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Hypothesis

Hemispheric Disconnection and Neurodegeneration: Cross-Disciplinary Approaches to Apraxias and Alzheimer's

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Abstract: Introduction: Alzheimer's is a neurodegenerative disease characterized by a progressive decline in cognitive and motor functions. This research proposes an innovative multimodal hypothesis. According to the hypothesis, the loss of emotionally engaging interests and goals in at-risk individuals leads to a reduction in conscious goal-oriented activities. Not only are enacted movements affected, but also those imagined during mental travels. Investigating these mechanisms can significantly accelerate research on apraxias and Alzheimer's. Method: A review of multidisciplinary literature on hemispheric connection and disconnection, proprioception, embodied cognition, motor language, and the syntax and semantics of gestural actions, among other topics, is employed to support the proposed hypothesis. From theoretical speculation, entirely new interpretations of motor-cognitive degenerations emerge. Discussion: Healthy connectivity between the dominant and contralateral hemispheres consists of a functional tension where data integration is complementary. The left hemisphere articulates already learned gestures into chains experienced as advantageous for achieving a goal, working towards maximum efficiency in goal-oriented action. In contrast, the right hemisphere provides a repertoire of gestural units with intrinsic meaning, independent of chains, to be used when execution on the left is interrupted or when more creative solutions are required. Conclusion: The lack of interhemispheric dialogue results in the atrophy of neural contacts capturing contralateral inputs, with progressive necrosis leading to the formation of amyloid plaques and advanced cerebral atrophy. The root cause of this lack of dialogue lies in the loss of value-driven motivations, particularly existential ones.

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Introduction

Alzheimer's is a neurodegenerative disease marked by progressive cognitive and motor decline. Recent theories highlight the importance of interhemispheric communication in maintaining cognitive functions, with disconnection between hemispheres potentially contributing to the disease (Yang et al., 2017; Ereira et al., 2024). This article explores a multimodal hypothesis to explain the roots of this disconnection, emphasizing human brain-body laterality and asymmetry, which are significantly more pronounced than in other species. Such asymmetry necessitates continuous interhemispheric information exchange for unity of consciousness.

Excessive asymmetry may lead each hemisphere, specialized functionally and anatomically, to use internal "languages" incomprehensible to the other. This idea draws from interdisciplinary studies by Yuri Lotman and Nikolai L. Balonov in the 1970s, a period of significant advancements in Russian neuroscience. In Moscow and Saint Petersburg, scientists such as A.R. Luria, Balonov, and D.I. Degin contributed to the understanding of brain asymmetry and interhemispheric communication, often collaborating across disciplines. Lotman, based in Tartu, organized regular interdisciplinary seminars that bridged semiotics, neuroscience, and cognitive studies, fostering the integration of these fields. The hypothesis of metaphorical translation between hemispheres is proposed as the foundation of human creativity and adaptive behavior. Breakdown of this dialogue results in synaptic disconnection, corpus callosum degeneration, and diminished creativity, impacting both actions and emotions. The left hemisphere, lacking existentially driven goals, struggles to organize actions, while the right hemisphere cannot use its repertoire of gestures to adapt. The mechanism of metaphorical translation remains unclear, but motor language theory suggests the cerebellum as a potential mediator. The contralateral connections between cerebellar lobes and cognitive areas likely support this cross-transmission. Understanding these processes requires examining the cerebellum's role in motor and cognitive control, action prediction, and subtle proprioception (Brooks, 1984).

Method

This study conducts a literature review grounded in a multimodal hypothesis proposing an evolutionary framework for motor language. The hypothesis suggests that motor language, predating oral communication, serves as its foundation. Unlike other primates, humans have developed the capacity to ascribe intrinsic meanings to individual gestures, integrating them with goal-oriented meanings tied to existential values, such as the pursuit of food, social connections, or cultural goals. Most human gestures, however, anticipate tasks that are not immediately perceptible, projecting them into future contexts or alternate spaces.

