Theoretical Analysis of the Brain and Artificial Intelligence

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Abstract – Many articles have expounded on and defended the potential advantages of co-robotics (cobots), robotics, AI, and quantum computers in the domains of research and development, clinics, community health and virology. Numerous trailblazers in the domains of artificial intelligence, robotics, and quantum computing have been recognised for their groundbreaking concepts and principles. Among these luminaries are Richard Feynman, Kurt Godel, John Nash, Norbert Wiener, Alan Turing, John von Neumann, Vannevar Bush, and John McCarthy. Theorems formulated by Kurt Godel were misinterpreted by researchers who erroneously equated computer and brain paradigms. Godel himself had recognised this misinterpretation. The individual's commendation of the brain's supremacy over computational systems was met with disapprobation. This article delineates the diverse array of artificial intelligence techniques, frameworks, and programming languages that are developed by humans and can be employed in tandem with contemporary computational systems. These advancements facilitate advancements in the realm of electrons and quantum mechanics. The process of evolution has resulted in the development of neurons in various animal species, which rely on the flow of electrons to carry out their biological functions. The identification of mirror neurons represented a significant shift in the paradigm of neuroscience. The proposed paradigm shift towards the 'hall of mirror neurons' represents a potentially effective approach to studying, warranting further investigation. The aforementioned concepts are instrumental in advancing the field of artificial intelligence and in furthering research on the intricacies of the human brain.

Keywords – Mirror Neuron System, Mild Cognitive Impairment, Inferior Parietal Lobule, Hall of Mirror Neurons.

I. INTRODUCTION

Neural networks, machine learning, and deep learning are among the techniques subsumed under the rubric of artificial intelligence. The learning algorithms in question may comprise a multitude of layers, potentially numbering in the hundreds. Several designs incorporate a layered structure consisting of an input, a secret, and an output, as indicated in [1]. Instances of artificial intelligence in operation can be observed in a diverse range of computer applications and structural blueprints. Significantly, with regards to artificial intelligence and the potential emergence of consciousness, specific computer systems have the ability to acquire the skill of playing computer games. Currently, there is ongoing development of a unified theory of cognition that relies on sub-symbolic computing. Semlincs, an architectural tool for cognitive control, was introduced by Schrodt, Kneissler, Ehrenfeld, and Butz [2]. This agent acquires novel assemblies by utilizing the regulations acquired from its uninterrupted sensorimotor encounters.

The primary characteristic of this tool is its ability to acquire knowledge on how to engage with its surrounding environment, thereby enabling it to generate and manage micro-environments within said ecology. This is accomplished through individual initiative, adaptability, concentration, and internal drive. The present cognitive and symbolic architecture represents a novel and enhanced version, distinct from its predecessors. Semlincs is utilized in the creation of the character of Mario, who is resulting from a derivative version of the widely recognized kid's videos game "Super Mario Brothers" [3]. This serves as an illustration of the program's capacity to self-regulate and gather data across diverse contexts. The evolution of production rules is a result of sensory experiences over time. Therefore, it functions as an exemplar of a noteworthy agent that has contributed to the progression of artificial intelligence and the trajectory of cognitive computational theory and application.

The field of artificial intelligence (AI) frequently draws support from the discipline of neuroscience as a whole, with a particular emphasis on the examination and emulation of brain function. The relationship between advancements in artificial intelligence and the exploration of the human brain is reciprocal, as progress in AI serves as a catalyst for novel avenues of investigation into the intricacies of the brain. The investigation of mirror neurons within the primate brain has garnered significant attention and represents a significant advancement in the field of neuroscience over the past few decades. A search conducted by Schmidt, Sojer, Hass, Kirsch, and Mier [4] using the keywords "mirror neuron system" yielded a total of 1,139 results, with records dating back to 1967. On the other hand, a search using the keywords "cortical mirror motor neurons" returned 365 results, with records dating back to 1987 [5]. Additionally, it is plausible that antecedent papers in diverse contexts preceding the specific application of the term "mirror neurons" may have been overlooked in said inquiries.

The brain comprises diverse regions that contain mirror neurons, which exert an impact on, regulate, and imitate specific sensorimotor activities through various interconnections. Mirror neurons are present in various regions of the brain, such as the ventral intraparietal and inferior lateral parts of the parietal lobe, primary motor cortices, the ventral premotor cortex's rostral division, and the dorsal premotor areas. The mirror neurons are stimulated whenever an individual, including primates, executes a motor action or witness another individual performing a task that they themselves are capable of performing. It has been observed that the activation of mirror neuron clusters can be elicited by both visual and auditory stimuli. Mirror neurons are believed to have different functions when compared to the cybernetic feedback control neurons initially proposed by Svard [6]. Mirror neurons are involved in various cognitive processes such as the formation, retrieval, acquisition, and rehearsal of actions, whether they are self-initiated, observed, or heard, while other types of neurons are responsible for feedback regulation. It is a justifiable proposition to posit that comparable mirror neurons are implicated in the recollection of deliberate motor actions.

The relevance of the postnatal and adult evolution of neurons lies in their association with multiple mirror neuron foci. Stem cells have the potential to undergo differentiation and develop into neurons. The process of differentiation occurs within the local environment and encompasses the potential for stem cells to migrate to different regions of the brain and differentiate in response to diverse signaling stimuli. Furthermore, the collection of DNA expression information during fetal growth and in later stages of life is imperative for the appropriate differentiation of mirror neurons, as indicated by Wiley et al. [7]. The hippocampus' dentate gyrus, the lateral ventricles' subventricular zone, and the olfactory bulb are widely recognized sites for adult stem cells in both rodents and humans. Certain groups of nascent neurons have the capacity to migrate from their original location to another prior to undergoing differentiation, concurrently extending their axons during the process. Upon concluding their migration routes, these cells will exhibit enhanced capacity to differentiate into the specific types of neurons that are essential for the brain, specifically, mirror neurons.

