Article

Not peer-reviewed version

Neurosemiotics of Human Language: Gestural Asymmetry and the Emergence of Signification

Marco Sanna *

Posted Date: 2 June 2025

doi: 10.20944/preprints202506.0100.v1

Keywords: Embodied Cognition; Functional Lateralization; Proprioception; Neurosemiotics; Gesture and Language Evolution; Default Mode Network

Article

Neurosemiotics of Human Language Gestural Asymmetry and the Emergence of Signification

Marco Sanna *

* Correspondence: marcosanna@yahoo.it

Abstract: This essay offers a theoretical contribution to the investigation of the origins of consciousness, thought, and human language, with particular attention to the themes of functional lateralization and proprioception. Through a neurophenomenological and sensorimotor analysis, it explores how the operational distinction between the upper limbs — for instance, between force and finesse, impulse and control — generates a sensitive motor differentiation that constitutes the foundation of signification. It is argued that tool use, understood not merely as a technical act but as a complex perceptual experience, has induced anatomo-functional transformations in the human brain, primarily through the cooperation between the cerebral hemispheres and the mediation of a reflective interhemispheric structure (the Default Mode Network). Within this framework, language is not conceived as a disembodied abstraction, but rather as the differential symbolization of proprioceptively perceived gestures, supported by a dynamic bodily grammar. Special emphasis is placed on the evolutionary continuity between gestural and vocal language: phonetic articulation is interpreted here as a reflective transformation of manual gesture, internalized and made capable of acting upon the other not through objects, but through sound. The voice, therefore, is not detached from the body but emerges as a reorganized motor expression, in which each spoken phrase functions as an effective gesture. Consciousness is thus conceived as the body's capacity to question its own modes of action, enabling intentionality, symbolic construction, and self-reflection. From this embodied grammar — grounded in proprioceptive tension and interhemispheric mediation — human language emerges as a symbolic technology of gesture.

Keywords: embodied cognition; functional lateralization; proprioception; neurosemiotics; gesture and language evolution; default mode network

---

Differentiating to Integrate

Lateralization is a neurobiological principle whereby certain cognitive or motor functions become specialized in one of the two cerebral hemispheres. It is a universal phenomenon, observed across numerous animal species, from fish to birds to mammals. Its evolutionary persistence suggests a significant adaptive advantage (Rogers, Zucca, & Vallortigara, 2004).

Throughout evolution, human beings have developed an increasingly marked functional lateralization, particularly with regard to the upper limbs. This differentiation has led to a clear distinction between a dominant hand — often the right — responsible for tasks involving strength, percussion, and rhythm, and a non-dominant hand, more refined and sensitive, capable of orienting and modulating movement in space (Sanna, 2025). Such specialization is likely the result of selective evolutionary pressures: for thousands of years, humans — uniquely among primates — traversed savannahs and new environments carrying heavy defensive tools, wielded predominantly with the dominant limb: pointed sticks, clubs, and the like.

This differential bodily experience, lived individually through proprioception, may have constituted the pre-linguistic foundation of conscious signification.

 doi:10.20944/preprints202506.0100.v1

In birds and reptiles, sensory processing is strongly lateralized: one hemisphere, typically the left, is focused on foraging, attending to discrete and distinctive cues such as a shiny object that attracts a magpie's attention (Rogers, 2021). The opposite hemisphere, by contrast, monitors the broader environment, detecting gradual and global variationsFrom an evolutionary perspective, as foraging behaviors became more complex and demanded selective precision, the left hemisphere refined its analytical capacities. Meanwhile, the right hemisphere developed greater sensitivity to subtle fluctuations: chromatic variations, textures, latent threats, spatial orientation. The result was a functional complementarity between focused attention and diffuse awareness — both vital for survival.

However, in lower species, this complementarity does not imply integration. The activation of one modality inhibits the other: the "discrete" mode of the left hemisphere is in clear opposition to the "continuous" mode of the right, with no dynamic mediation between the two (Vallortigara, 2018).

Only in higher mammals, and especially in humans, do neural systems emerge capable of enabling communication between these two cognitive registers, paving the way for semiosis, reflective consciousness, and symbolic flexibility. At the same time, the increasing specialization of these opposed and complementary hemispheric modes demands an ever greater capacity for integration between the discrete and the continuous — which, following the insights of Yuri Lotman, become mutually untranslatable (Lotman, 1990).

With the manual use of tools, as previously noted, unique anatomo-functional changes occurred over time. In the human being, action is accompanied by an internal differential perception — an embodied awareness of two complementary modes of agency: on the one hand, strength, rhythm, and directional impulse; on the other, subtle guidance, spatial precision, and perceptual balancing.

Were this not the case, humans — like other primates — would use their hands in an interchangeable or undifferentiated fashion depending on the task. What distinguishes the human species, however, is the capacity to use both hands in an independent yet coordinated manner, assigning to each a specific and complementary function (Stout, Hecht, Khreisheh, Bradley & Chaminade, 2015).

This type of "stereoscopic" coordination, not observed in other primates of comparable complexity, is made possible by functional lateralization and interhemispheric cooperation. Yet this distinction, we propose, would not have been possible without a progressive proprioceptive awareness of the functional difference between the two limbs.

