of autonomy as one where humans offload decision-making powers to AI, and they worry that "the growth in artificial autonomy may undermine the flourishing of human autonomy". On this analysis, if humans delegate a decision to an AI, then humans lose some autonomy and the AI gains some autonomy (Floridi & Cowls, 2022).

Thus, continuous reliance on AI for decision-making could erode critical thinking skills over time. Individuals might become less adept at assessing information, weighing alternatives, and making independent judgments. This erosion of critical thinking can make society vulnerable to misinformation or poorly designed AI systems. As AI takes over more cognitive tasks, individuals may lose their ability to maintain expertise in certain fields. If AI-driven decision-making becomes the norm, future generations may lack the knowledge and skills to make complex decisions without AI assistance.

Human-Robot Relationships

The nature of human interaction with robots and AI systems is another area of concern. While AI can enhance certain aspects of human life, such as providing companionship and performing mundane tasks, it might also lead to reduced human-to-human interactions and social skills (Krpan & Urbaník, 2024). The emotional and social connections typically fostered through human interactions might be diminished as people interact more with machines. Following the rapid development of robotics and AI, it is not difficult to find that robots are permeating into almost every corner of human life ranging from housework, healthcare (Ghosh et al., 2024), education and commence to sex (Sheng & Wang, 2022).

In this sense, it is quite understandable that people gradually breed emotions toward robots initially manufactured to serve them. More importantly, the continuously updated technology of AI makes it possible to produce more lifelike robots that master voice recognition, facial recognition, deep learning and other skills. It can be said that robots can give a certain companionship and comfort to people, especially to those who live with social anxiety disorder. By programmed algorithm, certain human-orientated emotions will likewise arise in robots. David Levy, the pioneer of AI, predicts a symbiotic relationship between humans and robots, believing that "robots will be hugely attractive to humans as companions because of their many talents, senses, and capabilities." He further elaborates, "They will have the capacity to fall in love with humans and to make themselves romantically attractive and sexually desirable to humans. Robots will transform human notions of love and sexuality (Levy, 2009. p. 22). Thus, the interactivity and receptivity of social robots can encourage humans to form social relationships with them. As social robots and AI that powers them becomes more advanced (Lutz et al., 2019). They will likely take on more social and work roles. This could include undertaking care work for children, the elderly and the sick, becoming our teachers and work colleagues and, eventually, our social companions (Darling, 2015).

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Breazeal (2003) defines social robots as the “class of robots that people anthropomorphize in order to interact with them”. The computers as Social Actors (CASA) paradigm suggests that humans tend to act as if computers and other forms of technology, such as social robots, are agents (or “social actors”) and not mere things. This leads humans to interact with technology by following the same social scripts, schemas, and rules, such as norms of politeness and reciprocity, that are used in human–human interactions (Formosa, 2021). This helps to explain the human tendency to anthropomorphize technology by attributing human qualities and characteristics, such as motivations, intentions, and emotions, to non-human entities and inanimate objects (Fossa, 2018).

Despite the positives offered by AI in general and social robots in particular, the increasing reliance by humans on them and the ease of providing services and obtaining information leads to negative results, as the literature has shown, including: (1) fewer valuable ends; (2) worse autonomy competencies; and (3) less authentic choices; (4) making human autonomy more vulnerable; and (5) disrespecting human autonomy (Formosa, 2021; Vrontis et al., 2023).

For example, offloading important decisions to social robots by users by relying on social robots to make the best choices for the user can not only directly limit users’ control over important aspects of their lives, but also lead to atrophy of their autonomy capacities when this offloading occurs repeatedly. Furthermore, users need to be educated about their bias towards relying uncritically on technology such as social robots (Goddard et al., 2012). Thus, despite social robots having the potential to help their users to be more independent and autonomous and improve their autonomy competencies, but also the potential to manipulate, deskill, illicitly surveil, and disrespect their users’ autonomy. Whether the impacts of social robots are positive or negative overall for human autonomy will depend on the design, regulation, and use that we make of social robots in the future. What is clear is that the potential impacts of social robots on human autonomy are profound and multifaceted (Formosa, 2021).

Discussion

AI is a process that simulates the human brain, meaning AI imitates human behavior and provides services based on human needs. Algorithms have been designed to perform these functions after being programmed with data that makes the machine intelligent in carrying out tasks (Bostrom, 2014). Although there is a difference between artificial and human intelligence—the former operates according to designed algorithms, while the latter does not—the human mind remains more creative than AI

(Salazar, 2024). However, AI performs tasks faster, saving more effort, reducing costs, and offering greater convenience for users, companies, and organizations alike.