Upon completion of their differentiation processes, mirror neurons may undergo migration to distant locations from their initial groupings of motor neurons, while preserving their long-range, distinctive communication connections via their axonal projections. The existence of shadow neurons has been proposed as a plausible constituent of mirror neuron activity. These neurons are believed to exhibit topological properties akin to manifolds, which may overlap or coexist in close proximity with neighboring neurons, resembling tangential sheets or encompassing neuron clouds. Different mirror neurons categorizations exist, such as ensembles, satellites, clusters, swarms, and colonies. In addition, it is possible that specific mirror neurons exhibit direct coupling, where a single motor neuron is linked to a single mirror neuron. This result in an isomorphic association between each mirror neuron and the neuron it reflects, as well as any other sensory-based neural circuits which could function. In the event that the latter proposition holds true, it is plausible that mirror neurons may execute their neurobiological functions autonomously and with greater levels of precision and accuracy than had been previously posited. The extent of the interaction between motor and mirror neurons remains a topic of ongoing investigation within the realm of brain function research.

This article provides an extensive discussion of the brain and artificial intelligence. The rest of the article has been arranged as follows: Section II provides a theoretical understanding of mirror neuron system. Section III focuses on a discussion of mirror neurons and the brain disease. Section IV reviews the mirror systems and the prodromal AD. Section V provides a discussion of the paradigm shift of the hall of mirror neurons. Lastly, Section VI provides final remarks to the article.

II. MIRROR NEURON SYSTEM: THEORETICAL UNDERPINNINGS

The Alternate Hypothesis

The theory posits that the primate predecessors of contemporary Homo sapiens predominantly utilized nonverbal signals as their principal mode of communication. Subsequently, over time, auditory signals became associated with physical movements and became the primary means of conveying information. The mirror mechanism played a significant role in addressing two critical communication challenges, namely parity and direct comprehension, during a pivotal phase of human language evolution. The presence of mirror neurons may enable the receiver of a communication to precisely mirror the affective state of the communicator. The utilization of arbitrary symbols was deemed superfluous. Due to the similar wiring of the brains of the two individuals, comprehension occurred effortlessly.

The mirror mechanism alone is insufficient to explain the complexity inherent in speech. The inquiry into the process by which the presuppositions of a message's originator are internalized by the recipient is a fundamental issue in the field of language acquisition, and the present theory provides a resolution to this quandary. Recent academic discourse has introduced novel theories and hypotheses regarding the sequence of occurrences that initiated with the monkey mirror system and culminated in the development of human language.

Studies utilizing functional magnetic resonance imaging in humans have purportedly identified regions that bear resemblance to the mirror neuron framework found in monkeys [8]. These regions are situated closer to Broca's end and in the inferior frontal cortex. This region is considered to be one of the potential language centers of the brain. The aforementioned occurrence has incited conjecture regarding the impetus behind the evolution of human language, which posits that it was necessitated by the requirement for a mechanism to perform and interpret gestures through mirror neurons. Certain scholars posit that the phenomenon of "mirror neurons" could potentially account for our aptitude to acquire knowledge and emulate the behaviors of others. Considering the hierarchical implementation of the recursive structure in human languages, it appears that the mirror neuron framework is intrinsically unsuitable for participating in syntax, as the system is compressed into linear phoneme arrangements.

Theory of Cross-Modal Abstraction

It is possible that the capacity for humans to establish reliable associations between various senses was passed down from their primate ancestors. However, this ability underwent a process of enhancement through the reconfiguration of mirror neurons. Subsequently, these neurons were repurposed for other forms of abstraction, in which humans have demonstrated proficiency, such as the formulation of metaphors through reasoning. In terms of language, humans possess a unique characteristic attributed to the evolution of intricate modules within the brain.

The phenomenon of sound-mediated visual abstraction and synesthesia is influenced by the interconnections between the inferior temporal gyrus, which is also known as the fusiform gyrus and is responsible for visual processing, and the auditory area. The phenomenon of cross-modal abstraction, specifically the bouba-kiki effect, is exemplified by Costa Pereira et al., cognitive researchers in [9] (refer to **Fig 1**). In the context of the present study, when presented with the visual stimuli, individuals tend to associate the name "bouba" with the former and "kiki" with the latter, as evidenced by the results of the experiment.

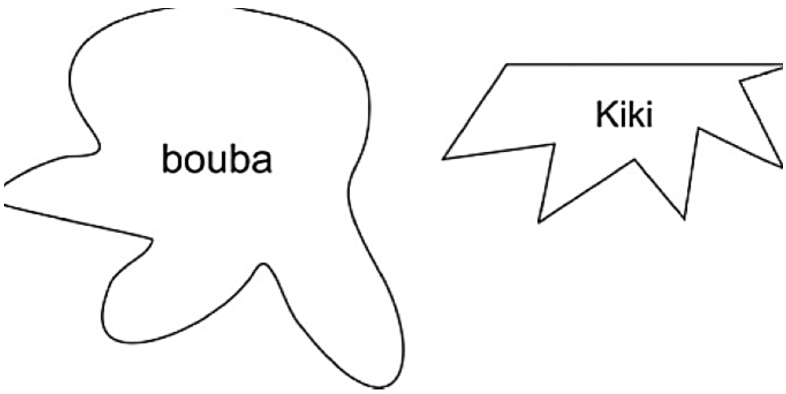

Fig 1. Demonstration of the Mirror Neurons Role in Sound-Based Visual Abstract Cognition

The analysis of the bouba and kiki shapes reveals that the former is perceived as having abstract qualities such as voluptuousness, roundness, and grossness, while the latter is perceived as having sharper and more chiseled features. This perception is primarily observed in the visual center.

Likewise, the act of performing manual gestures resembling a pincer while enunciating words such as "tiny", "little", and "diminutive", as well as protruding the lips outward while articulating the word "you" in reference to an individual, have been observed.

The aforementioned characteristics are indicative of intermodal associations among neurons located in the motor cortex's facial and manual regions, commonly referred to as motor-to-motor synkinesia.

