

THE ISCR MODEL IN MUSIC THERAPY: AN INTEGRATIVE FRAMEWORK FOR PSYCHOPHYSIOLOGICAL REGULATION IN STRESS AND ANXIETY

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Abstract: This study presents the Integrative Synchronization–Change–Regulation (ISCR) model as an integrative conceptual framework for understanding psychophysiological regulation in the context of music therapy. The model conceptualizes music therapy as a multilevel process that integrates neuroscientific, psychophysiological, and cognitive–affective mechanisms, framing regulation as a dynamic coordination between brain networks, the autonomic nervous system, and interoceptive processes. The theoretical foundation of the model is based on the integration of key approaches, including neurovisceral integration, polyvagal theory, and rhythmic entrainment, which are synthesized into a coherent and sequential regulatory framework. In this context, music therapy is positioned as a structured bottom-up intervention that operates through sensory activation and physiological synchronization, leading to affective and cognitive modulation and ultimately resulting in sustained psychophysiological regulation. The ISCR model is structured into four interrelated stages: Input, Synchronization, Change, and Regulation, which describe the transition from sensory stimulation to stable regulatory outcomes. This process emphasizes the role of synchronization as a central mechanism linking physiological and psychological processes and enabling the coordination of internal rhythms and external stimuli. As a conceptual contribution, the model shifts the focus from symptom reduction toward the expansion of regulatory capacity, defined as the ability to maintain adaptive stability under varying internal and external conditions. In addition, the study outlines a quasi-experimental framework that may serve as a basis for future empirical validation of the model.

Keywords: *music therapy; ISCR model; psychophysiological regulation; regulatory capacity; stress and anxiety*

Field: Social Sciences

1. INTRODUCTION

Stress and anxiety represent some of the most significant risk factors for mental and physical health in contemporary societies. The growing interest in integrative interventions reflects the need for approaches that simultaneously address cognitive, emotional, somatic, and physiological processes. Music therapy has emerged as such an approach, as it engages a wide range of neural and autonomic mechanisms involved in the regulation of stress and emotions (Koelsch, 2014). Recent meta-analytic evidence further supports the efficacy of music-based interventions in reducing physiological and psychological indicators of stress across diverse populations (de Witte et al., 2022).

Neuroscientific research demonstrates that music engages distributed brain networks—including the auditory cortex, limbic system, mesolimbic dopaminergic pathways, and prefrontal regions—that are involved in emotional regulation, motivation, and cognitive control (Levitin, 2006; Salimpoor et al., 2011; Vuust et al., 2022). In parallel, music influences the autonomic nervous system by modulating heart rate, respiration, and physiological arousal (Bernardi et al., 2006).

These mechanisms position music therapy at the center of integrative models of regulation, which conceptualize adaptation to stress as a dynamic coordination between brain, body, and physiology. Stephen Porges’ polyvagal theory and the neurovisceral integration model proposed by Julian F. Thayer and Richard D. Lane highlight the role of autonomic flexibility and functional connectivity between the prefrontal cortex and limbic structures as key factors for effective regulation.

Within this context, the present paper introduces the ISCR model (Input–Synchronization–Change–Regulation) as an integrative framework that unifies neural, physiological, and affective mechanisms into a coherent regulatory process. Empirical observations from an 8-week intervention involving active and receptive music therapy are presented as supportive evidence illustrating the applicability of the model.

2. GAP STATEMENT

Despite substantial advances in music therapy research, significant conceptual and methodological gaps remain in the literature. Existing theoretical approaches tend to examine neural, autonomic, interoceptive, and cognitive–affective mechanisms in isolation, without integrating them into a unified framework that conceptualizes regulation as a coordinated, multilevel process.

Current models—including the polyvagal framework, the neurovisceral integration model, and

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rhythmic entrainment theory—offer valuable insights into specific aspects of regulation. However, they are rarely synthesized into a comprehensive model that explains how these mechanisms interact within a single regulatory system. As a result, an integrative perspective on psychophysiological regulation in music therapy remains underdeveloped.

In addition, the majority of empirical studies focus primarily on symptom reduction, such as decreases in anxiety and perceived stress (de Witte et al., 2022), rather than on the expansion of regulatory capacity as a core therapeutic outcome. At the same time, conceptual contributions that explicitly position music therapy as a structured bottom-up regulatory intervention remain limited.

