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A Three-Layer Cognitive Structure Theory of "Soma-Emotion-Meaning" Based on Embodied Cognition: Integrating Somatic Marker Hypothesis and Progressive Weakening-Compensation Principle — An Integrative Framework for Understanding Autism Spectrum Disorder and Depression Comorbidity

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Abstract

The comorbidity rate between Autism Spectrum Disorder (ASD) and depression reaches 50%, yet there is a lack of an integrated theoretical framework to guide digital health interventions. Existing research on sensory processing, emotion regulation, and meaning-making is fragmented, which limits the development of technology-enabled treatment solutions. This study integrates embodied cognition theory, the somatic marker hypothesis, and the principle of decreasin entropy and compensation, proposing a three-layer cognitive structure theory of "sensory awareness - emotional awareness - sense of meaning". This framework reveals that the comorbidity of ASD and depression stems from impairments in the three-layer cognitive pathway. Art therapy operates through dual mechanisms: sensory integration activates bottom-up neuroplasticity, while narrative reconstruction achieves top-down cognitive reappraisal. This theoretical model provides clear guidelines for the development of intelligent assessment tools, adaptive intervention algorithms, and data-driven personalized strategies in mobile health applications.

Keywords: Art therapy, Autism Spectrum Disorder, Depression, Embodied cognition, Somatic marker hypothesis, Progressive weakening and compensation principle, Soma-emotion-meaning theoretical framework

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1. Introduction

1.1 Research Background and Clinical Significance

The comorbidity phenomenon between Autism Spectrum Disorder (ASD) and depression constitutes one of the most pressing clinical challenges in contemporary mental health. Research indicates that the risk of depression in individuals with ASD is significantly higher than in the general population, with a comorbidity rate reaching 50% [1]. This high comorbidity rate not only exacerbates functional impairment and quality of life decline in individuals with ASD but also increases suicide risk, imposing a heavy burden on families and society. However, traditional verbal psychotherapy faces unique challenges in intervening with ASD comorbid depression: approximately 25% of individuals with ASD have alexithymia, making it difficult to identify, express, and describe their emotional experiences [2].

This difficulty in verbal expression limits the effectiveness of talk-based therapeutic approaches, highlighting the importance of non-verbal intervention methods.

Art therapy, as a non-verbal psychological intervention method, promotes emotional expression, self-exploration, and meaning construction through the visual art creation process, providing unique possibilities for treating ASD comorbid depression. Art creation bypasses the barriers of verbal expression, allowing individuals to directly express internal experiences through sensory media such as color, shape, and texture, while gaining a sense of control, self-efficacy, and meaning during the creative process. In recent years, art therapy has accumulated rich clinical experience and preliminary empirical evidence in interventions for ASD and depression [3, 4]. However, despite fruitful outcomes at the practical level, art therapy research lags relatively behind in theoretical construction, exhibiting significant "disciplinary fragmentation" and "theoretical fragmentation."

Recent cutting-edge research further highlights the urgency of theoretical integration. Hao et al. revealed through neuroscientific research that the core mechanism of ASD comorbid depression may lie in the separation between subjective perception and objective symptoms — individuals with ASD who have a history of depression show higher self-rated ASD symptoms and poorer social satisfaction, but no significant differences in objective social function tests, with anterior cingulate cortex (ACC) volume closely related to this subjective-objective separation [5]. Khachadourian et al., based on a large-scale study of 42,569 individuals with ASD, found that 74% of individuals with ASD have at least one comorbidity, with perinatal exposure related to multiple comorbidities, suggesting a common early neurodevelopmental foundation [6]. Camus et al. revealed through psychosocial research a complete mediation pathway from autistic traits to depressive symptoms: autistic traits → social self-efficacy↓ → social motivation↓ → loneliness↑ → depressive symptoms↑, with psychosocial factors completely mediating the relationship between the two [7].

These latest studies provide important puzzle pieces from three levels: neuroscience, epidemiology, and psychosocial mechanisms, but they also face a common dilemma: the lack of an integrative theoretical framework to connect these findings. In parallel, design-driven multimodal mental health screening frameworks are increasingly exploring privacy-preserving collaboration (e.g., federated learning) and cultural adaptation to translate neurodevelopmental assessments into scalable, human-centered digital workflows[8]. Neuroscience tells us "which brain regions are activated," epidemiology tells us "how prevalent comorbidity is," and psychosocial research tells us "what the mediating variables are," but we still do not know: How do these findings from different levels constitute an organic, hierarchical, and causal cognitive process? How does art therapy play a role in this process?