Onomatopoiec Theory

The onomatopoeic theory is centered on mirror neurons. The Onomatopoeia is a linguistic device that reflects the human perception of sound. Sounds can be characterized as disruptions in mechanical energy that travel through a medium in the form of a wave. The distinctiveness of a sound is determined by its properties, such as speed, period, frequency, amplitude, and wavelength. Onomatopoeia is a linguistic device that aims to represent auditory stimuli through the use of phonetically imitative words. As an illustration, it can be stated that the auditory manifestation produced by a firearm discharge is commonly referred to as "BANG". Despite the dissimilarity in auditory characteristics, the onomatopoeic term "BANG" has become conventionally linked with firearms. It is postulated that mirror neurons facilitate the ability to establish a symbolic correlation between auditory stimuli and their corresponding visual representation in the form of language comprehension.

Theory of Recursive Embedding

According to Michael Corballis, a renowned cognitive neuroscientist, the unique characteristic that sets humans apart from other animals is our ability to engage in recursion. This cognitive ability allows us to incorporate our views within other views [10]. The statement "I think, therefore I am" exemplifies recursive view, as the theorist has incorporated themselves into their own thought process. The concept of recursion allows for the contemplation of both personal and external cognitive processes. Moreover, it confers upon us the capability of cognitive "temporal displacement," which is the aptitude to incorporate prior events or envisioned future occurrences into our current state of awareness. Corballis illustrates how the utilization of recursive structures facilitated the development of language and speech, thereby enabling individuals to communicate their ideas, collaborates with others, and transforms their surroundings to align with their imaginative faculties. The power of recursive embedding is shaped by mirror neurons.

Theory of Mind

The proposition posits that individuals possess the cognitive ability to create a mental representation of the cognitive states and volitional aims of other individuals. It is possible to anticipate the cognitive processes and behaviors of individuals. According to the theory, individuals engage in mental processes that would result in comparable behavior if executed, in order to anticipate and comprehend the actions of others. This encompasses both deliberate actions and the manifestation of affective states. As per the theory, juveniles employ their personal emotions to anticipate the actions of others. Consequently, individuals tend to attribute their own cognitive and emotional experiences to those around them. Mirror neurons are triggered during both the execution of actions and their observation. The distinctive capacity of mirror neurons may provide a rationale for the cognitive process by which individuals perceive and comprehend the mental and emotional states of others. Specifically, the brain mirrors the observed action as if the individual were performing the same action.

Fig 2 depicts a schematic diagram that illustrates the different regions of the brain, which could have facilitated protolanguage advancement.

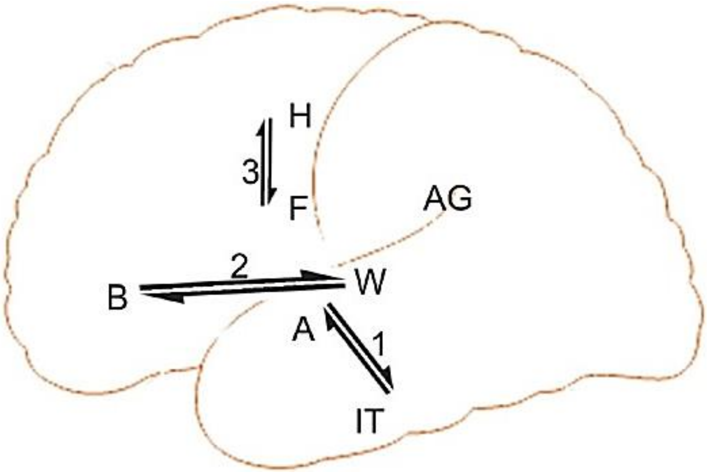

Fig 2. The aforementioned cortical regions are known to play a crucial role in various aspects of language processing. Specifically, the auditory cortex is responsible for processing auditory information related to hearing, while Broca's area is involved in the production of speech and syntax.

In **Fig 2**, Wernicke's area is responsible for the processing of semantic information. The angular gyrus, also known as AG, is a brain region that is involved in cross-modal abstraction. The area of the hand, denoted as H. The inferior temporal cortex, specifically the Fusiform area, is commonly referred to as IT in academic literature. The variable denoted by "F" represents the surface area of the face. The Bouba-Kiki effect alludes to the concept in which individuals tend to relate certain sounds with specific shapes or visual characteristics. Two neural pathways that facilitate the mapping of sound contours to motor maps are the arcuate fasciculus and cortical motor to motor mapping, which can also result in synkinesia.

Human Self-Awareness

There exists a conjecture that mirror neurons could potentially serve as the neurobiological foundation for human self-awareness. Mirror neurons possess the ability to not only replicate the actions of others, but also to generate self-referential or meta-representations of an individual's prior cognitive processes. The aforementioned phenomenon may represent the neural underpinnings of introspection, as well as the interdependent relationship between self-awareness and awareness of others.

III. MIRROR NEURONS AND BRAIN DISEASE

The establishment of "mirror neurons" was initially reported within the macaque monkeys' premotor cortex. The activation of neurons occurs when a primate engages in a particular behavior or when it merely observes another primate performing the same action. The phenomenon of a direct correspondence between the optical depiction of a given accomplishment and its subsequent execution was initially expounded upon within the present context. Tomiyama et al. [11] have established that the inferior parietal lobule (IPL) is merely a component of a more extensive network that encompasses human mirror neurons. The atypical behavior of mirror neurons appears to serve a role in the neural regions of the human brain that are implicated in the replication of actions, by conveying somatosensory feedback related to intended and observed actions. The IPL exhibited a comparatively accelerated expansion during the evolutionary progression from great apes to humans, ultimately bifurcating into the angular gyrus (AG) and supramarginal gyrus (SG).

