Mechanisms of Change in Dance/Movement Therapy and their Neural Correlates: A Theoretical Framework

Abstract

Dance/movement therapy (DMT), at the intersection of creative arts therapies and somatic therapies, has been difficult to pin down due to a lack of an official theoretical framework. Through an in-depth literature review of publications that suggest therapeutic factors specific to DMT, we here propose a theoretical framework that includes five main elements or mechanisms of change: 1. Connection through movement, 2. Emotional regulation through movement, 3. Body sensing and being, 4. Creative movement expression, and 5. Meaning making through movement. Each of these change mechanisms is then considered in relation to ongoing neurobiological inquiries and research.

Introduction

Dance/movement therapy (DMT) uses the psychotherapeutic qualities of dance and movement, rooted in long-standing healing practices, to foster integration in body, mind, and spirit and thus improve health and well-being in individuals and groups (American Dance Therapy Association, 2025). It is widely practiced including with infants and their parents, children, teenagers, adults, and older adults, attending to neurodiversity and learning difficulties, substance abuse, mental health issues, medical conditions, psychological trauma and more (Goodill, 2016). Situated at the intersection of creative arts therapies, somatic therapies, and Psychotherapy, DMT taps into the creative and expressive art of dance, asserts that mind, body, and spirit are interconnected, and holds fast to the core components of psychotherapy: genuineness, empathy, and unconditional regard (Rogers, 1977). Dance/movement therapy also overlaps with other disciplines, including philosophy, anthropology, psychology, human development, and biology (Goodill, 2016; Samaritter & Cantell, 2021) and employs observational skills also utilized in behavioral science (Wengrower, 2021). With these numerous intersections, the specific therapeutic factors or mechanisms of change in DMT can be difficult to pinpoint (ADTA, 2025), calling for the need to commonly recognize and acknowledge different theoretical frameworks and methods. Meanwhile, recent publications have highlighted the need for a more congruent language and a shared understanding of concepts, practices, and techniques (deWitte et al., 2021; Imus & Young, 2023; Samaritter & Cantell, 2021). In this theoretical paper, we summarize the evidence base for DMT and existing understandings of its therapeutic or active factors. Further, we synthesize the literature, identifying clusters of mechanisms of change in DMT in a proposed model, and bring these into conversation with relevant research and ongoing questions in neurobiology. Lastly, we examine how these mechanisms raise questions for the field of neuroscience and dance/movement therapists.

A Note on "Neural Correlates"

The field of neuroscience has undergone rapid expansion with the advent and widespread availability of a greater variety of neuroimaging methods over the last 30 years, such as PET, fMRI, and EEG. These methods have allowed researchers to make increasingly detailed observations of changes in neural activity and structure that occur in relation to, or coordinated with, mental states and phenomena (Nani et al., 2019). The term "neural correlates" generally refers to patterns of brain activity observed as a result of research paradigms investigating aspects of behavior, motion, and cognition. It is important, however, to remember that "correlation does not imply causation". Observations and interpretations of activity in the brain are just that - observations and interpretations. They do not, in and of themselves, explain or justify theories nor are they in any way conclusive. At best, studies that use neural correlates can provide information on biological changes that we previously could not access - they may be considered biological "traces" or inscriptions (Ness & Noland, 2008) that somehow relate to things we have done, experiences we have had, and emotional-mental phenomena such as memory, learning, trauma, pain, joy or sadness. In bringing together concepts and theories from DMT and neurobiology, we need to seek common language while remaining aware of the promises and limitations of both fields. Our methods of practice and research may differ, but both fields are interested in understanding and integrating aspects of human experience that are nuanced and can be difficult to access. Findings from both fields require careful observation and respectful interpretation. In this spirit, we invite the reader to consider how concepts and theories from DMT (which are extensive!) can benefit from engaging with research in neuroscience, while also considering how clinical experience from DMT may suggest new questions or interpretations for the field of neurobiology.

Evidence Base of Dance/Movement Therapy

Research examining the empirical evidence of DMT for various populations has also increased over the last 25 years (Cruz & Berrol, 2019). For example, Koch et al. (2019) in their meta-analysis suggested that DMT could decrease depression and anxiety and increase quality of life and interpersonal and cognitive skills. Karkou et al. (2019) substantiated these findings concluding that DMT was an effective intervention in the treatment of adults with depression. Aithal et al. (2021) reviewed DMT studies with children with autism spectrum disorder (ASD) and put forth that DMT could promote well-being in children with ASD including social and communication skills. In their systematic review, Wu et al. (2022) concluded that DMT could effectively improve both motor function and cognitive deficits in individuals with neurodegenerative diseases. On the other hand, Karkou et al. (2023) in their analysis of a randomized control study with dementia clients did not find a statistically significant difference in cognitive functioning between a DMT and a wait list group. However, this study indicated sustained reduction in depression for the participants and highlighted the urgent need for

continued research in dementia care. Tomaszewski et al. (2023) evaluated the efficacy of DMT for posttraumatic symptoms and concluded that it may be a useful modality for improving psychological and physiological symptoms associated with trauma experiences, such as avoidance and dissociation. Dance/movement therapy has been indicated in improving body image and promoting a sense of self-worth (Allet et al., 2017), reducing stress and cortisol (Ho et al., 2017), and decreasing aggressive behavior while building social skills in children (Hervey & Kornblum, 2006). On a molecular level, dance and DMT have been suggested to increase levels of serotonin, estrogen, high-density lipoprotein cholesterol and nitric oxide while lowering levels of serum triglycerides, serum glucose, and low-density lipoprotein cholesterol (Lopez-Nieves & Jakobsche, 2022).

An Overview of Suggested Therapeutic Factors of Dance/Movement Therapy

According to the ADTA (2025), DMT relies on several premises: Movement is our first language and as important as verbalization; mind, body, and spirit are linked; functional, communicative, developmental, and expressive movement may emerge in DMT sessions; and therapists observe, assess, and intervene through movement and from a movement perspective. With these premises in mind, what are the specific ingredients, the therapeutic factors that make DMT unique? In other words, what are the components that produce therapeutic benefits (deWitte et al., 2021)?

In a comprehensive search of the literature, we used the search terms ‘therapeutic factors,’ ‘mechanisms of change,’ ‘active factors,’ ‘unique,’ ‘differentiate,’ ‘theoretical model,’ and ‘theoretical framework’ in conjunction with ‘dance movement therapy,’ ‘dance therapy,’ ‘movement therapy,’ and ‘dance movement psychotherapy’ to identify relevant articles and texts. Databases used were PsycINFO and Google Scholar. We also combed through early original works not available through the databases. We included empirical research texts, theoretical papers, reviews, and book chapters (including original works, some of them no longer in print) outlining the history of DMT to honor all voices. Nevertheless, the list of works highlighted here may not be exhaustive. Table 1 presents a concise largely chronological overview of the findings which are further summarized below.