1.2 Theoretical Dilemmas in Existing Research

Through a critical review of existing literature, we found that art therapy research exhibits three levels of "fragmentation" dilemmas:

Fragmentation in ASD research: Existing research mainly develops along two parallel paths. One path focuses on the "Soma" layer, adopting sensory-based art therapy, improving sensory processing abnormality in individuals with ASD by providing diverse tactile, visual, and proprioceptive stimulation [9]. The other path focuses on the "Emotion" layer, adopting socially-oriented art therapy, promoting social interaction and emotional expression through group art activities [10]. However, there is a lack of connection between these two paths: How does improvement at the "Soma" layer translate into enhanced social-emotional abilities at the "Emotion" layer? The causal pathway is unclear. More importantly, these studies almost completely ignore the "Meaning" needs of high-functioning adults with ASD — they not only need to improve sensory processing and social skills but also need to construct life meaning, self-identity, and sense of value.

Fragmentation in depression research: Art therapy research for depression mainly focuses on the "Emotion" layer and "Meaning" layer. On one hand, researchers emphasize that art creation promotes emotional expression and regulation, helping clients identify, name, and release repressed emotions [11]. On the other hand, researchers emphasize the narrative reconstruction function of art therapy, helping clients reconstruct life stories and discover meaning and hope through the creation and interpretation of symbolic symbols [12]. However, these studies generally suspend the "Soma" layer — that is, the role of bodily sensations and embodied experiences in depression. Increasing evidence suggests that

depression is not only a disorder of emotion and cognition but also an embodied experience, involving numbness, fatigue, and pain in bodily sensations [13]. The tactile and kinesthetic experiences in the art creation process may play an important role in the healing of depression, but this dimension is seriously neglected in existing research.

Fragmentation in neuroscience research: Neuroscience research provides an important biological foundation for art therapy but also exhibits the limitation of "seeing the trees but not the forest." Researchers have separately revealed different brain regions activated by art creation: sensorimotor cortex (somatic processing), amygdala and prefrontal cortex (emotional regulation), default mode network (self-reflection and meaning construction) [14]. However, how do these brain regions work synergistically to form a hierarchical, dynamically interactive neural network, thereby achieving the transformation from sensory experience to emotional integration to meaning construction? Existing research lacks an integrative neurocognitive model.

1.3 Theoretical Innovation: An Integrative Framework of Embodied Cognition Theory and Three-Layer Cognitive Structure

To bridge the above theoretical gaps, this study proposes an integrative "Soma-Emotion-Meaning" three-layer cognitive structure theoretical framework, with Embodied Cognition Theory and Damasio's Somatic Marker Hypothesis as the main theoretical foundations, and integrating the Progressive Weakening and Compensation Principle as a cross-cultural philosophical perspective supplement.

Embodied Cognition Theory was systematically elaborated by scholars such as Varela, Thompson, and Rosch, arguing that cognition is not pure symbolic manipulation or computational processes within the brain but is deeply rooted in the dynamic interaction between the body and the environment [15]. The core views of this theory include: (1) The body is the foundation of cognition — higher cognitive functions (such as abstract thinking, emotion, self-awareness) are built on the foundation of sensorimotor experience; (2) Cognition is contextualized — cognitive processes cannot be separated from the physical and social environment in which the body is situated; (3) Bodily states profoundly affect cognitive and emotional processes — the body's posture, movements, and sensations directly shape our thinking and emotional experiences.

Damasio's Somatic Marker Hypothesis further reveals how bodily sensations influence decision-making and cognition through emotional marking. The hypothesis proposes: (1) Changes in bodily states produce emotional experiences — when we face stimuli or situations, the body produces physiological responses (such as increased heart rate, muscle tension), which are perceived by the brain as emotions; (2) Emotional experiences form "somatic markers" — repeated body-emotion experiences form markers in the brain, which are associated with specific stimuli or situations; (3) Somatic markers guide cognitive processing and decision-making — when we face similar situations again, somatic markers are activated, quickly guiding our attention, judgment, and action. Neuroscience research indicates that this process involves the synergistic work of the prefrontal cortex, amygdala, and somatosensory cortex.

Based on these two mainstream theories, the Progressive Weakening and Compensation Principle provides a unique evolutionary philosophical perspective. This principle, proposed by Chinese philosopher Wang Dongyue, argues that in the evolutionary process, as the degree of existence decreases (i.e., survival ability declines), organisms must maintain survival through the enhancement of compensatory functions. Applied to the human cognitive system, this principle helps us understand: (1) Why the human cognitive system exhibits a hierarchical structure — each higher cognitive level is a compensation for the insufficiency of lower-level functions; (2) Why higher cognitive functions depend on the integrity of lower cognitive functions — compensatory functions must be built on the foundation of the functions being compensated; (3) Why cognitive impairment exhibit a "cascade effect" — impairment in lower-level functions lead to the failure of upper-level compensatory functions.

