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Extended Minds and Instrumentality: On the Role of the Nonhuman in Human Cognition

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Keywords

extended cognition, instrumentality, nonhuman, cognitive development, bodily-sensory perception, signal processing

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_Abstract

This contribution offers a literary approach to extended cognition and asks in which capacity interactions with the nonhuman come to shape cognitive development. Specifically, this question is posed in regards to our active use of nonhuman instruments that are recognized as a reflection of social practices that mediate our engagement with the world. In this sense, the fictional journal entries of this *_Perspective* track the development of novel cognitive structures on the basis of a recently introduced communication device. The narration provides a genealogy of a communal shift in thought and in conclusion advances speculations on the mediating role of instruments. In continuation, the narrative segment is followed by a scholarly reflection which decidedly rejects the idea of cognition as limited to the confines of the head. Through elaborating the hybrid alliances between ourselves and the nonhuman, this second segment mobilizes concerns of the extended mind hypothesis in the context of artificial intelligence. This succinct reflection hence applies questions regarding the mediating role of instruments to the domain of artificial intelligence and asks how computational architectures which actively adapt to our behavioral patterns modify the way in which the instrument relation ought to be critically assessed.

The Mobilization of Matter

Date 05/02/0021; Origin Time 00:42:00; Location E (321.551|223.009); Depth < 0.1km; Magnitude 2ML; Locality: Sector 5;

There were 10 events of earthquakes recorded by the PGS seismic monitoring network during the early days of the second period, with nine having magnitudes of 1.75 ML and one having a magnitude of 2 ML. Only the event on the fifth day of the second period was reported felt; accumulating a total of five felt earthquakes at said location.

The event of the fifth day was recorded by the local network of seismic sensors (LSN) and occurred during the period from 00:42 until 00:56 hours.

I was still drowsy from a dizzying mix of sleep and caffeine induced heartbeats. Slowly, I stepped into the room where my two colleagues had already taken their seats. I reached for a chair, sat down and placed my steaming cup of coffee on the table beside me, exchanging it for the notebook and pen. The seismographs in our

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middle gave off nothing but a continuous noise, metal needles scraping over a rolling drum of paper. The three devices were similar in type but three different material composites in the needles produced three distinct tones. Together they filled a spectrum of indecipherable noise akin to an untuned radio. A rustling that in its continuity receded into the background of attention. The monotonous noise denoted nothing other than the actively listening sensors and the silence on the other end.

The room itself was empty. Four blank walls, no windows. Only ourselves on chairs, enclosing the instruments in a triangular formation. Behind me was a single black painted door, the only opening of this space. This one was one of many containers hauled out to Sector 5. Outside, gusts of wind were breaking on the corners of our observation rooms and gave off a series of forlorn cries. The rush of air that brushed over this flat and desolate land was disrupted only by the white containers posing as observation rooms. One behind another, they were lined up in rows as if beats on a string. By following the natural shape of the shore line, the white containers formed a network of ravines through which air hustled itself at high speeds.

From the moment of my arrival, I encountered this place contemptuously. The silence here presented a stark contrast to the environments I was used to. Through the upgrades to our body machinery, I had become, like most others, fully accustomed to communication through ground vibrations. This practice had in particular established itself as the vehicle to transport gossip and rumors, thereby enabling the wildfire-like spread of any news one deemed interesting enough. The habit of transmitting information over distances by setting off vibrations through metal plates on the undersides of feet, was common in both the densely populated metropolis as well as surrounding areas. Naturally, the city's communications were multitudinous, whereas the scarcely populated lands around were rather quiet in comparison. Having been an inhabitant of the city for the entirety of my life, I could pick out the newcomers from the country, regardless of the size of the crowd they were in. It was common to go through an initial phase of confusion when first confronted with the dense array of information transfer in the city. The packed spectrum of communications afforded a high level of attention so as to attune oneself to a narrow frequency and to shield off all other chatter momentarily irrelevant. People unfamiliar with such ubiquitous communications could not help, but openly display their baffled faces. Hundreds of

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voices relentlessly crashing down upon them. Likewise, the inhabitants of the city experienced the reverse, a feeling similar to agoraphobia, when they would find themselves in the solitude of the country. The springs underneath their feet, used to shaking at rapid rates, stood still and only occasionally picked up a communication. Lacking the stimulation they were so attuned to, these individuals would consequently begin to hallucinate. Their cognitive assemblies would attempt to fill the void that the city's high level of stimulation left behind. I was frightened such a destiny would also befall me, now that I found myself in such a desolate region. One could be certain not to encounter many out here; only the few dozen people already stationed on site would present potential interlocutors. In many regards then, the stream of vibrations, or lack thereof, one was used to, played a significant role in the mental wellbeing of an individual. It was important for the springs in our feet to vibrate at a continuous rate, however fast or slow. The finely tuned levers and nodes of our cognitive assemblies reacted sensitively to all too rapid phase changes of the communication devices.

The reason for the commotion on this otherwise uninhabited site was the repeated sensing of seismic activities, first recorded by some AI operated observation stations. To start with, the readings were regarded as malfunctioning equipment, seeing as the waveforms displayed a strangely regular composition and periodically reappeared over time. The magnitude of the phenomenon was consistently measured at 1.75 ML, the severity of a minor earthquake. After the old seismographs had been exchanged for updated ones, the previous readings persisted in unchanged continuity. To be sure that also the new results were not a mistake, a small observation container was set up along with personnel. Again, the readings were confirmed, and finally any malfunctioning in the equipment or the software it was operating on, was entirely ruled out. The little container housing personnel and seismographs was the first of many, as around it slowly grew a small settlement of rectangular boxes.