Two novel concepts, one incorporating an evolutionary viewpoint and the other based on the theory of mind (ToM), have posited a correlation between Alzheimer's disease (AD) and the mirror system. As per the initial concept, malfunctions within the mirror system could potentially result in neurodegenerative ailments. The mirror system's impairment, particularly in AD, would lead to the hippocampus losing its capacity to sample explicit memory experiences. The disruption of the hippocampal connections with interlinked paralimbic domain and cortical areas, which process explicit memory and cognition leaders to explicit amnesic syndromes and changes in eye-based treatment and explicit hand of information such as transcortical aphasia, agnosia, visuospatial deficit, and ideomotor apraxia. With regards to the second concept, recent research has investigated individuals diagnosed with amnestic mild cognitive impairment (aMCI), commonly referred to as prodromal Alzheimer's disease, as they engaged in an activity that is closely associated with mirror neuron system stimulation, such as the RME test (Reading the Mind in the Eyes).

Individuals with prodromal Alzheimer's disease exhibited suboptimal performance on two second-order false belief tasks, suggesting a deterioration of theory of mind abilities at both the behavioral and cognitive levels. The task involved attributing mental states through the analysis of eye-gaze. Additionally, the fMRI scans indicate that the Broca region (BA 44) and the precentral gyrus (BA 6) exhibit a relatively intact anterior portion of the mirror system. The aforementioned discoveries recommend a possible engagement of the posterior mirror neuron network of the inferior parietal lobule in the cognitive dysfunction observed in individuals with prodromal Alzheimer's disease. A previous EEG study (reference [12]) has suggested the potential involvement of mirror system "uncoupling" in neurological conditions. Upon presentation of a visual stimulus depicting an individual seizing a chromatic object, subjects afflicted with particular lesions localized in the inferior parietal lobe (IPL) evinced augmented electroencephalographic (EEG) activity and a propensity towards a readiness potential (RP). The study examined both healthy controls and patients who had lesions in the parietal and ventral premotor cortices. The results indicated that individuals in the healthy control cluster as well as those in the premotor patient group exhibited a substantial RP prior to the action being observed. However, patients with parietal lesions did not display this response. The findings indicate that interference with the parietal cortex has an impact on an individual's capacity to regulate the initial stages of organization and the mirroring mechanism.

The IPC (inferior parietal cortex), comprising the IPS (intraparietal sulcus), anterior cingulate cortex (ACC), and supplementary gyrus (SG), is a notable neuroimaging indicator for forecasting the advancement of mild cognitive impairment (MCI) to AD (Alzheimer's disease). The utilization of resting-state functional magnetic resonance imaging (fMRI) has demonstrated a notable deficiency in connectivity between the SG and various brain regions, such as the fronto-parietal cortex. The distinctive atrophy of temporo-parietal regions of the brain, which is a hallmark of AD, can be utilized to anticipate the transition from MCI to the AD dementia. Furthermore, a study utilizing positron emission tomography (PET) has established that decreased blood flow in the angular gyrus (AG) and the superior frontal gyrus (SG) may serve as a distinguishing factor between the prodromal phase of Alzheimer's disease (AD) and the advanced stage of frontotemporal dementia (FTD).

The prevailing notion is that electroencephalogram (EEG) rhythms in the brain are indicative of the functioning of the brain's networks. The alterations in EEG rhythms may indicate modifications in the anatomical and functional networks within the brain that are linked to Alzheimer's disease during its preclinical phase. Furthermore, it has been demonstrated that an increment in frequency power ration of alpha3/alpha2 serves as an electroencephalogram (EEG) indicator that can forecast the progression of individuals with MCI to AD, but not to other demential types.

This article posits that the reduction of temporo-parietal cerebral networks, specifically the IPL, is associated with a rise in the ratio of alpha2/alpha3 EEG frequency power. If such is the case, there may be a potential correlation between the disruption of the mirror system network and AD. This assertion presents a clinical-theoretical premise that could serve as a basis for initiating a discussion on the topic of Alzheimer's disease in a more comprehensive manner. The region known as Broca's area, which shares homology with the F5 area where mirror neurons were initially discovered in primates, has been associated through the use of fMRI scans with a hereditary language deficit that arises from Forkhead box P2 (FOXP2) gene mutation found on the chromosome 7. The researchers postulated a potential correlation between the anterior mirror system of the human brain and the aforementioned linguistic disorder. The hypothesis being investigated in this study was based on prior research indicating a possible pathological disconnection within the mirror system, which could potentially account for the cognitive impairments observed in individuals with prodromal Alzheimer's disease. Specifically, the posterior region of the mirror network was found to be particularly affected.

The findings by de Vidania et al. [13] indicate that individuals exhibiting prodromal Alzheimer's disease manifested an electroencephalogram (EEG) signal linked to atrophy in the inferior parietal lobule (IPL), which was initially recognized as the posterior element of the mirror framework. It would be challenging to conclusively determine the engagement of mirror neurons in IPL. The existence of neurons outside the mirror system in the IPL is a plausible proposition. The node responsible for facilitating unconscious facial processing has been identified as the inferior parietal cortex, which has been recently discovered as a component of this network. Likewise, it is improbable that Alzheimer's disease constitutes a major mirror neuron system malfunction, and its magnitude cannot be confined solely to the system’s impairment. The mirror system is purported to play a vital role in initial phases of AD, as indicated by clinical and neurophysiological evidence.

Subsequent research endeavors ought to examine whether the anomalous cerebral encoding mechanisms responsible for heightened alpha generation in persons with MCI resulting from AD signify a malfunction of the mirror neuron system. Additional investigation into other neurodegenerative disorders, along with larger cohorts of individuals in the prodromal phase of AD, is necessary to provide empirical support for the current study's results that reveal a link between cognitive abnormalities and the condition.

IV. MIRROR SYSTEMS AND THE PRODROMAL ALZHEIMER'S DISEASE

Cortical thickness evaluation refers to the method that involves calculating the available distance between the cerebrospinal fluid/gray matter boundary and the white matter surface in the cortex, as depicted in **Fig. 3**. This approach is highly sensitive and enables accurate matching of cortical anatomy across subjects, while also serving as a reliable evaluation of brain atrophy amounting from neuronal loss. Morrison, Dadar, Shafiee, and Collins [14] have demonstrated that a cortical feature indicative of prodromal Alzheimer's disease is the progressive thinning of specific cortical regions. The thinning of cortical regions in AD is associated with symptom intensity, even during the initial stages of clinical symptoms. This correlation is consistent with the known regional sensitivity to AD neuropathology.

