A Framework for the Systematic Quantified Training of Meditation across Meditative Development

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Abstract

That meditation is similar to mental training is a widely used analogy that seeks to capture the growth-oriented processes that unfold through the intentional performance of mental activities. However, despite its intuitive appeal, this notion remains conceptually underdeveloped. To our knowledge, no interdisciplinary dialogue has been established with training science—a field dedicated to the understanding of training variables and principles. In this paper, we address this gap by first providing an overview of foundational principles in exercise science, introducing key concepts such as *programming* and *periodization*. Building on this foundation, we outline how core *training variables*—such as volume, frequency, duration, density, and intensity—can be meaningfully adapted to contemplative training contexts. Among these, we propose *training intensity*, defined as the graded phenomenal presence of specific meditative qualities together with the minimization of counteractive qualities. Referenced against a normative standard, this construct offers a particularly promising link between objective training metrics of meditative experience and subjective markers of meditative proficiency. We argue that advanced meditation entails not only the accumulation of training volume over time but the refinement and mastery of specific skills that enable access to advanced meditative states, stages, and endpoints. Finally, we suggest that meditation would benefit from adopting a unified semantic framework and systematically assessing these training variables, thereby enabling more precise, comparable, and cumulative analyses across studies. This work represents a first step toward integrating principles from training science into meditation research, offering novel tools to understand the mechanisms and trajectories underlying meditative development.

Keywords
meditative development, systematic mental training, advanced meditation, meditative experience, meditative proficiency, exercise science

1. Introduction

The conceptualization of meditation as a form of systematic training is widespread in both contemplative science and traditional meditation scriptures. Within the research literature, meditation is frequently described as a form of training and practice, such as "intentional mental training" (Dahl et al., 2020), "cognitive training" (Álvarez-Pérez et al., 2022), "systematic mental training" (Dahl et al., 2015), "systematic practice" (Katzbeck et al., 2008), "intentional and repeated practice" (King et al., 2023), "intensive and systematic […] training" (Tang et al., 2007), and "a form of mental training that aims to improve an individual's core psychological capacities, such as attentional and emotional self-regulation" (Tang et al., 2015). Likewise, meditation manuals use phrases such as "systematic focused training," "systematic practice," (Young, 2016a, 2017) and "mind-training" (Ingram, 2018; Sayadaw, 1971). Traditional frameworks often refer to concepts such as the "three trainings" or "insight training," (Anuruddha & Anuruddha, 2000) reinforcing the view of meditation as a structured training process.

Despite the prevalence of training-related terminology, the concept of "training" remains poorly defined within contemplative science, and to our knowledge, exercise science has not been referenced in the contemplative science literature. This oversight limits the field's theoretical and methodological progress, as it neglects a well-developed scientific domain that rigorously investigates training principles and their outcomes.

In this paper, we aim to address this gap by first highlighting the relevance of exercise science for understanding meditative development—the progressive cultivation of positive qualities and outcomes over time through sustained meditative practice (Ehmann et al., 2025c, 2025d; Galante et al., 2023; Sparby & Sacchet, 2025b). We then offer a comparative analysis that introduces key training principles and variables from exercise science that could be adapted to contemplative science. Integrating these concepts may allow for the standardized quantification of training parameters, enabling more sophisticated statistical modeling and predictive analyses, and ultimately a more comprehensive science of meditation.

These efforts are complementary, but conceptually orthogonal, to recent attempts to improve the systematic classification of meditative practices and related phenomenology (Sparby & Sacchet, 2022). Rather than focusing on the typology of meditative practices or first-person reports, our approach emphasizes objective measurement and the relationship of training variables, which could support emerging computational models that simulate and test the neurocognitive and phenomenological effects of sustained meditation practice (Tal et al., 2025; Wright et al., 2023).

Thus, to elaborate on both the qualitative and quantitative domains of meditative development, the final section discusses implications for the study of advanced meditation, which emphasizes skill-based and phenomenological markers of expertise instead of duration or volume-based metrics (as in long-term meditators). To advance our understanding of how different meditative practices influence meditative states, stages, and endpoints, and to account for the diversity of meditative approaches across traditions, clear definitions and standardization of training variables are essential. We argue that exercise science offers a promising foundation for the multidimensional, nonlinear phenomenon of advanced meditation and meditative development.

2. An Introduction to Exercise Science

Exercise science has long recognized the health benefits of structured physical activity, with its modern scientific foundations formalized in the early 20th century at the Harvard Fatigue Laboratory, which is widely regarded as having established exercise physiology as a discipline (Tipton, 1998). Since then, the field has expanded into a broad, interdisciplinary science with major impacts on public health, clinical practice, and athletic performance (Booth et al., 2012; Bouchard et al., 2015). Contemporary exercise science advances this work by systematically investigating how specific training variables influence desired outcomes. Over time, a set of foundational principles and constructs has emerged as central to this enterprise.