Integrating these three theoretical perspectives, we propose three levels of cognitive functions:

- First Layer: Soma — The basic compensatory function of life. Soma is the most primitive and direct survival compensation mechanism, directly perceiving the environment through the sensory system (touch, vision, hearing, smell, taste, proprioception, vestibular sense) and making immediate approach-avoidance responses. This level is evolutionarily the oldest and most stable, serving as the foundation for all higher cognitive functions.
- Second Layer: Emotion — The compensatory product of social animals. With the emergence of sociality, mere sensory responses are insufficient to cope with complex social environments. Emotion, as a higher-level compensation mechanism, integrates multiple sensory information and endows it with social meaning (such as safety, threat, intimacy, exclusion). Emotion is not only an internal experience of the individual but also a medium for social interaction. Through emotional expression and empathy, individuals can establish social connections and obtain group support.
- Third Layer: Meaning — The unique compensation of humans. The greatest survival challenge humans face is not only the physical and social environment but also existential anxiety — fear of death, loneliness, and meaninglessness. Meaning, as the highest-level compensation mechanism, alleviates existential anxiety

by constructing narratives, symbolic systems, and value systems, thereby endowing the individual's existence with purpose and value. The construction of meaning depends on the integration of past experiences, understanding of current situations, and imagination of future possibilities.

This three-layer structure is not a simple linear superposition but a dynamically interactive system: there is bottom-up constructive dependence (upper-layer functions are built on lower-layer foundations) and top-down functional regulation (higher cognitive functions can reversely affect lower-level perception).

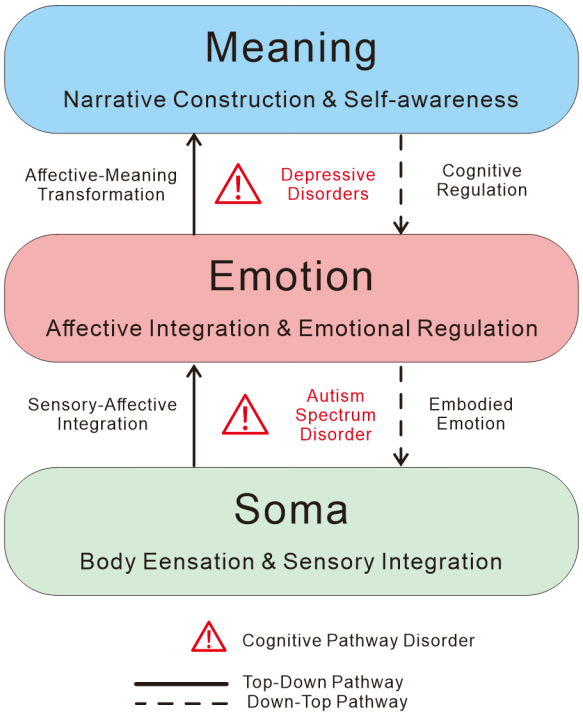

Figure 1. Three-Layer Cognitive Structure Based on Embodied Cognition Theory and Somatic Marker Hypothesis

Figure 1 demonstrates the three-layer cognitive structure based on Embodied Cognition Theory and Somatic Marker Hypothesis. The bottom "Soma" layer corresponds to the bodily foundation of Embodied Cognition Theory, the middle "Emotion" layer corresponds to the emotional marking mechanism of the Somatic Marker Hypothesis, and the top "Meaning" layer corresponds to the meaning construction process of Embodied Cognition Theory. Arrows indicate bottom-up constructive dependence (solid lines) and top-down functional regulation (dashed lines). The Progressive Weakening and Compensation Principle provides an evolutionary philosophical perspective for understanding this hierarchical structure.

1.4 Research Objectives and Paper Structure

The core objective of this study is: to construct an integrative theoretical framework that explains the comorbidity mechanisms of ASD and depression and elucidates the mechanisms of art therapy. Specifically, this study will:

- Systematically review the fragmentedstate of existing research and reveal theoretical gaps (Part 2)
- Construct the "Soma-Emotion-Meaning" three-layer cognitive structure theoretical framework, integrating the Progressive Weakening and Compensation Principle and Embodied Cognition Theory (Part 3)
- Elucidate the implications of this theoretical framework for art therapy mechanisms, providing theoretical guidance for clinical practice (Part 3)
- Discuss theoretical contributions, clinical significance, and future research directions (Part 4)

The innovation of this study lies in:

- Theoretical integration: Integrating Embodied Cognition Theory, Somatic Marker Hypothesis, and Progressive Weakening and Compensation Principle to construct a cross-disciplinary, cross-cultural hierarchical cognitive structure model
- Interdisciplinary dialogue: Integrating research achievements from philosophy, neuroscience, psychology, and art therapy
- Clinical guidance: Providing a clear theoretical framework for art therapy, guiding the design of assessment and intervention strategies
- Cutting-edge integration: Systematically integrating the latest research from 2023-2025, providing unified explanations for fragmented findings

2. Literature Review: Seeking Unified Pathways in Fragmented Evidence

2.1 Introduction: The Necessity of Moving from "Disciplinary Fragmentation" to "Integration"

Art therapy research has made significant progress over the past two decades but also exhibits an increasingly serious trend of "disciplinary fragmentation." Research targeting different impairment (ASD, depression, post-traumatic stress disorder, etc.), different age groups (children, adolescents, adults), and different art forms (visual arts, music, dance, drama) has developed independently, forming relatively

independent research fields. While this disciplinary fragmentation has promoted specialization and in-depth research, it has also led to theoretical fragmentation: different studies use different theoretical frameworks, assessment tools, and intervention strategies, lacking cross-field dialogue and integration. This section will systematically review art therapy research targeting ASD and depression, revealing its fragmented state and theoretical gaps.