To explore these mechanisms, the study synthesizes interdisciplinary evidence on interhemispheric communication, proprioception, embodied cognition, and the syntax and semantics of gestures. It examines how gestures acquire meaning through spatial relationships with the body, the environment, and the interplay of body parts in action. Goal-oriented gestures, typically processed by the left hemisphere, are distinguished from subtle, intrinsic gestures that rely on proprioceptive memory and are linked to the right hemisphere and contralateral cerebellum. The cerebellum, known for its role in proprioception and action prediction, is highlighted as a neglected yet critical contributor to these processes. The review also considers how embodied memory, the capacity to recall and simulate gestures, enables humans to engage in meaningful motor activities. This capacity is progressively lost in neurodegenerative diseases like Alzheimer's, where the inability to assign meaning to gestures or integrate them into purposeful actions manifests in apraxias and cognitive decline. By examining these patterns and their neural underpinnings, this study aims to provide a new theoretical framework for understanding these deficits and to propose new avenues for prevention and rehabilitation.

Discussion

Proprioception and Multimodality

From the compact brains of insects to those of vertebrates and primates, the left and right sides of known as lateralization (Roger L.J., 2021). Lateralized brains can perform simultaneous functions, such as focusing on prey with one visual field while scanning for threats with the other. In humans, asymmetry and lateralization have evolved to an exceptional level, reaching a critical threshold: the awareness of this difference. A significant aspect of human asymmetry lies in the gap between tactile perception of an object's characteristics and the proprioceptive awareness of muscle tension, particularly concerning manipulable objects. Proprioception involves two key dimensions: the general positioning of the body in relation to its surroundings and the nuanced awareness of muscle tension, tendons, or joint position. For instance, recognizing that the left hand is more suited for holding a stone while the right hand is better at striking it repeatedly marked a pivotal evolutionary moment. This insight enabled the creation of tools like scrapers, conceived for use in future contexts based on memories of gestures experienced across different times and spaces. Moreover, the evolution of bipedalism may have accentuated lateralization. Early hominins likely developed a stronger right arm and hand due to frequently carrying heavy tools, such as clubs, with one hand

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while freeing the other for different tasks. This asymmetry contrasts with the behavior of chimpanzees, who demonstrate limited lateralization. For example, when chimpanzees break nuts with stones, they bring the stones to the nuts rather than transporting the nuts to the stones, indicating an inability for true mental travel. Furthermore, chimpanzees use both hands symmetrically to generate force when striking, underscoring a fundamental difference from human lateralization, which supports complex motor and cognitive abilities. Maurice Merleau-Ponty emphasized the critical link between perception and proprioception, a concept that is central in neurophysiological studies (Gallese & Sinigaglia, 2011). Similarly, Heidegger's notion of "being-in-the-world" (Dasein) highlights the intrinsic awareness of the body's position in space as foundational to human existence. This idea aligns with modern frameworks of embodied cognition, which emphasize the interplay between the body, brain, and environment in shaping consciousness. Varela et al. (1991), in The Embodied Mind, argue that cognition emerges through the dynamic coupling of these elements, providing a framework for understanding proprioception as a driver of motor and cognitive processes. Building on these insights, Gallagher (2005) elaborates on how the lived body (Leib) functions as the primary medium through which individuals engage with their world. These interdisciplinary perspectives underline the foundational role of proprioception and embodied memory not only in practical actions but also in transcendent experiences, suggesting that these capacities significantly shaped the evolution of human culture and cognition. Even in animals, bodily movements often serve as explorations of new gestures, which can be emotionally gratifying. In humans, these movements—common in children's play—carry meanings independent of goal-oriented actions. Such movements are mapped within the brain, forming an embodied memory regulated by a network involving the right hemisphere and the contralateral cerebellum. This network enables sophisticated activities like tool construction, archery, or tribal dance, all reliant on consciously learned gestures stored in memory (Gonzalez-Grandon et al., 2021). At an individual level, each person's repertoire of learned movements allows for unpredictable actions in social contexts, conferring advantages beyond genetic traits. Cerebellar structures involved in forecasting movements (Bhanpuri et al., 2013) may have played a crucial role in this capacity. This unpredictability influenced social dynamics, giving rise to emotions such as admiration and envy and fostering a semiotics of passions (Greimas, 1991). The ability to interpret proprioceptive differences likely provided humans with both individual and collective advantages, transforming social inclusion and dominance into critical existential goals. Unlike other primates, human dominance became tied to cognitive and behavioral factors, enabling individuals within a tribal group to find purpose in mastering their roles and fulfilling assigned tasks with precision. During initiation rituals or rites of passage, young individuals learned complex gestures from elders, incorporating them into daily practices such as hunting, rituals, or social interactions. These learned sequences were processed primarily by the left hemisphere, which excels in organizing actions into coherent chains. However, the right hemisphere contributed proprioceptive awareness and alternative solutions, emphasizing the complementary nature of hemispheric functions. Motor language can be understood as comprising two interdependent components: syntax, the organized sequence of gestures leading to a goal, and semantics, the proprioceptive system of mental images associated with gestures, enabling their use in future contexts or corrections of ongoing actions. These meanings, shaped by cultural contexts, are more universally translatable than verbal or written language. Semantics arises from relative inter-definitions of gestures based on opposition, contradiction, complementarity, and presupposition (Greimas, 1970). For example, pushing opposes pulling, lifting complements striking, and releasing a bowstring presupposes its tension. Modern spoken language likely developed after the evolution of creative motor actions. Neural adaptations initially dedicated to body movement were co-opted for linguistic processing. For instance, Broca's area (Brodmann 44/45) is activated during the observation of expressive gestures (Ardila, 2016), supporting the idea that circuits evolved for motor control later contributed to language articulation (Gallese & Cuccio, 2018). While prior research has focused on visual imitation, this hypothesis emphasizes differential proprioception as a primary tool for embodied cognition and memory,