The difference between AI and human intelligence in terms of processing speed is significant due to how each processes information. AI has a tremendous ability to process data at very high speeds, analyzing millions of points per second and performing complex calculations almost instantly, depending on device capabilities (LeCun et al., 2015; Mnih et al., 2015). In contrast, the human brain processes information more slowly due to biological limitations (Damasio, 2000); neurons communicate at much slower speeds than the electrical signals used in AI systems, with neural transmission speeds of about 200 meters per second (Kandel et al., 2000). This makes conscious thinking and solving complex problems slower for humans. Although AI is designed to handle multiple tasks simultaneously, humans have a limited ability to parallel-process and excel at processing information sequentially, especially in tasks requiring deep thinking and analysis. Additionally, AI can perform tasks it has been trained for quickly and efficiently once training is complete, although the training itself can be intensive and time-consuming. Human learning, on the other hand, requires time and experience to adapt and learn through trial and error, making it slower but more flexible. Humans have a unique ability to apply learning from diverse experiences in a more adaptable and effective way (Fuller, 2017).

Therefore, AI witnessed strong performance growth in the past few decades, transitioning from the phase of mimicking human intelligence to algorithmic dominance. Human imitation, such as learning, adapting, predicting, and interacting, has remained fundamental to AI. However, with the growth in data-intensive computing, newer techniques such as machine learning (deep neural networks) and learning everything directly from data emphasize predictive accuracy over human agency. Such developments emphasize measuring the success of a system by its superior predictive accuracy over others. For instance, many research studies state the supremacy of their method by outperforming others in contention, piling up on complexity, and focusing less on human influence, factors, or needs (Raees et al., 2024).

For example, the rapid advancement of generative AI technologies is significantly broadening the scope of automation across various occupations. This shift is expected to accelerate the pace at which jobs are automated, affecting a larger set of work activities than previously anticipated (Ellingrud et al., 2024. p. 58). For this reason, studies indicate that excessive reliance on AI without verification leads to a decline in human autonomy and cognitive abilities (Floridi & Cowls, 2022; Formosa, 2021; Keller & Drake, 2021; Sharma et al., 2022; Yu, 2023; Zhu et al., 2023).

AI and Undermining Critical Thinking

Habermas argues that technology, while offering numerous benefits, can also lead to what he calls “technocratic consciousness," where technical efficiency becomes the primary value, potentially overshadowing democratic processes and moral considerations. This perspective is elaborated in his theory of communicative action, where he distinguishes between "instrumental rationality" (focused on control and efficiency) and "communicative rationality" (focused on mutual understanding and consensus). The overemphasis on instrumental rationality, often driven by technological advancement, can undermine the capacity for critical public discourse and democratic decision-making (Kirkpatrick, 2002; Oraldi, 2023; Vaughan, 2016).

Therefore, Alain Deneault notices instrumental rationality by his book (The System of Banality). He examines how "banality" has become a systemic force in modern society, shaping institutions, workplaces, and everyday life. Deneault argues that contemporary systems—corporate, bureaucratic, and educational—promote mediocrity and discourage critical thinking, creativity, and individuality. In doing so, they create environments where conformity and compliance are prized, often at the expense of meaningful work and genuine human connection (Deneault, 2018).

The term "banality" here draws from philosopher Hannah Arendt's concept of the "banality of evil," which refers to how ordinary people can become complicit in harmful systems by following rules without questioning them (Arendt, 2006).

Although Deneault’s discussion does not focus specifically on technology and AI, his criticisms implicitly address how these tools are used within bureaucratic and corporate systems. Automation, productivity metrics, and task standardization enabled by technology and AI can discourage deep, reflective thinking. When technology is employed to support bureaucratic efficiency or corporate objectives, it often reinforces the very structures of "banality" that Deneault critiques. In essence, his argument can apply to how AI is used in these systems, as it frequently serves to enhance control, standardization, and efficiency—hallmarks of the "system of banality."

Currently, both governance and corporate operations are increasingly reinforced by AI. Users of this technology are not necessarily the most proficient in AI and often do not fully understand how algorithms work. They tend to follow AI-generated rules without questioning them, completing tasks in the ready-made formats provided by AI platforms and technologies. For example, Perry Keller and Archie Drake describe how the British government, in collaboration with private companies, has adopted a paternalistic approach using AI. This approach weakens principles of individual liberalism, as it limits people’s ability to make fully informed decisions. It also diminishes transparency, accountability, and opportunities for public participation,

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as individuals often lack a clear understanding of the AI systems that significantly influence their choices (Keller & Drake, 2021).

The figure below illustrates the percentage of people who demonstrate critical thinking toward AI and the ability to modify algorithms.