Anatomical possession of two hands is not sufficient; one must feel them as different, must recognize within the body two complementary modes of action. It may be precisely this lived differentiation — more than mere anatomical symmetry — that enabled the emergence of a syntax of conscious gesture, and ultimately, the first form of language accompanying early vocalizations.

Theories on the origin of language are numerous and often irreconcilable, and it is not possible to summarize them all here. It suffices to state that the present work aligns with the theoretical perspective that locates the original matrix of meaning in the living, acting body.

In particular, it draws upon Maurice Merleau-Ponty's phenomenology of the body (1945), the enactive cognition theory developed by Varela, Thompson, and Rosch (1991), and the neurophenomenological contributions of Shaun Gallagher (2005). These are complemented by the neuroscientific evidence provided by Stout et al. (2011; 2015) concerning brain evolution induced by tool use, which supplies an empirical grounding for the hypotheses advanced in this study.

Framing these theoretical anchors is a foundational reference that shapes the deeper orientation of the essay: the neurosemiotics of Yuri Lotman (1985; 1990; 2009; Sanna, 2025b), and in particular his hypothesis of a "third structure" for the compensation of asymmetries — both cultural and mental — first formulated in the late 1970s. Lotman anticipated the need for a mediating interface (semiotic boundary) capable of translating and integrating the differential languages of the cerebral hemispheres, which he regarded as two mutually untranslatable cognitive systems (Lotman, 2022).

It is within this boundary zone — or rather, this space of intersection — that he located the origin of human creativity: the capacity to restructure heterogeneous information into a coherent and symbolically operative form.

However, this contribution departs from the aforementioned perspectives in at least three key respects.

Whereas for Merleau-Ponty the body already bears meaning in its perceptual relation to the world, this work proposes that meaning emerges originally from the internal tension between divergent motor polarities — such as force and finesse, automatism and control — as they are perceived within the gesture itself. Motoric tension is not merely the foundation of perception, but a dynamic matrix of sense.

While embracing the core concepts of embodied cognition (as developed by Varela et al.) and subsequent neurophenomenological elaborations — particularly Gallagher's work on the body schema and sense of agency — the present study advances an additional shift.

If for Varela the mind emerges from the organism–environment coupling, here a semiotic genesis internal to the body is explored: one centered on the tensive perception of motor differences within the body itself, prior to their external contextualization or social codification.

Finally, although it draws upon neuroscientific data from Stout regarding brain evolution via tool use, this work redirects attention from technical efficacy to the embodied self-reflection of gesture: what gives rise to consciousness and language is not merely the functional act, but its capacity to be felt, differentiated, and reconfigured as a meaningful event.

It is within this intermediate zone — between execution and anticipation, between gesture and motor image — that what may be termed, in homage to Lotman's idea of the "ternary structure," the semiotic third structure becomes active: a neurocognitive form of internal translation and rewriting, which enables tension to become thought and difference to acquire semantic value.

From a semiotic standpoint, the very difficult of translation — and the inevitably "inadequate" manipulations in relation to the original input — generates a surplus of information: a cognitive excess beyond what is actually integrated by the receiving hemisphere. This surplus is not a system failure, but rather the dynamic core of symbolic creativity, as it yields new meanings from the discordance between non-isomorphic cognitive codes.

In the following sections, it will be shown how this intra-corporeal tensive perception — this "stereoscopic" domain of action — may have played a decisive role in the evolution of prelinguistic syntactic structures, preparing the ground for the emergence of symbolic thought and human language.

The Thinking Body

When early humans became aware of the functional difference between their hands, they did not merely use them automatically: they began to think through them.

The primordial cultural object — such as the bifacial stone scraper — did not arise solely from a technical necessity, but from an implicit reflection on the body and its differential potentialities.

Unlike other primates who, in bimanual manipulation, instinctively rely on the grip most deeply rooted in their motor memory as the advantageous option, the human being is confronted with a non-obvious choice. One must experiment, test, and differentiate action possibilities between the two hands before selecting the most effective modality for a given task (Stout & Chaminade, 2011). As Lotman (2022) observed, authentic semiosis begins at the moment of choice among alternatives, and such a choice cannot be made by a closed system — a single cerebral block. What is required is an active boundary between the two hemispheres: a mediating instance capable of translating and generating the new — essential in the face of unforeseen situations.

Thus, it becomes necessary to suspend automatism and internally compare different motor options — a foundational condition for the emergence of reflective gesture, and with it, of technical and symbolic intentionality.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 June 2025 doi:10.20944/preprints202506.0100.v1

The subject does not simply act in the world; rather, in performing a gesture, they perceive and distinguish the different modalities through which that gesture becomes possible: force and fine orientation, impulse and direction, automatism and spatial control.

As lateralization increases, so too does the need to strengthen informational communication between the two sides. The left hand holds and rotates the stone, responding to the efficacy of the strike; the right hand strikes rhythmically to incise “just enough,” guided by the sensitivity of the other hand, so that the denticulation forms without the stone splitting in two. The sensory signals that regulate the task flow bidirectionally — but asymmetrically. This is not a distinction born of conceptual abstraction, but a lived difference, emerging in the very moment of action.

