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Hypothesis

The “Subjectica” Hypothesis: A Lateralized Neurophenomenological Model of Embodied Cognitive Dynamics

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Abstract

Contemporary accounts of hemispheric asymmetry in cognitive neuroscience predominantly emphasize neuroanatomical localization and functional specialization, while offering limited explanatory mechanisms for how lateralized neural processes become observable in embodied behavior. The Subjectica Hypothesis proposes a neurophenomenological framework in which hemispheric asymmetry is expressed not as a fixed correspondence with bodily sides, but as a dynamic pattern of sensorimotor embodiment manifested through bodily kinematics. The model introduces four operational constructs—Personal-Oriented Left Side (PO-LS), Society-Oriented Right Side (SO-RS), Asymmetric Neurobehavioral Signal (ANS) and the Body Segments (BS)—designed to link hemispheric functional dominance, cognitive orientation, and measurable bodily dynamics. These constructs function as interpretative intermediaries, enabling the analysis of lateralization through continuous patterns of posture, movement, and segment-level motor dominance rather than through discrete anatomical mappings. Subjectica does not report empirical results; instead, it defines a theoretically coherent and operationally specified framework intended to guide future experimental, observational, and phenomenological research on lateralized embodiment. The hypothesis generates falsifiable predictions concerning task-dependent cognitive orientation, hemispheric dominance, and asymmetric sensorimotor expression, extending existing models of hemispheric specialization within the broader paradigm of embodied cognition.

Keywords: embodied cognition; hemispheric lateralization; neurophenomenology; kinematic asymmetry; operationalization; cognitive neuroscience

Introduction

Embodied cognition proposes that cognitive states arise from sensorimotor processes (Barsalou, 2008; Wilson, 2002) rather than from purely abstract computations, and relies on causal narratives of the mind to attempt to interpret them through this hypothesis. Despite extensive work in cognitive science, key issues remain unresolved: (1) the lack of a unified mechanism explaining the correlation of subjective content with body side asymmetry; (2) conflicting evidence linking hemispheric processing to behavioral movement bias; and (3) the lack of a quantitative measure of cognitive states at any given moment in time. Research on hemispheric asymmetry (Davidson, 1992; Tucker, 1981; McGilchrist, 2019) establishes directional biases in how the hemispheres process information. Neurophenomenology emphasizes the need to integrate first- and third-person perspectives (Varela, 1996). However, existing theories fail to provide an operational bridge between cognitive stance and kinematic outcome (Martinez et al., 2017). This hypothesis addresses this gap by proposing a succinct postulates structure and a directly operationalizable kinematic index that, together, generate falsifiable predictions and offer the prospect of understanding the fundamental underpinnings of hemispheres as manifested through bodily dynamics.

Theoretical Explanations

Embodied Cognition

The concept of embodied cognition proposes that cognitive processes are based on sensorimotor systems; posture, gestures, and movements are not epiphenomena but components of cognition (Barsalou, 2008; Wilson, 2002). Empirical research links body states with perception, memory, and affect; however, mapping specific cognitive contents to lateralized motor features remains underdeveloped.

Hemispheric Asymmetry

Neuroscience documents functional lateralization: hemispheres differ in information processing style and function, with implications for emotion, attention, and self-referential information processing (Davidson, 1992; Tucker, 1981; McGilchrist, 2019). Translating these neural asymmetries into reliable behavioral markers requires a clear operationalization of how lateralized brain dynamics relate to whole-body kinematics.

Neurophenomenology

Neurophenomenology requires the integration of first-person and third-person data to bridge the explanatory gap (Varela, 1996). The Subjectivity Hypothesis adopts a neurophenomenological approach: subjective positional designations (e.g., “personal” versus “social”) are viewed as phenomenological categories that must be linked to objective kinematic indicators.