Insert Table 1 here

Marian Chace, the “Grand Dame” of DMT initially stressed four major areas: Body action, symbolism, therapeutic movement relationship, and group rhythmic movement relationship (Chaiklin & Schmais, 1986). Several of these were reiterated in Schmais’ (1985) healing processes specific to group DMT, while she added synchrony, integration, cohesion, and education. Chaiklin (2017), a student of Chace and one of the first dance therapists in the United States, accentuated the significance of the movement connection and summarized that “dance, relationships, and the offer of new possibilities for expression and communication through the

body are fundamental to DMT" (p. 147). Other early dance/movement therapists emphasized similar or additional crucial aspects about DMT, including creative dance improvisation (Blanche Evan), playful interactions (Trudy Schoop), authentic movement (Mary Whitehouse, Janet Adler, Joan Chodorow, Marcia Plevin (2017), Patrizia Pallaro, and others), inner sensing (Alma Hawkins), and the use of music (Franziska Boas, Liljan Espenak, Elizabeth Rosen) (Levy, 1988). The therapeutic factors of movement itself were also detailed by philosopher and theorist Sheets-Johnstone (2010) who posed six arguments, with the first one being that movement is at the core of life and the foundation of human development.

As DMT became increasingly established, the developments of movement assessments (including Laban Movement Analysis [LMA], Kestenberg Movement Profile [KMP], Movement Psychodiagnostic Inventory [MPI], Nonverbal Assessment of Family Systems [NFS], Outcomes Framework [MARA], etc.) offered and have continued to offer important ways to guide, direct, and describe movement.

Throughout the years, theoretical models have been suggested, such as Leventhal's (2008) integrative DMT treatment model with six elements that illustrate the conscious healing dance and Shim et al.'s (2019) model that outlines five key therapeutic mechanisms of DMT for resilience building in the management of chronic pain. In addition, Koch (2017) proposed a theoretical framework for embodied aesthetics with five clusters of mechanisms for the creative arts therapies that can apply to DMT.

More recently, efforts have been made to clarify the key therapeutic aspects of DMT. Lauffenburger (2020) for example suggested 10 features that are unique to the nonverbal, nonlinear, interactional, dynamic, and communicative inner and outer spaces that characterize DMT. One of these, the significance of ancient healing practices, was also presented by Dunphy et al. (2021) in an international overview of DMT across six world regions. They highlighted that dance and ritual are used in the service of collective healing, supporting physical, emotional, social, individual, and community health with methods adapted to the local culture. A slightly different focus was suggested by Imus (2021) who identified nine fundamental mechanisms of DMT based on an analysis of her extensive practice, education, and research, with unique factors such as safety, empowerment, and interdisciplinary approaches. Some of Imus' mechanisms were substantiated in a recent scoping review by deWitte et al. (2021). In this report, active factors specific to each creative arts therapy (CAT) discipline (DMT, music therapy, art therapy, and drama therapy), joint factors between the disciplines, and common factors across all psychotherapy approaches were laid out based on an analysis of empirical studies. The authors found 19 domains in total that were common to the CATs and isolated 12 specific DMT factors, including discharge of energy/release of tension. Lastly, Estel and Koch (2023) in their recent multi-location study asked 82 patients what made DMT effective for them. Based on the textual responses, the authors established the nine most frequently named categories, such as access to new experiences and expression of emotions. Furthermore, they created a complex thematic network with six global themes (contact with self, group, therapist, medium, theme, atmosphere) and numerous subthemes.

The references listed above provide only a fraction of the existing theories and musings about the active ingredients of DMT and advancements are continuing to be made. Although there is overlap in the literature, a shared understanding and consistent, congruent language is largely missing (Imus & Young, 2023). The call has been made repeatedly to systematically examine DMT and its specificities (Imus & Young, 2023; Samaritter and Cantell, 2021). Below we offer a synthesis and integration of the existing identified therapeutic factors in DMT and suggest some relevant research on neural correlates in an effort to underscore the mechanisms of change in DMT. We use de Witte et al.'s (2021) definition of mechanisms of change as "a theory-driven causal chain or sequence of events or processes (or mediating variables) that explain, in greater detail than factors or mediators alone, how or why therapeutic change occurs" (p. 4). Two points to consider: although we here intentionally isolated the specific therapeutic factors of DMT from common factors with other disciplines in order to deepen our shared understanding of DMT theory, overlap still exists as this is not an unequivocal endeavor. Secondly, in our synthesis, we included a wide range of theories and with variable populations. Our aim was to present a comprehensive model with mechanisms of change that is broadly applicable. Nevertheless, the relevance and pertinence of some of the mechanisms of change will vary with what population and age group is served, where DMT is practiced (cultural variations), whether it occurs in group or individual sessions, what training was received, and with personal preferences of the therapist.

Synthesis of Therapeutic Factors and Neural Correlates to derive Mechanisms of Change

In order to synthesize the selected relevant studies identified through the literature review, we first created a synthesis matrix with all the suggested unique DMT components and sub-components and organized them thematically. We then identified five main thematic clusters that could encompass all components. Subsequently, we distributed the subcomponents, either using the commonly mentioned specific factors verbatim from the literature or creating labels that comprised less commonly mentioned ones. This was an iterative process that entailed multiple revisions and discussions. Following main mechanisms of change clusters were identified: 1. Connection through movement, 2. Emotional regulation through movement, 3. Body sensing and being, 4. Creative movement expression, and 5. Meaning making through movement (Figure 1). Of note is the interconnected and dynamic nature of these clusters, which makes it virtually impossible to compartmentalize them. Their subcomponents, too, are intricately linked and sometimes used interchangeably in the literature. Nevertheless, we present them here in a discretionary separation followed by plausibly relevant research on neural correlates and associated insights from recent neuroscientific literature. In general, the overlap between the subcomponents from one cluster is fluid in nature, whereas the overlap between subcomponents from different clusters is functionally distinct (such as in the case of rhythm which appears twice). Again, this is not meant to be an exhaustive list from the perspective of DMT or neuroscience, but hopefully it can inspire important dialogue.

Figure 1. Theoretical model for DMT with five suggested mechanisms of change

1. Connection through Movement

In DMT, nonverbal connection of body and movement occurs through the therapeutic movement relationship (Chace in Chaiklin & Schmais, 1986), a "shared presence of body, mind, and spirit between the dance/movement therapist and client where healing occurs within the safe containment of a creative collaboration, and results in a resonance" (Young, 2017, p.104). This resonance reflects what Buber (1970/1970) described as an *I–Thou* relational event—co-created, emergent, and not fully residing in either participant alone. In considering connection through movement, we here highlight eight overlapping components that arguably fall under this umbrella: attunement, kinesthetic empathy, mirroring, somatic countertransference, empathetic witnessing & authentic movement, connecting rhythm, synchrony, and touch. These and their neural correlates have been summarized in Table 2.

Insert Table 2 here

Attunement has been defined as "the sense of being fully aware of the other person's sensations, needs, or feelings and the communication of that awareness to the other person" (Erskine & Trautmann, 1997, p. 90). In DMT, therapists match and "feel" the movement qualities of their clients through attunement (Tortora, 2011), which can lead to clients feeling understood, safe, and ready for connection (Deveraux, 2017), promoting attachment (Homann, 2020). Attunement is a foundational entry point for the emergence of unconscious movement patterns stored in the body (Chaiklin, 2017).