Awareness of the asymmetry between the hands gives rise to a motor identity and a corporeal orientation that transcends functional automatism, transforming into projective consciousness. Over time, this bodily differentiation finds its correlate in cerebral organization. Cortical structures have progressively adapted to accommodate increasingly complex functions, integrating gestures, trajectories, and perceptions with symbolic capacities (Corballis & Badzakova-Trajkov, 2012; Bernard & Taylor, 2011; Michel, 2021).

This evolutionary process has not been linear, but circular in nature: action has modified perception, and perception has restructured action. One of the most significant turning points was the shift from a primarily hand–mouth coordination — common among many species for feeding or communicating — to an increasing centrality of hand–hand coordination (Peters, 1988).

The same *notched* stone thus becomes a tangible testimony of an evolutionary threshold: an object that, by its material consistency, might once have been marked by teeth, but, being too hard, is instead chipped with a tool held in a differentiated and intentional grip. It stands as concrete evidence of the lateralization of the bite into gesture — the shift from oral function to reflective manipulation.

This ancient assimilation seems to persist even today: it is not uncommon, while manipulating objects, to move the tongue or lips unconsciously — as if the body retained the memory of a primordial alliance between mouth and hand.

Embodied Repertoires of Gestures

Returning to the primordial tool, we can conceive of the object as receiving the strike, while the right hemisphere records each percussion in terms of its rhythmic, directional, and spatial variations.

Attention is not focused solely on the macroscopic outcome of the action, but on the minimal sensory qualities of the gesture: the acoustic resonance produced by the blow, the mechanical vibrations in the wrist, the tactile consistency of the impacted surface, the pressure on the palm, and so on.

These characteristics are not mere “background noise” of the technical act; they are fundamental informational cues upon which both the quality of the artifact and the accumulation of embodied skills for accurate reproduction depend.

Since conscious attention can be directed to only one manual role at a time — either the guiding hand or the striking hand — the other must operate through automatisms that are not innate but must be learned and consolidated in embodied memory.

It is precisely through this capacity for fine listening and conscious modulation of the gesture that technical action is transformed into a sensitive, aesthetic, and intentional practice. In this process, the body not only refines its effectiveness: it becomes aware of the rhythm of its own action — as shown in Marchand’s (2010) observations of the technical gestures of carpenters, or in Morris’s (2017) analyses of the actor in performance. Rhythm, far from being an aesthetic embellishment, structures the internalization of motor sequences (Gill, 2012), becoming a true form of embodied and temporal thought (Varga & Heck, 2017).

In this context, the goal-oriented action — such as scraping the flesh from an animal carcass — is deferred and disappears from immediate observation, to the point that the goal may lie elsewhere, still to be reached. The act no longer aims solely at completing an immediate task. The task is fragmented and distributed across a series of micro-outcomes: each blow becomes a perceptible

 doi:10.20944/preprints202506.0100.v1

event, each notch a variation to be heard, corrected, repeated; attaching and tying a handle become further actions requiring meticulous and specific attention.

It is the right hemisphere, in close connection with perceptual and proprioceptive networks, that registers the rhythmic, directional, and tactile qualities of each gesture. Through repetition, these registrations do not dissipate: they are deposited as stable traces in embodied memory, giving rise to a refined gestural repertoire (Ianì, 2019).

The functional unity of the action thus decomposes into distinct sensory segments, each of which assumes its own meaning once placed in the context of an action. This gives rise to a true grammar of doing, linked to a rhythmic memory of the gesture (Fuchs, 2016), where even the smallest variation acquires differential value. This repertoire is not static: it can be recognized, modulated, and innovated — generating a cumulative motor semantics.

The left hemisphere, permanently goal-oriented, acts as an executive tactician: it evaluates action sequences, measures their effectiveness relative to the immediate goal, selects the most successful ones, clusters them into recurrent modules, and automatizes them to free up attentional resources. While the left "calculates" the strategic pertinence of a gesture within the operational chain, the right hemisphere operates as an adaptive strategist: it "listens" to the gesture as it emerges in its qualitative form, retains alternative gestural repertoires, and evaluates latent scenarios and fallback solutions (Serrien & Sovijärvi-Spapé).

The brain thus develops a dual structure of control and resonance, in which the two hemispheres do not compete but cooperate as a stereoscopic learning system.

However, it may happen that, when faced with the unexpected, the left hemisphere cannot produce an adequate response: certain gestures are absent from its "program," others prove ineffective. In such cases, the opposite hemisphere intervenes (Mutha, Haaland & Sainburg, 2012), drawing upon its immense gestural memory to offer corrective solutions of insertion, displacement, substitution — much like when one utters a flawed sentence and promptly corrects it.

It is important to recall, however, that interhemispheric dialogue, as previously noted, is never direct, but always mediated by structures of interhemispheric integration (Rounis, Thompson, Scandola & Nozais, 2024).

Interhemispheric cooperation thus gives rise to a primitive yet powerful form of motor semantics and syntax. Semantics emerges from the differential value of each gesture — the way it distinguishes itself through rhythm, effect, or intention. Syntax arises from the capacity to concatenate gestures into recurrent and modifiable structures, in which each segment retains relative autonomy while participating in an overarching design. Crucially, this organization is not localized in a single center, but is distributed across a broad cerebral network involving — and connecting — multiple functional domains: motor, sensory, proprioceptive, visual, and limbic (Sanna, 2005).