Furthermore, empirical findings are infrequently used to illustrate and support underlying theoretical mechanisms, and are more often presented as independent clinical outcomes without clear integration into a broader conceptual framework.

The present study addresses these gaps by proposing the ISCR model as an integrative theoretical framework that unifies neural, physiological, and affective mechanisms within a coherent regulatory process, supported by empirical observations.

3. THEORETICAL CONTRIBUTION

The present paper contributes to the literature by introducing the ISCR model as an integrative theoretical framework for understanding psychophysiological regulation in the context of music therapy. The contribution can be summarized along three primary dimensions.

Formulation of the ISCR model as an integrative regulatory framework.

The proposed model conceptualizes regulation as a sequential, multilevel process comprising four interrelated stages—Input, Synchronization, Change, and Regulation. This structure establishes a systematic link between sensory activation and psychophysiological adaptation, offering a novel conceptual perspective on regulatory mechanisms in music therapy.

Integration of multisystem mechanisms.

The ISCR model brings together key processes that are traditionally examined in isolation, including rhythmic entrainment, autonomic regulation, limbic activation, cognitive processing, and interoceptive awareness. By integrating these components within a unified framework, the model provides a comprehensive account of how neural, physiological, affective, and cognitive processes interact in the regulation of stress and anxiety. In this way, music therapy is positioned as a multisystem regulatory intervention operating across multiple levels of functioning.

A conceptually structured framework with potential for empirical validation.

Beyond its descriptive function, the ISCR model offers a structured theoretical architecture that lends itself to empirical investigation. The framework enables the formulation of testable hypotheses concerning the dynamics of regulatory processes and supports the integration of psychological and physiological indicators (e.g., anxiety, perceived stress, heart rate variability). As such, the model provides a foundation for future experimental and clinical research aimed at examining the mechanisms and efficacy of music therapy interventions.

4. THEORETICAL FRAMEWORK

Music Therapy as an Integrative Regulatory Intervention

Music therapy can be conceptualized as an integrative intervention that simultaneously engages cognitive, emotional, somatic, and physiological processes. Its multisensory nature enables the activation of complex regulatory mechanisms, including rhythmic synchronization, affective modulation, and autonomic stabilization (Koelsch, 2014; de Witte et al., 2022).

In contrast to traditional psychotherapeutic approaches that rely primarily on cognitive strategies, music therapy predominantly engages bottom-up regulatory processes originating at sensory and bodily levels. This characteristic makes it particularly relevant for conditions associated with heightened physiological arousal, impaired autonomic regulation, and reduced cognitive control, such as anxiety and chronic stress.

Neural Foundations of Psychophysiological Regulation through Music

Neuroscientific research indicates that music engages distributed brain networks, including the auditory cortex, limbic system, mesolimbic dopaminergic pathways, and prefrontal regions (Levitin, 2006; Salimpoor et al., 2011). Recent integrative reviews further conceptualize music processing as the dynamic interaction of perception, action, emotion, and reward systems within a predictive coding framework (Vuust et al., 2022), with meta-analytic evidence confirming the simultaneous engagement of top-down

and bottom-up neural pathways during music listening (Pando-Naude et al., 2021). These structures are critically involved in emotional regulation, motivation, and cognitive control.

Such widespread neural engagement underlies music's capacity to modulate affective states, reduce physiological arousal, and facilitate adaptive emotional regulation. In parallel, music influences the autonomic nervous system by modulating heart rate, respiration, and overall physiological activation (Bernardi et al., 2006). Within this framework, neural activation provides the basis for processes of synchronization, which represent a central mechanism in the ISCR model.

Autonomic Regulation and the Polyvagal Perspective

The polyvagal theory proposed by Stephen Porges provides a key framework for understanding the relationship between music and autonomic regulation (Porges, 2011). According to this perspective, effective regulation depends on the flexible functioning of the vagal system and the capacity to shift adaptively between different autonomic states. More recent reformulations emphasize perceived safety and co-regulation as foundational conditions enabling the social engagement system and the parasympathetic dominance required for restoration and learning (Porges, 2022).