Attunement and *kinesthetic empathy*, a term coined by Miriam Roskin Berger (Cruz, 2012), are closely linked and sometimes interchangeably used concepts. Described as having "antennae all over the body" (Chace in Chaiklin, 2017, p.145), kinesthetic empathy lies at the core of DMT (Meekums, 2012; Samaritter & Payne, 2013) and is essential for the therapeutic relationship (Federman, 2011; Fischman, 2009). The recreation of the client's bodily movements in the therapist's body may allow the therapist to sense and respond to the client's emotional state (Vulcan, 2009). Chaiklin & Wengrower (2015) further describe kinesthetic empathy as a movement dialectic of identification and differentiation—where identification connects and reflects, while differentiation introduces novelty, distance, and otherness. Through body and movement sensing, the therapist could come to understand and respond to the other's inner experience (Rova, 2017). Ultimately, kinesthetic empathy is a reciprocal process in which client and therapist attune to each other (Eberhard-Kaechele & Goll-Kopka, 2022).

Mirroring, a method used by dance/movement therapists that is clearly distinguished

from mimicry, entails similar body movements that occur in synchrony or slightly echoed in time (McGarry & Russo, 2011). In this process, therapists may experience the emotions and intentions of their clients, which can then inform a deliberate reflection of specific qualities to increase awareness and establish trust (McGarry & Russo, 2011). Mirroring is considered kinesthetic empathy in practice (Meekums, 2012) and, when successfully done, leads to heightened attunement (Eberhard-Kaechele, 2012). The therapist's ability to differentiate what belongs to whom is crucial in this shared somatic process.

Another connected concept, *somatic countertransference*, can be defined as "the subjective experience or embodied response to another individual or a situation" (Downey, 2016, p.5). As dance/movement therapists engage with their clients, they become aware of their own physical sensations, impulses, and feelings. According to Lewis (1984), this "inner pas de deux " of the somatic countertransference is the locus of transformation as it connects the core of the patient to the healing parts of the therapist. Importantly, therapists must recognize and manage their own responses so as not to superimpose their own motility (Vulcan, 2009). Sandel, Chaiklin, & Loman (2013) emphasize that when observing one's movement, clinicians must also critically examine their own assumptions and implicit biases - considering how bodies are read through lenses of power, privilege, identity, and culture.

In addition to attunement, kinesthetic empathy, mirroring, and somatic countertransference, *empathetic witnessing* of the client can further promote a therapeutic alliance and build trust and rapport (Burns, 2012). Being seen as one's authentic self is a vulnerable experience, yet it can be truly transformative (Tortora, 2011). "Seeing with the heart" (Newman-Bluestein, 2020, p. 178) means having the intention to be a container for healing. In DMT, empathetic, safe witnessing is associated with the technique of *Authentic Movement*, where the therapist holds space for and witnesses the mover/client - a potentially curative and healing factor (Adler, 1999; Meekums, 2012).

Rhythm is an ancient *connecting*, healing, and organizing power that lies at the core of DMT (Gray, 2018). Rhythmic activity in DMT groups results in interpersonal synchrony, cohesion, and trust, and encourages clients to relate to each other (Dieterich-Hartwell, 2025; Gray, 2018; Prakash et al., 2024). Rhythm also plays a significant role in emotional regulation and group bonding (see *Emotional Regulation through Movement* section). Syncopation - unlike perfect synchrony - supports a relation between relations, enriching group interaction by allowing difference within togetherness, a principle that reflects the DMT ethos of connection through diversity (Nelson et al., 2024).

Synchrony, the "simultaneous movement of like or unlike body parts which operate at identical rates" (Fraenkel, 1983, p.38), is another well-known key concept in DMT and is also widely used in ritual and ceremonial dance forms throughout the world. Synchrony can promote feelings of well-being, stronger relationships, communication, and cooperation (Prakash et al., 2024). When layered with syncopation, as shown by Nelson et al. (2024), movement becomes a multidimensional relational field—supporting both empathy and individuality within the therapeutic process (Fontanesi & Newman-Bluestein, 2024).

Lastly, the use of *touch*, when indicated, can be a powerful connector. Touch is our first language and crucial for social and emotional development. Nevertheless, it is a controversial subject. In DMT as in other professions, touch is dependent on the culture of the treatment setting. Sakiyama and Koch (2003) presented a clear distinction between the western relationship to touch where it is largely avoided and other cultures that naturally include touch. When appropriate, and with ethical guidelines in place (Caldwell, 1997; Motherly, 2013), therapeutic touch as part of a therapeutic movement relationship may help clients develop trust, bonding, openness, and self-esteem (Caldwell, 2002; Ho, 2015; Motherly, 2013) and can have organizing and restorative effects (Sandel, 1987).

Neural Correlates

From a neuroscientific perspective, the processes described in DMT - attunement, kinesthetic empathy, mirroring, rhythm, and synchrony - can be further illuminated by recent insights into the complexity and plasticity of relational brain functioning. Contemporary models of empathy, for example, dismantle the notion of empathy as a singular, automatic response. Batson (2009) identifies at least eight distinct processes - including emotional contagion, mentalizing, aesthetic projection, and empathic concern - each involving different cognitive and neural mechanisms. These distinctions are confirmed by Marsh (2018), who shows that empathy for pain, pleasure, or fear activates distinct brain networks, many of which are shared across social species. Moreover, simulation-based models demonstrate that perceiving another's state can recruit brain areas involved in first-hand experience, such as the anterior insula and anterior cingulate cortex, thus offering neurobiological grounding for what DMT practitioners observe in kinesthetic empathy and somatic countertransference (Marsh, 2018).

Further, the widespread adoption of mirror neuron theory (MNT) to explain empathy and mirroring in DMT has been called into question. Although early findings in monkeys (di Pellegrino et al., 1992; Rizzolatti et al., 1996) sparked significant excitement across disciplines, including DMT, much of this enthusiasm has outpaced empirical support—especially regarding its application to complex human phenomena such as imitation, empathy, and social resonance. Despite claims that MNT underpins therapeutic mirroring, its foundations remain speculative in human contexts due to the lack of direct single-cell recording evidence (Mukamel et al., 2010). In fact, the original monkey studies found mirror neurons did *not* respond to emotionally expressive movements, which are central to DMT practice. Contemporary critiques suggest that MNT, as applied to human behavior, may oversimplify the rich relational and contextual dynamics inherent in therapeutic attunement. Associative learning models and socially embedded frameworks offer more nuanced alternatives (Heyes, 2009), aligning better with the experiential, embodied, and emergent nature of movement-based psychotherapies. This calls for a more cautious and layered use of neuroscientific terms in DMT, while encouraging neuroscience to learn from the relational complexity and contextual richness of embodied mirroring (Barnstaple, Fontanesi, & DeSouza, 2019).