P*rogramming* refers to the deliberate structuring of specific activities and practices that an athlete undertakes over time to achieve a predefined outcome. It assumes that by manipulating the type of activity, dosage, intensity, and their short-term temporal and structural organization, different outcomes can be systematically produced. Hence, the central question becomes which configuration of training variables—i.e., which *programming*—yields the most effective results. *Programming* can be understood as interrelated but distinct from the *training activity* itself, which is typically defined qualitatively and closely tied to learning and skill acquisition. On the other hand, *programming* encompasses a set of *objective training predictors*, which are used to modify and quantify the athlete's engagement with the activity. The former takes the form of an embodied, enactive process, requiring experiential refinement and, in many cases, direct instruction. Despite some research combining these two domains—for example, in biomechanics, where technical skill is measured and evaluated (Straub & Powers, 2024)—the actual enactment of a skill remains a trial-and-error process which is deeply personal and shaped by the athlete's situated context.

Objective training predictors, in turn, are typically captured by variables that describe the extent and mode of engagement over time, such as volume (e.g., dose or duration), frequency (e.g., one or two sessions per week), and intensity (e.g., proximity to muscle failure or absolute weight lifted). Exercise science has amassed extensive empirical data that informs sport- and population-specific recommendations for optimizing training outcomes (Grgic et al., 2018; Mangine et al., 2015; Radaelli et al., 2025; Schoenfeld et al., 2016). Moreover, a growing body of literature identifies translational mechanisms—such as dose-response molecular signal transduction pathways—through which changes in *training variables* produce physiological improvements (Ato et al., 2019; Gonzalez et al., 2015; Ogasawara et al., 2017).

Multiple theories in exercise science describe how training stimuli elicit physiological adaptations over time, involving both local and systemic processes that unfold in a nested, temporal sequence (Zatsiorsky et al., 2020). One foundational model is the *General Adaptation Syndrome* (GAS), originally proposed by Hans Selye and later adapted for exercise contexts through the *stimulus-fatigue-recovery-adaptation* framework (Cunanan et al., 2018). Selye's original work, based on experiments with toxins, identified three distinct phases of adaptation in response to a stressor: (1) an *alarm* phase, where baseline performance temporarily declines; (2) a *resistance* phase, marked by adaptive processes that elevate performance above baseline; and (3) an *exhaustion* phase, where prolonged or excessive stress depletes resources and impairs performance (Selye, 1950). Importantly, progression to the exhaustion phase is not inevitable and can often be avoided with appropriate recovery. The extended exercise-specific model elaborates this process into four stages: First, a training stimulus induces an initial decline in performance (alarm). Second, the system recovers, returning to baseline levels (resistance). Third, adaptation exceeds the previous baseline, resulting in *supercompensation*, which enhances resilience against future stressors. Finally, if the stimulus exceeds the system's adaptive capacity, *overreaching* or *overtraining* occurs, leading to either transient or chronic performance decrements.

Another influential framework, the *fitness-fatigue model*, posits that each training stimulus simultaneously produces both fitness-enhancing and fatigue-inducing effects (Calvert et al., 1976). The observable outcome—that is, net performance—is the result of the dynamic interaction between these opposing processes. This model emphasizes that different physiological systems recover and adapt at varying rates, depending on the nature and magnitude of the stressor, underscoring the importance of stimulus-specific recovery timelines.

Building on these models, researchers recognized the limitations of purely general accounts of adaptation. This gave rise to the SAID principle (Specific Adaptations to Imposed Demands), also known as the principle of specificity, which emphasizes that adaptations are not only dependent on the magnitude of stress but are highly specific to its form, intensity, and context (Stone et al., 2022; Zatsiorsky et al., 2020). Thus, SAID complements the other models by highlighting that effective training requires alignment between the imposed demands and the desired outcomes.

Together, these developments, along with growing biological evidence (Coffey & Hawley, 2017; Fisher & Csapo, 2021; Flück, 2006; Nyland et al., 2023), led to the recognition that training adaptations involve both specific and generalizable effects (Cunanan et al., 2018; Minett & Costello, 2015). In response, exercise science developed sophisticated *periodization paradigms*—systematic frameworks for manipulating training variables over extended timescales (e.g., weeks to months)—with the goal of optimizing performance at targeted time points (Turner, 2011). *Periodization* typically involves organizing training into *blocks* that strategically sequence the development of different physiological systems. For instance, early training phases often focus on systems with longer stimulus-adaptation cycles, such as structural or metabolic foundations that broadly support overall performance. Subsequent blocks then emphasize more specific, short-term adaptations (e.g., neuromuscular or technical skills), which are layered on top of and supported by the earlier foundational work. Research has explored *periodization paradigms* across sports, populations, and goals, consistently showing that alternate configurations produce significantly different results (Buskard et al., 2018; Coelho-Júnior et al., 2018; Moesgaard et al., 2022).