A fundamental property of this embodied syntax is the functional substitutability of the meaningful gesture. In a context of action or expression, a gesture is not bound forever to a single function: it can be extracted from a learned gestural chain, modified in rhythm, spatial vector, or intention, and reinserted into another sequence with a new effect. This dynamic capacity for recombination transforms the gestural sequence from an automatic routine into a semiotic structure — a grammar of the body that is not static, but generative (Pulvermüller, 2016; Bressem, 2021).

Lotman went even further: he argued that the difficulty of translating the language of one hemisphere into that of the other — a task performed by the mediating instance (semiotic boundary) — leads to distorted (metaphorical) translations. Far from being unproductive, such distortions are the driving force of creativity.

It is within this space of flexibility and variation that complex expressive forms such as dance or acrobatics emerge — domains in which the identity of a gesture depends on its position within a sequence, its relationship to time, space, and the gaze of the other. Every gesture, even if learned, can be reassigned, overloaded with meaning, or creatively substituted. Dance is therefore not merely movement: it is embodied poetics — the art of composing and decomposing gestures like a language without words, yet rich in meaningful differences (Lotman, 2009).

 doi:10.20944/preprints202506.0100.v1

The same principle applies to vocal gesture: sounds, too, can be isolated, modified, and substituted in different phonetic contexts. A single phonetic articulation — a rhythmic emission, a tonal variation — can acquire different meanings depending on its position within the sentence, its prosody, or its emotional accent. Just as bodily gestures can be reused, distorted, modulated, and reintegrated, so can phonemes (Armstrong & Wilcox, 2007).

The syntax of sound emerges from the same principles that govern the syntax of gesture: distinction, selection, recombination.

This embodied syntax of gesture and voice forms the pre-linguistic foundation from which human language develops. Language does not arise from nothing, nor from a sudden leap: it emerges from a continuous sensorimotor reorganization (Noiray, Popescu, Killmer & Rubertus, 2019), in which body and sound modulate one another, sustained by interhemispheric cooperation, proprioceptive memory, and the plasticity of neural networks.

Finally, it is essential to recall that the verbal utterance — however abstract it may seem — is itself a gesture, a fully-fledged goal-oriented action. Speaking is not a disembodied act: it is a finely coordinated motor behavior involving respiratory, laryngeal, oro-facial, and abdominal muscles, performed with a precise intention: to modify the mental, emotional, or cognitive state of another. Each spoken sentence is a gesture — with a purpose, a trajectory, and an expected effect (Cowley, 2014).

In this sense, the verbal utterance can be understood as the phonic evolution of manipulative gesture: whereas early humans acted upon objects, we now act upon minds. The vocal apparatus has become specialized in the articulation of vocal symbols, but the underlying logic remains the same: to act upon the world through embodied efficacy (Venezia & Hickok, 2009).

Language is not an abstract symbolic system, but a transposed form of corporeal action — a technology of presence in which gesture and voice remain inextricably linked. Even when the body is not visible — as in a phone conversation — the voice evokes motor imagery: in the listener's mind, postures, movements, and gestural intentions take shape.

A simple variation in prosody, a sudden inflection, or an unjustified pause is enough for the mind to construct vivid motor scenarios from absence: a hand rising, a face tensing, a finger pointing, a body withdrawing or advancing.

Recent studies suggest that such images are not mere metaphors, but actual activations of the motor and premotor areas of the brain, involved in the perception and simulation of others' gestures. In other words, even without seeing, we feel with the body what language implies (Sato, Troille, Ménard & Cathiard, 2013).

It is precisely in this capacity to evoke absent gestures and make them present to consciousness that one of the deepest roots of empathy, imagination, and human signification resides (Grabski, Schwartz, Lamalle & Vilain, 2013).

The Role of the Default Mode Network

A crucial role in this dynamic architecture is played by the Default Mode Network (DMN), a neural network that activates during moments of rest, reflection, or disengagement from immediate action. The areas involved include the medial prefrontal cortex, the posterior cingulate cortex, the precuneus, and the medial temporo-parietal regions (Buckner & Andrews-Hanna, 2008). These regions are known to support autobiographical memory processing, mental simulation, and—increasingly supported by empirical evidence—high-level motor planning (Gerlach, Spreng, Gilmore & Schacter, 2011).

The DMN does not operate in isolation, but interacts with proprioceptive and sensorimotor circuits through integrative systems that cross interhemispheric commissures (such as the corpus callosum) and extend to the basal ganglia, thalamus, and insula. The insular cortex functions as a bridge between the perception of internal bodily states and the construction of action. It is also responsive to deep proprioceptive signals—such as muscle tension, joint pressure, and balance—and contributes to generating a "subjective map" of the body in motion (Fermin & Friston, 2022).

 doi:10.20944/preprints202506.0100.v1

During moments of pause or error, the DMN receives these signals, integrates them with motor memory and abstract task representations, and evaluates their implications. This process results in a tensional reorganization of the body schema, which becomes reflective, plastic, and strategic rather than rigid.

The default state is thus deeply tied to proprioception. Not only does it enable abstract or autobiographical thought, but it also re-establishes an internal contact with the body, often suspended during external action. It constitutes a space of interhemispheric exchange and sensorimotor reintegration: a laboratory where the body can become an object of reflective attention.