Furthermore, research utilizing amyloid imaging has demonstrated that there exists a certain degree of cortical thinning in older individuals without symptoms who exhibit amyloid binding. In general, this approach to cortical morphometry provides a dependable assessment of cortical atrophy and neuronal depletion. Selective cortical atrophy was observed in persons with MCI due to prodromal Alzheimer's disease (AD), specifically affecting cortical areas that are integral to the posterior mirror neuron framework, such as the inferior parietal lobule (IPL). For instance, individuals with MCI who are at a higher risk of developing AD exhibited significantly greater levels of atrophy in the supramarginal gyrus (SG), a substantial subregion of the inferior parietal lobule (IPL).

The present findings support the results of a prior fMRI study by Marsden et al. [15] that demonstrated the preservation of the anterior component, located in the frontal lobe, when cognitive functions related to the mirror neuron system are explicitly challenged. Furthermore, a meta-analysis conducted recently by Antunes, da Silva, and de Souza [16] has corroborated that a significant component of the mirror neuron systems in humans is situated in the inferior parietal lobule (IPL). Additionally, an fMRI investigation has demonstrated that an activation pattern involving the inferior parietal cortex bilaterally is essential for the replication of gestures, a pivotal characteristic of praxic abilities [17]. The IPL is located at the convergence of the temporal, occipital, and parietal lobes, making it an ideal site for cross-modal abstraction involving proprioceptive, aural, and visual information. This abstraction is essential for mirror neuron-like computation and motor praxis. The IPL's mirror neuron system has been suggested to have undergone modifications to facilitate the execution of abstract forms of re-conceptualization, including arithmetic and metaphor.

These modifications were originally developed to enable cross-modal abstractions needed for praxis and prehension. This proposal has been put forth in recent times. The IPL lobe's multimodal capabilities play a crucial objective in the processing of visual and spatial data. The manifestation of numerous neuropsychological disorders is often observed in cases where the anterior cingulate gyrus or the superior frontal gyrus sustains damage. The AG syndrome encompasses a range of cognitive symptoms, including but not limited to acalculia, anomia, alexia, disgraphia, finger agnosia, ideomotor apraxia, and right-left disorientation. The right parietal lobe syndrome manifestation integrates a range of symptoms such as visuospatial impairment, constructional apraxia, unilateral spatial neglect, aprosodia, topographical disorientation, and deficient navigation. Furthermore, the IPL approach entails the cultivation of fundamental linguistic concepts. The utilization of graphemic symbols to represent phonological articulation is a distinctive characteristic of the SG. A study in [18] found a correlation between cortical thinning in the SG (BA 40) region and difficulties in naming.

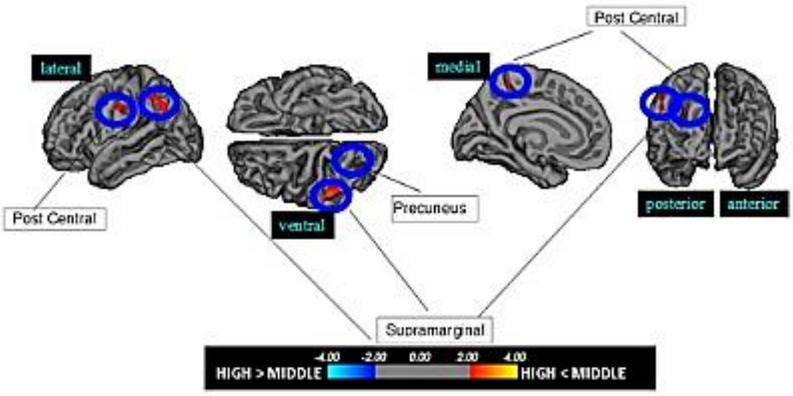

Fig 3. The cortical thickness in the right hemisphere exhibited notable alterations among the groups with MCI having high and intermediate a3/a2 ratios, ($p < 0.01$ uncorrected).

In **Fig 3**, the logarithmic representation of P values is achieved through the use of a color spectrum. A warmer tint is indicative of a thinner cortex, while a cooler hue is suggestive of a thicker cortex. The pial cortical surface of the brain is utilized to present the results, where regions of darker gray denote sulci, and regions of lighter gray signify gyri.

Prodromal Alzheimer's disease is associated with challenges in both linguistic and spatial cognition. Melokinetic apraxia is considered a preliminary indication of the ideo-motor apraxia syndrome or normal disorientation, which are recognized as advanced manifestations of MCI triggered by AD. The clinical findings are reinforced by functional and morpho-structural research. The study has demonstrated that a reduction in cortical thickness in SG, along with alterations in the volume of the hippocampus and entorhinal cortex, is a highly precise and valuable method for distinguishing individuals with Alzheimer's disease from those without it. The findings of a PET investigation conducted during rest indicated the presence of the typical early Alzheimer's disease covariance pattern, which involves reduced blood flow in the inferior parietal lobule and posterior cingulate regions on the contralateral side.

Recently, anomic aphasia has been categorized as a logopenic symptom of Alzheimer's disease with regards to language. Recent research by Gavazzi et al. [19] has shown that within efficient encoding of novel objects, there is desynchronization between networks that are involved in language and visuo-spatial abilities. Conversely, synchronization between these networks hinders successful semantic encoding. The results of our study reveal an increment in alpha2/alpha3 EEG frequency power ratio, suggesting heightened synchronization of high alpha. This finding is in line with previous fMRI investigations on semantic learning [20], [21], which is a noteworthy observation.