2.2 Art Therapy and Autism (ASD): Fragmented Interventions Focusing on the "Soma→Emotion" Pathway

Sensory processing abnormality is one of the core features of ASD, manifesting as hypersensitivity or hyposensitivity to tactile, visual, auditory, and other sensory stimuli. Sensory-based art therapy improves sensory integration abilities in individuals with ASD by providing rich and diverse sensory experiences. For example, Schweizer et al. found that clay sculpture activities can provide tactile, proprioceptive, and visual stimulation, helping children with ASD improve sensory processing and reduce anxiety [16]. Similarly, Epp reported that painting activities using different textures of materials (such as sand, fabric, sponge) can help individuals with ASD explore and adapt to diverse sensory inputs [9].

However, these studies mainly focus on improvements at the sensory level, lacking exploration of how sensory improvements translate into higher-level emotional and social abilities. The causal pathway from "Soma" to "Emotion" remains a black box.

Another research path focuses on using art therapy to promote social interaction and emotional expression. For example, Schweizer et al. found through group art therapy that collaborative art creation can promote social interaction, turn-taking, and empathy development in children with ASD [16]. Martin reported that art therapy helps individuals with ASD identify and express emotions, improving emotional regulation abilities [10].

However, these studies rarely discuss how the bodily sensory experiences in the art creation process support emotional development. The connection between the "Soma" layer and the "Emotion" layer is missing.

Most existing research focuses on children and adolescents with ASD, with interventions primarily targeting sensory and social skills. However, high-functioning adults with ASD face not only sensory and social challenges but also existential challenges — they need to construct self-identity, find life meaning, and establish a sense of value. Existing art therapy research almost completely ignores this "Meaning" layer need.

2.3 Art Therapy and Depression: Suspending the "Soma" Layer

Art therapy research for depression mainly focuses on emotional expression and regulation. For example, Hass-Cohen and Carr proposed that art creation provides a safe space for expressing repressed emotions, helping clients identify, name, and release emotional experiences[11]. Kaimal et al. found through neuroimaging studies that art creation activates the reward system, promoting positive emotional experiences [14].

Another research path emphasizes the narrative reconstruction function of art therapy. For example, Malchiodi proposed that art creation helps clients reconstruct life stories through symbolic symbols, discovering new meanings and possibilities[12]. Rubin emphasized that art therapy promotes self-exploration and identity construction, helping clients find hope and direction [17].

However, these studies generally suspend the "Soma" layer — that is, the role of bodily sensations and embodied experiences in depression. Correspondingly, recent wearable innovations in skin conductance sensing (e.g., micro-lace electrode designs) make it feasible to capture continuous electrodermal activity as an objective soma-layer signal for integrated physical and mental activity monitoring, which may enrich embodied evidence beyond self-report in related intervention research. [18]. The tactile and kinesthetic experiences in the art creation process may play an important role in the healing of depression, but this dimension is seriously neglected in existing research.

2.4 Cutting-Edge Progress: Latest Research (2023-2025)

Hao et al. revealed through neuroimaging research that individuals with ASD who have a history of depression show higher self-rated ASD symptoms and poorer social satisfaction, but no significant differences in objective social function tests. ACC volume is closely related to this subjective-objective separation, suggesting that subjective perception may be a key mechanism of comorbidity [5].

Khachadourian et al., based on a large-scale study of 42,569 individuals with ASD, found that 74% of individuals with ASD have at least one comorbidity, with perinatal exposure related to multiple comorbidities, suggesting a common early neurodevelopmental foundation [6].

Camus et al. revealed a complete mediation pathway from autistic traits to depressive symptoms: autistic traits → social self-efficacy↓ → social motivation↓ → loneliness↑ → depressive symptoms↑, with psychosocial factors completely mediating the relationship between the two [7].

2.5 Summary: The Urgent Need for an Integrative Theoretical Framework

Existing research provides rich empirical evidence from different levels (sensory, emotional, meaning, neuroscience, psychosocial), but these findings are fragmented and lack an integrative theoretical framework to connect them. We need a hierarchical, dynamically interactive, and causally clear theoretical model to explain how these different levels of findings constitute an organic cognitive process, and how art therapy plays a role in this process.