Human beings exhibit an evolutionary uniqueness in their capacity to elevate proprioception to a highly intentional level. This is exemplified by the athlete who, before jumping, assesses muscle tone, calibrates distances, and imagines the sequence of movement. This internalized observation of the body in preparation for action is already a form of thought—the foundation of embodied reflective consciousness. The body becomes not only an instrument of action but an object of conscious evaluation (Toner, Montero & Moran, 2016). A paradigmatic example is the practice of "body scanning" in some meditative traditions, where the subject, while at rest, focuses proprioceptive attention on the smallest bodily segments they can sense.

In the absence of an immediate external task, the body returns as an implicit object of consciousness, allowing the subject to re-cognize themselves as an embodied, intentional agent. This state is not passive but a suspended tensional equilibrium—a silent listening in which flesh and thought approach, observe, and transform each other. From here arises not only the decision to act but also the capacity to imagine new ways of being in the body and in the world. It is from this threshold of embodied attention that proprioceptive self-consciousness originates—arguably the deepest and most primordial form of human consciousness.

Recent studies show that the corpus callosum is not merely a conduit for exchange but an active structure in the transformation of cognitive signals between hemispheres, especially in cooperation with the DMN (Roland, Snyder, Hacker & Mitra, 2017). Its absence, as shown in research on callosotomized patients, impairs interhemispheric functional coherence, confirming its mediating role (Marcantoni, Piccolantonio & Ghoushi, 2024).

This suggests that the DMN, far from being a closed circuit devoted solely to introspection, operates as a transformative network: it "recycles" information from one hemisphere, reformulating it to be compatible with the computational system of the other. A direct exchange between hemispheres—each anchored in its own mode of processing, continuous or discrete—would be ineffective without such mediation. Thus arises a cognitive space of resonance, in which gestures are not only executed but also contemplated, suspended, and transformed.

At first glance, such suspension may appear as a delay in action—a hesitation that, in critical contexts, could seem counterproductive. Yet it is precisely within this brief hesitation that a uniquely human faculty emerges: the possibility of reflective choice, the ability to evaluate alternatives, imagine scenarios, and modify motor or cognitive trajectories before acting. Yuri Lotman repeatedly emphasized this principle in his work (1990; 2009).

It must be noted, however, that in situations of immediate danger, even in humans, neurophysiological automatisms prevail—fast, unconscious defensive circuits. Still, when context allows, even a pause of a few milliseconds may suffice to activate a creative selection among alternatives. The true human uniqueness lies not in the duration of the pause, but in its transformative quality: the ability to use even the briefest window of time as a space for conscious decision-making.

Lotman's insight into the unpredictable in human behavior is illuminating: "We may say that human behavior differs in principle from animal behavior by the significant role played by the unpredictable" (2009, p.46).

The integrated DMN is a bilateral and metacognitive network that coordinates distributed circuits in both hemispheres, allowing them to communicate through transformative commissural structures capable of translating information from one operational code into another. In this process, not only the corpus callosum but also the anterior and hippocampal commissures actively participate

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 June 2025 doi:10.20944/preprints202506.0100.v1

in the transformation and functional reconfiguration of cognitive contents (Botez-Marquard & Botez, 1987; Gloor, Salanova, Olivier & Quesney, 1993).

As neural devices of translation, these commissures ensure that the symbolic, analytical, and sequential models of the left hemisphere can be integrated with the spatial, rhythmic, and contextual representations of the right, preserving global coherence while enriching the system with complementary perspectives. It is here—in the continuous exchange between reflection and readiness for action—that gesture evolves, distances itself from routine, and becomes meaning.

This "third structure," composed of the integration between the Default Mode Network and the transformative commissural pathways, functionally corresponds to the semiotic boundary described by Yuri Lotman in The Semiosphere and Universe of the Mind. As recent neurosemiotic literature has noted (Sanna, 2025b), Lotman foresaw that, in order to enable dialogue between the specialized "languages" of the two hemispheres, an active mediating zone was necessary—a zone capable not only of transmitting but of translating and reformulating information in an intersemiotic key.

In Lotman's cultural model, the semiotic boundary serves as a site of exchange between heterogeneous codes—like a border city between languages—and it is precisely this tension between incommensurable systems that generates new meanings. By analogy, the integrated DMN and commissural structures are not mere channels of exchange but dynamic transduction systems enabling the encounter between the symbolic and sequential competencies of the left hemisphere and the spatial, rhythmic, and contextual capacities of the right. It is within this space of cognitive metaphorization that new thought arises, just as creative semiosis occurs in cultural systems.

The integrated DMN thus functions as a system of interhemispheric consciousness, enabling reflective choices, strategic suspensions of action, and, above all, the emergence of a form of thought that is neither purely motor nor purely symbolic, but embodied and transformative.