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enabling humans to simulate motion even at rest. Integrating these findings into an interdisciplinary framework enhances our understanding of the evolutionary foundations of human cognition and opens new possibilities for clinical applications, particularly in treating neurodegenerative diseases like Alzheimer's, where proprioception and embodied memory play crucial roles. As discussed, a chain of actions oriented toward a goal constitutes the very essence of human activity—a sequence of interconnected or even discontinuous steps executed to achieve a final purpose. Humans possess the unique ability to mentally foresee such action plans before initiating them, recalling previously effective or failed attempts. This faculty, referred to as "deep narrativity" by the French semioticians of A.J. Greimas's school, underpins the construction of primordial myths. Greimas (1970) defined the Narrative Program as a fundamental framework for understanding procedures of goal-oriented actions. When an objective is distant and challenging to achieve, human mental narrativity employs strategies to navigate paths and overcome obstacles, mirroring the structure of myths or fairy tales. These Narrative Programs can involve a comprehensive conquest plan—what J.M. Floch (1995) referred to as an Existential Narrative Program (ENP)—tied to higher values such as social prestige, morality, or salvation. Such overarching ENPs encompass a series of accessory or utilitarian subprograms, each involving specific tools or methods to surmount immediate challenges. This structure is reminiscent of classical mythological trials, where the hero must demonstrate ingenuity and adaptability. When these programs are implemented with gestures and behaviors previously proven effective for a given task, the sequences of actions tend to become routine and predictable, lacking the creative element. Habitual behaviors, while efficient, often lead to automatic gestures performed without conscious intervention. This automated execution of goal-oriented chains is likely mediated by the right cerebellum, which provides dynamic motor coordination for repetitive tasks. Such behavior is also observable in animals, whose combat or courtship rituals rely on perfected, learned movements performed without conscious awareness (Lotman, 1993). In contrast, humans exhibit creativity, a trait that enables deviation from predictable actions. Humans can feign, deceive, adjust to unforeseen situations, or behave unpredictably. This uniquely human creativity arises from the interplay between two asymmetrical, specialized hemispheres. While the left hemisphere governs goal-oriented action plans, the right hemisphere introduces interruptions in expected action flows and proposes alternative gestures or short chains to resolve emerging challenges. This bilateral coordination likely occurs through sensorimotor information exchange between the parietal lobes and the premotor cortex. Notably, the inferior parietal lobules (IPLs) play a critical role in bilateral sensorimotor integration, enabling flexible adjustments and creative solutions. Memory of actions, however, is not solely cognitive. The hemispheres communicate extensively with their contralateral cerebellar lobes, forming an integrated network. On one side, the right cerebellum supports the left hemisphere in generating goal-directed motor chains. Conversely, the left cerebellum collaborates with the right hemisphere to provide meaningful, semantically rich gestures independent of the overarching action plan. These gestures rely on proprioceptive input, which reflects the body's spatial orientation and the relationships between its individual parts. Proprioception involves sensory receptors in the skin, muscles, and joints, providing the brain with information on the relative position and tension of body parts. Motor areas in the brain can even generate sensations of movement or displacement in the absence of sensory input (Proske & Gandevia, 2012). This embodied sense becomes critical in complex, coordinated actions, such as when each limb or finger must execute independent movements within a unified sequence (Tang, 2015; Gazzaniga, 2000). The bilateral IPLs are instrumental in these processes, with distinct specializations: Left IPL: Primarily involved in representing and executing specific goal-oriented movements, integrating sensory information for fine motor control, and coordinating voluntary actions Right IPL: More focused on constructing a global body map, managing reciprocal relationships between individual body parts, and supporting gestures independent of the primary task These sensorimotor networks extend beyond the IPLs to involve the cerebellum, premotor cortex, and various sensory cortices, all collaborating in coordinated action. For instance, consider the ancient and universal activity of archery. Proprioceptive information, refined through repetitive practice, governs the ideal shooting