Currently, there was no great concern about the event being an early messenger of a dawning quake, none of the attributes of this phenomenon were consistent with research into early recognition of major seismic activity. Nevertheless, there was an incentive to observe and remain aware of the phenomenon. Ever since the introduction of mechanical upgrades such as Lyken I, severe ground movement had taken on a new kind of threat. Not having thought of the full range of consequences,

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equipping a large part of the population with vibratory communication devices was done with the complete ignorance of the potential impacts environmental processes might present. Since this technology entailed a full integration into the cognitive apparatus, severe vibrations from earthquakes were detrimental to the fine arrangements in our mechanical bodies. A geological event was violent compared to minute vibrations the sensors were built to receive. The public's interest in the periodically appearing vibrations was a reflection of the still vivid memories of past traumas. Hence, there was also a political incentive to at least simulate research activity on the seismic phenomenon, however fruitful the ongoing process truly was.

Perhaps fortunately, there was only limited communication between the observation site and the metropolis since the distance between them was too far for the common use of vibrations to converse. There was little interest on the part of officials, to communicate more than necessary and risking exposing their own helplessness in the matter.

> **Date 06/02/0021; Origin Time 02:13:30; Location E (321.551|223.009); Depth < 0.1 km; Magnitude 1.75ML; Locality: Sector 5;**
>
> *The seismic activity continues unchanged at a maximum magnitude of 1.75 ML. The gap between the starting points of active phases remains consistently at 25:31:05 hours. Across available recordings the patterns of seismic activity remain unchanged.*
>
> *Records are only distinguishable through timestamps, to the naked eye the waveforms are isomorphic.*

Upon my arrival, I saw, with some relief, that the little observation posts had each been placed upon a magnetic levitation field, shielding people inside by allowing to steady the container independently of the ground below. Having been chartered via air transportation, I was granted a clear view over the entire assembly. From above I could make out dozens of white boxes, stretching in three rows from east to west, all identical in size. At the north westerly end of the grouping stood a larger, more permanent structure, also white in color but with a clearly decayed exterior hull. Organized in rings that each served as separate floors, the three-level design enclosed an open space in its middle, cradling a park-like arrangement. This center space,

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operating as a recreational area, was the only spot under open skies shielded from the relentless gusts. Once per day swarms of people would trickle out of the architecture and disappear in groups of three into the observation rooms.

To prevent people on site from feeling deprived of communications, the floors of this main unit had been modified to excellently transport vibrations, so as to encourage an ceaseless flow of chatter. Most of us indeed struggled with the desolate setting and out of necessity established a highly active network of exchange, simulating the presence of a familiar environment. The talk filling the station was of course open to anyone equipped with the appropriate mechanical upgrades. It was therefore not before long that I had got myself up to date. During these first hours inside the base, I learned of the common theories that had become the lens through which everyone now attempted to read the seismic activity.

The first people stationed on site were all trained geologists. This core group, which had endured the inhospitable environment the longest, quickly established among themselves that the phenomenon they were observing did not align with the structure of natural seismic events. What perplexed them the most was the epicenter of the vibrations, the point at which the recorded activity was picked up at its highest magnitude. This point appeared to be not below the surface but to hover exactly above the ground. A miniscule spot figured as the origin of the vibrations whose magnitude decayed in a circular shape extending outwards from the epicenter. Akin to the shockwaves of an invisible hammer hitting a metal sphere or a stone disrupting the perfectly flat surface of a body of water, the intensity of vibrations fell off with an increase in distance, approaching a magnitude of 0 ML roughly 200 kilometers from the observation site. Coupled with the periodical pattern of the phenomenon, this constellation formed the breeding ground for a wide range of hypotheses. To broach the issue from a number of perspectives, the core group of geologists univocally agreed to request a range of experts to be stationed on site with them. Among these novel specialists was I, an information theorist and developer of the Lyken I communication devices. Given the unprecedented circumstances, none of us had been assigned a clear set of tasks. Our given purpose was to propose solid theories explaining the origin of the vibrations. The idea was to choose the most promising of these speculations so as to direct a further plan of action.

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I believe that across disciplines there was an unvoiced tendency to interpret the seismic activity as an extraterrestrial signal. This leaning might have had its historical roots in the introduction of the vibratory communication devices.

The seamless integration of the mechanical upgrades and the intuitive use meant for many an innate comfort with ground vibrations as communication. Beyond mere utility, this new means of conversing entailed a sense of familiarity toward the different tones and frequencies through which others sent their messages. We could sense an agitated mood or a tired mumbling - the design of vibratory communication managed to emulate these attributes of spoken language. Since all of the scientists on site also used such devices daily, viewing the seismic readings inside the containers was akin to reading the transcript of a voice, present but muted. It was as if we could read a correspondence, but, unable to pick up vital characteristics of tones or emphasis of the voice itself, some of us felt as if we struggled to decipher its intent.