3. Theoretical Framework: The "Soma-Emotion-Meaning" Three-Layer Cognitive Structure

3.1 Overview: An Integrative Framework Based on Multiple Theoretical Perspectives

This study proposes a "Soma-Emotion-Meaning" three-layer cognitive structure theoretical framework, integrating three theoretical perspectives:

- Embodied Cognition Theory — Provides the epistemological foundation, emphasizing that the body is the foundation of cognition.
- Damasio's Somatic Marker Hypothesis — Provides the neuroscientific mechanism, revealing the transformation from body to emotion to cognition.
- Progressive Weakening and Compensation Principle — Provides the evolutionary philosophical perspective, explaining hierarchical structure and causal relationships.

3.2 Embodied Cognition Theory: The Body as the Foundation of Cognition

Embodied Cognition Theory, systematically elaborated by Varela, Thompson, and Rosch, challenges the traditional view of cognition as pure symbolic manipulation, arguing that cognition is deeply rooted in the dynamic interaction between the body and the environment [15].

Core Views:

- The body is the foundation of cognition: Higher cognitive functions (such as abstract thinking, emotion, self-awareness) are built on the foundation of sensorimotor experience. For example, our understanding of abstract concepts (such as "warmth," "support," "pressure") is rooted in bodily experiences.
- Cognition is contextualized: Cognitive processes cannot be separated from the physical and social environment in which the body is situated. Cognition is not computation within the brain but the result of the body's interaction with the environment.
- Bodily states affect cognition and emotion: The body's posture, movements, and sensations directly shape our thinking and emotional experiences. For example, studies have shown that maintaining an upright posture can enhance confidence, while slouching increases negative emotions.

Relationship to the Three-Layer Structure:

- Soma Layer: Corresponds to the bodily foundation of Embodied Cognition Theory — sensory experiences are the starting point of all cognition
- Emotion Layer: Bodily states produce emotional experiences through physiological responses
- Meaning Layer: Abstract concepts and meanings are constructed based on bodily metaphors and sensorimotor experiences

Neuroscientific Evidence:

Neuroimaging studies have shown that when we understand abstract concepts, the sensorimotor cortex is activated, indicating that abstract thinking is rooted in bodily experiences [19].

Implications for Art Therapy:

Art creation is atypical embodied activity — through tactile, visual, and kinesthetic experiences, individuals can directly access and express internal states, bypassing the barriers of verbal expression.

3.3 Damasio's Somatic Marker Hypothesis: The Bridge from Body to Meaning

Damasio's Somatic Marker Hypothesis provides a neuroscientific mechanism for understanding how bodily sensations influence decision-making and cognition through emotional marking [20].

Core Mechanism:

- Changes in bodily states produce emotional experiences: When we face stimuli or situations, the body produces physiological responses (such as increased heart rate, muscle tension), which are perceived by the brain as emotions.
- Emotional experiences form "somatic markers": Repeated body-emotion experiences form markers in the brain, which are associated with specific stimuli or situations.
- Somatic markers guide cognitive processing and decision-making: When we face similar situations again, somatic markers are activated, quickly guiding our attention, judgment, and action.

Neuroscientific Foundation:

This process involves the synergistic work of the prefrontal cortex (decision-making and planning), amygdala (emotional processing), and somatosensory cortex (bodily sensation perception) [21].

Relationship to the Three-Layer Structure:

- Soma Layer: Bodily physiological responses are the starting point of somatic markers
- Emotion Layer: Somatic markers are the neural representation of emotional experiences
- Meaning Layer: Accumulated somatic markers guide cognitive processing and meaning construction

Implications for Art Therapy:

Art creation can generate new somatic markers (such as a sense of accomplishment, control, and safety), replacing negative somatic markers (such as helplessness, anxiety, and threat), thereby changing emotional experiences and cognitive patterns.

3.4 Progressive Weakening and Compensation Principle: The Evolutionary Philosophical Perspective of Hierarchical Structure

The Progressive Weakening and Compensation Principle, proposed by Chinese philosopher Wang Dongyue, provides a unique evolutionary philosophical perspective for understanding the hierarchical structure of the cognitive system.

Core Views:

- Progressive weakening: In the evolutionary process, as organisms become more complex, their degree of existence (i.e., survival ability) gradually decreases. For example, single-celled organisms have strong survival abilities, while humans are relatively fragile.
- Compensation: To maintain survival, organisms must develop compensatory functions to make up for the decline in survival ability. For example, humans have developed complex cognitive and social abilities to compensate for physical fragility.
- Hierarchical structure: Each higher cognitive level is a compensation for the insufficiency of lower-level functions, forming a hierarchical structure.