Mehrabbeik, Ahmadi, Bakouie, Jafari, Jafari, and Ghosh [22] have explored the fascinating interlinkage between structural and functional degeneration of temporo-parietal heteromodal associative domains in Alzheimer's disease. These investigations have presented convincing proof of the harmful impact of synchronization. The impairment of inhibitory interneurons results in a reduction of cellular inhibition, indicating that these regions are particularly vulnerable in the advancement of AD. As per the authors, disinhibition results in an increase in neural activity at the network level, ultimately leading to a hyper-synchronization of various brain regions. The phenomenon of cell death and brain shrinkage is ultimately caused by the excitotoxicity resulting from excessive neuronal activity. Deutsch, Rosse, Schwartz, Mastropaolo, Burket, and Weizman [23] emphasize the significance of impaired inhibitory interneurons in inducing hypersynchronization. The results of our study align with the seminal research in this field. A possible comprehensive viewpoint regarding the results could be formulated as follows: Regions that are excessively activated are susceptible to neurodegeneration and atrophy. An indication of this over-synchronization may be observed through the elevation of the alpha2/ alpha3 power ratio in the posteriolateral (IPL) cortex.

The physiological relevance of mirror neurons is reinforced by their possible engagement in human brain disorders, such as ALS (amyotrophic lateral sclerosis). Ferrari, Méndez, and Coudé [24] posited that a particular malfunction of mirror neurons may be linked with the commencement of amyotrophic lateral sclerosis and frontotemporal dementia. The occurrence of mirror neuron dysfunction could potentially affect various cognitive processes such as empathetic processing, language, gesture, and imagery in individuals with amyotrophic lateral sclerosis, as suggested by Rush et al. [25]. The following discourse delves into other neurological conditions that potentially implicate mirror neurons. The Embodied Cognition Hypothesis posits a correlation between motor function and Alzheimer's disease. Per this theoretical framework, there may exist a correlation between the cognitive representations of our actions and our visual perceptions. The phenomenon in question may be subject to significant influence from our mirror neurons. Findley et al. [26] investigated the impact of AD, normal aging on the integrity of mirror neurons, and mild cognitive impairments with hippocampal atrophy. Alzheimer's disease is typified by the direct degradation of mirror neurons.

The preservation of cognitive function in persons with MCI may be attributed to the safeguarding of anterior mirror neurons. Individuals with MCI may potentially derive benefits from the activation of posterior mirror neurons during the initial phases of their cognitive decline. According to Lindeman, Yau, Baumgartner, Morley, and Garry [27], mirror neurons tend to remain intact during the process of typical aging. Research using fMRI [28] has shown that mirror neurons play a critical role in various cognitive processes such as emotions, empathy, intention recognition, and advanced cognition. This has been observed in both individuals with autism and those who are typically developing. The prevalence of psychological dysfunction across various illness categories and subcategories makes it reasonable to consider the potential role of mirror neuron malfunction in the manifestation of schizophrenia.

V. PARADIGM SHIFT OF THE HALL OF MIRROR NEURONS

The paradigm of the 'hall of mirror neuron' is introduced as a novel approach towards comprehending the interplay between the mirror neurons of the brain and our subjective awareness and cognitive processes. It is conceivable that the complementarity between mirror neuron groups and motor has undergone further evolution beyond the earlier motor-sensory activities, which activated them. This hypothesis is based on the possibility that multiple mirror neuron foci exist, and that they may be organized in a chain-like fashion at various levels. The degree of similarity between mirror neuron foci decreases as the distance from the initial motor-sensory groups and complexes increases. These procedures have the potential to positively impact cognitive and emotional states. It is plausible that a heightened level of "theoretical" cognition, whereby the mirror neuron foci that are further removed from immediate sensory-motor input neurons are no longer directly linked, may have emerged or evolved through this process. Likewise, the advancement and exploration of artificial intelligence could potentially reap advantages from this shift in outlook. The exponential increase in the number of axonal and synaptic connections within the 'hall of mirror neuron' group contacts highlights the need for the development of quantum computers.

Theoretical and Topological Framework for Hall of Mirror Neurons

The significance of comprehending mirror neurons in the framework of observing the actions of others is reiterated. As per the research conducted by de Gelder [29], the primary role of mirror neurons (MNs) is to facilitate an organism's ability to mentally simulate the cognitive and emotional states of its observed conspecifics, thereby enhancing its capacity to recognize such states.The present theory posits that mirror neurons serve as the fundamental basis for the acquisition of mind reading abilities, as they align with the simulation theory conjecture, which posits that the mental conditions of others are signified by emulating them based on one's own. The aforementioned statement stands in opposition to the "theory theory" perspective that argues that mental conditions are depicted as deduced suppositions derived from the observer's unsophisticated mental states theory. The procedural framework suggested by Ferreira [30] delineates the functioning of mirror neurons (MNs) within a mental simulation, as depicted in **Fig 4**.

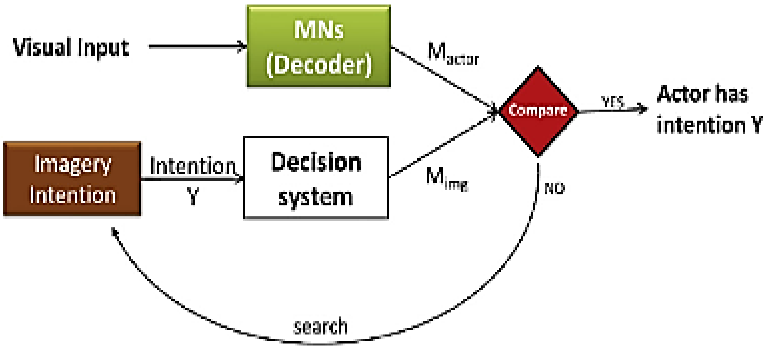

Fig 4. Determining the Application of Mirror Neurons in Intentional Understanding Model

Within the context of motor terminology, the demonstration of a particular behavior by an entity is denoted by the activity of motor neurons (MNs), also referred to as Mactor. The observer subsequently employs his or her decision-making mechanism to make an assessment of the hypothetical mental state or intention (g) that may have prompted the behavior under observation. The decision-making model generates a theoretical motor planning, referred to as Mimg that can be contrasted with the factual motor plan, referred to as Mactor. Subsequently, through the process of refining the initial approximation, the individual conducting the observation can approach Mimg by a factor of Mactor, ultimately achieving a state of cognitive or objective equilibrium that is mutually satisfactory. This perspective situates the comparison within the motor area, wherein the mirror neurons output is evaluated in relation to the output of a hypothetical motor system that is able to reach mirror neurons. The computing challenge at hand is quite arduous as it necessitates the maintenance of geographical or temporal segregation between self and other activations within the mirror system, in order to facilitate comparison.