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position, bowstring tension, and finger grip release. The action impulse originates from attentional centers and emotional stimuli linked to the anticipated capture. The right eye calculates trajectory under the guidance of the left hemisphere, while proprioceptive adjustments ensure precision. Studies like McDonald & Paus (2003) have employed transcranial magnetic stimulation to demonstrate the parietal cortex's role in self-awareness during movement, highlighting the importance of proprioception in motor control. Similarly, Anfred et al. (2014) explored proprioceptive processing in schizophrenic patients, underscoring how interhemispheric cooperation is essential for body perception and coordination. These findings, supported by research on motor-cognitive integration (Serrien et al., 2007), reveal how cognitive and motor domains converge during the learning of complex skills, requiring conscious sequencing of goal-oriented actions alongside coordinated movements. In this context, human proprioceptive awareness—rooted in embodied memory and fine sensorimotor coordination—emerges as a cornerstone of creativity and adaptability. This integrated neural framework not only supports routine tasks but also enables the invention of novel solutions, setting humans apart from other species in their ability to navigate and manipulate their physical and social environments with remarkable ingenuity.

The Value of Values in Disease

As previously discussed, the chain of actions oriented toward a goal constitutes the essence of human activity, driven by a deeper sense of purpose. This sense, encapsulated in existential values, is the "meaning of all meanings," imbuing every objective with value (Geninasca, 2008). Unlike animals, humans often pursue abstract values such as power, prestige, moral integrity, or social recognition - objectives that transcend immediate needs and are embedded in the broader social structure. Being "high" on the social ladder, receiving acclaim, or achieving superiority over others brings gratification and pride, yet these pursuits can also lead to profound dependencies, shaping individual identities and behaviors. Such complex emotions and motivations are distinctly human, underpinning universal gestures of humility, pride, discouragement, and aggression. Facial expressions are a particularly vivid manifestation of this human uniqueness. Micro-gestures, often involuntary, convey emotions and are understood intersubjectively through embodied simulation. This mechanism allows us to "feel" the emotions of others as if they were our own, forming the basis of social interaction and the cognitive self (Ammaniti & Gallese, 2019). Similarly, goal-oriented actions, whether simple or complex, are understood pre-linguistically through this same mechanism. This embodied simulation of others' actions likely played a crucial role in the evolution of communication, bridging the gap from gestural to verbal language (Arbib, 2008). Neuroimaging studies on proprioceptive sensations reveal that the representation of the human body relies on the interaction of three brain systems: the motor network, specialized parietal systems, and the right inferior fronto-parietal network (Naito, Morita, & Amemiya, 2016). Additionally, the Superior Temporal Sulcus (STS), as a multimodal area, plays a central role in analyzing biological motion, understanding the intentions of others, and integrating sensory inputs (Grossman et al., 2000). Together, these systems form a robust network supporting proprioceptive imagination—the mental simulation of movements without physical execution. This capability underpins the narratives that guide personal growth and personality development. For instance, a child inspired by an Olympic athlete's gestures may create a "deep existential narrative," influencing future actions and aspirations. Over time, embodied cognition allows them to internalize the specifics of the movements, enabling a deeper understanding of similar gestures in others through embodied simulation. This pursuit of values and existential narratives shapes human history and culture. Goals such as achieving scientific acclaim, gaining fame, or seeking divine approval represent existential values that motivate human action. In smaller communities, roles such as becoming a skilled craftsman or a revered soldier hold comparable significance, reflecting the universal importance of shared social values. However, when these beacons of action fade, daily life can lose its meaning. The loss of existential purpose often leads to disengagement, with cognitive functions declining into ruminative states or apathy. In such cases, the cerebellum may assume a more prominent role, compensating for