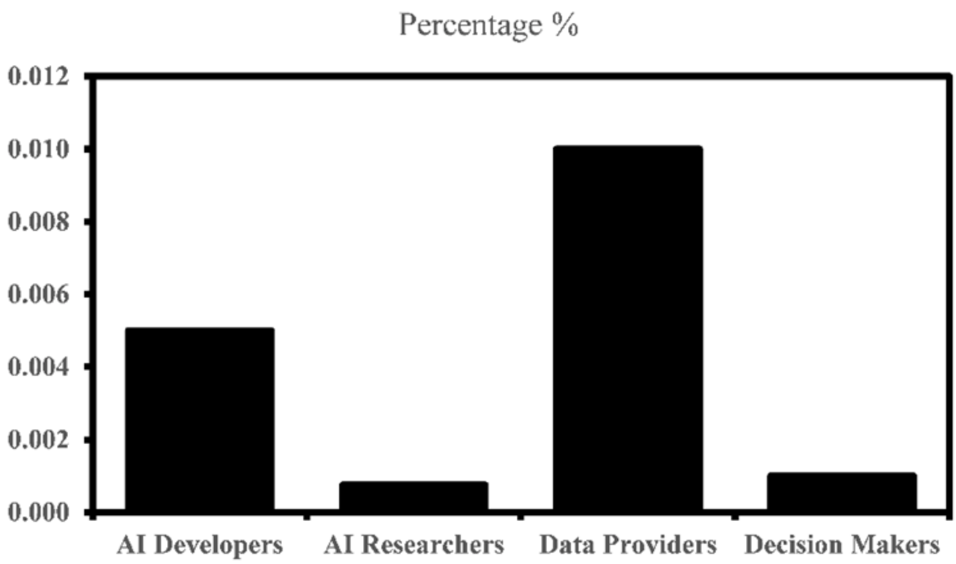

Figure 1: shows the percentage of people who influence AI algorithms.

This figure represents the percentage of different groups involved in the creation and implementation of AI, which can be linked to the discussion of the impact of AI on human intellectual and cognitive decline [2]:

1. Representation of Knowledge Gaps: The figure shows that AI Developers and AI Researchers represent a very small percentage of the global population (0.004% to 0.006% for developers and 0.0005% to 0.001% for researchers). This starkly contrasts with the much larger percentage of Data Providers (0.01%). This illustrates that only a very small fraction of the population has the deep knowledge needed to create or modify AI algorithms, supporting the argument that most people are consumers rather than active participants in AI creation.

2. AI Dependency and Comfort: The figure emphasizes that while AI developers have the power to shape or modify algorithms, the general population

2 - Element AI Founder Releases 2020 Global AI Talent Report: Element AI Founder Releases 2020 Global AI Talent Report. Date accessed 10/24/2024.

(represented indirectly by the data providers) relies on AI for convenience and decision-making. The much larger proportion of people contributing indirectly (like data providers) or passively (like the general public) shows a reliance on AI that supports the concept of ccomfort zone leads to biological atrophy or cognitive atrophy. People are becoming increasingly comfortable with letting AI make decisions for them, as they don’t possess the expertise to challenge or modify it.

If general artificial intelligence (GAI) is developed, it may no longer require human developers or researchers, as it would be capable of self-improvement. Nick Bostrom explains that superintelligent AI would be a highly advanced form AI, able to refine and enhance its own structure. In its early stages, superintelligent AI might still rely on trial and error, external information, or assistance from programmers to improve. However, as it advances, it would need to gain a deep understanding of its own mechanisms to independently engineer new algorithms and computational structures that boost its cognitive abilities. This required understanding could emerge if superintelligent AI reaches a sufficient level of general intelligence across multiple domains or crosses a threshold in a relevant area, such as computer science or mathematics (Bostrom, 2014. p.29). Consequently, if AI achieves this level, it could significantly replace human cognitive functions, potentially undermining key aspects of the human mind—such as critical thinking, creativity, and autonomous control.

AI as a Postmodern Result

As we live in a postmodern era, human brain activity appears to have declined compared to the modern era, where banality, cynicism, and a loss of trust in institutions now dominate social behavior and individual perceptions. The extensive use of AI and its increasing control over social and individual life further reinforces postmodernity. Relying on AI for complex cognitive tasks, such as decision-making and problem-solving, may lead to cognitive atrophy—a process similar to muscle atrophy due to inactivity as we explain (Sparrow et al., 2011). Individuals who depend on AI for activities like navigation, memory retention, or calculations may suffer from declines in spatial awareness, memory, and computational abilities. This aligns with postmodern skepticism towards objective truths, as dependence on personalized AI information that reinforces biases can hinder the development of critical thinking skills necessary to distinguish fact from opinion (Wegner & Ward, 2013).

Following Jean Baudrillard’s (2019) concept of hyperreality, AI-driven environments, such as virtual reality and social media, often overwhelm real-world experiences, creating a reality in which representations hold more influence than the real. Prolonged exposure to these hyperreal environments can impair social skills, emotional intelligence, and empathy, as the brain requires tangible experiences to maintain cognitive health (Ophir et al., 2009). Children raised in hyperreal environments may miss out on crucial sensory and cognitive development that traditional, real-world experiences provide (Rosen et al., 2014).