This "third structure"—an emergent configuration linking the Default Mode Network and commissural pathways—can be aligned, though not entirely equated, with Antonio Damasio's concept of the autobiographical self. Unlike the narrative self, this model delineates a function of interhemispheric consciousness: a system that not only connects but interprets, suspends, restructures—integrating gesture, memory, and simulation. Its function is not merely reflective but transformative: thought emerges here as deferred, embodied, and strategically modulated action.This hypothesis aligns more closely with the paradigm of embodied cognition, wherein consciousness is not a static content but a tensional process between divergent modes of sensorimotor and symbolic organization. In this sense, the "third structure" proposed here may be understood as an embodied autopoietic device in Maturana's sense: not a reflective module, but a dynamic network that generates meaning through its own organization.

In dialogue with the insights of Varela and the enactive paradigm, it functions as an interhemispheric consciousness capable of integrating motor differences, mental simulations, and reflective choices. Here, the gesture is no longer simply executed but contemplated: a thought that is neither purely motor nor purely symbolic, but embodied and transformative.

It is at this neurofunctional crossroads—where proprioceptive tension, cognitive anticipation, and interhemispheric translation converge—that the grammar of the body emerges. A grammar not made of words, but of gestures that are contemplated, modulated, and meaningful insofar as they are recognized and transformed within a system of exchange between hemispheres. From this exchange, enabled by the commissures and the default network, the deepest origins of human language emerge.

At the foundation of all this lies a primary form of proprioceptive inquiry. When an action fails, the organism does not simply abort it: it activates an internal evaluation, an embodied exploration of its motor possibilities. Without the need for verbal language—or, optionally, in dialogue with it—the body begins to modulate, recalibrate, experiment: what variation in tension, what directional adjustment, what alternative coordination might yield a different effect?

This corrective activity is not mere reaction, but an original form of embodied thought: motoric, tensional, and situated reflection. It is within this circuit—between error, sensation, and reorganization—that the root of human thought is embedded: not as disembodied abstraction, but as the body's capacity to interrogate itself, to perceive itself as a plastic and modifiable system.

It is this proprioceptive awareness—this capacity to transform gesture into learning—that distinguishes the human being: an organism that not only acts but reorganizes itself to act differently, thereby giving rise to reflective intentionality and, ultimately, to self-narration.

Language, finally, does not emerge suddenly as a symbolic system. It is grafted upon pre-existing bodily structures, on differential gestural chains, on rhythmic and modulated variations of movement. Gestures such as pointing, intentional touching, rhythmic striking are already carriers of meaning. Language arises when these embodied structures become symbolized, without severing

their link to corporeality. It is not abstract reason that creates the body, but the body, in its sensorimotor differentiation, that creates the conditions for thought.

Thus, language is not the triumph of disembodied rationality, but the emergence of a consciousness that has learned to speak through its hands, its muscles, its silences.

This proposal departs from both the nativist theories of Noam Chomsky and the interactionist hypotheses of Michael Tomasello.

Chomsky has argued that human language originated through a sudden evolutionary "leap," attributing its emergence to the appearance of an innate, modular generative grammar — a specifically human "faculty of language" (Chomsky, 1986).

Tomasello, by contrast, interprets the origin of language as the result of progressive cooperative and social pressures, grounded in the ability to share intentions and coordinate interpersonal actions (Tomasello, 2008).

Both perspectives agree in positing a discontinuity from non-human communicative forms, but they diverge in causal framing: Chomsky locates the origin within the brain as a preformed structure, while Tomasello emphasizes social interaction as a pragmatic necessity.

The present work proposes an alternative path: language does not emerge from an isolated cognitive module, nor does it conform to a purely cooperative strategy. Rather, it arises from an internal bodily tension, lived through gesture and continually reworked. Manual and vocal gestures — likely in dynamic interaction from the outset — constitute the complementary matrices of this transformation.

The system of arbitrary signs we call "language," based on the naming of actions (verbs) and objects, represents the spontaneous culmination of an evolutionary process that unfolded over tens of thousands of years: not a leap, but a slow transposition — from gesture to voice, from practice to symbol.

Conclusion

Ultimately, human consciousness, language, and culture originate from a body that reflects upon itself.

A human becomes human the moment they feel the difference between their own hands, between muscular tensions, between motor trajectories. It is in this tensional awareness, in this embodied differentiation, that thought, meaning, and the potential for symbolization arise.

And above all, it is in the moment one becomes aware of one's own posture, of the axes of the body, and asks the body itself: "How can I do this differently?" — that proprioceptive self-consciousness is born.

From there, thought takes shape as inner movement, reflection, and creation. In recognizing, modifying, and reorganizing the axes of one's own body, the human being does not merely act: they begin to think themselves.

And it is precisely in this transition — from gesture to the awareness of gesture, from action to reflection — that the human emerges in its fullness.