Kinematic Behavior as a Cognitive Indicator of Body Segment Kinematics

Advances in motion capture and pose estimation allow for the precise measurement of motion bias and segmental displacement (Martinez et al., 2017). These methods enable the calculation of lateralized motion indices on time scales relevant to cognitive processes at any given moment. Theoretical integration and empirical guidelines: The hypothesis brings together three interrelated lines of research. First, studies of gesture and action show that hand movements and posture are closely linked to cognitive and thought processes, suggesting that bodily activity is not merely an epiphenomenon but rather underlies certain cognitive operations (McNeill, 1994). Second, hemispheric approach/withdrawal models link lateralized cortical dynamics to approach and avoidance behavior, providing a neural basis for lateralized motor expressions of motivational stance. Third, the literature on motor compensation and interlimb adaptation shows that when one segment is limited or suppressed, other segments reliably increase output to maintain action (Hylin, M. J., Kerr, A. L., & Holden, R., 2017). Clearly, the factors underlying compensation and postcompensatory cognitive performance need to be examined. Research in motor control and embodied cognition consistently demonstrates that proximal segments (trunk, shoulders, hips) are more strongly associated with global action planning, motivational orientation, and postural intention, whereas distal segments (hands, fingers, facial musculature) support fine-grained symbolic, communicative, and task-specific operations.

Proximal musculature is engaged earlier in action preparation and reflects higher-level motor schemas, including approach–avoidance tendencies and spatial orientation. Distal segments, particularly hands and fingers, are closely linked to cognitive sequencing, symbolic representation, and linguistic processing, as evidenced by gesture–speech coupling and motor simulation studies.

This proximal–distal gradient provides a theoretical basis for differential contributions to lateralization, with proximal segments exerting greater influence on whole-body asymmetry and ANS stability, while distal segments allow rapid modulation and compensatory expression.

Gesture, Symbolic Action, and Upper-Limb Segments

Empirical research demonstrates a robust connection between hand and forearm movements and cognitive processing. Gesture production correlates with problem solving, memory retrieval, and

conceptual structuring, supporting the claim that hand movements are not mere outputs but integral components of thinking (Goldin-Meadow, 2014).

Neuroimaging studies further indicate overlapping neural substrates for gesture, language, and action planning, particularly in lateralized cortical networks. These findings support the hypothesis that upper limb segments are the primary hosts of the autonomic nervous system associated with symbolic and reflective cognition, particularly in contexts requiring explicit communication or deliberation.

Axial and Lower-Body Segments: Postural Intention and Motivational Orientation

Axial segments (torso, spine, hips) and lower-body segments (legs, feet) play a central role in postural regulation, balance, and locomotor intention. Research in affective neuroscience and embodied emotion links posture and weight distribution to motivational states, including approach, withdrawal, dominance, and submission.

Hemispheric models of approach-withdrawal behavior suggest that lateralized cortical activity influences postural bias and locomotor readiness. The engagement of axial and lower segments thus provides a behavioral channel through which hemispheric asymmetry becomes embodied at the level of stance and movement direction, rather than fine motor action.

Facial Segments and Communicative Modulation

Facial musculature occupies a distinct position within the segmental hierarchy of embodied cognition. While facial expressions are central to emotional signaling and social communication, they are also subject to high levels of voluntary control, social masking, and strategic modulation. Research in nonverbal communication and deception consistently demonstrates that facial signals are frequently regulated in accordance with social norms, display rules, and contextual expectations, which can obscure underlying affective or motivational states.

This regulatory flexibility renders facial segments highly expressive but comparatively low in interpretative reliability when considered in isolation. Unlike postural or gross motor patterns, facial expressions can be rapidly altered, suppressed, or exaggerated without corresponding changes in deeper sensorimotor or autonomic dynamics. Saccades last on time scales of 20–50 ms, making them significantly less accessible to conscious control than facial expressions or gestures (Rayner, 1998).

A partial exception within the facial domain is oculomotor activity, which exhibits robust evidence of lateralized control and asymmetric deployment of attentional and sensorimotor resources. Eye movements, fixation bias, and saccadic dynamics have been shown to reflect lateralized neural processing and attentional orientation, operating at temporal scales that are less accessible to conscious modulation than overt facial expressions (Posner & Petersen, 1990; Munoz & Everling, 2004; Corbetta & Shulman, 2002).