Another area of intersection lies in rhythm and synchrony. Neuroscientific literature has increasingly confirmed what DMT has long practiced: that shared rhythmic movement enhances intra- and inter-brain synchrony, reinforcing social bonding, coordination, and emotional regulation (Basso et al., 2021). Rhythm activates multiple domains - including sensory, motor, emotional, and social processing - and is a scaffold for cognitive development and therapeutic change. However, much of the focus in neuroscience has been on synchrony and entrainment, perhaps because they are easier to quantify. The subtler but equally vital phenomenon of syncopation, central to DMT practices involving improvisation and differentiation, is only beginning to receive attention. Studies suggest that syncopated rhythms activate brain areas related to motor timing, reward, and endorphin release and foster emotional engagement and social pleasure (Witek et al., 2014; Matthews et al., 2020), while allowing individuals to maintain expressive individuality within a shared framework - echoing DMT's emphasis on connection without merging (Nelson et al., 2024).

Therapeutic touch has been shown to support mental and physical wellbeing, and may increase the efficacy of health-related interventions through associated reductions in cortisol, pain, and anxiety (Packheiser et al., 2024). Tactile cues between partners can also serve to improve communication, fostering deeper "movement conversations" and facilitating motor cognitive integration (Hackney et al., 2024). Within a therapeutic relationship, touch may accelerate reductions in distress and negative mood states (Sumich et al., 2022). Touch has also been shown to have beneficial effects through reducing feelings of loneliness and neglect, even in small doses (Tejada et al., 2020).

Finally, neuroscience is increasingly confirming the critical role of context, identity, and belonging in shaping interpersonal engagement - concepts deeply embedded in DMT's relational and socio-cultural frameworks. Rippon (2023) highlights that social exclusion and stereotype threat activate pain-related brain regions and inhibit cognitive and relational functioning, thereby confirming DMT's clinical attention to power, privilege, and embodied difference (Sandel et al., 2013). Neuroplasticity studies suggest that empathic capacities can be trained and are sensitive to context, reinforcing DMT's experiential and adaptive therapeutic methods. Taken together, neuroscience and DMT offer complementary lenses through which to understand therapeutic change - one offering neural mechanisms, the other embodied relational wisdom. In dialogue, they enrich each other, encouraging nuanced, ethical, and integrated approaches to healing through movement.

2. Emotional Regulation through Movement

Without emotional regulation we cannot take in new information or make sound decisions. In DMT clients are supported in tapping into their naturally available systems and use the therapeutic relationship and movement to regulate their emotions. We here offer seven interrelated concepts: relative safety, breath, co-regulation, regulating rhythm, mobilizing &

side-shifting, settling, and positive emotions through movement. These are summarized with their suggested neural correlates in Table 3.

Insert Table 3 here

The human need for *safety* has been well understood; only when individuals appraise themselves as safe can they relax and be fully present (Grawe, 2007). When a therapeutic alliance is established, clients feel comfortable and secure in sessions and are more likely to engage meaningfully with others (Yalom & Leszcz, 2020). Therapists in DMT can foster this sense of safety and engagement through their facial expressions, body language, tone of voice (prosody), and use of language.

Breath is the most fundamental rhythm of all, indicating the beginning and end of our life (Gray, 2018). It is a bridge between the body and mind and serves as an important tool in DMT (Mehling et al., 2011). The growing and shrinking or expanding and contracting that accompanies breathing can be observed and notated through bipolar shape flow, a concept from the KMP (Loman & Sossin, 2016). A balance in growing and shrinking patterns encourages stability and an internal sense of balance. Caldwell and Victoria (2011) highlighted the significance of therapists using their own breath as a conscious intervention as well as teaching clients balanced diaphragmatic breathing to use in and out of sessions to regulate their nervous system.

Relatedly, the concept of *co-regulation* is important to consider in the therapeutic context. In DMT, therapists promote co-regulation by picking up on their clients' emotional state through attunement and kinesthetic empathy, gauging their own somatic countertransference, and making adjustments to self-stabilize and regulate (e.g. keeping breath and movements slow, smooth, and at ease), while inviting clients to engage with them (Gray, 2018). Clients can then unconsciously assimilate and consolidate these new regulation abilities (Schore, 2019).

Rhythm is a *connector* (see above) and a *regulator*. Our bodily rhythms, including breath, heart beat, blood pressure, swallowing, etc. are surrounded and affected by external rhythms. According to Berrol (1992), "bodily rhythms and activities appear to relate to external rhythmic stimuli, matching tempi" (p. 25). Thus, external rhythms provided in DMT (through music, movement, dance, drumming, etc.) can restore a sense of emotional control and balance (Gray, 2018).

Mobilizing and side-shifting are concepts intricately linked through the polyvagal theory (Porges, 2011). According to this theory, three neural circuits are sequentially recruited depending on the severity of threat appraisal: the social engagement system (ventral vagal), followed by the fight/flight system (sympathetic), and lastly the dorsal vagal complex, a passive defense system that engages when everything else has failed. In DMT, therapists can invite physiological state shifts in the reverse sequence toward social engagement. The theory holds that clients who are emotionally shut down move back through fight/flight to social engagement and settling. In other words, when clients are in a state of hypoarousal, they can use the

movement space offered in DMT to first mobilize and reactivate their nervous system, then, with the help of an attuned therapist, side-shift to an active and safe playful state that entails social connection (Dieterich-Hartwell, 2020; Dumaresq, 2023; Gray, 2018). While this model draws on philosophical views and clinical experiences to offer a helpful framework, it is important to acknowledge that the scientific mapping of these systems remains complex and incomplete, with ongoing debate around how autonomic processing unfolds in real time and across individuals.

Interrelated and on the other end of the spectrum is *settling* through movement, a concept that supports emotional downregulation and calming of the nervous system (Dieterich-Hartwell, 2020; Dumaresq, 2023). In addition to breathing and internally focused relaxation such as meditation practices, movement in DMT sessions can meet the client in their state of hyperarousal and provide an externalization that may promote gradual settling and grounding, e.g. through the discharge of energy and release or "letting go" of tension (Dumaresq, 2023; Dunphy et al., 2021; Estel & Koch, 2023). Again, a playful approach can invite the social connection component that supports a feeling of safety and trust (Gray, 2018). For children, the "brake, breath, brain, body" technique can promote settling and grounding (Kornblum, 2002).

Movement as nonverbal communication expresses internal states, including feelings, emotions, and attitudes (Acolin, 2016; Bartenieff & Lewis, 1980). Dance and movement are not only catalysts of physiological regulation but have shown to promote *positive emotions* and reduce negative affect (Zhang & Wei, 2024). Importantly, emotional expression is highly shaped by culture, mental health, personal history, and family dynamics - and is therefore easily misread. The search for universal emotional expressions in movement has long captivated theorists, but it remains unresolved, largely because emotion is not expressed through fixed motor "codes" but rather through context-dependent physicality shaped by narrative, intention, and meaning. Nevertheless, quantitative (increased intensity) and qualitative (change in posture, facial expression) movement modifications have shown effects on emotional wellbeing (Shafir, 2016). Vertical movements in particular have been found to correspond with positive affect and feelings of uplift and enjoyment (Koch et al., 2007). Music, when used in the DMT space, may also play a significant role in emotion evoking and regulation (Dieterich-Hartwell, Gilman & Hecker, 2022).