References

1. Adrien, V., Bosc, N., Peccia Galletto, C., & Diot, T. (2024). Enhancing agency in posttraumatic stress disorder therapies through sensorimotor technologies. Journal of Medical Internet Research, 26(1), e58390. https://www.jmir.org/2024/1/e58390/
2. Armstrong, D. F., & Wilcox, S. (2007). The gestural origin of language. Oxford: Oxford University Press. https://books.google.com/books?id=1fgRDAAAQBAJ
3. Bernard, J. A., & Taylor, S. F. (2011). Handedness, dexterity, and motor cortical representations. Journal of Neurophysiology, 105(1), 88–99. https://doi.org/10.1152/jn.00512.2010
4. Bressem, J. (2021). Repetitions in gesture: A cognitive-linguistic and usage-based perspective. Berlin: Mouton de Gruyter. https://books.google.com/books?id=hwVGEAAAQBAJ
5. Botez-Marquard, T., & Botez, M. I. (1987). Role of the anterior commissure in interhemispheric transfer and cognitive function. Neurology, 37(10), 1541–1547. https://doi.org/10.1212/wnl.37.10.1541
6. Buckner, R. L., & Andrews-Hanna, J. R. (2008). The brain's default network: Anatomy, function, and relevance to disease. Annals of the New York Academy of Sciences, 1124(1), 1–38. https://doi.org/10.1196/annals.1440.011
7. Chomsky, N. (1986). Knowledge of Language: Its Nature, Origin, and Use. Praeger.
8. Cowley, S. J. (2014). Linguistic embodiment and verbal constraints: Human cognition and the scales of time. Frontiers in Psychology, 5, 1085. https://doi.org/10.3389/fpsyg.2014.01085
9. Corballis, M. C., & Badzakova-Trajkov, G. (2012). Right hand, left brain: Genetic and evolutionary bases of cerebral asymmetries for language and manual action. WIREs Cognitive Science, 3(1), 1–17. https://doi.org/10.1002/wcs.158
10. Fermin, A. S. R., & Friston, K. (2022). An insula hierarchical network architecture for active interoceptive inference. Royal Society Open Science, 9(6), 220226. https://doi.org/10.1098/rsos.220226
11. Fuchs, T. (2016). Embodied knowledge–embodied memory. In G. Etzelmüller & C. Tewes (Eds.), Embodiment, enaction, and culture: Investigating the constitution of the shared world (pp. 203–228). Berlin: De Gruyter.
12. Gallagher, S. (2005). How the body shapes the mind. Oxford, UK: Oxford University Press.
13. DOI: 10.1093/0199271941.001.0001 (Oxford, 2005; online edn, Oxford Academic, 1 Feb. 2006), https://doi.org/10.1093/0199271941.001.0001)
14. Gallese, V. (2008). Mirror neurons and the social nature of language: The neural exploitation hypothesis. Social Neuroscience, 3(3–4), 317–333. https://doi.org/10.1080/17470910701563608
15. Gerlach, K. D., Spreng, R. N., Gilmore, A. W., & Schacter, D. L. (2011). Solving future problems: Default network and executive activity associated with goal-directed mental simulations. NeuroImage, 55(2), 936–944. https://www.sciencedirect.com/science/article/pii/S1053811911000656
16. Gill, S. P. (2012). Rhythmic synchrony and mediated interaction: Towards a framework of rhythm in embodied interaction. AI & Society, 27(1), 111–123. https://doi.org/10.1007/s00146-011-0362-2
17. Gloor, P., Salanova, V., Olivier, A., & Quesney, L. F. (1993). The human dorsal hippocampal commissure: An anatomically identifiable and functional pathway. Brain, 116(5), 1249–1273. https://doi.org/10.1093/brain/116.5.1249
18. Grabski, K., Schwartz, J. L., Lamalle, L., & Vilain, C. (2013). Shared and distinct neural correlates of vowel perception and production. Brain and Language, 127(3), 314–322. https://www.sciencedirect.com/science/article/pii/S0911604412000899
19. Ianì, F. (2019). Embodied memories: Reviewing the role of the body in memory processes.Psychonomic Bulletin & Review, 26(4), 1101–1115. https://link.springer.com/article/10.3758/s13423-019-01674-x
20. Lotman, Y. M. (2005). The semiosphere (W. Clark, Trans.). University of Minnesota Press. (1984 in Russian) ISBN: 9780816643410
21. Lotman, Y. M. (1990). Universe of the mind: A semiotic theory of culture (A. Shukman, Trans.; U. Eco, Ed.). Bloomington, IN: Indiana University Press. ISBN: 9780253209209
22. Lotman, Y. M. (2009). Culture and explosion (W. Clark, Trans.). Berlin: Mouton de Gruyter.
23. Lotman, Y. M. (2022). Talk. March 13, 1981, at Tartu State University. METHOD: Moscow Quarterly Journal of Social Studies, 2(1), 12–27. https://doi.org/10.31249/metodquarterly/02.01.02