The utilization of the forward model represents a more realistic computational approach, as it involves the conversion of motor signals into sensory predictions that can be subsequently compared to the sensory input that is generated by the observed action.As a consequence, the motor neurons are relieved from the task of executing the dual representation. The computational framework employed by Abouhussein and Peet [31] was utilized to estimate the activity of a demonstration in their forward-inverse model architecture. Despite the sensory nature of the comparison, the resulting mirror code that mirrors the observed action does not align with Sutter et al.'s [32] concept. The model proposed by Lopes, Campos, Fonoff, Britto, and Pagano [33] posits that motor neurons (MNs) function as decoders for motor information, necessitating an auxiliary layer for the interpretation of intended actions. This concept is differentiated from the process of intentional decoding or the engagement of mirror neurons based on direct matching.

As an illustration, the assertion does not purport that automated comprehension can be achieved solely through the use of MNs, but rather necessitates the incorporation of an additional decision-making and exploration mechanism. The Mental State Inference (MSI) mode serves as an instance of a computationally simulated search process. It employs a comparable mechanism. Nevertheless, the utilization of micro/nanorobots is fundamentally distinct. As per the proposal put forth by Gallese and Goldman, motor neurons (MNs) solely function as decoders of motor signals and do not contribute to motor control in any capacity.In the MSI framework, the accountability of sensory-forward forecast is assigned to MNs, thereby facilitating swift motor execution. Please refer to **Fig 5** for further details.

The model proposed by Onigata and Bunno [34] includes a control function for the motor neurons, specifically in the form of inverse modeling. According to O'Sullivan et al. [35], action comprehension encompasses a broader mental process beyond mirror neurons, specifically referred to as "mental simulation" of action, as opposed to mere "mirroring". The mirror neurons (MNs) suggested by Bonfiglio [36] play a vital role in effectively achieving a mental act simulation. Mental simulation has been identified as a plausible origin of MN (mirror neuron) activity. Given that prior research on mirror neurons has predominantly relied on correlation as opposed to causation as the primary method of analysis, the present study's findings are unlikely to be at odds with existing literature. A simulation mechanism is necessary to generate a motor code that aligns with the observed action. Allow me to demonstrate. In order to determine the optimal selection of motor code (Y), it is advisable to engage in a process of mental imagery whereby one envisions the execution of said motor code and the corresponding sensory response, which could ensue. The outcome might be a collection of artificial signals pertaining to somatosensory gating, referred to as Simg signals. The calculation of an error for motor code Y can be performed by comparing the aforementioned signal with the actual signals, also known as Sactor.

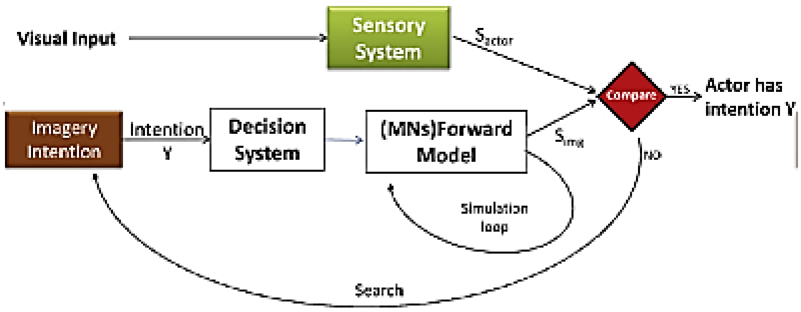

Fig 5. Determining the Intention Comprehension and Sensory Forward Forecasting Objective of mns Within The Computational Framework

Thus, by employing a suitable methodology, the optimal motor code for the candidate can be selected, which reduces the available discrepancy between the actual sensory input and the simulated sensory input. In cases where the motor space is continuous, it is possible to utilize a methodology similar to gradient descent to identify the motor code that achieves minimal error. The MN activity in this instance could be associated with either the depiction of the user motor codes or the findings of recognition. As per the aforementioned theory, the temporal activities of mirror neurons (MNs) are likely to escalate as additional information regarding an action is made available, particularly when the action of grasping is approaching its culmination. This heightened activity is believed to persist until a resolution is attained. The perspective presented by Binder et al. [37] regarding the mirror neuron system posits that the communication of outcomes in the understanding process occurs through the mirror neurons (MNs). In this case, the process pertains to the decoding of the motor code. This perspective aligns with the aforementioned concept to a certain degree. The model proposed by Chen, Gao, Chen, Oloulade, Lyu, and Li [38] can be interpreted as a parallel search architecture that computationally implements the process, replacing the conventional simulation loop with a set of inverse models. Is there an overreliance on coincidences in our perception and interpretation of events?

The aforementioned text has underscored the perils of formulating hypotheses based solely on correlation analysis. Currently, there exists inadequate evidence to make a selection among the three potential designs that integrate mirror neurons, as suggested by Zhang and Hedwig [39]. Lesion and TMS investigations have the potential to overcome the constraints of correlation analysis. Lesion studies, albeit useful, are limited in their ability to provide adequate circumstances for a subset of brain areas, as they only establish sufficiency for a given function in a specific region (for instance, region A is sufficient for function B). Furthermore, their spatial resolution is often suboptimal, particularly in cases involving human patients. It is imperative to devise a novel causal methodology that can establish adequate conditions, wherein the spatiotemporal brain activity in region A can generate function B. A novel methodology, known as Decoded Neuro-Feedback (DecNef), has been recently devised. In order to establish the causal role of mirror neurons (MNs), it is necessary to provide evidence that a specific pattern of spatial brain activity within the mirror neuron system can be stimulated through the use of fMRI DecNef, resulting in the induction of a "understanding of actions."