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diminished cognitive cortical activity (Yang, 2005). As goal-oriented verbal processes lose their natural gestural support, cognitive decline accelerates. This interpretation aligns with the early deterioration of the default mode network (DMN) observed in Alzheimer's disease and apraxias (Le Chevalier, Andersson, & Morin, 1977). Disruptions in the corpus callosum, the prefrontal cortex, and the Inferior Parietal Lobules (IPLs) impair interhemispheric communication, leading to the progressive disintegration of coordinated sensorimotor functions. Functional connectivity studies reveal that altered network activity often precedes structural brain changes and the onset of clinical symptoms in dementia (Ereira et al., 2024). For example, the inability of Alzheimer's patients to recognize familiar faces could be linked to the loss of embodied simulation, which plays a critical role in interpreting emotional expressions. The IPLs and STS form a complementary network for social cognition and motor coordination. The left IPL (LPI), closely connected to the premotor cortex, specializes in processing linear, logical reasoning and goal-oriented actions (Caspers et al., 2010). In contrast, the right IPL (RPI) supports associative-paradigmatic thinking and contributes to constructing a global body map. The STS, meanwhile, enhances these processes by decoding motion dynamics and social signals, enabling the understanding of intentions and actions of others. This integrated network falters when existential values cease to illuminate deep narrativity. As Alzheimer's disease progresses, the interconnected neural networks that sustain brain-cerebellum communication deteriorate. Neurons and synaptic terminals degenerate, while toxic tangles form due to the detachment of tau proteins from microtubules (Apatiga-Perez et al., 2021). Recent studies suggest that amyloid-beta (Aβ) proteins, in addition to forming plaques characteristic of Alzheimer's disease, may facilitate the spread of tau pathology, amplifying its damaging effects on neural circuits (Hojjati et al., 2024). These findings underscore the critical role of maintaining functional connectivity in delaying or mitigating the symptoms of neurodegeneration.