This groundwork of information gathering happened rapidly and I completed an initial overview within the first hours after my arrival. By the time I took my seat for the fifth time in the little observation laboratory, I had already made my own judgments of the phenomenon. Getting more familiar with the routine of seismic activity, I was now sitting in my seat as patiently as my colleagues, awaiting increased movement of the seismograph's needle:

Every day, reliably 91.5 minutes later than the day before, the monotony of static ink needles dragging over paper stopped and quickly became overshadowed by four decisive strokes, stretching almost to the edges of the paper drum. The amplitude of the first phase showed exactly the same height as the three succeeding ones, with a constant phase length across all of them. The clearly stated bounds of this initial announcement resembled the authoritative tone of an auditive marker denoting the beginning of a speech. As if to underline this interpretation, the needles again fell silent for a short period after these initial strokes, generating the impression that everyone was given the chance to settle in. A belief had established itself, according to which the crux of the message was buried in the rapid phase changes that broke the pause. Once the movement picked up again it continued in a slower but steady stream for thirteen minutes. At rapid rates the seismographs' needles paced across the paper, following a strange syntax alien to our known world.

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Date 07/02/0021; Origin Time 03:45:00; Location E (321.551|223.009); Depth ~ Surface; Magnitude 2ML; Locality: Sector 5;

The observed seismic activity continues steadily at a magnitude of 1.75 ML. The waveform of the phenomenon produced by the seismographs is consistent across observation posts. It is also consistent across readings from the past twelve days.

One casualty was reported. Individual wandered out on site, unprotected, was exposed to seismic activity. Individual was seen heading away from headquarters - suspected damage to cognitive architecture and resulting disorientation.

Today, being off-duty, I was looking out the windows of my sleeping quarters, and a sight so peculiar caught my eyes that I wish to give an account of it here.

The vista over which I was contemplating showed a portion of the observation rooms and the green grassland, up until the point where a sharply drawn line marks the edge at which the land drops off toward the sea. Beyond that line I could only make out the gray textures of the ocean. Letting my gaze travel along the zigzagging cliffs, I began to notice the scientists moving between the observation rooms. It seemed they were walking toward my position, back to the housing unit. But one of them caught my eye. This person would neither go to the headquarters nor head back to one of the observation rooms, but instead stood perfectly still. I loosened my gaze and let it travel across the view once again. Shortly afterwards, the spot on which they had just stood was cleared. Gazing across the landscape I managed to spot them once again, this time heading straight towards the northern horizon. It appeared eerie to me that anyone would aim for a location away from the safety of the station. There was nothing in that direction, only the vast interior of the continent. Still, nobody seemed to attempt to disturb this person or hold them up, and they continued on their way.

Later, with everyone returning to the main unit, I could gather that this had been the second case of such kind. Against elaborate safety measures, one person had wandered out onto the open land to feel the vibrations through their own sensors. Plagued by insomnia, brought on by the never changing communication amongst this limited population, they had longed for the vibrations as a novel voice. Disregarding

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the severity of the event, they had exposed themselves to the phenomenon. What they must have felt was unimaginable to the rest of us; their cognitive assembly suffered damage hopeless of repair. The resulting consequences were most likely multiple malfunctioning parts out of which came the disorientation.

> **Date 10/02/0021; Origin Time 08:19:30; Location E (321.551|223.009); Depth ~ Surface; Magnitude 2ML; Locality: Sector 5;**
>
> *The observed seismic activity continues steadily at a magnitude of 2 ML. The waveform of the phenomenon produced by the seismographs is consistent across observation posts. It is also consistent across readings from the past fifteen days.*

In many respects, the problem at hand developed into a contemplation of origin theories as a process of determining the source behind the vibrations. In explicitly assuming an intelligent sender on the other end of the message, many sensed themselves ever so close to a grand discovery. The makeup of this entity, which represented a cosmic variable to us, was believed to deliver the key for deciphering the message itself. I had decided to follow, in a similar vein, a line of questioning that attempted to determine the grounds on which we could make a decisive claim on the origin of the vibrations. My intention was to rework the question on whether the source of the signal was living or nonliving, before jumping to further conclusions.

Since the first day of experiencing the live seismic reading, I had busied myself with the study of the waveforms of the fourteen-minute recordings. Initially I began by tactically eliminating origin theories that I thought could plausibly be ruled out. This included terrestrial seismic events, for, the vibrations reappeared at precisely the same interval, and ‘sounded’ for the same duration everyday. Additionally, the structural attributes of the waveform itself were unfitting to support a hypothesis of terrestrial origin, as the frequency spectrum was too narrowly confined. These set parameters placed the readings much closer to the design of the mechanical devices for vibratory communication. Many of these initial assumptions I imported from the valuable groundwork performed by the initial group of geologists.

I found myself traveling back in my thoughts to the work we performed to construct the first mechanical upgrade allowing vibratory communication via medium

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range distances. The company that employed us gave clear conceptual guidelines of setting up integrated versions of a mechanism able to broadcast vibrations, as well as one tuned to the reception of said communications. Thereby the engineering of the devices themselves was accomplished with much less difficulty than the design of the syntax that would allow for the transmission of information. Via a process of encoding, we had to come up with ways of modulating one or more characteristics of the signal. The trials we initially ended up with utilized different tactics of manipulating either amplitude, frequency, phase, or a combination of these characteristics. The prints of the seismic readings I held in my hands now shared a distinct set of parallels with the design choices we had contemplated when constructing the first prototypes. It was not so much the fact that this new reading would in any way be decipherable by the rules of syntactic encoding known to us, but I sensed behind its distinct arrangement an artificial and perhaps intelligent intent. That a communication through vibrations distinguished itself from the mere rumbling of geological activity was intuitively known by anyone who regularly sensed incoming and outgoing signals. To transport a message one would make use of a fixed set of techniques. The predominant aim of the methods for encoding information was to achieve an entropy level as low as possible. The distinct readings of phase changes was what primarily distinguished vibratory communication from the rattling noise of natural phenomena. This constituted the central consideration in designing the syntax and software for the prototypes of Lyken I.