Various mathematical disciplines are well-suited to the field of neuroscience research. The application of concepts derived from the manifolds' differential topology could be relevant to the study of networks, arrangements, and clusters of neurons, specifically those engaged in mirror image perceptions. The focal points of motor neurons and their corresponding mirror neurons, which mirror their activity, can be conceptualized as mappings between distinct spatial domains. The degree of connectivity between these linkages can be quantified by assessing the frequency of bidirectional interactions. Each cluster of mirror neurons engages with distinct sets of motor and sensory neurons, and these interconnections can be conceptualized as bundles of fibers. The quantitative analysis of fiber clusters' strengths may be contingent upon their interactions with sensory input, among other factors.

The utilization of geometric and algebraic topology is expected to have a significant impact on the quantitative analysis of topological engagements among the mirror neurons, provided that the 'hall of mirror neuron' model yields favorable results. Based on these aforementioned considerations, it can be inferred that the various foci of mirror neuron within the 'hall of mirror neuron' model may possess certain common characteristics. In this scenario, it is evident that the topological characterization of fiber bundles bears resemblance to the fundamental issues of mathematical mapping. Given that fiber bundles have the potential to function as manifolds, it is plausible to regard the subsequent tier of mirror neuron foci as yet another fiber bundle, and so forth. Topological methodologies, such as the M manifold, J topology, B base space mirror neuron cluster, -1 inverse mapping, arrow mapping à, and mappings, have been utilized to model the aforementioned brain activity.

Therefore,

$$Mi \leftarrow ij\, Bj(Mi) \rightarrow \pi ij - 1\text{à} \leftarrow \pi jk\, (Bj\, Bk\, (Mi)) \rightarrow \pi jk - 1 \leftarrow \pi kl - 1 \rightarrow \pi kl\, (Bk\, Bl\, (Mi)\, (Bj))\, etc \ldots$$

It is worth mentioning that, beyond unidimensional interaction, the mirror neurons hall paradigm allows for the possibility of multiple interactions among diverse mirror neurons, taking place in 2D/3D, arranged in either cubical or planar arrays. This augmentation of intricacy in the paradigm may potentially facilitate its application in the fields of brain and artificial intelligence modeling.

Artificial Intelligence-Brain Heuristic Comparison

A heuristic is a quantitative measure utilized to assess the proximity of the present state to an optimal state. The functions of heuristics exhibit variability across different issues and problems, thereby requiring tailored approaches. Artificial intelligence challenges typically entail copious amounts of data, regulations, and constraints, necessitating the determination of a viable strategy to progress from the current state to the desired outcome. The heuristics function enables us to ascertain our proximity to the optimal state in this instance. The distance formula would be a suitable heuristic function for determining the distance between two points in a two-dimensional space. These techniques may prove beneficial in the progression of artificial intelligence. The concept of mirror neurons is currently being applied to artificial intelligence with the aim of enhancing its cognitive abilities and subtlety, which presents an additional challenge. The aforementioned concepts could potentially be incorporated into the mirror neuron hall via the application of foci swarm structures or topological groups.

Kurt Godel, a prominent mathematician of the early 20th century, is widely regarded as one of the most accomplished mathematicians since Euclid and Archimedes. He is known for his completion analyses and theorems of consistency continuum hypothesis, as documented in [40]. This study employed an alternative methodology as opposed to the research conducted by [41], who posited that mathematical logic may show mathematical completeness. In the subsequent decades, [42] offered unequivocal verification of Godel's discoveries. Numerous researchers in the fields of artificial intelligence and neuroscience have made the simplistic assumption that axiomatic algorithms possess the capability to effectively characterize both artificial intelligence and brain function. It was believed that there was no distinct algorithm that could be compared to this conventional approach. Furthermore, there is an implicit assumption that both artificial intelligence and the human brain can be simplified into straightforward axiomatized algorithms and paradigms.

Subsequent to the publication of his theorems in 1931, Kurt Godel contested the aforementioned perspectives. According to Godel's perspective, his work was misinterpreted by mathematicians, computer scientists, and neuroscientists [43]. Mathematicians and computer scientists were refuting the notion that computers are incapable of solving propositions that are deemed unsolvable. Godel cautioned researchers in neuroscience that the human brain, unlike computers, is a highly intricate system. Godel propagated the notion that the brain and a computer are distinct entities, as the former cannot be simplified to a program.

VI. CONCLUSION

The concepts and structural designs derived from the study of artificial intelligence, specifically computer programs, could potentially offer valuable insights to the field of brain organization research, which pertains to the biological architecture and functionality of neurons. The primary objective of these inquiries is to establish and comprehend the concepts of cognition and consciousness, which involve various methods, terminologies, structures, and innovations. In order to expedite the process of identifying a viable resolution, the implementation of heuristic functions within the realm of artificial intelligence is imperative. Heuristic algorithms have the potential to be advantageous due to their ability to swiftly generate a problem solution. Due to its rapid implementation, a close match is deemed acceptable. Caltech's graduate-level course offers comprehensive knowledge on artificial intelligence and machine learning. The course comprehensively covers the latest techniques and software pertaining to Artificial Intelligence. The concept of the 'Hall of mirror neurons' represents a significant shift in paradigm that has the potential to bridge the divide between the human brain and artificial intelligence. The intricacy of the brain and consciousness surpasses that of any computer, and it is imperative for both brain researchers and computer scientists to comprehend this reality. In order to advance paradigms, it is necessary to introduce innovative approaches that surpass the limitations of current computational models, which tend to be overly simplistic and reductionist in nature. There is an urgent need for the development of quantum computers that are capable of performing such complex operations.

Data Availability

No data was used to support this study.

Conflicts of Interests

The author(s) declare(s) that they have no conflicts of interest.

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Ethics Approval and Consent to Participate

The research has consent for Ethical Approval and Consent to participate.

Competing Interests

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