Accordingly, within the model, facial segments are treated as informative but conditionally reliable indicators of embodied cognitive dynamics. Facial signals are not interpreted as direct markers of the Asymmetry Neurobehavior Signal (ANS) unless they are corroborated by less consciously regulated segments, such as axial posture, limb kinematics, or whole-body orientation. Oculomotor asymmetries, by contrast, are afforded higher interpretative weight due to their closer coupling with lateralized sensorimotor control and attentional processes.

Theoretical Postulates

The Subjectica Hypothesis is grounded in the following research postulates, formulated as provisional theoretical commitments rather.

The Integrative Nature of Body and Mind (Neuro-Behavioral Connection)

This postulate postulates that the human mind and physical body are not independent entities, but form a single, inseparable neurobehavioral system, where every internal cognitive state (thought,

emotion, intention, belief, internal conflict) inevitably and instantly manifests at the physiological and behavioral levels. This means that the body is a direct and objective reflection of the individual's current cognitive state. Hemispheric asymmetry is not exhausted by neural localization or cognitive function alone but is continuously expressed through patterns of bodily kinematics, posture, and sensorimotor regulation.

Functional Asymmetry: Brain Lateralization and Behavioral Projection

This postulate posits that the functional lateralization of the brain, which consists of the specialization of its hemispheres in processing different types of information and cross-control over opposite sides of the body, has a direct and observable manifestation in behavioral patterns. The hypothesis interprets this innate asymmetry through the concept of two primary neurobehavioral domains, or "sides of the body," each reflecting a specific cognitive orientation. The manifestation of hemispheric dominance in bodily behavior is mediated by cognitive orientation, specifically personal (self-referential) and social (externally oriented) modes of engagement with the environment.

Semantic Segmentation of the Body: Cognitive Projections and Behavioral Dominants

This postulate asserts that the human body is not homogeneous in its cognitive manifestations, but rather functionally segmented, with each part (or group of parts) serving primarily to express specific categories of cognitive activity and behavioral responses. This segmentation is based on principles of neuromotor control, evolutionary adaptation, and the physiological functions of various body parts.

Neurobehavioral Adaptation and Modification

This postulate postulates that, thanks to the principles of neuroplasticity and dynamic adaptation, an individual is able to consciously influence their cognitive background and, consequently, their behavioral manifestations through the targeted modification of bodily movements and postures. This creates a mechanism of active self-regulation and transformation, allowing the formation of desired cognitive priorities and behavioral patterns.

Cultural Modification and Contextual Interpretation

This postulate recognizes that, although the basic neurobehavioral mechanisms of consciousness manifestation (described in postulates 1-4) are universal for all people, the specific forms, nuances, and interpretations of bodily manifestations are significantly shaped and modified by cultural, social, and individual contexts. This means that an accurate analysis must consider the dynamic interaction between universal biological signals and acquired cultural patterns. Cultural aspects of personality are hypothesized to shape chronic cognitive-behavioral aspects.

Operating Structures

While the concept of Right-Hemisphere Dominant Embodiment (RHDE) and Left-Hemisphere Dominant Embodiment (LHDE) describes a neural state associated with holistic processing and self-awareness, it remains a neurophysiological descriptor that does not formally necessitate a specific kinematic vector. In other words, RHDE or LHDE describes what the brain is doing, but it lacks a precise operational definition for how the body manifests this state spatially. To bridge the explanatory gap between internal hemispheric activity and observable bodily dynamics, it is necessary to introduce a level of interpretation that links neural lateralization to specific, measurable kinematic orientations.