A radio that is left poorly tuned, receiving no signal from a broadcasting station, spits out only waves of undulated noise. Broadcasting in total equilibrium amongst all frequencies, the total lack of syntactic structure expels the non-existence of information. Since our task was to achieve the opposite, we set out to draw a clear distinction between pure noise and the communications from Lyken I.

In returning to the observations of the seismic activity, I considered a method for the measure of entropy to be a guiding principle in deciding whether or not the source of the vibrations could be said to be living.

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Date 21/02/0021; Origin Time 01:05:30; Location E (321.551|223.009); Depth ~ Surface; Magnitude 2ML; Locality: Sector 5;

The observed seismic activity continues unchanged at a magnitude of 2 ML. The waveform readings produced by the PGS monitoring system remained constant since the start of the observation period.

To spare resources a quarter of the observation posts will be taken down over the coming days.

The evolution of speech marked a point at which a medium, in this case air, could be manipulated according to a set of commonly shared techniques. We pronounce and enunciate, compress and shift air, send waveforms through the medium, so that on the other end someone with the ability to hear will listen. We can make ourselves heard and hear others. Our apparatus is not limited to sending, but based on reciprocity we can receive information too. A lengthy evolutionary process enabled this first manipulation of a medium for the transmission of information. In a mutually dependent dialectic of language and the mechanisms enabling it, we are left with a highly specialized composition of parts and executable functions. Our bodies are designed to pronounce language; language is arranged within the constraints of our organs.

I can find some irony in the fact that the tenuous evolution of speech was now overshadowed by the sudden leap of communication instantiated by the introduction of Lyken I. The painstaking process of grasping ways to manipulate a medium and to simultaneously develop a system expressive within the constraint of said matter was essentially recapitulated in vibratory communication technology.

The discovery of solid matter, the ground which we use to take for an immutable given, for unused potential for communication, did more than simply open the gateways to ubiquitous chatter. Introducing new techniques for communication was less significant as a change of language itself, since people continued to speak and read in an ordinary manner. Rather, many developed an additional awareness towards the activities of their surroundings. The finely tuned springs underneath our body suits do not filter between messages sent between people and other interferences. Consequently, there erupted a sensibility towards subsurface activities. Standing in a

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meadow one could sense the mole pushing soil underneath. The echo of hollow tunnels hidden from sight produces a vivid image of subterranean layers. Expanding the spectrum of media available to communication unveiled an entirely novel manner of spatial engagement to us.

But since this newly developed sensitivity towards movement within the ground rendered even minor geological activity a critical threat, hundreds of seismic observation stations sprang up in a short period of time. The profession of geologists became widely regarded as a protector of contemporary civilization and much energy was invested into research on early detection of quakes. Not being able to sense the mole crawling through its tunnels underground was now tantamount to songs of birds rendered inaudible by the noise of the city.

I believe that this discovery of solid matter as a communication medium does not constitute an end point, yet I want to hypothesize that the expansion of communication media displays a developmental trajectory. Simultaneously to our adding of conversing techniques, the conceptual horizons with which we understand and grasp expanded. The sense of touch that now grants access to what lies below initiates a mental image that speaks to the connectivity of the world above and below. The composite ocean of stone that our celestial body consists of is no longer a hidden mystery but now a sensible phenomenon. I do not want to deny the social downsides of a constant, and involuntary, exposure to information, yet I find it even more difficult to overlook the intellectual enhancement additional senses have provided us with.

I can only imagine, beyond our current conceptual boundaries, beyond our line of sight, in a different world, a civilization that has skillfully mastered the art of conversing across an entire range of media. Matter in its smallest components, yet to be discovered by our comparatively primitive society, is modulated and manipulated so that it rhythmically carries across space the intent of the sender. A civilization that has mastered the translation of communications across media would possess the means to let go of a celestial body. Roaming the emptiness of cosmos they might populate a range of worlds, readily sending and receiving communications amongst each other. Decidedly more advanced in basic research than ourselves, such a civilization would understand the means with which to enrich a spectrum of media with information. What is to us the expanse of space or dead matter, to them is a

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sponge with a capacity near infinity, able to uphold communications across light years as they travel through time. From joyful chatter to encrypted intelligence, a never-ending stream of information fills the silence of the void, but only for those with the ability to listen.

Ourselves, too low on the evolutionary ladder to understand the gaps between words had by chance fallen into the lines of communication between two worlds. Either populated by one and the same civilization or two distinct people, the conversation had been rudely brought to a halt by our celestial body becoming an involuntary deflection surface for their signal. Not understanding the basic etiquette of interstellar communication, we had not only interrupted a conversation, but mistakenly interpreted ourselves as the legitimate addressees.