Neural Correlates

Current neuroscience offers strong support for the mechanisms of change observed in DMT, particularly in relation to emotional regulation, breath, and interoception. Research on the neural basis of breathing highlights its central role not only in autonomic regulation but also in cognitive and emotional processing. Ashhad et al. (2022) show that the brainstem structure responsible for generating respiratory rhythm is intimately connected to higher brain regions such as the prefrontal cortex and amygdala, key areas in emotion regulation. The rhythmic nature of breathing, especially when consciously modulated through practices like deep or paced

breathing, can synchronize neural activity and modulate affective states, providing neurobiological validation for the therapeutic use of breath in DMT.

This integration of brainstem and cortical processes through breathing also recalls Lisa Feldman Barrett's (2017) theory of constructed emotion, which suggests that emotions arise from the brain's predictive models combining interoceptive input and contextual experience to maintain allostasis. Dance and movement therapies, by directly engaging the body's internal rhythms, serve as interventions that shift these predictive models, creating opportunities for re-categorizing affect and accessing new emotional experiences. Similarly, Damasio and Carvalho (2013) identified feelings as the conscious readout of interoceptive states, rooted in deep brain structures - again emphasizing that movement-based therapies operate at a fundamental level of consciousness and affect regulation.

Interoception, also highlighted in the next section (*Body Sensing and Being*), plays a crucial role in the development of emotional intelligence, as outlined by Brackett and Cipriano (2020), who argue that emotional competence relies on recognizing and naming internal states. Practices in DMT that foster body awareness, settling, and co-regulation may serve as embodied training grounds for this skill, especially when introduced early in development or used to repair emotional dysregulation.

Furthermore, interoceptive awareness, emotion regulation, and bodily engagement converge in psychotherapy as essential dimensions of healing. Grecucci et al. (2017) emphasize that both cognitive and experiential strategies are needed for effective emotion regulation, with body-based and rhythm-based interventions offering bottom-up access to neural systems involved in memory, emotion, and self-regulation. Neuroscience and DMT thus come together to support a model where movement, breath, rhythm, and relationship scaffold the brain's capacity to adapt, regulate, and thrive.

Finally, neuroscience has shown how rhythmic synchronization through movement and music affects intra- and inter-brain coupling (Basso et al., 2021). While much attention has been given to perfect synchrony, emerging evidence highlights the importance of syncopation—intentional rhythmic variation—as a means to sustain engagement, reward processing, and social connection (Witek et al., 2014; Nelson et al., 2024). These findings echo the DMT principle that therapeutic rhythm involves not just alignment but also variability, allowing for flexibility, novelty, and individual expression within a shared structure.

3. Body Sensing & Being

The body is the point of focus in DMT. As individuals are invited to sense, listen to, and be in their bodies in therapy, they begin to also relate more deeply to their emotions and connect more intimately with themselves. Here we differentiate body sensing & being into seven overlapping concepts: body/self-awareness, interoception, embodiment, body memory, body image, habitus, and body as home. These concepts are briefly introduced below and subsequently explicated to their corresponding neuroscientific understandings as summarized in Table 4.

Insert Table 4 here

Body/self-awareness is informed by interoceptive (see below) and proprioceptive data (Hindi, 2012). Here the core self integrates the dynamic experiences of the tactile-kinesthetic/affective body ultimately leading to self-agency, self-coherence, self-affectivity, and self-history (Sheets-Johnstone, 2019; Stern, 1985). Much has been written about the role of body and self-awareness in DMT (e.g., Acolin, 2016; Bloom, 2006; Caldwell, 2017; Chyle et al., 2020; Fuchs & Koch, 2014; Homann, 2020; Imus & Young, 2023; Payne et al., 2019; Pass Erickson, 2021; Shim et al., 2019; Tantia, 2019), including how awareness of breathing, posture, and gesture can assist in understanding emotional content (Imus & Young (2023).

A connected concept, *interoception*, the awareness of the physiological condition of the body (Craig, 2003), is relevant for the practice of DMT (Dieterich-Hartwell, 2017; Hindi, 2012; Homann, 2020) as it creates an avenue for therapeutic change through the conscious integration of emotions and sensations. In this context, the spine is often highlighted as a passage for sensory information to traverse to the brain which can bring unconscious interoceptive data into consciousness where it can be processed (Hindi, 2012).

Embodiment is a common term that is somewhat loosely utilized. Tantia (2019) suggested that rather than attention *to* the body (body/self-awareness), embodiment is attention *with* the body. Koch & Fischman (2011) defined embodiment as a living system that unites mind and body, perception and action, creativity and recognition, and cognition and emotion and can be engaged in inter-subjective dyadic processes and relationships. Represented experiences are shaped by the body and can be notated and analyzed through the KMP which focuses on patterns of embodiment (Kestenberg Amighi et al., 1999). In DMT an embodied enactive perspective highlights the agency of individuals who can increase wellbeing by becoming conscious of their body and movement (Koch & Fischman, 2011). It is a form of dynamic concretization, in other words it is a concrete expression of an abstract idea or quality (Imus, 2021).

Body memory, acquired in early childhood and adjusted throughout life, is the implicit knowledge mediated by the body needed for being in the world; it is elicited by sensing or moving (Koch, Caldwell, & Fuchs, 2013). Different types of body memory have been suggested by Fuchs and include habitual -, situational -, intercorporeal -, incorporative -, pain-, and traumatic body memory. In DMT, difficult and traumatic- as well as resourceful and positive body memories can be attended to by sensing, moving, and integrating.

According to Pylvänäinen (2003), *body image* can be subdivided into three interrelated features, image-properties (perceived appearance & societal/cultural perspective of the body), body-self (interactive, experiencing, emotional body-based core self), and body memory (see above). These socially constructed features are developed through movement and simultaneously influence what kind of movement is created. Body image is addressed in DMT as individuals are

supported in improving their mental representation and self-body schema (Muller-Pinget et al., 2012).

Another related concept, the *habitus* (Bourdieu, 1984), is imparted pre-verbally and not accessible to our cognitive selves. It exhibits racial identity and ethnic inclusion, underpinning cultural cohesion through dance and movement (Chang, 2006). The habitus is a crucial consideration in DMT and therapists are called to be aware of a client's cultural heritage during assessment and treatment. As an extension of the habitus, inquiring and learning about a client's embodied intersectionalities can shed light on hidden barriers and privileges as well as historical implications of transgenerational trauma (Rivera, Furcron, & Beardall, 2022).

Lastly, the *body as home* is a construct that implies having an internalized view of self; having comfort, attunement, acceptance, and trust in self; and fully inhabiting the body and authentically expressing self (Meeks, 2012) which is relevant to all, but in particular for homeless and displaced populations (Dieterich-Hartwell & Koch, 2017) and transgender and nonbinary individuals (Jackman, 2022). In DMT, exploration of this metaphor has been shown to directly affect body image and may foster healthy attachment as well as a sense of security, control, and comfort.