To summarize, exercise science is primarily concerned with the study of *training variables* and principles that shape how the athlete engages in their training. This includes, first, the definition and construct validation of *training variables* that, through modification, lead to predictable changes in a specific outcome metric (Marston et al., 2017). Second, empirical research then tests specific combinations of variables across sports and populations to create a space that can serve as a reference ground for practical decision making (evidence-based *programming*). Third, complex, theory-driven programming sequences—known as *periodization*—are evaluated for their ability to transfer earlier adaptations to later performance goals, such as competition readiness. For a summary of key exercise science constructs, see Figure 1.

These foundational concepts from exercise science provide a rich framework for rethinking advanced meditation, including meditative development and meditative endpoints, not merely as a set of practices or outcomes, but as dynamic, trainable systems governed by principles of adaptation, dose, specificity, and progression.

Fig. 1

Summary of Foundational Concepts in Exercise Science Relevant to Systematic Training

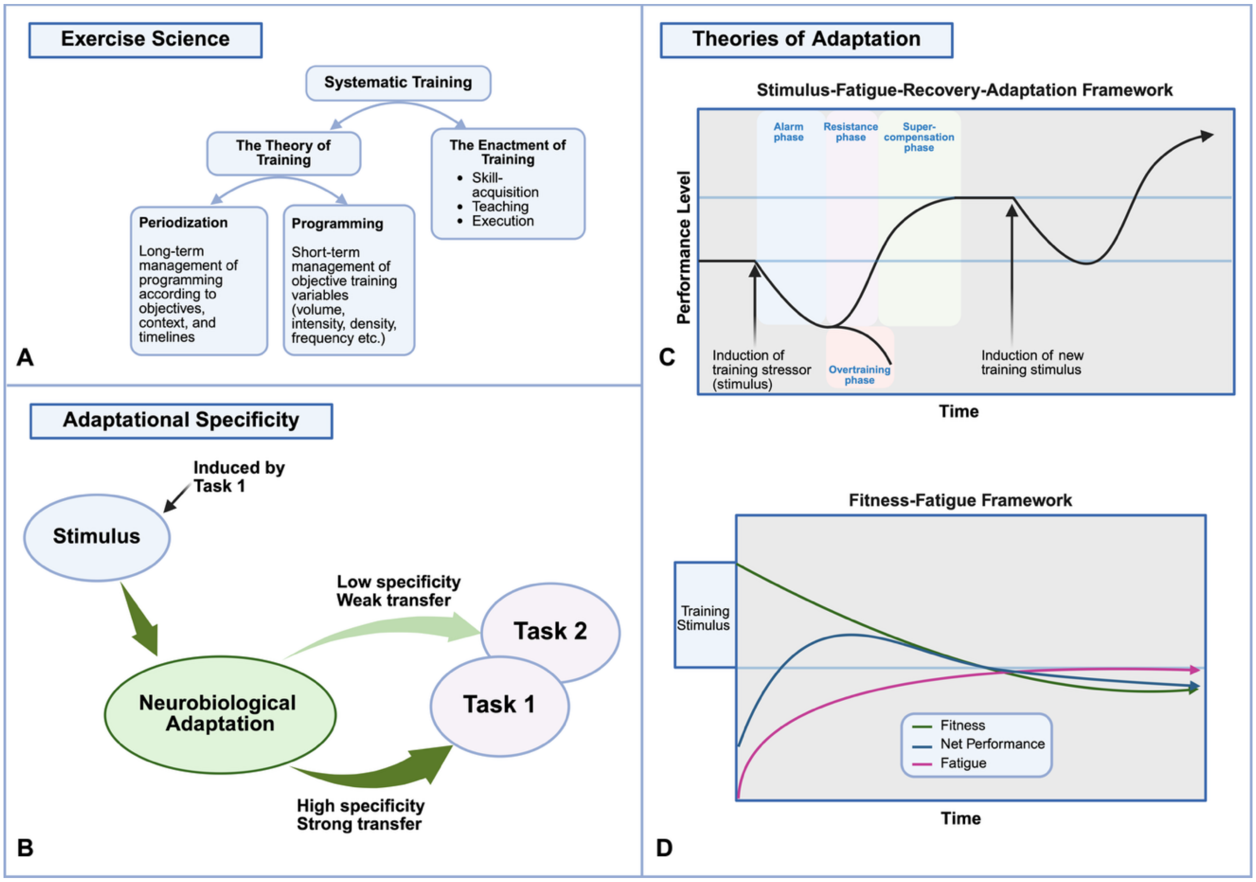

Figure Legend. This figure provides an overview of core frameworks in exercise science that inform the structured development of training adaptations. A. The distinction between the theory and enaction of training highlights two complementary domains. The theory of training involves the systematic manipulation of objective training variables (e.g., volume, intensity, frequency, density) through programming and long-term structuring through periodization. The enactment of training emphasizes skill acquisition, coaching, and execution in context. B. The principle of Adaptational Specificity demonstrates how neurobiological adaptations induced by a stimulus (e.g., Task 1) transfer with varying strength to other tasks (e.g., Task 2), depending on specificity. High specificity leads to strong transfer, while low specificity leads to weak or minimal transfer.
On the right-hand side, two major theories of adaptation are depicted. C. The *Stimulus-Fatigue-Recovery-Adaptation* framework models how performance fluctuates over time in response to a training stressor, moving through alarm, resistance, supercompensation, and overtraining phases. D. The *Fitness-Fatigue* model illustrates how each training stimulus induces both fatigue and fitness effects, with net performance determined by their dynamic interaction over time.

3. Programming in Meditation—The Mapping of Training Variables

3.1. Training Specificity

Training-specific adaptations have long been established in physical domains, such as muscular changes following resistance training (Campos et al., 2002) and central nervous system structure and function after exercise (Morgan et al., 2015). More recently, similar patterns have been documented in contemplative science, where different meditation activities induce specific adaptations in cognitive functioning (Chiesa et al., 2011; Ehmann et al., 2025c, 2025d) and in neural structure and function (Sezer & Sacchet, 2025). Importantly, such adaptations depend not only on the nature of the activity itself but also on how the activity is structured, its *programming*.