Therefore, introduce four core operational constructs designed to translate abstract hemispheric states into concrete, falsifiable kinematic variables:

1) Personal-Oriented Left Side (PO-LS)

Propose PO-LS not merely as a synonym for left-sided movement body, but as the kinematic interface of RHDE. While the right hemisphere (RH) provides the neural substrate for the “Personal Self” (internal focus), this state remains internal until projected. Due to contralateral motor control, the RH projects this internal state onto the left hemibody. Consequently, PO-LS is defined as the active maintenance of the left hemibody as the dominant agent of expression. It serves as the physical anchor for the “Personal Orientation,” transforming the abstract RHDE signal into an observable behavioral vector. Without this specific term, researchers cannot distinguish between random left-sided motion and the intentional, embodied maintenance of the “Personal” cognitive stance.

Definition: A cognitive position primarily associated with right-hemisphere functional patterns, expressed behaviorally through left-sided motor activity.

Key semantics: self-oriented processing, intuition, holistic integration, autobiographical access.

Behavioral indicators (operationalization): relative displacement of movement and occupied spatial domain or frequency of activity on the left side of the body; movement displacement is viewed as a general kinematic indicator of embodied cognitive activity; the hypothesis provides an interpretative framework for correlating displacement patterns with a phenomenological position.

Task/state activation profile: autobiographical reflection, intuition-based tasks, internalized evaluative processing.

2) Social-Oriented Right Side (SO-RS)

Similarly, the Left Hemisphere (LH) is functionally associated with social adaptation, language, and normative regulation (“Social Self”). We define SO-RS as the kinematic projection of this LHDE. SO-RS represents the recruitment of the right hemibody to serve social-communicative functions. By isolating this as a specific construct, we allow for the measurement of “Social Orientation” not through linguistic analysis, but through the spatial dominance of the right side. This distinction is crucial: it posits that social compliance is not just a mental state but a lateralized physical stance mediated by the left hemisphere’s control over the right side.

Definition: A cognitive position primarily associated with functional patterns of the left hemisphere of the brain, expressed behaviorally through right-sided motor activity.

Key semantics: social adaptation, verbal-analytical control, normative regulation, role performance.

Behavioral indicators (operationalization): relative displacement of movement and the occupied spatial domain or frequency of activity on the right side of the body; movement displacement is considered a general kinematic indicator of embodied cognitive activity; the hypothesis provides an interpretative basis for correlating displacement patterns with the phenomenological position.

Task/state activation profile: normative evaluation, role-based behavior, impulse control, external decision making.

3) Asymmetrical neurobehavioral signal (ANS)

To unify these lateralized projections presented above into a single coherent model, introduce the ANS. The ANS is the quantitative differential between PO-LS and SO-RS activity at any given moment ($ANS = \Delta(PO_LS, SO_RS)$).

The ANS provides the necessary integrity to the interpretation model. It postulates that the body does not simply “move”; it oscillates between these two poles. The ANS allows us to interpret the shifting balance between the “Personal” (PO-LS) and “Social” (SO-RS) orientations as a continuous signal, offering a holistic metric of the subject’s embodied cognitive state.

Definition: A quantitative index of lateralized motor activity used to classify PO-LS or SO-RS dominance during a given cognitive epoch.

Interpretation:

$ANS \approx +1 \rightarrow$ left-sided dominance (PO-LS).

$ANS \approx -1 \rightarrow$ right-sided dominance (SO-RS).

Segment-level dominance calculation: For each bilateral segment (e.g., shoulder, upper arm, forearm, trunk tilt, head rotation, leg), the local dominance index can be defined as the difference between the absolute left and right displacements during a given epoch.

The global ANS is a normalized aggregation of these local dominance values and thus directly reflects the dominance structure of paired segments while preserving the contribution of each segment. Operational computations (brief description): For each functional segment, lateral activity is quantified as the total absolute displacement of tracked joint positions within a defined interpretation period (typical factors include task performance while maintaining conscious awareness of the context). Segment-level dominance is discretely categorized (+1/-1) for conceptual clarity in some analyses, although continuous ANS formulations are conceptually equivalent and may be preferable in statistical modeling. Coordinates should be normalized relative to participant proportions, smoothed to reduce high-frequency noise, and checked for artifacts.