It is in this vein, dear sender, that I retain this record of our engagement with your message. If your manner of communication follows similar principles to our own and you never received an answer, perhaps you will begin to investigate. In many eons' time, too long a time span for our civilization to conceive of, you will stumble upon our rock and find in it the reason for why your communication never reached its intended end. Recognizing our world as a resourceful environment, maybe you will travel towards us and touch upon the surface of this world after a voyage through space. Long gone will I be by then, a time that is so far away that I think of it not as a future but a kind of fiction. This record shall remain, so that it speaks to you of an ancient civilization and deliver a cosmic artifact to hold as a memento of your own history too.

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1_Introduction

To set the scene the narrative begins by retracing a crucial development in the recent history of the story's civilization. Large parts of the population have subjected themselves to upgrades of their mechanical makeup. The purposive alteration of bodily compositions has advanced an enhancement of their sensory repertoire, providing an additional mode of engagement with their surroundings. Unfolding the narrative around this artificial addition to the base state of individuals delivers a vivid example of extended cognition and sets the point of departure for the theoretical reflection on the storyline in the present segment of my contribution.

In continuation of the image set forth in the narrative, I would like to expand upon the intricacies entailed in our use of instruments external to the human body. It is in this sense that this second part of my contribution aims to elucidate the theoretical ideas which underlie the narrative structure of the journal entries. In particular, I will address the notion of the nonhuman[1] from the perspective of human cognition and determine how the active use of external instruments is central to our navigation of environments. The conceptual outset from which I address the role of the nonhuman in human cognition is framed by theories of the extended mind.[2] More specifically, I make use of Andy Clark's conception of humans as natural born Cyborgs[3] and explore how tools external to the body temporarily become active elements in human cognition. This angle focuses on the nonhuman as an instrument and aid to human cognition and on how something outside the physical confines of the head can become causally linked to a mental process.

In the latter part of the text, I want to utilize the initial framework of the narrative and its grounding ideas to ask what a critical account of extended cognition in the age of intelligent machines might look like. This succinct reflection will schematically sketch a critique of machine intelligence that is fundamentally grounded on a reciprocity of the human and the nonhuman. What this suggests is that human intelligence is not analogous to a(n) (en)closed circle, but that "human cognition [is] interdependent with embodied, nonhuman technologies."[4] As shall be demonstrated, the use of technologies and instruments represents a characteristic trait of human intelligence. Holding on to the postulation whereby "the human has always coevolved, coexisted, or collaborated with the nonhuman,"[5] I will argue that an

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exploration of this reciprocity is integral to understanding the embedded condition of human cognition. I conclude by stating that a model of distributed cognition heeding the reciprocity between the human and nonhuman offers a ground on which to elaborate a critical theory of artificial intelligence based on a notion of interactionism. Finally, I will provide a brief reference to one example that illustrates the interactivity of human cognition and nonhuman tools in practice.

2_The Role of Instruments in Human Cognition

The upgrades to the body armature under the label 'Lyken I' are initially intended as mere communication devices, and it is by virtue of chance that this instrument exceeds its inscribed applications. In one of the journal entries, the narrator notes: "The finely tuned springs underneath our body suits do not filter between messages sent between people and other interferences. Consequently, there erupted a sensibility towards subsurface activities." (p. 10) The introduction of an expanded sensory repertoire hence generates the means to record environmental stimuli inaccessible before. This in turn entails a successive construction of cognitive models by which the story's population comes to newly comprehend their world, as well as their individual positions within environments. The technology of Lyken I is readily incorporated in the existing cognitive organization of individuals, resulting in an expansion of the mind's capacities. Individuals who become deprived of their ability to sense vibrations or who lack exposure to a habitual level of vibratory communication, display a trauma as if a part of them had been violently removed.

The ease with which these non-native upgrades are flexibly incorporated into existing assemblages could intuitively be ascribed to the mechanical composition of the narrative's population. But an innate ability to cooperate with and utilize technologies outside the confines of the skull presents a crucial process in human cognition too. Andy Clark notes in *Natural-Born Cyborgs* that humans indeed exhibit a "natural proclivity for tool-based extension, and profound and repeated self-transformation."[6] In fact, Clark identifies the ability to use tools as a possible explanation for "how we humans can be so very special while at the same time being not so very different, biologically speaking, from the other animals with whom we share both the planet and most of our genes."[7] Attempting to understand the human mind from the angle of external interactions fundamentally changes the way we can

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approach our own cognition and its embedded condition. The viewpoint Clark advances shifts a focal point toward the mind as a distributed system and places particular emphasis on a notion of interactionism. The question posed on the workings of the mind thereby does not solely concern an internalization of knowledge but regards a process of organization that is decidedly dependent upon an intricate cooperation with nonhuman instruments and technologies. Such technologies range from tools for handwriting all the way to modern communication and multimedia devices like our trusted smartphones. Clark sets forth the example of "kanny,"[8] a term used by the Finnish youth of the early 2000s to describe cellphones as a "prosthetic limb over which you wield full and flexible control."[9] The cellphone in particular, even in its early stages of popularization, yields an externalization of memory. A friend's number is now stored in a device that is readily at hand. To remember the phone number itself becomes superfluous, and what instead turns relevant is to memorize the way in which such information can be accessed at any given time. Granted, a particular phone number is only a very rudimentary example, as of course contemporary devices present/provide an incomparably larger network of information that can be called up and accessed at any moment.