Music therapy may facilitate this process through rhythmic patterns, vocalization, and breathing synchronization, which support parasympathetic activation and physiological stabilization. These mechanisms correspond to the Synchronization stage of the ISCR model, where coordination across physiological systems is established.

Neurovisceral Integration and Regulatory Capacity

The neurovisceral integration model, developed by Julian F. Thayer and Richard D. Lane, conceptualizes regulation as the result of functional connectivity between the prefrontal cortex, limbic structures, and the autonomic nervous system (Thayer & Lane, 2000). Effective regulation involves not only symptom reduction but also the development of regulatory capacity, reflected in autonomic flexibility and the ability to recover efficiently from stress. Music therapy may support this integration by coordinating affective, cognitive, and physiological processes, corresponding to the Change and Regulation stages of the ISCR model.

Bottom-Up Regulation and the Role of Bodily Processes

As a regulatory intervention, music therapy is characterized by its capacity to engage processes originating at the sensory and bodily level. These bottom-up mechanisms include rhythmic activity, breathing regulation, and interoceptive awareness, which influence both limbic and prefrontal systems (Trost, Labbé, & Grandjean, 2017). Contemporary frameworks further conceptualize interoception as a multi-dimensional construct encompassing accuracy, sensibility, attention, and metacognition, with direct relevance for adaptive emotion regulation and clinical outcomes (Suksasilp & Garfinkel, 2022). This direction of influence enables more direct modulation of physiological arousal and is particularly relevant in anxiety, panic responses, and stress-related conditions. Within the ISCR framework, these processes underpin the Input and Synchronization stages, initiating the regulatory sequence.

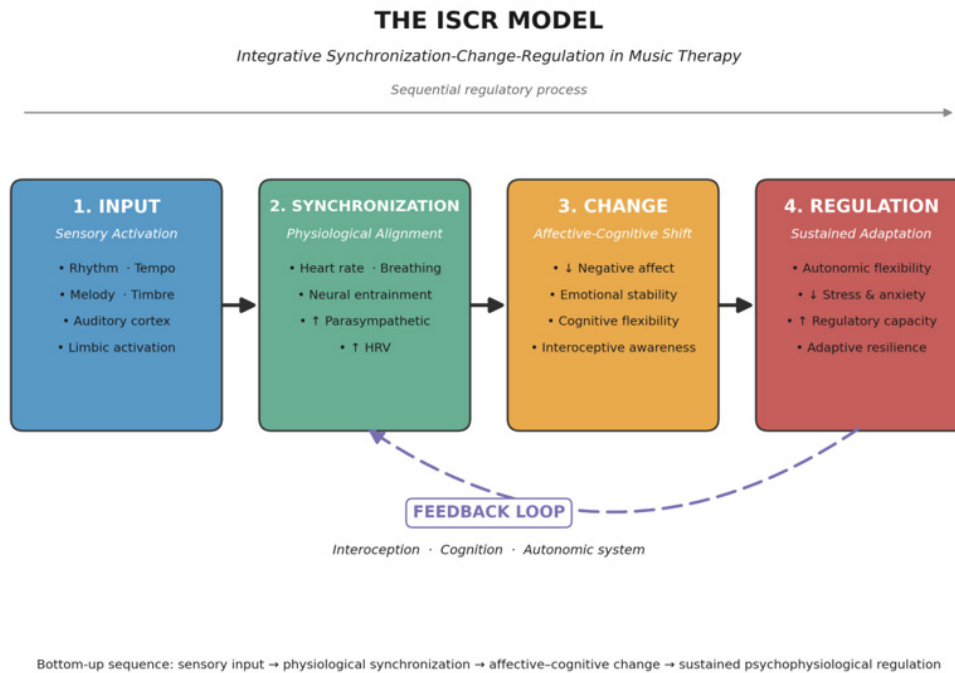
The ISCR Model as an Integrative Framework for Psychophysiological RegulationThe ISCR model (Input–Synchronization–Change–Regulation) provides an integrative conceptual framework that unifies neural, physiological, and affective mechanisms within a coherent regulatory process. The model describes how a musical stimulus (Input) initiates neural and physiological synchronization (Synchronization), leading to affective and cognitive modulation (Change), and culminating in sustained psychophysiological regulation (Regulation). Through this structured sequence, the ISCR model integrates existing theoretical approaches into a unified system and offers a novel way of conceptualizing music therapy as an intervention for psychophysiological regulation in stress and anxiety.