For instance, in meditation, practices consisting of *focusing* on a specific object may be preferable for increasing sustained attention (Ehmann, et al., 2025c), suggesting activity-dependent neurocognitive changes. However, *training specificity* is also influenced by programming. In resistance training, for example, higher relative intensities (expressed as a percentage of one-repetition maximum) lead to disproportionately greater strength gains within that intensity range compared to lower intensities (Campos et al., 2002). Analogously, the *programming* of meditation—including variables such as volume, intensity, density, and frequency—may significantly influence not only the degree but also the *type* of cognitive-affective adaptations that emerge over time. For example, practicing a concentration meditation in a single continuous one-hour session, as opposed to distributing the same total time across six ten-minute sessions throughout the day, may differentially affect the depth of absorption and thereby engage distinct attentional mechanisms. This reflects the *training specificity* principle, which holds that practice outcomes depend on both the nature of the activity and its implementation (Sparby, 2024).

It is important to note that, much like our previous example of biomechanics, which is at the intersection of the art (the enactment of the activity) and science of systematic training, *programming* can influence how a meditative activity is carried out—that is, how one systematically engages with and builds skills through a given practice. Programming and periodization decisions, for instance, may determine which meditative object or attentional frame is emphasized at different stages of training. However, for conceptual clarity, we deliberately maintain a distinction between *activity type* and *training variables*. The former refers to the skill-based nature of the meditative act itself (e.g., focusing on the breath at the stomach versus the tip of the nose), whereas the latter concerns how that act is structured across time and context.

For a comprehensive account of meditative activity types, we refer readers to our previously published *activity-based phenomenological classification system*, which organizes meditative techniques according to shared mental activities and meditative objects (Sparby & Sacchet, 2022). In contrast, the present effort focuses on systematically mapping programming variables onto meditation practice, so that future research can integrate both domains—*activity type* and *implementation*—to better understand how different training structures and practices produce specific outcomes and shape the trajectory of meditative development over time.

Thus, the approach that we developed here should be seen as complementary but orthogonal to taxonomic efforts aimed at classifying meditative techniques. Rather than asking *what kind of practice* is being performed, we ask *how* it is being practiced—how often, with what intensity, for how long, and in what sequence—and how these programming and periodization decisions shape the trajectory of adaptation and expertise development.

3.2. Training Variables

3.2.1. Training Volume

Arguably, the most extensively researched training variable in exercise science is *training volume*—the total amount of training performed within a defined time period. In strength training, *volume* has been operationalized in multiple ways, including *volume load* (sets × reps × weight), *time under tension*, *total work*, and *total number of sets*, each offering unique insights into physiological outcomes (Baz-Valle et al., 2021; McBride et al., 2009). For instance, research has shown that when *total training volume* is matched, varying *training frequency* produces similar gains in muscle hypertrophy and strength, suggesting that volume may have a stronger influence on outcomes than frequency (Hamarsland et al., 2022). Nonetheless, dose-response relations often suggest an inverse U-shape, with *frequency* or training distribution potentially mattering when aiming to maximize the efficiency or effectiveness of an intervention (Figueiredo et al., 2018).