The fragmentation of attention also results from postmodernity's embrace of multiplicity and diversity, leading to a lifestyle saturated with constant digital stimulation. AI-driven algorithmic content delivery on platforms like social media has created a fragmented cognitive environment where sustained attention is rare. Studies suggest that constant exposure to fragmented information can impair the brain's ability to focus, engage in deep thinking, and process complex information (Carr, 2020; Rosen et al., 2014). Overstimulation from AI-curated content contributes to cognitive atrophy, as the brain becomes less able to engage in focused, meaningful work.

Moreover, AI's role in providing ready-made solutions reduces the need for humans to engage critically and independently with challenges, leading to what can be described as "capacity atrophy." This dependency on AI aligns with postmodernity's decentralization of authority but can also reduce cognitive flexibility as people feel less inclined to tackle complex problems on their own (Greenfield, 2009; Wegner & Ward, 2013).

In the postmodern age, fragmented identity is further supported by AI, as individuals adopt multiple people online. While this can be empowering, it may also lead to internal fragmentation of the self and ultimately affect memory retention. Research suggests that people who rely on digital devices for memory tasks are more likely to experience "digital amnesia," in which they retain less information independently (Acharya, 2015; Sparrow et al., 2011). With an increasing dependence on external digital aids, the brain may exhibit cognitive atrophy in memory function over time.

Furthermore, postmodernism's acceptance of multiple truths (Vattimo, 1988), combined with AI's algorithmic delivery of personalized information, could erode traditional critical thinking skills and limit our capacity to tolerate ambiguity. Traditional cognitive development includes building skills for analyzing information, synthesizing ideas, and handling ambiguity, but personalization tends to discourage deep thinking, which can lead to the atrophy of critical thinking abilities. The human brain, growing accustomed to simplified answers provided by algorithms, may become less adept at complex analysis. However, this perspective is not completely deterministic. The role of AI as a cognitive partner and not as a substitute could also lead to neuroplastic adaptations. Just as the vision loss in cavefish is compensated by enhanced sensory perception, humans could develop new cognitive abilities tailored to symbiosis with AI, such as the metacognition process (monitoring AI performance) or creative innovation. There are historical precedents: The invention of writing, once feared as a threat to memory, ultimately expanded human intellectual horizons (Yoshizawa et al., 2010). Socrates warned that writing would undermine memory by supplanting the oral tradition of storing knowledge (Jowett, 1873). This parallels modern fears about the impact of AI on cognition. For that reason, AI dependency can be classified into passive dependency and active collaboration. Passive dependence can be represented by an over-reliance on AI for tasks such as decision making or memory relief and carries the risk of cognitive atrophy. Similar to GPS reducing spatial navigation skills, the Google effect outsourcing mental work weakens neural pathways. Conversely, active collaboration recognizes that the success of writing lies in its role as a tool rather than a substitute for thinking. Similarly, AI can enhance human intellect if used symbiotically. Active collaboration based on human intervention can enhance metacognition and enabling creative innovation by analyzing the AI results, much like the printing press enhanced literacy and scientific research.

Conclusion

This study hypothesizes that the evolutionary concept of vestigiality, in which traits atrophy as their utility adaptively diminishes, provides a crucial framework for understanding the potential cognitive consequences of artificial intelligence (AI). This paper discusses the possibility that human cognitive abilities may gradually decline as AI systems are increasingly involved in problem solving, decision making and knowledge retention because they require less human mental effort. However, this perspective also raises important questions about the future of human intelligence — whether AI will serve as an aid or a crutch that weakens cognitive abilities. Further research is needed to examine the long-term effects of AI dependence on human cognition and explore potential strategies to mitigate mental decline. Ultimately, understanding this relationship will be crucial for shaping policies, such as educational systems and societal norms to ensure that technological advancement enhances, rather than hinders, human intellect.

References

Acharya, K. R. (2015). Book Review: Alone Together: Why We Expect More From Technology and Less From Each Other. *Journal of Business and Technical Communication*, *29*(4), 496–499. https://doi.org/10.1177/1050651915588086

Arendt, H. (2006). *Eichmann in Jerusalem: A report on the banality of evil*. Penguin.

Baudrillard, J. (2019). Simulacra and simulations (1981). In *crime and media* (pp. 69–85). Routledge.

Beets, B., Newman, T. P., Howell, E. L., Bao, L., & Yang, S. (2023). Surveying public perceptions of artificial intelligence in health care in the United States: systematic review. *Journal of Medical Internet Research*, *25*, e40337.