Emotional Disconnection

Maintaining a healthy mind in daily actions oriented toward an existential value does not necessarily depend on individual ambitions. For instance, the renowned longevity of Sardinian communities is closely linked to the pride of belonging to a cooperative society where every role is complementary to the others. Existential values in this context stem from a shared sense of purpose. Religious sentiment is experienced as being "in God's grace," rather than as an individual demand for salvation. Strong family and neighborhood ties remain active, and older adults maintain routines of small, meaningful tasks, such as farming, craftsmanship, basket weaving, embroidery, or loom work. These tactile and proprioceptive activities help sustain the sense of presence and social participation. Such task, like the fruits of gardens and orchards. become part of cycles of gift and counter-gift, providing gratification to participants. One crucial aspect lies in the deliberate focus placed on manual activities, accompanied by a mental recall of proprioceptive signals indicating muscle positions, actions, and spatial movements. This connection fosters care for one's work, driven by the knowledge that the resulting products will be appreciated, reinforcing self-esteem within the community. Conversely, the loss of traditional roles, particularly for women, often coincides with the onset of depression during menopause, highlighting the importance of maintaining purpose and contribution within a social framework. This contrast can be stark when compared to the modern artist, whose works are produced primarily for sale at high prices rather than within a community cycle of shared value. The detachment from communal values, evident in the often-inaccessible nature of contemporary art, may reflect a broader societal trend of emotional disconnection. The absence of a credible existential sense linked to the moving body and emotions often leads to automatism in gestures. These automatic actions, while capable of executing highly articulated sequences stored in unconscious memory, lack conscious presence and meaning. For example, when we drive a car while thinking of something else, the automation is functional and allows creative thought during default states. However, in Alzheimer's disease, such automatism degenerates into purposeless behaviors, such as wandering aimlessly or becoming lost in once-familiar woods.

This analysis reveals an ancient philosophical opposition: rationality versus passion. Rationality, associated with the left hemisphere, seeks efficiency and precision, focusing on the most effective gestural concatenations to achieve a goal. This mode treats the body as an object piloted by neural centers, primarily the left cortex and right cerebellum. In contrast, the situated, passionate body imbues actions with symbolic and existential value, creating new gestural chains with ritualistic or mythical significance, as seen in tribal dances or oral narratives. Healthy minds balance these complementary modes. The left hemisphere provides pragmatic orientation, acting as an existential compass, while the right hemisphere ensures creativity by inserting novel gestures into well-practiced, goal-oriented chains. Together, they sustain a metaphorical interhemispheric dialogue that underpins conscious and meaningful actions.

For goal-oriented actions to remain conscious rather than automatic, the hemispheres must engage in dialogue. The left hemisphere focuses on objectives, temporal sequences, and the overall sense of action, while the right hemisphere interprets the meaning of individual gestures and situates them within spatial and imaginative contexts. The loss of a guiding goal negates the need for conscious gestures, disrupting the syntactic chains required to achieve objectives. In such cases, synaptic fibers crossing the corpus callosum cease to transmit stimuli, leading to dendritic and axonal degeneration and eventual cell death. These clusters of necrotic cells leave amyloid plaques, hypothesized here to be an effect rather than a cause of the disease. Building on the cognitive model inspired by Yuri Lotman's interdisciplinary studies, we propose that the hemispheres require "translation devices" to integrate contralateral inputs into their distinct processing codes. Anatomically, these metaphorical translation areas may be located near the corpus callosum, where the most extensive necrotic damage is observed in Alzheimer's disease. This hypothesis aligns with studies indicating that patients with early-stage Alzheimer's or apraxias show significant difficulty in understanding metaphors, even while retaining the ability to comprehend literal language (Fujimoto et al., 2019). Metaphors often have embodied origins, closely tied to bodily movements. For example, "you missed the target" refers to a goal-oriented action, while "light as a feather" reflects gesture-object relationships. Alzheimer's patients demonstrate a reduced ability to understand such metaphors, particularly those relying on less salient properties (Roncero & de Almeida, 2014). This underscores the need for early diagnostic and preventive programs emphasizing proprioceptive recovery.

Depression, a significant comorbidity in Alzheimer's disease, is observed in up to 50% of patients and is a major factor in accelerating cognitive decline (Chi et al., 2014). Depression often precedes Alzheimer's diagnosis, exacerbating the disease's progression and increasing caregiver burden. Symptoms include diminished quality of life, greater disability in daily activities, and higher rates of nursing home admission (Starkstein et al., 2008). However, depression is frequently underdiagnosed due to overlapping symptoms with Alzheimer's, leaving many patients untreated. Early intervention with antidepressants and targeted therapies is essential for improving outcomes (Andersen et al., 2005). Addressing depression alongside cognitive decline is critical to preserving functionality and quality of life in Alzheimer's patients.