Within meditation science, emerging evidence similarly links higher meditation dosage to enhanced outcomes. For example, increased practice length, or what we call *training volume,* has been associated with greater perceived intervention benefits (Schlosser et al., 2024), improvements in mood (Cearns & Clark, 2023), reductions in systolic blood pressure (Adams et al., 2018), and greater same-day—but not next-day—levels of state mindfulness, decentering, and positive affect (Levi et al., 2021). However, other studies report minimal differences between lower (10-minute) and higher (20- or 30-minute) doses of mindfulness practice on state mindfulness and affect, both acutely and across short interventions (Fincham et al., 2023; Palmer et al., 2023). Another recent study, which analyzed dose-response relationships, with dose being defined as hours practiced per month, or what we refer to as *training density*, noted improvements in well-being, affect, and distress with higher meditation training densities (Bowles & Van Dam, 2025).

More nuanced modeling of meditative dose response patterns suggests that *total lifetime meditation volume* (often measured in cumulative hours) predicts outcomes most strongly within the first ~500 hours of practice, with effects varying by practice type (Bowles et al., 2022). These findings underscore the *non-linear* and *context-dependent* nature of meditative development. As we presented in Galante et al. (2023), the trajectory of different meditation-related outcomes, such as well-being, sustained attention, or even adverse effects like restlessness, may follow distinct, non-linear curves shaped by practice type, context, practitioner intention, population characteristics, and, arguably, programming and periodization structure, rather than conforming to a simple linear progression in the traditionally dominant mindfulness construct used in research.

Beyond the context-dependent nature of dose-response relationships in meditation outcomes, the studies above also reveal a key challenge in using *volume* as a reliable predictor of meditative development. These studies and our recent reviews on long-term meditators highlight inconsistencies in how volume-related predictors are operationalized (Ehmann et al., 2025c, 2025d). Specifically, researchers vary widely in how they incorporate *time* into their volume or dose-related metrics. For example, some studies use *lifetime years of practice* as a proxy for meditative experience, while others rely on *total hours of meditation* accrued (Cooper et al., 2022; Jachs et al., 2022). Using years of experience as a stand-in for expertise assumes a stable and effective practice across time—an assumption that may not hold. Similarly, even with total meditation hours, a practitioner who distributes them across decades of inconsistent and unfocused practice may show very different outcomes from someone who accrues them in a shorter, focused period. This distinction is rarely accounted for in the literature, yet it may significantly influence the interpretation of observed outcomes.

This issue extends to acute intervention studies, where daily practice time is sometimes labeled as *practice intensity*, defined as a function of both *practice frequency* (number of sessions across time) and *session length* (Abdoun et al., 2019). Abdoun et al. then go on to define estimated accumulated practice, or what we would classify as *volume*, measured in hours or minutes, as the product of *intensity* and *total time practiced.* While this formulation is a strong advance in the field, methodologically elegant and internally consistent, it results in criterion contamination, as *intensity* is defined in terms of *volume* through the inclusion of time-based metrics.

This conflation illustrates a deeper conceptual difficulty in translating training variables from exercise to contemplative science, with meditative *intensity* being arguably the most challenging to define and operationalize. Addressing this issue will require interdisciplinary dialogue and theoretical refinement, which we begin to explore in the following section. For now, within the context of *volume*, we propose that time-based metrics should be employed with conceptual precision, ensuring a clear separation from intensity. To help clarify this distinction, we suggest three related but distinct constructs: *training duration*, *training volume*, and *training density*.

Although all three rely on time as a unit of measurement, they represent different aspects of meditative engagement. *Training duration* refers to any defined time frame of interest—such as a day, the length of an intervention, or a meditator's entire lifespan—within which training occurs. In this context, *lifetime training duration* designates the total span of time over which a practitioner has engaged in meditation, regardless of *frequency* or consistency. *Training volume*, by contrast, captures the accumulated time spent in actual meditation within that duration—typically measured in minutes or hours. Thus, *lifetime training volume* reflects the total number of hours a practitioner has meditated across their life. Finally, *training density* is defined as the ratio of *training volume* to *training duration*, offering a novel metric that reflects the degree of engagement with meditative practice over time. *Lifetime training density*, for example, may provide insight into the practitioner's consistency and commitment, potentially serving as a proxy for motivation, discipline, or strength of engagement across the lifespan.

To summarize, contemplative science has increasingly sought to investigate relations between short- and long-term meditative *dose*—or what we refer to as *training volume*—and its effects on meditative development. However, the constructs used to quantify this relationship are often applied ambiguously and remain underdefined, contributing to substantial heterogeneity across studies. To address this, we have proposed three conceptually distinct but related metrics: *training duration*, *training volume*, and *training density*. These offer a more precise framework for measuring dose-related variables in meditation research. In the following section, we turn to *training intensity* as a novel and potentially transformative construct for contemplative science.