3_Neural Plasticity

The aptitude of the human mind to interact with a range of nonhuman tools and technologies goes as far as incorporating signals and sense impressions inaccessible to the repertoire of sensory devices we are born with. Early on in *Natural-Born Cyborgs*, Clark points out that "neural plasticity [...] may well prove great enough to allow our brains to learn to make use of [...] new kinds of sensory signals."[10] This statement is followed (up) by the example of the performance artist Stelarc, who has attached to his body a mechanical arm that is fully integrated into his nervous system. The mechanical prosthesis can thereby be intuitively controlled by the artist, despite it being an artificial enhancement to the body's natural form. Beyond the spectacular images delivered by the artist's performance, the productive import of this example lies in how the neural plasticity of the human mind delivers a highly flexible and generalizable cognitive architecture. It is at this point that the innate interactionism of the human mind converges upon the points set forth in the narrative. The manner in which the communication device Lyken I has been both individually and collectively

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incorporated parallels the intuitive use of the third arm in Stelarc's performance piece. As is recorded by the narration, the introduction of Lyken I not only demonstrated integration of new limbs, but also highlighted the active construction of mental models in an attempt to accommodate the novel sensory input:

> Standing in a meadow one could sense the mole pushing soil underneath. The echo of hollow tunnels hidden from sight, produces a vivid image of subterranean layers. Expanding the spectrum of media available to communication opened an entirely novel manner of spatial engagement to us. (10–11)

The flexibility expressed by the neural architecture of the human mind therefore presents a crucial entry point to place particular emphasis on change, reorientation, and transformation in the development of human cognition. Alterations to our own constitution are enabled and influenced by a continuous interaction with the nonhuman. The lens rendering an image of the human mind as confined to the limits of the skull follows "an ancient western prejudice," namely "the tendency to think of the mind as so deeply special as to be distinct from the rest of the natural order."[11] In contrast to this view, we have seen that it is in fact the diversities of interactions with the nonhuman that enable the status of the human mind we tend to experience as a special trait of our existence.

The notion of a mind with minimal genetic programming, whose structure is largely determined by exterior relations, is also advanced by Catherine Malabou. In *Morphing Intelligence*, Malabou investigates the consequences that findings of the so-called *epigenetic turn* have brought to the field of neurophysiology. In particular, studies such as the Human Genome Project have repeatedly demonstrated that "everything was not written in DNA sequences, even at the molecular and cellular level.[12] The development of the individual is thereby not already engraved in its age-old pool of genomes, but is determined instead by notions of reciprocity and interaction. Malabou quotes Henri Atlan, who proposes a model of the mind grounded in such findings:

> The idea that the totality, or essential aspects of the development and functioning of living organisms, as determined by a genetic program is gradually being replaced by a more complex model, one based on notions of interaction, reciprocal effects between the genetic, whose central role is not negated, and the epigenetic, whose importance we are gradually discovering.[13]

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If there is anything akin to a blueprint encoded in our genetic information, then it is a phylogenetic optimization for an organism with the innate ability for ontogenetic learning. An understanding of the development of the human form ought therefore to be approached via its diverse interactions. By extension, placing our focus on external relations could further acknowledge the procedural dynamics by which environments are formed. Systems and organisms overlap and come to coextensively precondition each other in a continual cycle of feedback. Instead of staging a neutral ground on which autopoietic organisms come to occasionally touch upon each other, environments must be accounted for as states that emerge from a multitude of interactions.

It is in this sense that we return to the construction of adaptive mental models, in order to mobilize the concept within the context of the nonhuman as instruments. The narrator advances a relevant speculation according to which the expanse of the cosmos is filled with information and speech but that only instruments advanced enough enable the conceptualization of this dense network:

> I can only imagine, beyond our current conceptual boundaries, beyond our line of sight, in a different world, a civilization that has skillfully mastered the art of conversing across an entire range of media. [...] What is to us the expanse of space or dead matter, is to them a sponge with a capacity near infinity, able to uphold communications across light years as they travel through time. From joyful chatter to encrypted intelligence, a never-ending stream of information fills the silence of the void, but only for those with the ability to listen. (11)

Specifically, the point that is raised here refers to the two-sided interaction between mental models and instruments. How does the adaptation of a novel instrument alter the interfaces by which worlds are engaged, and in turn, how does the mutation of mental models bring about the construction of new instruments?

The narrative does not provide any closure on the genesis of cognition against the backdrop of this interactionism, but instead focuses on the grounding framework that establishes the basic relationship between the human and the nonhuman. In the following segment, I would like to mobilize this framework of interaction in the context of artificial intelligence. In particular, I want to pose the question of how the active externalism of the mind is to be understood *vis a vis* a nonhuman intelligence that operates largely autonomously.