Berry, R. J. A. (1900). The true caecal apex, or the vermiform appendix: its minute and comparative anatomy. *Journal of Anatomy and Physiology*, *35*(Pt 1), 83.

Bock, W. J. (1959). Preadaptation and multiple evolutionary pathways. *Evolution*, 194–211.

Bostrom, N. (2014). Superintelligence Paths, Dangers, Strategies. In *Oxford University Press is* (Vol. 01).

Bourdieu, P. (2020). Outline of a Theory of Practice. In *The new social theory reader* (pp. 80–86). Routledge.

Boyer, D. M., & Harrington, A. R. (2018). Scaling of bony canals for encephalic vessels in euarchontans: Implications for the role of the vertebral artery and brain metabolism. *Journal of Human Evolution*, *114*, 85–101. https://doi.org/https://doi.org/10.1016/j.jhevol.2017.09.003

Božić, V., & Poola, I. (2023). Chat GPT and education. *Education*, *1*(4), 1–8. https://doi.org/10.13140/RG.2.2.18837.40168

Breazeal, C. (2003). Toward sociable robots. *Robotics and Autonomous Systems*, *42*(3–4), 167–175. https://doi.org/10.1016/S0921-8890(02)00373-1

Carr, N. (2020). *The shallows: What the Internet is doing to our brains*. WW Norton & Company.

Chang, L., Taghizadeh-Hesary, F., & Mohsin, M. (2023). Role of artificial intelligence on green economic development: Joint determinates of natural resources and green total factor productivity. *Resources Policy*, *82*, 103508.

Chen, C. C. W., & Welch Jr, K. C. (2014). Hummingbirds can fuel expensive hovering flight completely with either exogenous glucose or fructose. *Functional Ecology*, *28*(3), 589–600. https://doi.org/https://doi.org/10.1111/1365-2435.12202

Chen, X., Ji, Y., Liu, R., Zhu, X., Wang, K., Yang, X., Liu, B., Gao, Z., Huang, Y., Shen, Y., Liu, H., & Sun, H. (2023). Mitochondrial dysfunction: roles in skeletal muscle atrophy. *Journal of Translational Medicine*, *21*(1), 503. https://doi.org/10.1186/s12967-023-04369-z

Clifford Geertz. (2017). The Interpretation of Cultures. In *The Interpretation of Cultures: Selected Essays*. Macat Library. https://doi.org/10.4324/9781912128310

Corballis, M. C. (2007). The evolution of consciousness. In P. D. Zelazo, M. Moscovitch, & E. Thompson (Eds.), *The Cambridge Handbook of Consciousness*. Cambridge University Press. https://doi.org/DOI: 10.1017/CBO9780511816789.022

Csikszentmihalyi, D. T. G. and M. (2016). Discovery in an age of artificial intelligence. *Learned Publishing*, *29*(2), 75–76. https://doi.org/10.1002/leap.1024

Damasio, A. (2000). The feeling of what happens: body and emotion in the making of consciousness. In *Choice Reviews Online* (Vol. 37, Issue 11). https://doi.org/10.5860/CHOICE.37-6553

Darling, K. (2015). “Who’s Johnny?” Anthropomorphic Framing in Human-Robot Interaction, Integration, and Policy. *SSRN Electronic Journal*, *2*. https://doi.org/10.2139/ssrn.2588669

Darwin, C. (1859). *The Origin of Species by Means of Natural Selection: Or, The Preservation of Favoured Races in the Struggle for Life*. Odhams.

Dede, C. (2009). Immersive Interfaces for Engagement and Learning. *Science*, *323*(5910), 66–69. https://doi.org/10.1126/science.1167311

Deneault, A. (2018). *Mediocracy: the politics of the extreme centre*. Between the Lines.

Durkheim, E. (1995). *Elementary forms of the religious life*. Simon and Schuster.

Ellingrud, K., Sanghvi, S., Dandona, G. S., Madgavkar, A., Chui, M., White, O., & Paige, H. (2024). Generative AI and the Future of Work in America. *McKinsey Global Insitute*.

Esteva, A., Robicquet, A., Ramsundar, B., Kuleshov, V., DePristo, M., Chou, K., Cui, C., Corrado, G., Thrun, S., & Dean, J. (2019). A guide to deep learning in healthcare. *Nature Medicine*, *25*(1), 24–29. https://doi.org/10.1038/s41591-018-0316-z

Fanzani, A., Conraads, V. M., Penna, F., & Martinet, W. (2012). Molecular and cellular mechanisms of skeletal muscle atrophy: an update. *Journal of Cachexia, Sarcopenia and Muscle*, *3*(3), 163–179. https://doi.org/10.1007/s13539-012-0074-6

Feinberg, T. E., & Mallatt, J. (2016). *The ancient origins of consciousness: How the brain created experience*. MIT Press.