3.2.2. Training Intensity

Alongside *training volume*, *training intensity* is one of the most central variables in exercise science. It is typically defined as *the degree to which* strength, force, or effort is applied during a given activity or condition (Zatsiorsky et al., 2020). *Training intensity* is conceptually complex because it spans both objective and subjective domains. In strength training, for instance, *relative intensity* often refers to the percentage of an individual's one-repetition maximum (1RM) used in a specific lift, with *absolute intensity* denoting the actual weight lifted on that day—both objective metrics based on measurable performance. In contrast, *exertion intensity* describes how close the athlete is to muscular failure during a given set and is inherently more subjective, resembling a psychometric or phenomenological assessment.

Returning to the earlier example of Abdoun et al. (2019), who used *training density* or daily practice time as a stand-in for intensity, we can now appreciate why this may feel intuitively correct—higher *training volume* within a short period often *feels* more intense. However, the problem is that the construct of *training intensity* becomes imprecise and difficult to measure when subjective effort is treated as a surrogate for validating an objective metric. Indeed, many training variables and contextual factors may impact the perceived intensity of a practice. For instance, meditating for two hours in the morning may feel substantially less intense than attempting the same session late at night after a large meal.

Given this ambiguity—and the problem of criterion contamination discussed earlier—it is crucial to develop an operational definition of *training intensity* in the context of meditation that captures more than a vague or global sense of effort. Because meditation is fundamentally a mental activity (Sparby & Sacchet, 2022), we propose that intensity in this domain should be approached as a phenomenal construct—one that can be assessed through psychometric measures and potentially triangulated with objective physiological or behavioral correlates. This construct should remain orthogonal to volume-based metrics and instead aim to index a qualitative dimension of engagement that maps onto specific outcomes of interest. In the sections that follow, we develop this proposal in more detail and suggest that, if appropriately operationalized, researchers could combine measures of *training volume* and *intensity* to derive a composite metric—what we might term *training stress*—that more accurately models the total psychological and neurocognitive load and therefore adaptive potential imposed by a given meditative regimen.

Within philosophy, *intensity* refers to the degree of magnitude of a quality or property as it is experienced or conceptualized. Intensity is often invoked in discussions of qualitative states. For example, Frijda attributes emotional intensity to how strongly an event is appraised (Frijda, 2017).

In metaphysics, intensity has been discussed as the degree of property manifestation. Kant, for example, describes 'intensive magnitude' as a quality of sensation that varies in degree but not in extension—such as the brightness of a light—which he contrasts with extensive magnitudes that have parts (Kant, 1781/1997). Lotze, for instance, suggests that the intensity of feeling reflects the degree of alignment or misalignment between the organism and its environment, such that feelings function as indicators of well-being (Lotze, 1889; Milkov, 2021; Textor, 2024). The more strongly a perception or idea promotes or threatens the organism's well-being, the more intense the resulting feeling of pleasure or pain. According to Lotze, pleasure arises when a mental or sensory state furthers life, health, and coherence; pain arises when such a state disrupts or hinders them. However, this account breaks down in cases such as substance abuse, where pleasure may arise from states that ultimately undermine health and coherence.

Within phenomenology, intensity as an index of graded experiential qualities has already been emphasized, even as early as during the Middle Ages, where the 'latitudo formarum' refers to the range or field within which variations of qualitative intensity occur (Corbin, 1981). This resonates with later Husserlian phenomenology, in which intensity refers to the strength with which an object is presented to consciousness (Van Mazijk, 2019). Albeit mostly discussed in the context of sensory awareness, Husserl extends this idea to feelings and emotions, such as joy (Summa, 2024). Notably, Husserl emphasizes that intentional acts of attending do not themselves vary in intensity. Instead, the object of attention can appear more vivid, salient, present, or clear depending on the degree of fulfillment achieved in the act. For Husserl, such intensity-like qualities in consciousness arise from structural and relational factors—functions of fulfillment—rather than indicating any metaphysical force underlying the mental act itself (Vidali, 2024).

Converging with Husserl's rejection of reducing intensity to physical analogies, Jorge Morales reframes *experiential intensity* as the degree of *presence* of a given phenomenal character (e.g., mild, moderate, or searing pain) (Morales, 2023). He terms this *mental strength*, a construct related to, but distinct from, *salience*, which involves relevance and contrast. Mental strength captures how vividly or forcefully something is experienced, regardless of its content. Morales argues that intensity is a formal property of experiences themselves, not confined to specific domains such as affective, sensory, or cognitive states. Instead, it marks a *phenomenal gradation* that can be modulated by attention and salience but is not reducible to either. As such, mental strength functions as a phenomenological dimension for describing *how* experience feels from the inside, beyond its qualitative content.