Hemispheric Monologue

When an individual ceases to engage in emotionally significant activities, the hemispheres begin to operate in isolation. The left hemisphere may fall into a pattern of chronic rumination, cycling through repetitive thoughts and memories without the original sense or purpose that once motivated them. Meanwhile, the right hemisphere, deprived of guidance toward purposeful action, may indulge in gestural fantasies or create disconnected and sometimes distressing scenarios. This dynamic may contribute to the apathy and hebetude observed in advanced stages of neurodegenerative disorders. Studies have corroborated these insights. In Alzheimer's patients, reductions in asymmetric hemispheric activation during cognitive tasks are linked to difficulties in managing ruminative thoughts (Fallgatter et al., 1997). Diffusion tensor imaging has revealed anomalous hemispheric asymmetries in white matter, with topological alterations predominantly affecting the left hemisphere. These changes correlate with memory deficits, as evidenced by the Rey Auditory Verbal Learning Test (Yang et al., 2017). Additionally, Moon et al. (2014) found that bilateral inferior insula damage is associated with symptoms such as apathy and irritability. The insula, crucial for processing emotions like joy, anger, fear, and disgust, also assigns emotional significance to memories and movements. When disconnected from its network, the insula fails to imbue decisions and actions with emotional value, further disrupting interhemispheric communication. Over time, the absence of meaningful hemispheric dialogue leads to the degeneration of neural connections. These connections, vital for integrating contralateral inputs, undergo necrosis, with evidence suggesting that neuron terminals crossing the corpus callosum may degenerate before amyloid plaques form (Teipel et al., 1998; Kelly et al., 2017).

Anatomical and Functional Damage of Disconnession

The degeneration of neural connections coincides with the formation of amyloid plaques, a hallmark of Alzheimer's disease. These plaques form in regions of cerebral atrophy, where necrotized neurons accumulate. However, the hypothesis that amyloid plaques are the primary cause of dementia has been increasingly challenged. Proteomic analyses have identified differing compositions in plaques from rapidly progressing Alzheimer's compared to more typical forms, suggesting that plaques may result from neurodegeneration rather than cause it (Drummond et al., 2016). Other hypotheses propose that plaques impair the brain's capacity for repair and regeneration after injury (Grammas et al., 1995). A recent investigative report in Science (Piller, 2022) revealed potential manipulation of data supporting the amyloid hypothesis, shaking confidence in its validity. This has prompted us to consider hemispheric disconnection as a primary causal factor.

Apraxias and Alzheimer's disease are interconnected, as Alzheimer's damages brain regions responsible for planning and executing movements. This results in various types of apraxia, which should not be viewed as isolated conditions but as interdefined states reflecting distinct aspects of hemispheric disconnection. Below, we redefine the most common apraxias to highlight their functional interrelationships.

Simple Apraxia

In simple apraxia, the patient fails to imitate a gesture upon request but can execute it spontaneously when responding to a need or goal-oriented task. This reflects a deficit in gestural organization (Lesourd et al., 2013). Functional Explanation: The left hemisphere retains its ability to execute learned, goal-oriented actions but lacks input from the right hemisphere, which provides meaning to individual gestures. Conversely, the right hemisphere preserves gesture meaning but cannot integrate these gestures into a sequence. This disconnect leaves gestures partially meaningful but contextually incoherent.

Ideational Apraxia

In ideational apraxia, the patient can perform the individual gestures needed to achieve a goal but fails to sequence them properly. Neurophysiologists term this "automatic-voluntary dissociation."Functional Explanation: The right hemisphere identifies and differentiates gestures based on sensory and proprioceptive input, such as spatial relationships (e.g., top-bottom, right-left) or tactile feedback (e.g., weight, tension), but cannot assemble them into a temporal sequence. The left hemisphere, which organizes goal-oriented chains, cannot integrate these gestures effectively. For example, a patient may fail to uncork a bottle and pour its contents into a glass, despite recognizing each object's function. This syndrome highlights the human ability to abstract individual gestures from sequences, which likely provided evolutionary advantages.