4) Body Segments (BS)

As a functional framework for analyzing how embodied cognitive dynamics are distributed across the body. Rather than treating the body as a homogeneous motor output system, this approach assumes that distinct anatomical segments contribute differentially to cognitive expression, lateralization, and neurobehavioral signaling.

Segment-based interpretations are not novel per se; however, existing research remains fragmented across gesture studies, motor control, affective neuroscience, and posture analysis. Subjectica integrates these findings into a unified segmental model aligned with embodied cognition and hemispheric asymmetry.

The body is divided into functional segments (head, neck, shoulders, arms, trunk, legs), which are further divided into subsegments (eyes, mouth, shoulders, forearms, elbows, hands, fingers, chest, abs, lower back, upper back, hips, knees, shins, feet). Proximal segments typically contribute more to lateralization than distal segments, allowing for segmental decomposition of the ANS, identifying associative variations in the cognitive background at the moment.

Segment Semantics – Empirical Parallels. The behavioral semantics of various segments have been described in the literature: hands/forearms are closely correlated with symbolic actions and gesture production (gesture-thought connection), while axial segments (torso, hips, legs) indicate approach/retreat and postural intention; facial musculature is regulated more consciously and reflects communicative masking (microexpressions) (Burgoon JK (2018)). These empirical associations support the segmental assignments in Subjectica and are consistent with classical data on gesture cognition and emotional expression.

Segmental semantics refer to probabilistic associations between specific body segments and classes of cognitive-affective processes. These associations are not deterministic mappings but interpretative constraints grounded in empirical regularities.

Hands / forearms: symbolic processing, cognitive sequencing, communicative intent

Shoulders / upper trunk: action readiness, agency, boundary regulation

Chest / axial spine: motivational orientation, emotional valence, engagement vs. withdrawal

Hips / legs / feet: approach-avoidance dynamics, stability, intentional directionality

Face: communicative display, affect regulation, social masking

This segmentation allows ANS to be decomposed into segment-specific sub-signals, enabling finer-grained interpretation of cognitive background dynamics at a given moment.

Segmental Decomposition of Asymmetry Neurobehavior Signals (ANS)

The autonomic nervous system is viewed not as a single phenomenon, but as a composite signal distributed across segments. Segmental decomposition allows researchers to distinguish:

global asymmetries (proximal dominance, postural bias)

local asymmetries (unilateral arm use, facial tension)

compensatory asymmetries, in which suppressing or limiting the activity of one segment leads to increased activity in another.

Research on motor compensation and interlimb adaptation shows that when the output of one segment is limited, other segments reliably increase their activity to maintain functional goals (Hylin et al., 2017). This hypothesis extends this principle to cognitive embodiment, suggesting that compensatory segmental activation reflects changes in cognitive background rather than purely mechanical substitution.

Interpretation Hierarchy and Reliability:

A hierarchical interpretation model is used, prioritizing segments based on their susceptibility to conscious control and compensatory biases:

Axial and postural segments (highest reliability)

Proximal limb segments

Distal limb segments

Facial musculature (lowest reliability without intersegmental confirmation)

This hierarchy mitigates overinterpretation of individual gestures or expressions and aligns the model with established criticisms of simplistic decoding of body language.

Theoretical Contributions of the Segmental Model:

The concept of body segments extends research on embodied cognition and hemispheric asymmetry by introducing:

A structured, non-reductive model of body asymmetry

A mechanism for linking neural dominance to observable kinematics

A scalable interpretive framework compatible with qualitative, quantitative, and phenomenological methods

By integrating segmental differentiation with the autonomic nervous system, Subjectica provides a theoretically grounded method for analyzing the dynamics of embodied cognition without reverting to anatomical determinism or metaphorical interpretations of body language.

Observed Variables

The following variables represent measurable inputs from which segmental dominance estimates are derived: absolute joint displacement (the primary metric for the ANS), segmental path length within a moment, lateral displacement of the extraocular muscles, shoulder and trunk rotation displacement, fine hand movement displacement, and activation frequency of other segments. These metrics can be obtained using standard motion capture methods or markerless pose estimation methods.