Floridi, L., & Cowls, J. (2022). A Unified Framework of Five Principles for AI in Society. In *Machine Learning and the City* (pp. 535–545). Wiley. https://doi.org/10.1002/9781119815075.ch45

Formosa, P. (2021). Robot Autonomy vs. Human Autonomy: Social Robots, Artificial Intelligence (AI), and the Nature of Autonomy. *Minds and Machines*, *31*(4), 595–616. https://doi.org/10.1007/s11023-021-09579-2

Fossa, F. (2018). Artificial moral agents: moral mentors or sensible tools? *Ethics and Information Technology*, *20*(2), 115–126. https://doi.org/10.1007/s10676-018-9451-y

Frazer, J. G. (1983). The Golden Bough. In *Macmilin Press London* (Vol. 53, Issue 9). Palgrave Macmillan UK. https://doi.org/10.1007/978-1-349-00635-9

Fuller, S. (2017). The Age of Em: Work, Love and Life When Robots Rule the Earth. *Journal of Posthuman Studies*, *1*(1), 104–100. https://doi.org/10.5325/jpoststud.1.1.0104

Fullerton, D. J., Zhang, L. M., & Kleitman, S. (2021). An integrative process model of resilience in an academic context: Resilience resources, coping strategies, and positive adaptation. *PLoS ONE*, *16*(2 February), 1–22. https://doi.org/10.1371/journal.pone.0246000

Gašević, D., Siemens, G., & Sadiq, S. (2023). Empowering learners for the age of artificial intelligence. *Computers and Education: Artificial Intelligence*, *4*, 100130. https://doi.org/10.1016/j.caeai.2023.100130

Ghosh, P., Liedo, B., & Riek, L. D. (2024). The Problem of Ableist Paternalism in Assistive Robotics. *HRI 2024 Workshop on Assistive Applications, Accessibility, and Disability Ethics (A3DE), 2024, Boulder, CO, USA*, *1*.

Ginsburg, S., & Jablonka, E. (2019). *The evolution of the sensitive soul: Learning and the origins of consciousness*. MIT Press.

Goddard, K., Roudsari, A., & Wyatt, J. C. (2012). Automation bias: a systematic review of frequency, effect mediators, and mitigators. *Journal of the American Medical Informatics Association*, *19*(1), 121–127. https://doi.org/10.1136/amiajnl-2011-000089

Goody, J. (1976). *Production and reproduction: a comparative study of the domestic domain* (Issue 17). Cambridge University Press.

Graham, J. B., & Dickson, K. A. (2004). Tuna comparative physiology. *Journal of Experimental Biology*, *207*(23), 4015–4024. https://doi.org/10.1242/jeb.01267

Greenfield, P. M. (2009). Technology and informal education: What is taught, what is learned. *Science*, *323*(5910), 69–71.

Greve, W. (2023). Adaptation across the Lifespan: Towards a Processual Evolutionary Explanation of Human Development. *Integrative Psychological and Behavioral Science*, *57*(4), 1119–1139. https://doi.org/10.1007/s12124-023-09767-y

Guppy, M., Hulbert, W. C., & Hochachka, P. W. (1979). Metabolic Sources of Heat and Power in Tuna Muscles: II. Enzyme and Metabolite Profiles. *Journal of Experimental Biology*, *82*(1), 303–320. https://doi.org/10.1242/jeb.82.1.303

Gupta, P., Ding, B., Guan, C., & Ding, D. (2024). Generative AI: A systematic review using topic modelling techniques. *Data and Information Management*, *8*(2), 100066. https://doi.org/10.1016/j.dim.2024.100066

Hebb, D. O. (2005). *The organization of behavior: A neuropsychological theory*. Psychology press.

IBM. (2022). *IBM Global AI Adoption Index 2022: New research commissioned by IBM in partnership with Morning Consult*. https://www.multivu.com/players/English/9002053-ibm-global-ai-adoption-index-2022/

Ingersoll, R., & Lentink, D. (2018). How the hummingbird wingbeat is tuned for efficient hovering. *Journal of Experimental Biology*, *221*(20), jeb178228. https://doi.org/10.1242/jeb.178228

Johnson, N. A., Lahti, D. C., & Blumstein, D. T. (2012). Combating the Assumption of Evolutionary Progress: Lessons from the Decay and Loss of Traits. *Evolution: Education and Outreach*, *5*(1), 128–138. https://doi.org/10.1007/s12052-011-0381-y

Jowett, B. (1873). *The dialogues of Plato* (Vol. 4). Scribner, Armstrong.

Kandel, E. R., Schwartz, J. H., Jessell, T. M., Siegelbaum, S., Hudspeth, A. J., & Mack, S. (2000). *Principles of neural science* (Vol. 4). McGraw-hill New York.