5. THE ISCR MODEL: AN INTEGRATIVE FRAMEWORK FOR PSYCHOPHYSIOLOGICAL REGULATION IN MUSIC THERAPY

Figure 1. The ISCR model illustrates a sequential and multilevel process of psychophysiological regulation in music therapy. Sensory input initiates neural and physiological synchronization, enabling affective–cognitive change and culminating in sustained regulation. Feedback mechanisms reinforce adaptive regulatory capacity over time.

The Integrative Synchronization–Change–Regulation (ISCR) model provides a unified conceptual framework for understanding psychophysiological regulation in music therapy. It conceptualizes regulation as a dynamic, multilevel process in which neural, autonomic, affective, and cognitive systems interact in a coordinated cycle, ultimately supporting the expansion of regulatory capacity.

Figure 1. The ISCR Model (Input–Synchronization–Change–Regulation): An integrative framework for psychophysiological regulation in music therapy.



Note. The model illustrates the sequential process of psychophysiological regulation, where sensory input initiates synchronization of neural and physiological systems, leading to affective–cognitive change and sustained regulatory outcomes. Feedback loops reinforce regulatory capacity over time.

Source: Author’s own conceptual model.

The model is structured into four sequential yet interdependent stages—Input, Synchronization, Change, and Regulation—capturing the transition from sensory stimulation to sustained regulatory adaptation.

Input refers to the initial processing of musical stimuli, where acoustic parameters such as rhythm, tempo, melody, and timbre engage auditory and limbic systems, eliciting rapid sensory activation and primary affective responses (Vuust et al., 2022). This stage establishes the neurophysiological conditions necessary for subsequent system-wide coordination.

Synchronization constitutes the central mechanism of the model, involving the alignment of internal physiological rhythms with external musical structures. Through rhythmic entrainment, processes such as heart rate, respiration, motor activity, and neural oscillations become temporally coordinated. This synchronization is associated with autonomic stabilization, including increased parasympathetic activity, reduced sympathetic arousal, and enhanced heart rate variability (Porges, 2022). Concurrently, neural coupling across auditory, motor, and limbic networks supports integrative processing.

Change emerges from synchronized states and reflects the transition toward affective and cognitive modulation. This stage is characterized by attenuation of negative affect, stabilization of emotional tone, and enhanced prefrontal regulation of cognition. Increased interoceptive awareness enables individuals to detect and modulate internal bodily states (Suksasilp & Garfinkel, 2022), facilitating adaptive regulation.

Regulation represents the consolidation of these processes into stable psychophysiological functioning. It is expressed through improved autonomic flexibility, efficient recovery from stress, and reduced vulnerability to dysregulation. Crucially, regulation is conceptualized not merely as symptom reduction, but as the enhancement of regulatory capacity—the ability to maintain internal stability across varying conditions.

A defining feature of the ISCR model is its recursive structure. Feedback loops linking interoceptive awareness, autonomic stabilization, and cognitive processing reinforce ongoing regulation, transforming it into a self-sustaining adaptive process.

By integrating previously fragmented theoretical perspectives into a coherent framework, the ISCR model advances the conceptualization of music therapy as a structured bottom-up regulatory intervention. It offers a scalable architecture for future empirical investigation and provides a foundation

for understanding how music can systematically influence psychophysiological regulation in stress and anxiety.

6. MATERIALS AND METHODS

Study Design

The present study employs a quasi-experimental pre–post design, appropriate for examining temporal dynamics of change in intervention-based contexts where full randomization may not be feasible (Shadish, Cook, & Campbell, 2002). The methodological framework is developed to provide a structured basis for the empirical examination of processes described in the ISCR model and to illustrate its applicability within music therapy. Participants are allocated to two intervention conditions: active music therapy and receptive music therapy. The intervention is conducted over an 8-week period, with two sessions per week.

Participants

The study population consists of adults aged 25–55 years reporting elevated levels of stress and anxiety in everyday functioning.

Inclusion criteria: age between 25 and 55 years; self-reported elevated stress or anxiety; absence of ongoing psychiatric pharmacological treatment; no hearing impairments; provision of informed consent.