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4_Designing Interfaces for Human-Nonhuman Interaction

The recognition of environmental interaction and a realization of the integral role of the nonhuman in our own cognition necessitates the formulation of not only models of the nonhuman, but also of modes for designing interfaces allowing for interaction. As our neural architectures are affected by our relations with the nonhuman, it becomes necessary to direct our gaze towards the manner in which we choose to organize the gateways channeling this interaction. Specifically, I want to advance the above mentioned point that a critical theory of artificial intelligence and the modes of governmentality gives rise to ought to be approached via the nexus of human and nonhuman in cognition. To outline the structural framework against which our interaction with artificial intelligence can be grasped, it is helpful to turn to the AI researcher Ben Goertzel. Within the model that Goertzel provides, the infrastructural scale on which AI operates is emphasized. The ubiquitous presence of AI systems in the organization of digitized infrastructures is afforded via an embedding of such systems into a wider networked structure. Here, individual nodes do not remain in isolation but are purposefully geared towards active correspondence and the exchange of information, ultimately rendering themselves constituents of a larger organizational structure. This distributed network is elaborated in detail by Goertzel in *World Wide Brain*[14]:

> But eventually, I propose, most if not all humans will be drawn into the Web mind itself, and the Web mind will become a kind of collective human/digital entity. In this second phase, Moravec's vision[15] will become fulfilled, but with two twists: we will be incorporating ourselves into an “alien” intelligence of our own creation; and we will be partially synthesizing ourselves with other humans, rather than merely downloading our individual human selves into a digital world.[16]

The interaction between ourselves and the synthetic intelligence outlined in this sketch would be based upon particular interfaces that both enable and simultaneously regulate the possible manner of interaction. In returning to the above noted relationship between the use of instruments and the development of cognition, I would like to advance this question again in the current framework. Facing a system that operates autonomously on an infrastructural level warrants a re-evaluation of the question regarding our relationship with the instrument. How must our critical assessment of instrumentality and human cognition adapt, as we are pushed into the

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domain of a computational apparatus that automatizes reasoning chains and decision making?

It is well beyond the scope of this framework to provide a fleshed out account of a critical theory regarding the implementations of artificial intelligence and our channels of interactions with it. Instead, I would like to conclude by suggesting a ground on which such a task can be pursued by drawing on the writing of Luciana Parisi.

5_Instrumentality and the Challenges of Artificial Intelligence

The technologies of artificial intelligence with which Goertzel is concerned differ from the instrumentality of pen and paper or early phones in as far as they have the capacity to automate certain deductive and inductive reasoning chains. Machine learning networks facilitate a form of decision making based on a given set of input data all while being removed from human interference. The spectrum of automated operations enacted by such systems is thereby not limited to preselected pathways determined by (pre-)given facts. Parisi provides an account of the functioning of algorithmic computation that recognizes the production of novel outputs not directly engraved in datasets:

> A critical theory of automation should instead start with an effort to overturn the autopoietic dyad of instrumental reasoning, where machines either execute a priori reasoning or reduce the rule of reason (law and truth) to brute force and reactive responses.[17]

Hence, an assessment of automation should not be subjected to a reductive account that supposes the realm of potential operations to be confined by *a priori* defined decision trees. In other words, the networks that support the operations of computational agents are capable of producing a general statement on the basis of a set of concrete particulars. Parisi specifically identifies a capacity to incorporate and work with indeterminacy and unknowns in data as driving factors behind the algorithmic building of novel hypotheses.[18]

The computations of intelligent machines are enabled by the architectures of neural networks[19] that process information at "imperceptive or affective speeds," rendering this form of nonhuman intelligence "not immediately accessible to human cognition."[20] The distributed implementation of these technologies challenges a strict linearity of thought from cause to effect and instead presents a granular input

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structure of data. Rather than data passing through a central processing system with an observable relation between input and output, information is dealt with in parallel. This advances:

> an emergentist view of nonconscious cognition that challenges the centrality of human sapience in favor of a coevolutionary cognitive infrastructure, where algorithms do not passively adapt to data retrieved but instead establish new patterns of meaning by aggregating, matching, and selecting data.[21]

The manner in which intelligent machines process information and successively generate output is crucial for determining the precise nature of the interactive relation between ourselves and this form of nonhuman cognition. To close the feedback loop one has to set forth an account of how human-emitted data supplies the activities of algorithmic computation. In turn, it is the output patterns of machines that intend to capitalize on tendencies entailed in input data and thereby come to influence the trajectory of this feedback relation. In this sense the machine "does not follow its own internal, binary logic of either/or, but follows instead whatever logic we leave enclosed within our random selections."[22] The operations based on dispositions or leanings that are extracted from data constitute an echo chamber re-emphasizing sets of beliefs. Parisi specifically addresses the practice of microtargeting groups:

> Here, the microtargeting of populations involves not only the reproduction of biases in and through data aggregates, but the algorithmic elaboration of any possible data to become racialized, gendered, and classified as a potential enemy under certain circumstances.[23]

It is hence an analysis of input data that allows the extraction of biases and the presentation of such dispositions to the groups holding those beliefs in the first place, thereby completing a vicious circle. The feedback loop between the human and nonhuman is instantiated by an exchange of information in which the outputs of either side come to precondition the behavior of the other. In this context, the aim set for a critical account of intelligent machines is to devise strategies for intervention from within. If the interfaces by which we engage such forms of nonhuman cognition represent extensions of our own cognition, we can ask: how can a conscious modification of interactive channels destabilize a vicious feedback circle? In other words, the question presented here regards both an understanding of the human as an agent in a feedback system and the constructive intent placed in the computational architectures with which we come to interact. The proverbial echo chamber and the practice of microtargeting are not accidental practices, but purposefully built

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instruments of algorithmic governmentality. A critical account of machine intelligence must therefore heed the political and economic choices engraved in these networks from the vantage point of human-machine interaction.