Keller, P., & Drake, A. (2021). Exclusivity and paternalism in the public governance of explainable AI. *Computer Law & Security Review*, *40*(xxxx), 105490. https://doi.org/10.1016/j.clsr.2020.105490

Kirkpatrick, G. (2002). Progress and Technology in Habermas's Theory of Social Evolution. In P. Blackledge & G. Kirkpatrick (Eds.), *Historical Materialism and Social Evolution* (pp. 163–189). Palgrave Macmillan UK. https://doi.org/10.1057/9781403919977_7

Krpan, D., & Urbaník, M. (2024). From libertarian paternalism to liberalism: behavioural science and policy in an age of new technology. *Behavioural Public Policy*, *8*(2), 300–326. https://doi.org/10.1017/bpp.2021.40

Laitinen, A., & Sahlgren, O. (2021). AI Systems and Respect for Human Autonomy. *Frontiers in Artificial Intelligence*, *4*(October), 1–14. https://doi.org/10.3389/frai.2021.705164

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature*, *521*(7553), 436–444. https://doi.org/10.1038/nature14539

Levi-Strauss, C. (1966). THE SAVAGE MIND. In *Made and printed in Great Britain by The Garden City Press Limited Letchworth, Hertfordshire*. http://link.springer.com/10.1007/BF01248674

Levy-Bruhl, Lucien & Clare, L. A. (2018). *Revival: Primitive Mentality (1923)*. Routledge. https://doi.org/10.4324/9781315122458

Levy, D. (2009). *Love and sex with robots: The evolution of human-robot relationships*. New York.

Lewis, D. (1994). *We, the navigators: The ancient art of landfinding in the Pacific*. University of Hawaii Press.

Lutz, C., Schöttler, M., & Hoffmann, C. P. (2019). The privacy implications of social robots: Scoping review and expert interviews. *Mobile Media & Communication*, *7*(3), 412–434. https://doi.org/10.1177/2050157919843961

Macalister, A. (1871). XLIV.— On some points in the Myology of the Chimpanzee and others of the Primates. *Annals and Magazine of Natural History*, *7*(41), 341–351. https://doi.org/10.1080/00222937108696389

Mahdiani, H., & Ungar, M. (2021). The Dark Side of Resilience. *Adversity and Resilience Science*, *2*(3), 147–155. https://doi.org/10.1007/s42844-021-00031-z

McGuire, L. P., Johnson, E. M., Frick, W. F., & Boyles, J. G. (2021). Temperature alone is insufficient to understand hibernation energetics. *Journal of Experimental Biology*, *224*(14), jeb239772. https://doi.org/10.1242/jeb.239772

Mnih, V., Kavukcuoglu, K., Silver, D., Rusu, A. A., Veness, J., Bellemare, M. G., Graves, A., Riedmiller, M., Fidjeland, A. K., Ostrovski, G., Petersen, S., Beattie, C., Sadik, A., Antonoglou, I., King, H., Kumaran, D., Wierstra, D., Legg, S., & Hassabis, D. (2015). Human-level control through deep reinforcement learning. *Nature*, *518*(7540), 529–533. https://doi.org/10.1038/nature14236

Müller, G. B. (2002). Vestigial organs and structures. In *Encyclopedia of Evolution.* (pp. 1131–1133). Oxford University Press.

Nwakanma, C. I., Ahakonye, L. A. C., Njoku, J. N., Odirichukwu, J. C., Okolie, S. A., Uzondu, C., Ndubuisi Nweke, C. C., & Kim, D.-S. (2023). Explainable Artificial Intelligence (XAI) for Intrusion Detection and Mitigation in Intelligent Connected Vehicles: A Review. *Applied Sciences*, *13*(3), 1252.

https://doi.org/10.3390/app13031252

Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences*, *106*(37), 15583–15587. https://doi.org/10.1073/pnas.0903620106

Oraldi, A. (2023). Technology and Society in Habermas' Early Social Theory: Towards a Critical Theory of Technology beyond Instrumentalism. *Krisis | Journal for Contemporary Philosophy*, *43*(1), 66–84. https://doi.org/10.21827/krisis.43.1.37753

Raees, M., Meijerink, I., Lykourentzou, I., Khan, V.-J., & Papangelis, K. (2024). From explainable to interactive AI: A literature review on current trends in human-AI interaction. *International Journal of Human-Computer Studies*, *189*(December 2023), 103301. https://doi.org/10.1016/j.ijhcs.2024.103301

Raichle, M. E., & Gusnard, D. A. (2002). Appraising the brain's energy budget. *Proceedings of the National Academy of Sciences of the United States of America*, *99*(16), 10237–10239. https://doi.org/10.1073/pnas.172399499