Relationship to the Three-Layer Structure:

- Soma Layer: The most basic survival compensation mechanism — direct perception and response to the environment
- Emotion Layer: Compensation for the insufficiency of mere sensory responses — integrating sensory information and endowing it with social meaning
- Meaning Layer: The highest-level compensation — alleviating existential anxiety through narrative and value systems

Implications for Understanding Comorbidity:

Table 1. Integration of the Three Theoretical Perspectives

Theoretical Perspective	Positioning	Contribution to the Three-Layer Structure
Embodied Cognition Theory	Main theoretical foundation	Provides epistemological framework, emphasizing that the body is the foundation of cognition
Somatic Marker Hypothesis	Main theoretical foundation	Provides neuroscientific mechanism, revealing the transformation from body to emotion to cognition
Progressive Weakening and Compensation Principle	Supplementary philosophical perspective	Provides evolutionary perspective, explaining hierarchical structure and causal relationships

The Progressive Weakening and Compensation Principle helps us understand why impairment in lower-level functions lead to the failure of upper-level compensatory functions — because compensatory functions must be built on the foundation of the functions being compensated. (see Table 1) This explains why sensory processing abnormality in ASD (Soma layer impairment) leads to social-emotional difficulties (Emotion layer impairment), which in turn increases the risk of depression (Meaning layer impairment).

3.5 Detailed Explanation of the Three-Layer Structure

- Definition: The Soma layer refers to the individual's direct perception and response to the environment through the sensory system (touch, vision, hearing, smell, taste, proprioception, vestibular sense).
- Theoretical Basis: - Embodied Cognition Theory: The body is the foundation of cognition, and sensory experiences are the starting point of all cognition - Neuroscience: Sensory processing involves the sensorimotor cortex, thalamus, and cerebellum
- Role in ASD: - Sensory processing abnormality is a core feature of ASD, manifesting as hypersensitivity or hyposensitivity to sensory stimuli - Sensory abnormality

affects the individual's perception and response to the environment, forming the foundation for subsequent social-emotional difficulties
- Role in Depression: - Depression is often accompanied by bodily symptoms such as numbness, fatigue, and pain - Bodily sensations affect emotional experiences and cognitive patterns
- Implications for Art Therapy: - Art creation provides rich sensory experiences (tactile, visual, kinesthetic), helping individuals improve sensory integration abilities - Sensory experiences in the creative process can generate positive bodily sensations, laying the foundation for emotional healing
- Definition: The Emotion layer refers to the individual integrating sensory information and endowing it with social meaning (such as safety, threat, intimacy, exclusion), forming emotional experiences.
- Theoretical Basis: - Somatic Marker Hypothesis: Bodily physiological responses are perceived by the brain as emotions, forming somatic markers - Neuroscience: Emotional processing involves the amygdala, prefrontal cortex, and somatosensory cortex
- Role in ASD: - Individuals with ASD have difficulties in emotional recognition, expression, and regulation - Social-emotional difficulties stem from blocked "Soma→Emotion" pathways — sensory abnormality affects the formation and expression of emotions
- Role in Depression: - Depression is characterized by persistent negative emotions (such as sadness, hopelessness, emptiness) - Emotional impairment stem from blocked "Emotion→Meaning" pathways — the inability to construct positive meanings from emotional experiences
- Implications for Art Therapy: - Art creation provides a safe space for emotional expression, helping individuals identify, name, and release emotions - Collaborative art creation promotes social interaction and empathy development
- Definition: The Meaning layer refers to the individual constructing narratives, symbolic systems, and value systems based on emotional experiences, endowing existence with purpose and value.
- Theoretical Basis: - Embodied Cognition Theory: Abstract concepts and meanings are constructed based on bodily metaphors and sensorimotor experiences - Neuroscience: Meaning construction involves the default mode network, ACC, and prefrontal cortex
- Role in ASD: - High-functioning adults with ASD face existential challenges — they need to construct self-identity, find life meaning, and establish a sense of value - Difficulties in meaning construction stem from blocked "Emotion→Meaning" pathways — social-emotional difficulties affect the construction of self-identity and life meaning
- Role in Depression: - Depression is characterized by a loss of meaning (such as hopelessness, worthlessness, purposelessness) - Loss of meaning is the core feature of depression, stemming from the inability to construct positive meanings from past experiences and current situations
- Implications for Art Therapy: - Art creation helps individuals reconstruct life stories through symbolic symbols, discovering new meanings and possibilities - Art creation promotes self-exploration and identity construction, helping individuals find hope and direction

3.6 Dynamic Interaction Mechanisms of the Three-Layer Structure

The three-layer structure is not a simple linear superposition but a dynamically interactive system:

- Soma → Emotion: Bodily sensations are the foundation of emotional experiences. Sensory abnormality affects the formation and expression of emotions.
- Emotion → Meaning: Emotional experiences are the material for meaning construction. Emotional impairment affect the construction of self-identity and life meaning.
- Meaning → Emotion: Cognitive reappraisal and narrative reconstruction can change emotional experiences. For example, reinterpreting negative experiences can reduce negative emotions.
- Emotion → Soma: Emotional states affect bodily sensations. For example, anxiety increases muscle tension, while relaxation reduces bodily discomfort.
- Soma layer impairment → Emotion layer impairment: Sensory processing abnormality in ASD affects social-emotional development
- Emotion layer impairment → Meaning layer impairment: Social-emotional difficulties increase the risk of depression