6_Conclusion

What this framework has attempted to demonstrate is the intricate relation between ourselves and the nonhuman via an investigation of our own cognition. The nonhuman as an instrument comes to play a constitutive role in the development of our minds' operative capacities. The narrative has underlined a practice by which instruments can affect our modes of engaging with environments and highlighted the relations central to the organization of human cognition. By extension, this has provided a lens through which to approach the organization of infrastructure and surroundings, in particular the channels by which we interact with nonhuman agents in the digital realm.

One example among many, which explicitly highlight an interactive relationship between human users and a nonhuman interlocutor can be found in the design of intelligent housing. Projects such as the Evolving Sonic Environment by Haque and Davis constitute an attempt to shape architectural form that actively studies its user's behavior and adapts according to habitual patterns.[24] The relation that is thereby instantiated not only influences the executions of the code overseeing the housing infrastructure, but also has an impact on the way in which inhabitants engage with their environment. The instruments which enable a manipulation of variables around the building may, according to the extended mind hypothesis, pose a relevant resource for the inhabitant's cognition that she temporarily relies upon.

Ultimately, we do not find ourselves at the same impasse as the narrator of the diary entries. The nonhuman intelligence we are to critically assess does not hide behind a mythical layer of an otherworldly tongue, cryptically encoded in a series of vibrations. While the computational models described by Goertzel and Parisi do represent a processing of information different to our human cognition, we may find in them an entry point to assessing machine intelligence from the perspective of the human mind. As our own cognition is dependent and enhanced by external relations, it is sensible to approach a model of the mind via the nexus of human-nonhuman

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interactions. The outlook we thereby arrive at is a view of the human mind constitutively embedded in its immediate environment.

_Endnotes

1 For a description of the term 'nonhuman' I side with Richard Grusin's introductory words to *The Nonhuman Turn*, namely that the nonhuman figures as an umbrella term "understood variously in terms of animals, affectivity, bodies, organic and geophysical systems, materiality, or technologies." A term that defines in itself a broad spectrum of phenomena, yet under the common concern of decentering a false supremacy of the human over the 'nonhuman.' Here, I (care to) elaborate how human cognition is decidedly dependent on and enabled by connections with nonhuman (external) phenomena. For further reference, see Richard Grusin, "Introduction," VII, in *The Nonhuman Turn*, ed. Richard Grusin (Minnesota: University of Minnesota Press, 2015), vii–xxx, <http://www.jstor.org/stable/10.5749/j.ctt13x1mj0>.

2 My understanding of human cognition and the extended mind rests on the framework introduced by Chalmers and Clark which discusses cognition in a problem-solving capacity and in how external tools are specifically utilized as tools in this process. For specific examples of the problem-solving approach to cognition and the extended mind refer to Andy Clark and David Chalmers, "The Extended Mind," *Analysis* 58, no. 1 (1998): 7–19. Doi: 10.1093/analys/58.1.7.

3 Andy Clark, *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence* (Oxford: Oxford University Press, 2003).

4 Grusin, *The Nonhuman Turn*, X.

5 Grusin, *The Nonhuman Turn*, IX.

6 Clark, *Natural-Born Cyborgs,* 10.

7 Clark, *Natural-Born Cyborgs,* 10.

8 Clark, *Natural-Born Cyborgs,* 9.

9 Clark, *Natural-Born Cyborgs,* 9.

10 Clark, *Natural-Born Cyborgs,* 20.

11 Clark, *Natural-Born Cyborgs,* 26.

12 Catherine Malabou, *Morphing Intelligence: From IQ Measurement to Artificial Brains*, trans. Carolyn Shread (NYC: Columbia University Press, 2019), 60.

13 Malabou, *Morphing Intelligence*, 60.

14 Ben Goertzel, "World Wide Brain: Self-Organizing Internet Intelligence as the Actualization of the Collective Unconscious," in *Psychology and the Internet: Intrapersonal, Interpersonal, and Transpersonal Implications*, ed. Jayne Gackenbach (Cambridge, MA: Academic Press, 2007), 309–335.

15 Here Goertzel's reference establishes a connection to the scientist and robotics engineer Hans Moravec. Moravec put forward a futuristic speculation according to which humans would be downloading the content of their brains to a digital repository and thereby live a bodiless existence in a digital realm. We shall here be less concerned with the controversial and highly contestable claim of Moravec, but focus on the structural description of a web of interconnected agents that Goertzel provides.

16 Ben Goertzel, "World Wide Brain," 310.

[17] Luciana Parisi, "Reprogramming Decisionism," *e-Flux journal* 85 (2017): 1–12, here: 8, <https://www.e-flux.com/journal/85/155472/reprogramming-decisionism/>.

[18] Parisi, "Reprogramming Decisionism," 4.

[19] Connectionist models like NNs do not represent the sole model for artificial intelligence. Yet NNs form the basis for frequently deployed deep learning strategies that are central to the computational agents investigated by Parisi.

[20] Parisi, "Reprogramming Decisionism," 7.

[21] Parisi, "Reprogramming Decisionism," 7.

[22] Parisi, "Reprogramming Decisionism," 1.

[23] Parisi, "Reprogramming Decisionism," 9.

[24] For reference to the project by Haque and Davis, and a framing of the project within the extended mind hypothesis, see Michael Wheeler, "Thinking Beyond the Brain: Educating and Building from the Standpoint of Extended Cognition," in *Alleys of your Mind: Augmented Intelligence and Its Traumas*, ed. Matteo Pasquinelli (Lüneburg: Meson Press, 2015), 85–104. Doi: 10.25969/mediarep/1312.