Neural Correlates

Millman et al. (2021) in their systematic review of DMT studies placed alongside contemporary cognitive neuroscience research focused on embodied cognition and interoception, which has been defined by Chen et al. (2021) as the sensing and processing of signals that emanate from within the body. Millman et al. suggested that dance affects these cognitive functions. More specifically, marking, repeating sequential dance movements in a smaller form with a different body part (e.g. hands rather than feet) appears to improve recall and enhances performance (Warburton et al., 2013). Moffat and Cross (2024) examined the relationship between movement synchrony and embodiment of participants leading and following each other's spontaneous arm movements through fNIRS (a mobile brain imaging technique that uses near-infrared light to penetrate tissue). They detected heightened cortical activity in the followers' key action observation network regions (bilateral superior temporal gyri, left inferior frontal gyrus, right inferior parietal lobe) when they accurately recognized movements they had previously embodied themselves.

Interoception has been an emerging focus in neuroscience research as high-resolution multimodal tools are becoming increasingly available. The insula, part of the ventral salience network, and associated cortical and subcortical networks are integrally involved in interoception and in the embodied forming of cognition and perception (Wittmann, 2023). Located deeply in the brain, these regions are challenging to stimulate and image. Therefore, in human subject research, fMRI (functional magnetic resonance imaging) studies can only provide correlative findings, while non-invasive methods including TMS (transcranial magnetic stimulation) and tDCS (transcranial direct current stimulation) may be able to assess causal effects (Chen et al.,

2021). A heartbeat tracking method has suggested that dancers have higher interoceptive accuracy than controls (Christensen et al., 2018).

On broader terms, the mechanism of the umbrella term mindfulness has been examined. The anterior cingulate cortex is the most consistently reported region associated with mindfulness (specifically self-awareness, self-regulation, attention control, and emotion regulation) and the default mode network (including prefrontal cortex and posterior cingulate cortex) may be altered following mindfulness training (Tang et al., 2015). Nevertheless, mindfulness is a complex state that is likely to be supported by the large-scale brain networks and not single-brain areas.

4. Creative Movement Expression

This cluster is arguably the one that distinguishes DMT more than any other from somatic therapies while highlighting some parallels to other creative arts therapies. We have identified seven interrelated subcategories here: dance, culture & ritual, play, improvisation, creative process, artistic pleasure & aesthetics, and movement exploration & expansion. Please find them summarized in Table 5 alongside their suggested neural correlates.

Insert Table 5 here

Dance has always been at the center of DMT and remains a key ingredient (Bräuninger & Reips, 2021; Capello, 2007; Chaiklin & Schmais, 1986; Ho, 2021; Wengrower, 2021). As a primary tool for communicating, dance is a "statement of one's feelings and energy and desire to externalize something from within" (Chaiklin, 2009, p. 5). Dance/movement therapy practices have been influenced by a wide range of dance styles from around the globe. Music is tightly connected to dance and plays an integral role (Dieterich-Hartwell et al., 2022).

Relatedly, DMT takes into consideration and honors the *culture* and history of the ancient healing art of dance, including movement *rituals* and community healing (Gray & Fargnoli, 2022). Dance/movement therapy is studied and practiced on six continents, in close to forty countries, and clinicians exchange and share passed-down knowledge that promotes the health and well-being of individuals (Chang, 2016). That being so, dance/movement therapists are called to increase their awareness of cultural diversity while recognizing the effects of unconscious bias concerning cultural rhythmic patterns, movement styles, and music choices (Nichols, 2019; Rivera et al., 2022). Music is intricately connected to culture and can validate cultural identity (Dieterich-Hartwell et al., 2022).

Play, an intentional, intrinsically rewarding, and process-oriented behavior that is initiated when no threat is perceived (Burghardt, 2010) is a common feature in DMT, whether it is in working with children, teens, or adults. Early on, Trudi Schoop spoke to the healing benefits of humor and play which can bring up unconscious material (Levy, 2005). Other dance/movement therapists have highlighted the importance of play in their work (Capello,

2008; Caldwell, 2003; Imus; 2021; Kornblum, 2008; Tortora & Keren, 2022), which can include physical games, role play, playing with music, rhythm, props, etc.

Closely connected to play is dance *improvisation*, the "spontaneous creation of shape that entails a natural structure: a beginning, middle, and end" (Evan in Levy, 2005). Evan suggested three approaches, projective technique, sensitization to/mobilization of body action, and complex improvisation. Today, improvisation, which mirrors and can provide an inroad to unconscious processes, continues to be a crucial intervention in DMT sessions (Bräuninger, 2014; Imus, 2021; Kornblum, 2008; Purcell, 2021).

The *creative process*, another tightly knit concept that encompasses both play and improvisation, is at the core of DMT. According to Basso (2021), the creative process distinguishes dance as an art form from other physical activity. In her tribute to modern dancer Isadora Duncan, Berger (1992) highlighted the nature of creative elements in DMT. Creativity is used in DMT as a resource both within the client and within the therapeutic relationship (Wengrower, 2016).

When we move expressively, whether it is through creative, playful, and improvisational means or cultural dance forms, we experience an increased sense of *aesthetics and artistic pleasure* (Koch, 2017). This embodied beauty of expression in DMT is healing (Ho, 2021; Wengrower, 2021); dance as well as bodily resonance and feedback to dance are part of a cycle of embodied aesthetics that is pleasurable (Koch, 2017). According to Berger (1992), the aesthetic impulse is a reflection of the essence of nature.

Lastly, creative movement expression in DMT invites *movement exploration and expansion*, which can in turn create new ways of coping and increase emotional resilience (Acolin, 2016; Bloom, 2006). Clients in the safety of the DMT space, whether surrounded by one or several other(s), can begin to take in the dynamic changes around them, experiment and "try on" different movements, and practice alternative behaviors, thus accessing new experiences (Chyle, 2020; Estel & Koch, 2023; Lauffenburger, 2020).

Neural Correlates

Neuroscientific research on the effects of dance experience has ballooned over the past two decades, as recently outlined by Cross (2025) and Foster Vander Elst (2023). While early research used basic science to establish mechanisms involved in dancing such as motor-imagery, action perception, expertise and observational learning, recent studies are moving towards more applied topics such as emotional expression and perception, aesthetics, dance and aging, therapeutic effects and neurorehabilitation (Cross, 2025).

The budding field of neuroaesthetics, which investigates the impact of various arts and artistic languages on brain, biology, and behavior (Magsamen, 2019) is well-suited to the further development of research on the therapeutic dimensions of dance. Dance combines the known benefits of exercise and music (Dhami et al 2015) with artistry, expression, and creativity, with potential to induce stronger affective responses. Fontanesi and DeSouza (2021) compared a

dance program to a matched-intensity exercise intervention demonstrating that dance led to both functional improvements—such as enhanced gait symmetry and reduced dual-task cost—and psychological benefits including increased positive affect, elevated skin conductance, greater self-efficacy, and a reported sense of feeling beautiful. The authors suggest that this subjective experience of beauty, rooted in participants' belief in their ability to succeed in dance and feel aesthetically expressive, might have helped diminish diagnosis-related cognitive interference, potentially freeing up attentional resources for motor control or facilitating movement automatization through increased external focus (Fontanesi & DeSouza, 2021).