Ideomotor Apraxia

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In ideomotor apraxia, the patient possesses a clear mental plan but cannot translate it into action. For instance, they know how to light a candelabrum with matches but fail to execute the sequence correctly. Functional Explanation: Here, both the intrinsic meaning of gestures and the goal-oriented chain are preserved, but the hemispheres fail to complement each other. The left hemisphere cannot concatenate gestures into the correct order, and damage to the left parietal lobule - an asymmetric and lateralized brain region - further exacerbates this disconnection.

Constructive Apraxia

Constructive apraxia emerges with posterior parietal lobe damage, impairing the patient's ability to build or assemble objects in spatially correct relationships. Functional Explanation:

Right hemisphere lesions cause disorganized visuospatial arrangements, while left hemisphere lesions lead to oversimplified or incomplete constructions. This suggests that human cognition relies on oppositional relationships (e.g., opposition, contradiction, complementarity) to assign meaning within a semantic category. Constructive apraxia underscores the loss of paradigmatic and relational meaning, typically managed by the right hemisphere, while the left hemisphere struggles with syntactic assembly.

Conclusion and Future Applications

The proposed hypothesis provides a novel framework for understanding Alzheimer's disease, highlighting the significance of interhemispheric communication and subtle proprioception in maintaining cognitive coherence. The interplay between syntactic-goal-oriented functions of the dominant hemisphere and semantic-differential tasks of the non-dominant hemisphere ensures the continuity and adaptability of action. The disruption of this balance can result in apraxias, loss of movement sense, and cognitive decline. Monitoring and stimulating these functions represent promising strategies for early prevention and intervention in Alzheimer's progression.

Preventive Strategies

Integrating the theoretical insights from this framework, the following preventive measures are proposed to preserve cognitive and motor functions:

-Anamnestic Music Therapy

Music therapy focused on recalling emotionally significant memories can promote cognitive health. Family involvement in curating personally meaningful music - such as hymns, marches, or cultural songs - can enhance emotional connections, stimulate hippocampal plasticity, and mitigate emotional disconnection.

-Depression Management

Addressing early signs of depression - such as isolation, disinterest, or vague thoughts - is critical. Supporting at-risk individuals in maintaining their roles within family and community life can restore their sense of purpose and existential values.

-Micro Manual Activities

Encouraging small, meaningful manual tasks can help retain proprioceptive engagement and a sense of accomplishment. For instance, activities like embroidery, weaving, gardening, or small-scale craftsmanship engage tactile and proprioceptive receptors, reinforcing the individual's connection to their body and social role. These tasks provide satisfaction by combining mental and physical activity with social recognition.

-Stimulating Narrativity

Engaging patients in narrating personal or cultural stories fosters cognitive and emotional engagement. Recounting memories related to past roles or meaningful life events can reawaken deep narrativity, helping to reinforce an existential narrative and social identity.

-Proprioceptive Exercises

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Activities that involve recalling and mimicking movements from past professions or hobbies (e.g., rowing, dancing, or crafting) can re-engage embodied memory and proprioceptive networks. This process can stimulate motor areas and cerebellar functions, potentially slowing the disease's progression.

-Community-Based Interventions

Embedding these practices within a cooperative, value-driven community model—such as the traditional Sardinian context of shared roles and tasks—can provide an existential framework for patients, fostering belonging and purpose.

-Toward a Center of Excellence

These interventions could form the foundation of a multidisciplinary Center of Excellence for Alzheimer's care. Such centers could integrate neuropsychological monitoring, targeted therapy protocols (e.g., music therapy, narrativity exercises, and proprioceptive training), and caregiver education to improve patient outcomes and caregiver confidence.

Future Directions

Empirical validation of these interventions is critical. Collaboration among neuroscientists, clinicians, and social scientists can refine these strategies, exploring their efficacy in preserving interhemispheric communication and proprioceptive functions. Further research should focus on the neuroplastic effects of narrativity stimulation, music therapy, and micro manual activities, laying the groundwork for innovative, patient-centered care in neurodegenerative diseases. By blending theoretical insights with practical interventions, this approach aims to restore dignity and enhance the quality of life for individuals at risk of or affected by Alzheimer's, providing a compassionate and evidence-based path forward.

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