3.7 Explanation of Comorbidity Mechanisms

The three-layer cognitive structure provides a unified explanation for the high comorbidity rate between ASD and depression:

- Soma layer impairment (ASD core feature): Sensory processing abnormality affects the individual's perception and response to the environment
- Emotion layer impairment (ASD secondary feature): Sensory abnormality leads to social-emotional difficulties, manifesting as difficulties in emotional recognition, expression, and regulation

- Meaning layer impairment (Depression core feature): Social-emotional difficulties affect the construction of self-identity and life meaning, increasing the risk of depression
- Cascade effect: Lower-level impairment lead to the failure of upper-level compensatory functions, forming a vicious cycle

3.8 Implications for Art Therapy Mechanisms

The three-layer cognitive structure reveals that art therapy operates through bidirectional pathways:

- Soma layer intervention: Providing rich sensory experiences, improving sensory integration abilities
- Emotion layer effect: Positive bodily sensations promote positive emotional experiences
- Meaning layer effect: Accumulated positive experiences support the construction of self-identity and life meaning
- Meaning layer intervention: Reconstructing life stories through symbolic symbols, discovering new meanings and possibilities
- Emotion layer effect: New meanings change emotional experiences, reducing negative emotions
- Soma layer effect: Positive emotions reduce bodily discomfort, promoting physical and mental health

4. From Theory to Practice: Applications in Assessment and Intervention Design

The "Soma-Emotion-Meaning" framework is not merely a theoretical abstraction; it provides a practical blueprint for designing and implementing next-generation assessment tools and clinical interventions, particularly within the scalable medium of digital health.

4.1. Application in Assessment Tool Design

This model can guide the development of a multi-modal, three-layer assessment battery to create a holistic, dynamic profile of an individual's cognitive and emotional functioning, moving beyond static, self-report-only measures.(see Table 2)

Table 2. A Multimodal, Three-Layer Assessment Framework for Holistic Cognitive and Emotional Profiling

Layer	Assessment Modality	Example Digital Tool/Metric
Soma	Wearable Biosensors & Mobile Sensing to passively and actively capture physiological and behavioral responses to the user's real-world	A wrist-worn sensor (e.g., Empatica E4, Fitbit) measuring Electrodermal Activity (EDA/GSR) and HRV, correlated with smartphone data (GPS, ambient sound) to identify real-world
Emotion	Ecological Momentary Assessment (EMA) & Gamified Tasks that prompt users to label their emotions and corresponding bodily sensations	Push notifications prompting: "Right now, what are you feeling in your body? What emotion does that feel like?" combined with gamified tasks for facial emotion recognition or labeling emotions in
Meaning	AI-Powered Digital Narrative Journal where users upload images of their artwork and provide written or voice-recorded reflections on their meaning.	A secure web/mobile platform that uses natural language processing (NLP) to analyze journal entries for themes of hope, agency, and narrative coherence, providing visual feedback to the user and therapist.

4.2. Application in Intervention Design

The framework allows for the creation of personalized, adaptive digital art therapy interventions that target the specific layer of impairment, moving from a one-size-fits-all to a precision-medicine approach.

Phase 1: Baseline Assessment & Deficit Identification.

The system first administers the three-layer assessment battery to generate a comprehensive profile of the user's strengths and weaknesses, identifying their primary layer of impairment.

Phase 2: Targeted, Layer-Specific Intervention.

The intervention is then algorithmically tailored to address this primary deficit.

If the primary deficit is in the Soma layer: The app recommends sensory-rich, bottom-up creative tasks. Examples include a tablet-based finger painting module with a wide variety of digital textures and haptic feedback, or a virtual reality (VR) experience that simulates sculpting with digital clay to improve sensory modulation and integration.

If the primary deficit is in the Emotion layer: The app provides activities designed to build the bridge from soma to

emotion. This could include exercises that ask the user to create an abstract artwork representing a specific bodily sensation and then select from a list of emotion words, or a collaborative digital whiteboard where the user can co-create art with a therapist, practicing emotional reciprocity.

If the primary deficit is in the Meaning layer: The app offers top-down, narrative-focused prompts. For instance, it might guide the user to create a series of artworks representing their "past self," "present self," and "future self," and then use structured reflective questions to help them build a coherent and hopeful life narrative.

Phase 3: Continuous Monitoring & Dynamic Adaptation.

The system does not follow a static protocol. It continuously collects data on the user's progress via the measurable indicators for each layer. As the user shows improvement in their primary deficit layer, the algorithm dynamically adjusts the focus of the interventions, gradually shifting to address other layers and ensuring a holistic and responsive therapeutic process.