ANS, dominant hand and postural bias. The ANS is not proposed as a simple substitute for handedness or habitual posture. Handedness and cultural postural conventions are explicit covariates in the model: they shape baseline lateral tendencies and should be modeled as moderators at the participant level. The ANS is designed to capture task-dependent changes in relative segmental bias after accounting for baseline handedness/posture. In practice, this requires (1) measuring baseline lateral bias, (2) modeling handedness and culturally learned gestures as fixed effects or covariates, and (3) interpreting autonomic nervous system changes as context-dependent deviations rather than as absolute evidence of hemispheric state. Ethnographic and cross-cultural data (e.g., the history and distribution of greeting gestures such as the handshake) indicate that lateralized social rituals vary across cultures and can determine which side is used dominantly in social behavior; such factors should therefore be integrated into experimental design and interpretation. Claims about spontaneous reactions in isolated societies require ethnographic data and targeted fieldwork, not extrapolations from urban samples (Oxlund, 2020). For theoretical completeness, the hypothesis models cultural display rules as modulators, rather than falsifiers, of autonomic nervous system patterns.

Testable Hypotheses

Hypothesis 1 Activation of PO-LS. Self-related or introspective cues lead to statistically significant left-sided ANS dominance compared to neutral control tasks.

Falsification criterion: absence of systematic left-sided ANS dominance across participants in controlled self-focused tasks.

Hypothesis 2 Activation of SO-RS. Social-evaluative or normative cues lead to statistically significant rightward dominance of the ANS compared to neutral control tasks.

Falsification criterion: absence of systematic rightward dominance of the ANS across participants in controlled social-evaluation tasks.

Hypothesis 3 Segment-level consistency. Axial and proximal segments (head, neck, shoulders, trunk) demonstrate stronger and more reliable lateralization than distal extremities during task manipulation; leakage or inconsistency at the segmental level will be evident during cognitive conflict.

Falsification criterion: lack of a consistent segmental pattern in controlled tasks.

Criteria for Falsification

The operational form of the hypothesis is empirically falsified if, in adequately controlled and powered experiments, at least one of the following conditions holds: (1) no robust left-right asymmetry is observed at the group level under controlled cognitive conditions (personal vs. social perception); (2) the ANS fails to distinguish between personal and social tasks with sufficient power to go beyond chance; (3) segment contributions fail to show a reproducible pattern across repeated experiments; (4) task-dependent polarity does not change when switching conditions within subjects. A robust null result after careful controls for measurement error, segmentation choice, cultural context, and handedness constitutes empirical refutation of the given operationalization.

Methodological Considerations

Recommended methods for initial empirical work include: using validated motion capture or markerless pose estimation methods to extract joint coordinates; normalizing coordinates according to participants' body proportions; transparently describing epoch definitions and smoothing procedures; explicitly treating handedness and culture-related variables as covariates; and preregistering primary outcome measures and analysis plans.

Discussion

The hypothesis defines a specific, testable correspondence between cognitive stance and lateralized kinematic expression. If confirmed, it provides a practical kinematic index (PKI) that can be combined with neural measurements to study embodied aspects of cognition and self-representation. Potential applications include therapeutic self-regulation protocols, behavioral diagnostics, and human-computer interfaces that measure cognitive stance, psychology, parenting, and learning. Robust empirical testing requires cross-cultural replication and multimodal triangulation (behavioral kinematics with neural and phenomenological measurements).

Alternative explanations that should be considered in future research include the influence of handedness, habitual posture, affective valence (approach/distance dynamics), and cultural display rules. These alternative explanations should be explicitly tested and controlled for in subsequent studies.

Conclusion

The "Subjectica" hypothesis offers a clearly formulated theoretical model linking lateralized bodily dynamics to cognitive stance and proposes an operational index (ANS) for empirical testing. The next step is the implementation of targeted empirical tests, transparent reporting, and collaborative replication with laboratories equipped for kinematic and neural measurements.

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