Randal Bollinger, R., Barbas, A. S., Bush, E. L., Lin, S. S., & Parker, W. (2007). Biofilms in the large bowel suggest an apparent function of the human vermiform appendix. *Journal of Theoretical Biology*, *249*(4), 826–831. https://doi.org/10.1016/j.jtbi.2007.08.032

Rawas, S. (2024). AI: the future of humanity. *Discover Artificial Intelligence*, *4*(1), 25. https://doi.org/10.1007/s44163-024-00118-3

Robbins, C. T., Lopez-Alfaro, C., Rode, K. D., Tøien, Ø., & Nelson, O. L. (2012). Hibernation and seasonal fasting in bears: the energetic costs and consequences for polar bears. *Journal of Mammalogy*, *93*(6), 1493–1503. https://doi.org/10.1644/11-MAMM-A-406.1

Rosen, L. D., Lim, A. F., Felt, J., Carrier, L. M., Cheever, N. A., Lara-Ruiz, J. M., Mendoza, J. S., & Rokkum, J. (2014). Media and technology use predicts ill-being among children, preteens and teenagers independent of the negative health impacts of exercise and eating habits. *Computers in Human Behavior*, *35*, 364–375. https://doi.org/10.1016/j.chb.2014.01.036

Salazar, C. (2024). On the qualitative nature of conscious states: Insights from a structuralist theory of mind and meaning. *Anthropology of Consciousness*, *35*(1), 96–110. https://doi.org/10.1111/anoc.12221

Sharma, -Sudhansh, Sharma, S., & Yadav, R. (2022). Chat GPT-A Technological Remedy or Challenge for Education System. *Global Journal of Enterprise Information System*, *14*(4), 46–51. https://doi.org/10.18311/gjeis/2022

Sheng, A., & Wang, F. (2022). Falling in love with machine: emotive potentials between human and robots in science fiction and reality. *Neohelicon*, *49*(2), 563–577. https://doi.org/10.1007/s11059-022-00664-8

Smith, H. F., Parker, W., Kotzé, S. H., & Laurin, M. (2013). Multiple independent appearances of the cecal appendix in mammalian evolution and an investigation of related ecological and anatomical factors. *Comptes Rendus Palevol*, *12*(6), 339–354. https://doi.org/10.1016/j.crpv.2012.12.001

Sparrow, B., Liu, J., & Wegner, D. M. (2011). Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips. *Science*, *333*(6043), 776–778. https://doi.org/10.1126/science.1207745

Suzuki, D. G. (2022). The Anthropic Principle for the Evolutionary Biology of Consciousness: Beyond Anthropocentrism and Anthropomorphism. *Biosemiotics*, *15*(1), 171–186. https://doi.org/10.1007/s12304-022-09474-y

Vaassen, B. (2022). AI, Opacity, and Personal Autonomy. *Philosophy and Technology*, *35*(4), 1–20. https://doi.org/10.1007/s13347-022-00577-5

Vattimo, G. (1988). *The end of modernity: Nihilism and hermeneutics in post-modern culture*. Cambridge, UK: Polity Press in association with B. Blackwell.

Vaughan, G. M. (2016). Jurgen Habermas, The Lure of Technocracy. *Society*, *53*(5), 559–561. https://doi.org/10.1007/s12115-016-0065-x

Voinea, C., Wangmo, T., & Vică, C. (2024). Paternalistic AI: the case of aged care. *Humanities and Social Sciences Communications*, *11*(1), 1–9. https://doi.org/10.1057/s41599-024-03282-0

Vrontis, D., Christofi, M., Pereira, V., Tarba, S., Makrides, A., & Trichina, E. (2023). Artificial intelligence, robotics, advanced technologies and human resource management: a systematic review. *Artificial Intelligence and International HRM*, 172–201.

Weber, M., & Kalberg, S. (2013). *The Protestant ethic and the spirit of capitalism*. Routledge.

Wegner, D. M., & Ward, A. F. (2013). The internet has become the external hard drive for our memories. *Scientific American*, *309*(6), 58–61.

Yoshizawa, M., Gorički, Š., Soares, D., & Jeffery, W. R. (2010). Evolution of a Behavioral Shift Mediated by Superficial Neuromasts Helps Cavefish Find Food in Darkness. *Current Biology*, *20*(18), 1631–1636. https://doi.org/10.1016/j.cub.2010.07.017

Yu, H. (2023). Reflection on whether Chat GPT should be banned by academia from the perspective of education and teaching. *Frontiers in Psychology*, *14*.

https://doi.org/10.3389/fpsyg.2023.1181712

Zhu, J.-J., Jiang, J., Yang, M., & Ren, Z. J. (2023). ChatGPT and Environmental Research. *Environmental Science & Technology*, *57*(46), 17667–17670. https://doi.org/10.1021/acs.est.3c01818