24. Marcantoni, I., Piccolantonio, G., & Ghoushi, M. (2024). Interhemispheric functional connectivity: an fMRI study in callosotomized patients. Frontiers in Human Neuroscience, 18, 1363098. https://doi.org/10.3389/fnhum.2024.1363098
25. Marchand, T. H. J. (2010). Embodied cognition and communication: Studies with British fine woodworkers. Journal of the Royal Anthropological Institute, 16(S1), S100–S120. https://doi.org/10.1111/j.1467-9655.2010.01612.x
26. Meguerditchian, A., & Vauclair, J. (2013). The evolution of human handedness and language: A comparative review of hand preferences for bimanual coordinated actions and gestural communication in nonhuman primates. Developmental Psychobiology, 55(6), 637–650. https://doi.org/10.1002/dev.21150 (DOI 10.1002/dev.21150)
27. Merleau-Ponty, M. (1945). Phénoménologie de la perception. Paris: Gallimard. (Trad. it.: Merleau-Ponty, M. (2003). Fenomenologia della percezione (A. Bonomi, Trad.). Milano: Bompiani).
28. Michel, G. F. (2021). Handedness development: A model for investigating the development of hemispheric specialization and interhemispheric coordination. Symmetry, 13(6), 992. https://doi.org/10.3390/sym13060992
29. Morris, E. (2017). Rhythm in acting and performance: Embodied approaches and understandings. London: Methuen Drama. https://books.google.com/books?id=c_wqDwAAQBAJ
30. Mutha, P. K., Haaland, K. Y., & Sainburg, R. L. (2012). The effects of brain lateralization on motor control and adaptation. Journal of Motor Behavior, 44(6), 455–469. https://doi.org/10.1080/00222895.2012.747482
31. Noiray, A., Popescu, A., Killmer, H., & Rubertus, E. (2019). Spoken language development and the challenge of skill integration. Frontiers in Psychology, 10, 2777. https://doi.org/10.3389/fpsyg.2019.02777
32. Peters, M. (1988). The primate mouth as an agent of manipulation and its relation to human handedness. Behavioral and Brain Sciences, 11(1), 162–163. https://doi.org/10.1017/S0140525X00054352
33. Pulvermüller, F. (2016). Language, action, interaction. In The Future of the Brain Sciences (pp. 139–163). Frankfurt: MIND Group. https://archives.esforum.de/publications/sfr18/chaps/SFR18_09%20Pulverm%C3%BCller.pdf
34. Rogers, L. J., Zucca, P., & Vallortigara, G. (2004). Advantages of having a lateralized brain. Proceedings of the Royal Society B: Biological Sciences, 271(Suppl_6), S420–S422. https://doi.org/10.1098/rsbl.2004.0200
35. Rogers, L. J. (2021). Brain lateralization and cognitive capacity. Animals, 11(7), 1996. https://doi.org/10.3390/ani11071996
36. Roland, J. L., Snyder, A. Z., Hacker, C. D., & Mitra, A. (2017). On the role of the corpus callosum in interhemispheric functional connectivity in humans. Proceedings of the National Academy of Sciences, 114(50), 13278–13283. https://doi.org/10.1073/pnas.1707050114
37. Rounis, E., Thompson, E., Scandola, M., & Nozais, V. (2024). A preliminary study of white matter disconnections underlying deficits in praxis in left hemisphere stroke patients. Brain Structure and Function. https://doi.org/10.1007/s00429-024-02814-3
38. Sanna, M. (2025). Proprioceptive Resonance and Multimodal Semiotics: Readiness to Act, Embodied Cognition, and the Dynamics of Meaning. NeuroSci, 6(2), 42. https://doi.org/10.3390/neurosci6020042
39. Sanna, M., (2025) Dialogical Structure of the Brain and the Ternary System of the Mind: The Neurosemiotics of Yuri Lotman. Consortium Psychiatricum, vol. 6 issue 1 doi: 10.17816/CP15606
40. Sato, M., Troille, E., Ménard, L., & Cathiard, M.-A. (2013). Silent articulation modulates auditory and audiovisual speech perception. Experimental Brain Research, 228(2), 135–148. https://doi.org/10.1007/s00221-013-3510-8
41. Serrien, D. J., & Sovijärvi-Spapé, M. M. (2015). Hemispheric asymmetries and the control of motor sequences. Neuroscience Research, 96, 45–53. https://www.sciencedirect.com/science/article/pii/S0166432815000388
42. Stout, D., & Chaminade, T. (2011). Stone tools, language and the brain in human evolution. Philosophical Transactions of the Royal Society B: Biological Sciences, 367(1585), 75–87. https://doi.org/10.1098/rstb.2011.0099 (https://royalsocietypublishing.org/doi/10.1098/rstb.2011.0099)
43. Stout, D., Hecht, E. E., Khreisheh, N., Bradley, B. A., & Chaminade, T. (2015). Cognitive Demands of Lower Paleolithic Toolmaking. PLOS ONE, 10(4), e0121804. https://doi.org/10.1371/journal.pone.0121804

doi:10.20944/preprints202506.0100.v1

44. Tomasello, M. (2008). Origins of Human Communication. MIT Press
45. Toner, J., Montero, B. G., & Moran, A. (2016). Reflective and prereflective bodily awareness in skilled action. Consciousness and Cognition, 3(4), 303–315. https://psycnet.apa.org/journals/cns/3/4/303/
46. Vallortigara, G. (2018). Comparative cognition of number and space: the case of geometry and of the mental number line. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1740), 20170120. https://doi.org/10.1098/rstb.2017.0120
47. Varela, F. J., Thompson, E., & Rosch, E. (1991). The embodied mind: Cognitive science and human experience. Cambridge, MA: MIT Press.
48. Varga, S., & Heck, D. H. (2017). Rhythms of the body, rhythms of the brain: Respiration, neural oscillations, and embodied cognition. NeuroImage, 172, 294–306. https://www.sciencedirect.com/science/article/pii/S1053810017302088
49. Venezia, J. H., & Hickok, G. (2009). Mirror neurons, the motor system and language: From the motor theory to embodied cognition and beyond. Language and Linguistics Compass, 3(1), 1–20. https://doi.org/10.1111/j.1749-818X.2009.00169.x