Other studies comparing dance with exercise found that dance participation increased Brain Derived Neurotrophic Factor (BDNF), a marker of neuroplasticity (Muller et al, 2017). Learning novel dance choreography was also shown to induce neuroplastic changes in young professional dancers (Bar & DeSouza, 2016), and BOLD signal changes in subcallosal cingulate gyrus (SCG) have been reported in people with Parkinson's participating in a community-based dance program (Bearss et al, 2024). Brain area SCG is associated with the depression network; results in this study were correlated with improved scores on the Geriatric Depression Scale over 8 months. This research indicates that there are measurable brain-based differences pre and post dance, which may be read as "traces" of the embodied experience. Related research has shown slowing of disease progression for people with Parkinson's participating in dance (Bearss & DeSouza, 2021), suggesting that these changes could be adaptations that support healthy aging, even in the presence of disease.

DMT and other client-centered modalities that use dance with an aim to meet people "where they are at" tend to draw more heavily on improvisation than choreography. Improvisation itself is an expanding arena of research, closely aligned with studies on creativity and artistic processes. Described as a form of "collective sense making" (Nelson et al 2024) which can give insight into the construction of experience, the real-time artistic practice of exploration and discovery fostered by improvisation invites and encourages flexibility, adaptation, and problem-solving - key components of resilience. While scientific research on improvisation is still nascent, studies on improvising musicians have found distinct patterns of activation in the brain including generalized intensification in all sensory modalities along with deactivation of limbic structures, which regulate motivation and emotional tone (Limb & Braun, 2008). A study involving vocal improvisation observed changes in network connectivity consistent with being in a state of "flow", in which bottom-up processes, related to incoming sensory information, take precedence over top-down cognitive control (Vergara et al., 2021). In dance improvisation, these shifts in attention have been described as "oscillations of agency" (Ravn & Hoffding, 2022) which can feel as though the mover is "letting the movement happen".

In applied research investigating the impacts of an improvisational movement protocol for adults with a diagnosis of MCI (Mild Cognitive Impairment, an early form of dementia), changes were reported in brain network characteristics such as modularity and global efficiency (Thumuluri et al, 2022). More research is needed to better understand the relationship between

the development of specific creative skills associated with improvisation and supporting brain health throughout the lifespan.

5. Meaning Making through Movement

Body and mind are closely interwoven, as we have outlined throughout this paper. This principle is important considering the integration and cognitive understanding of what is nonverbally/physically transpiring and disclosed. In DMT meaning making is a subjective and individualized process (Acolin, 2016). We here emphasize six concepts: imagery, metaphor, symbolism, awareness & coping, integration of self, and empowerment & transformation. Once again, these are connected to each other and to other concepts already introduced prior. They are presented alongside their neural correlates in Table 6.

Insert Table 6 here

According to Knill, Levine and Levine (2005), in order to reach deep into the psyche, therapy needs to target imaginal life. *Image making* was one of Chace's signature approaches (Sandel, 1993). Whitehouse and Schoop encouraged active imagination and inner fantasy respectively (Levy, 2005) to allow all levels of conscious and unconscious experience to emerge and be named. Images and emotions that arise from the movement can be developed kinesthetically and reflected upon verbally (Serlin, 2020).

Similarly, *metaphors* (literally meaning "to carry across") can appear in the form of movements. Much has been written about movement metaphors in DMT (Ellis, 2001; Hayes, 2011; Meekums, 2012; Samaritter, 2009). They exist in the creative, potential space (Winnicott, 1971) between therapist and client/group members and offer a bridge from the unconscious to the conscious which can provide valuable insight in a less emotional (safer) way (Meekums, 2012).

A *symbol* is a "term, a name, or even a picture that may be familiar in daily life, yet that possesses specific connotations in addition to its conventional and obvious meaning" (Jung, 1968, p.20). Symbols are more complex and nuanced than metaphors and they can have multiple interpretations. In DMT, they are arguably the least comprehended yet the most valuable parts of the process (Schmais, 1985). Symbols, when they surface spontaneously and are not pressured, can establish a positive holding environment that can foster increased insight and meaning for clients by revealing what is inside (Samaritter, 2009), clarifying past issues, present concerns, and future anticipations (Schmais, 1985). Of note is that some individuals may have difficulty in working within the symbolic realm (Meekums, 2012).

As in other types of therapy, in DMT *awareness* of one's situation/problem and *coping* by changing the narrative is a helpful facet of healing (Estel & Koch, 2023). Specifically in DMT, Shim's (2019) model of resilience building (activating self-agency, connecting to self and others, enhancing emotional intelligence, and reframing) thoroughly describes this process which also

entails the use of expressive movement as self-fulfilling action, an autobiographical integration, emotional management, and permission to play. Christopher et al. (2024) suggested that DMT can increase management strategies and self-efficacy for treatment resistant depression.

The ADTA (2025) defines DMT as the psychotherapeutic use of movement to promote emotional, social, cognitive, and physical *integration*. Grayson et al. (2024) have added the importance of attending to and inviting the integration of one's spiritual self in DMT sessions. Integration can occur when affect is shared in the presence of another (Pierce, 2014) and refers to a dynamic and changing state of balance that entails a "sense of unity within the individual and a sense of community between internal and external reality" (Schmais, 1985, p. 26). It is a direct pathway toward health (Siegel, 1999) as individuals gain insight and make connections.

The creative art making process in DMT promotes *empowerment* as clients can gain agency over their bodies and movement (Imus, 2021). According to Leventhal (2008), the unique profession of DMT allows for healing and *transformation* by fostering an opening of one's healthy and complex potential. Transformation in DMT has been showcased in the Sampoornata model (Chakraborty & Tant, 2022) which supports clients in transforming their traumatic body to an "active, energetic, spontaneous, expressive, communicative, and peaceful one" (p. 148) and thus creating a new self-narrative and taking charge of their own lives. Others have written about the transformative power of DMT, including Harris (2007), Bernstein (2022), Gray (2001), Tropea and Kleinman (2022), Johnson (2023), and Muller-Pinget et al. (2012) to name a few.

Neural Correlates

The concepts in this section are among the most complex human capacities we can name, and it should be noted that the phenomenon of consciousness itself, of which these are aspects, has long been referred to as the "hard problem" in neuroscience (Brogaard & Gatzia, 2016). Research on the neuroscience of "imagination" as it relates to images and symbolic relationships, and the ability to visualise alternative futures or potential transformations has the potential to illuminate some of these concepts. Core brain areas recently found to be involved in our imaginal capabilities include the hippocampus, which is also integral for spatial navigation and memory formation (Comrie et al., 2022), both of which are mobilised through DMT.

Social and affective neuroscience, which investigates the neural bases of human interactions, may also contribute to neuroscientific models of these concepts. The advancement of "second person neuroscience", which studies relationships through new technologies such as hyperscanning (collecting data on multiple subjects simultaneously) has shown potential to illuminate processes involved in shared attention, joint regulation, and mutual affect (Czeszumski et al., 2020). As research methods evolve, they may become better suited to study mechanisms that facilitate connection and support well-being such as symbolic interactionism, a microsociological theory recently named as a core component of "secular rituals" in arts in health (Warren, 2025).