4. Discussion and Implications

4.1 Theoretical Contributions

This study proposes a "Soma-Emotion-Meaning" three-layer cognitive structure theoretical framework, successfully integrating fragmented findings from existing research:

- Sensory-based art therapy (Soma layer) + Socially-oriented art therapy (Emotion layer) + Narrative reconstruction (Meaning layer) = Integrative art therapy framework
- Neuroscience findings (brain regions) + Psychosocial findings (mediating variables) + Clinical observations (symptoms) = Hierarchical, dynamically interactive cognitive model

The core theoretical contribution of this study lies in constructing an integrative cross-disciplinary framework that:

(1) uses Embodied Cognition Theory as the epistemological foundation, emphasizing the central role of the body in cognition;

(2) uses Damasio's Somatic Marker Hypothesis as the neuroscientific foundation, revealing the transformation mechanism from body to emotion to cognition;

(3) integrates the Progressive Weakening and Compensation Principle as an evolutionary philosophical perspective, providing profound understanding of hierarchical structure and causality. This multi-theoretical integration not only bridges the fragmentation of existing research but also demonstrates the possibility of cross-cultural theoretical dialogue.

This study provides a unified explanation for the high comorbidity rate between ASD and depression: - ASD: Soma layer impairment (sensory processing abnormality) → Emotion layer impairment (social-emotional difficulties) - Depression: Emotion layer impairment (social-emotional difficulties) → Meaning layer impairment (loss of meaning) - Comorbidity: Cascade effect of lower-level impairment leading to upper-level impairment

This study reveals that art therapy operates through bidirectional pathways: - Bottom-up: Somatic repair → Emotional healing → Meaning reconstruction - Top-down: Meaning reconstruction → Emotional regulation → Somatic relief

4.2 Clinical Significance

The three-layer cognitive structure provides a clear framework for clinical assessment: - Soma layer assessment: Sensory processing abilities, bodily sensations - Emotion layer assessment: Emotional recognition, expression, and regulation abilities - Meaning layer assessment: Self-identity, life meaning, sense of value

The three-layer cognitive structure provides clear directions for intervention: - For ASD: Prioritize Soma layer interventions (sensory-based art therapy), then Emotion layer interventions (socially-oriented art therapy) - For depression: Prioritize Meaning layer interventions (narrative reconstruction), combined with Emotion layer interventions (emotional expression and regulation) - For comorbidity: Comprehensive interventions targeting all three layers, with emphasis on the "Soma→Emotion→Meaning" pathway

The three-layer cognitive structure supports personalized intervention: - Assess individual impairment at each layer: Identify the primary impairment layer - Design targeted interventions: Prioritize interventions at the primary impairment layer - Monitor progress: Dynamically adjust intervention strategies

4.3 Limitations and Future Directions

Use of hypothetical illustrative cases: This study uses hypothetical illustrative cases to demonstrate the application of the model, rather than real clinical records. While this approach clearly demonstrates the theoretical logic, it lacks empirical validation. Future research needs to verify the model's effectiveness through real case studies, single-case experimental designs (SCED), or randomized controlled trials (RCT).

- Challenges of multi-theoretical integration: Although this study integrates Embodied Cognition Theory, Somatic Marker Hypothesis, and Progressive Weakening and Compensation Principle, enhancing the

comprehensiveness and depth of the theory, it also brings challenges of theoretical integration. Future research needs to further verify the compatibility and complementarity of these three theoretical perspectives at the empirical level. Particularly, the Progressive Weakening and Compensation Principle, as an Eastern philosophical thought, requires more cross-cultural research to verify its applicability within Western psychological frameworks.

- Lack of quantitative assessment tools: The three-layer cognitive structure lacks validated quantitative assessment tools. Future research needs to develop and validate assessment tools for each layer, establishing normative data.
- Empirical validation: Verify the model's effectiveness through real case studies, SCED, or RCT
- Assessment tool development: Develop and validate assessment tools for the Soma, Emotion, and Meaning layers
- Neuroimaging research: Use fMRI, EEG, and other technologies to verify the neural mechanisms of the three-layer structure
- Cross-cultural research: Verify the model's applicability in different cultural contexts
- Therapist training research: Develop training programs and evaluate training effectiveness

4.4 Conclusion

This study proposes a "Soma-Emotion-Meaning" three-layer cognitive structure theoretical framework, integrating Embodied Cognition Theory, Somatic Marker Hypothesis, and Progressive Weakening and Compensation Principle, providing an integrative perspective for understanding the comorbidity mechanisms of ASD and depression and the mechanisms of art therapy. This framework not only bridges theoretical gaps in existing research but also provides clear directions for future empirical research and clinical practice, laying a theoretical foundation for the transformation of art therapy from "experiential craft" to "evidence-based science."

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