This notion can be extended through Heidegger's analysis of *being-as-such*, which he conceives not as a category but as *Anwesen*—a *presencing* that shines forth in and through phenomena (Heidegger, 1927). Heidegger's existential and hermeneutic phenomenology, which advances an ontology that transcends Cartesian subject-object dichotomies, offers a promising philosophical foundation for contemplative science. This is relevant given that many meditative traditions aim precisely at deconstructing such dichotomies. From a Heideggerian perspective, *experiential intensity* could be seen as the extent to which being comes into unconcealment by phenomena showing themselves from themselves, in their very mode of self-disclosure.

This resonates deeply with Buddhist ideas of inherent *luminescence* or recent models informed by computational phenomenology of *epistemological depth*, characterized respectively as the "intensity of knowing awareness within conscious experience" or the 'capacity for knowing itself' (Laukkonen et al., 2025). Using these developments and Heidegger's insight, *experiential intensity* could be understood as an onto-epistemological construct—equiprimordially bound up with the way *Sein* (being) comes to presence as *Bewusst-Sein* (consciousness). Rather than treating consciousness as a container or reflective medium, this account aligns with Heidegger's view of *Bewusstsein* as the very unfolding or event of disclosure, through which being shows itself—or comes into unconcealment—without representational mediation.

Before turning to concrete examples, we should note a limitation in the scientific conceptualization of *experiential intensity*. Drawing on Deleuze's framework, as discussed by Mader, *intensity* can be understood as a fundamental ontological dimension of becoming—non-extensive, qualitative, and resistant to reduction into measurable units (Mader, 2017). From this perspective, attempts to quantify such phenomena risk distorting their character, as mathematical or spatial translation inevitably alters the nature of the differences that generate qualitative change. Deleuze positions intensity as pre-phenomenological—a condition for experience rather than a product of it—which makes it not straightforwardly accessible through conventional metrics.

In light of this, and in the context of meditation research, we adopt a pragmatic approach that places lived experience at the center of how intensity should be defined and measured**.** Because meditative *training intensity* is fundamentally experiential, we treat phenomenological reports as primary, recognizing that each step toward abstraction or quantification introduces distortion. Measuring intensity, then, involves balancing qualitative fidelity with quantitative precision, rather than expecting either approach to capture the phenomenon in full.

Given these conceptual and methodological challenges, we propose that *training intensity* in meditation be defined as the *degree of phenomenal presence of specific meditative qualities and the simultaneous absence of counteractive qualities purposefully cultivated through the practiced technique*. Additionally, *training intensity* is shaped by how the practitioner relates to what is present or absent (e.g., contraction, equanimity, reactivity, detachment, or disinterest). This definition is broad enough to encompass diverse meditative approaches and goals, without presupposing that any particular content, lack thereof, or particular way of relating to that content is inherently indicative of higher intensity. While intensity can refer to the strength of a single quality, it may also arise from the integration of multiple co-occurring experiential features into a unified field of awareness. This resonates with Aristotle's notion of *koine aisthesis*—a form of common perception—where intensity is not merely additive, but reflects the coherence and richness of the experiential field as a whole (Johansen, 2012).

To illustrate, consider compassion meditation, a constructive practice aimed at fostering perspective-taking and reappraisal (Dahl et al., 2015). This technique is centered on the *active production* of somatosensory feelings of compassion toward self and others, often in conjunction with using *imagination*, or *repeated internal vocalizations* (Sparby & Sacchet, 2022). Within this context, higher *training intensity* refers to the degree to which the practitioner can generate both the mental imagery and the somatosensory feeling associated with compassion. Such intensity may be assessed through qualitative rating scales, such as the Compassion Practice Quality Scale (Campos et al., 2025). In traditional frameworks, *intensity* could be further linked to the depth of absorptive states attained with compassion as object, or to the degree to which compassion expands to encompass all beings or even the totality of experience. In contrast to *training volume*, which can be expressed as a stand-alone objective measure (e.g., total minutes practiced), *training intensity* is a relative construct, defined by how strongly a practitioner manifests a set of predefined experiential qualities against a given standard or benchmark.

One possible proxy for training intensity is *meditative depth*, a construct that may be adaptable across diverse meditative practices and already operationalized in assessment tools (Piron, 2022). Although often left undefined, meditative depth likely refers to the *felt presence* of experiential qualities associated with meditative states, alongside the *absence* of qualities that are counteractive to them. Prior research has shown an inverse relationship between self-reported mind-wandering—an unwanted experiential quality—and meditative depth during focused-attention meditation (Brandmeyer & Delorme, 2018). More recently, psychophysiological studies have decoded self-reported meditative depth using multivariate EEG analysis (Reggente et al., 2025). In an innovative application, Nath et al. used heart-evoked potentials—a psychophysiological marker of interoceptive awareness—to track meditative depth among Vipassana practitioners, suggesting that this construct can be meaningfully quantified across both subjective and objective domains, at least within certain practice traditions (Nath et al., 2025).