Metaphors and *symbols* are core aspects of language, a huge area of study in neuroscience with dedicated journals, conferences, and academic departments, a full consideration of which is outside the scope of this paper. The use of symbolic movement and meaning in DMT can also be considered in relation to cognitive theories such as the Integrated Theory of Primary Metaphor, which posits that subjective experience is informed by the sensorimotor domain and embodied, experiential metaphors are used in reasoning (Lakoff & Johnson, 1999). Interestingly, an emerging direction for research in dance neuroscience concerns the relationship between movement and language centers in the brain. While dance scholars such as Judith Lynn Hanna (1987; 2008) have long argued that dance is a form of non-verbal language, scientific interest in this question is more recent. Animal researchers noted that birds are one of few animals to exhibit dance-like behaviors, as in the case of Snowball the cockatoo who seems able to follow a beat and experiment with developing a movement repertoire (Jao et al, 2019). This dance-like capacity has been linked to the learning of birdsong, and very recent research has proposed that the mechanisms for producing speech (a motor behavior) and dance overlap, suggesting a direct therapeutic application for speech recovery via dance (Theofanopoulou 2025).

Discussion, Limitations, and Future Directions

In this paper, we suggested a theoretical framework for DMT that included five clusters of mechanisms of change and pointed to potential neural correlates from research in neuroscience. While the fields of DMT and neuroscience may not directly intersect, they both address phenomena pertaining to the human experience, albeit through different language and methods. Furthermore, our understanding of the joined functions of body and mind and their relationship to behavior and awareness has expanded significantly (Barnstaple & Dieterich-Hartwell, 2022). It is important to remember that while there are not, at this point, many direct correlations (neuroscientific research specifically on impacts or mechanisms in DMT), inferences can cautiously be made as Millman et al. (2021) proposed in their systematic review. To advance scientific research on DMT, it is essential to have clear definitions of elements and tools involved in its practice (Imus & Young, 2023; Samaritter and Cantell, 2021).

Our aim in compiling this inventory of theories in DMT and organizing them into mechanisms is to demonstrate the richness of the field while identifying discrete factors. As the knowledge base associated with arts and health and Creative Arts Therapies grows, there is an urgent need for translational research that fully engages with the holism involved in arts-based practices that aim/purport to treat or support health and wellness. Translational research promotes multidirectional and multidisciplinary integration while improving the health of the public (Rubio et al., 2010). Multifactorial designs that include interactions between elements and blend methods from arts and sciences have the potential to advance our understanding in new ways, leading to innovations in both practice and application.

As previously mentioned, depending on the setting and population, along with one's training, cultural heritage, and personal preferences, different mechanisms of change will dominate. For example, when working with clients with dementia, synchrony, rhythm, and body memory may be particularly salient concepts (Fontanesi & Newman-Bluestein, 2024), while DMT with children on the autism spectrum may focus on mirroring and emotional expression (Manders et al., 2021; Takahashi et al., 2019). Another clinical example we can share is therapy with survivors of trauma. When the nervous system is dysregulated, *Emotional Regulation through Movement* (e.g., relative safety, co-regulation, mobilizing & side shifting, settling) is an important initial focus that is aided by *Connection through Movement* (e.g., attunement, kinesthetic empathy, somatic countertransference, connecting rhythm, synchrony, etc.) *and*, depending on cultural context and client's intersectionalities, *Creative Movement Expression* (e.g., culture & ritual, play in safety). In trauma healing, most likely *Body Sensing & Being* is a later concept of focus as it may be vulnerable and uncomfortable to tune into the body initially (Dieterich-Hartwell, 2017). For most clinical situations, *Meaning Making through Movement* appears to be towards the end of treatment, although imagery, movement metaphors, symbolism, and coping through movement (and possibly other sub concepts) are beneficial catalysts and may be invited and sprinkled throughout the therapy process.

Regarding limitations, importantly, this model does not extend to the assessment process, a significant aspect of DMT in practice. Dance/movement therapists engage in assessment processes to better understand and serve the therapeutic needs of their clients. Assessments identify behavioral patterns, psychosocial challenges, and client resources in order to inform diagnostic considerations and treatment planning, guide therapy interventions, support the therapy process, and assist in monitoring client progress. The dynamic quality of movement in the therapy space demands the therapist's constant careful observation and assessment because interventions are often movement based (Cruz, 2009). Dance/movement therapy assessment is a holistic process that may include movement/nonverbal and verbal assessment methods and range from formal assessment sessions using standardized instruments (for example LMA, KMP, MARA, etc., see Table 1) to ongoing informal evaluation throughout the course of treatment. Assessments in DMT offer a rich array of potential tools for translational research through their nuanced and holistic means of observing, recording, and evaluating states and changes. There is an opportunity for researchers to engage with dance/movement therapists on the use of DMT assessments in study designs, as these may open new avenues for analysis and interpretation that are inclusive of shifts in movement behavior in relation to other outcomes.

As for other limitations, we are aware of possible misses and unintentional exclusions in our literature findings, particularly pertaining to cultural variations, as the breadth of literature is truly vast and not easily searchable. The mechanisms of change were derived and synthesized from a thorough review of the DMT literature, including empirical studies, writings by early dance/movement therapists, and theoretical papers from the last 40 years and from somewhat varying cultural backgrounds. Hence, one of the challenges in presenting this model was the incongruent use of language for related terms. In order to honor certain terms and streamline

others, we made discretionary choices that were, to some extent, unavoidably subjective. Moreover, each cluster entails several, often overlapping concepts, some of which may even be used interchangeably, and occasionally on different levels (e.g., one being an umbrella term and containing another), which may cause confusion. Another possibly limiting consideration is that the concepts in and of themselves are multidirectional - some are more specific to the client (e.g., metaphors, transformation, body image, habitus, etc.), some are more specific to the therapist (e.g., kinesthetic empathy, somatic countertransference, etc.), some are mutual (e.g., breath, dance, rhythm, synchrony, etc.). Adding to this complexity, some are provided by the framework, whether it is the environment, the therapist, or the group dynamics/interactions, while others are more solitary; some are more temporary, while others change gradually.

While this survey is extensive and involves as much detail as current space would allow, another important caveat is that differences in methods and scope between DMT and neuroscience require mutual appreciation and respect for their different forms of knowledge in order to advance collective understanding. Dance therapists may not have the tools or background to fully engage with scientific publications, and scientists may not have familiarity with movement and creative practices, limiting the type of questions that are asked along with applications that may be made. However, the similarities between these fields, which are both concerned with how we experience the world, offer the basis for exciting research programs that combine artistic integrity, scientific rigour, and concern with health and wellness. Translational research paradigms (multidisciplinary and multidirectional integration of research) are an important future direction for the field of DMT and could accelerate innovation in neuroscience through the incorporation of embodied, creative, and relational modalities into scientific research. In essence, this model and the proposed mechanisms of change we present are an attempt to articulate the complexity of the field of DMT and existing connections with neuroscience. We hope this effort will stimulate further conversation and discussion, bringing greater visibility and credence to the unique and multilayered field of DMT.

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