Exclusion criteria: presence of severe psychiatric disorders; neurological conditions; substance abuse; concurrent participation in other therapeutic programs.

Measures

Psychological outcomes are operationalized using standardized and widely validated instruments: State–Trait Anxiety Inventory (STAI) (Spielberger, 1983), assessing both state and trait anxiety through two 20-item subscales; Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983), measuring subjective stress perception, including perceived uncontrollability and overload.

Intervention

The intervention comprises two complementary modalities reflecting different levels of engagement and regulatory pathways.

Active Music Therapy

The active modality involves direct participation in musical processes, including rhythmic exercises, vocal improvisation, and synchronization of movement and breathing. This format is designed to engage sensorimotor integration, rhythmic entrainment, and interoceptive awareness, corresponding to synchronization and change processes within the ISCR framework.

Receptive Music Therapy

The receptive modality is based on structured music listening (60–80 BPM), combined with guided attention to bodily sensations, breathing regulation, and brief imagery. Musical selection is aligned with principles of parasympathetic activation and physiological stabilization.

Procedure

The study follows a structured sequence: pre-test assessment (STAI and PSS); 8-week music therapy intervention; post-test assessment (STAI and PSS); descriptive analysis of observed trends.

Expected Outcomes

Consistent with the ISCR theoretical framework, the intervention is expected to be associated with reductions in anxiety and perceived stress, improved psychophysiological stability, increased autonomic flexibility, and enhanced interoceptive awareness. Active music therapy is expected to produce more pronounced effects due to higher levels of sensorimotor engagement and direct involvement in rhythmic synchronization processes.

7. CONCLUSION

The present paper introduces the ISCR model (Integrative Synchronization–Change–Regulation) as an integrative conceptual framework for understanding psychophysiological regulation in the context of music therapy. By structuring regulation as a sequential and dynamic process—spanning sensory activation, physiological synchronization, affective–cognitive change, and sustained regulation—the model offers a coherent account of how music therapy may influence multiple levels of human functioning.

A central contribution of the ISCR framework lies in its capacity to integrate previously fragmented theoretical perspectives into a unified regulatory model. By linking neural, autonomic, affective, and cognitive mechanisms within a single process, the model advances the conceptualization of music therapy as a structured bottom-up regulatory intervention, in line with recent empirical evidence on its

psychophysiological efficacy (de Witte et al., 2022).

Importantly, the ISCR model shifts the focus from symptom reduction toward the expansion of regulatory capacity, emphasizing the development of adaptive flexibility and the ability to maintain internal stability under varying conditions. In this sense, music therapy is positioned not only as a modality for alleviating distress, but as a mechanism for enhancing psychophysiological resilience.

The conceptual structure of the model also provides a foundation for future empirical investigation, enabling the formulation of testable hypotheses and the integration of psychological and physiological indicators. As such, the ISCR framework offers both theoretical and methodological value for advancing research and practice in music therapy and stress regulation.

8. LIMITATIONS AND FUTURE DIRECTIONS

Several limitations should be acknowledged. First, the present work is primarily conceptual in nature, and the proposed framework has not yet been subjected to systematic empirical validation. While the model is grounded in established theoretical and empirical literature, its mechanisms and assumptions require direct testing through controlled experimental designs.

Second, the proposed intervention structure is based on a quasi-experimental logic and may be influenced by contextual and individual variability, including differences in baseline physiological regulation, musical experience, and responsiveness to sensory stimuli. These factors highlight the need for more refined methodological approaches in future studies.

Third, the integration of multiple systems—neural, autonomic, affective, and cognitive—poses inherent challenges in terms of measurement and operationalization. Future research should incorporate multimodal assessment strategies, including physiological measures, neurocognitive indicators (Pando-Naude et al., 2021), and validated psychological scales, to capture the complexity of regulatory processes.

Future investigations should focus on empirically testing the sequential dynamics proposed by the ISCR model, particularly the role of synchronization as a mediating mechanism between sensory input and regulatory outcomes. Comparative studies examining active versus receptive music therapy may further clarify the contribution of sensorimotor engagement to regulatory change. Additionally, longitudinal designs are needed to examine the stability and durability of regulatory effects over time, as well as the extent to which music therapy contributes to sustained changes in regulatory capacity.

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