In summary, while *training intensity* remains a challenging construct to operationalize within contemplative science, it can be meaningfully defined as the degree to which specific meditative qualities are experientially present and counteractive qualities absent. Caution must be exercised when translating this inherently qualitative construct into quantitative measures, as such abstraction inevitably distorts the underlying phenomenon. Future work should investigate the validity of *meditative depth* as a generalizable proxy for *training intensity*, while remaining open to the possibility that the construct may differ across practices. It should also seek interdisciplinary dialogue between religious and contemplative scholars, including those from Buddhist Studies, cognitive science, neuroscience, and exercise science, to specify and operationalize the qualities targeted by distinct meditative practices. In Section 3.3, we further discuss the significance of *training intensity* as a qualitative construct for bridging third-person perspectives in contemplative science with the study of advanced meditation and meditative development, where mastery of specific meditative skills serves as a gateway to accessing distinct meditative states, stages, and endpoints that are phenomenological in nature (Sparby & Sacchet, 2022; Wright et al., 2023).

3.2.3. Training Frequency

Within exercise science, *training frequency* is defined as the number of exposures to a specific exercise or workout within a predetermined timeframe (cf. *training duration*) (Zatsiorsky et al., 2020). *Training frequency* structures the partitioning of the *total training stress* and is thus thought to influence adaptation–recovery cycles, as fewer but larger boluses of *training stress* may be differently adapted to than smaller and more frequent boluses. These differences are believed to reflect modality-specific adaptation patterns, as certain practices appear to operate on shorter recovery-adaptation cycles, whereas others demonstrate the opposite. Such variability is thought to arise from the specificity of the training stimulus for distinct neurobiological subsystems, which exhibit differing stimulus thresholds, ceiling effects, and recovery dynamics. For instance, speed training may require a relatively low stimulus threshold, as excessive accumulated fatigue from high-volume training can impair speed production. Consequently, this form of training usually benefits from more frequent, smaller sessions rather than less frequent, larger ones.

Within strength training, exercising a muscle group twice per week, as opposed to once per week, is associated with higher muscle hypertrophy (Schoenfeld et al., 2016). This advantage is often attributed to the muscle protein synthesis (MPS) response, which demonstrates volume-dependent ceiling effects and functions within a limited time window. Distributing weekly training volume across multiple sessions may therefore maximize the total weekly area under the MPS curve by optimizing recovery and minimizing the diminishing returns associated with infrequent, high-volume sessions, even when *total training volume* is matched. Similar patterns are observed for strength outcomes; however, evidence suggests that any benefit of higher *training frequency* primarily reflects its role in facilitating recovery from greater overall *training volumes* (i.e., enabling the accumulation of more stress) rather than a direct effect of frequency itself.

Within contemplative science, preliminary evidence indicates comparable improvements in well-being following a two-week digital compassion-based intervention, in which 351 undergraduate students with clinically elevated depression and anxiety were randomly assigned either one 20-minute meditation or two 10-minute meditations per day, suggesting that *training frequency* did not significantly influence outcomes at lower *training volumes* (Riordan et al., 2024). In contrast, a cross-sectional study reported positive associations between meditation *training frequency*, but not *training volume*, and well-being, with no associations observed for psychological flexibility (Birtwell et al., 2019). Similarly, a large prospective longitudinal study found that *training frequency* exerted a stronger influence on outcomes than session length (*training volume*), although both were positive predictors (Bowles & Van Dam, 2025).

In sum, *training frequency* is an interesting training variable when it comes to understanding recovery-adaptation cycles within contemplative science. When considering meditative development in beginners, exploring the optimization of *training frequency* could be essential for finding the most efficient and accessible paradigm to maximize wellness outcomes. In more advanced practitioners, *training frequency* may be studied to investigate the optimization of meditative skills associated with later stages of meditative development.

3.3. Training Stress

In exercise programming, *training stress* is frequently discussed but rarely well-defined and operationalized as a quantitative construct, often functioning more as a conceptual heuristic to guide applied training decisions. This stems from the non-linear effects of training variables on physiological outcomes. For example, exertion intensity within strength training, as indexed by proximity to failure, can exponentially increase *training stress*, whereas *training volume* tends to have a more linear relationship. Although some applied work has attempted to mathematically model the multivariate, non-linear nature of *training stress*, empirical validation remains limited (Frederick, 2019). Heuristically, *training stress* is understood primarily as a function of *training volume* and *training intensity,* with other variables, such as time and frequency, influencing the dispersion or concentration of training stress within a given time window.

In this review, we similarly employ *training stress* as a heuristic construct—primarily a function of *training volume* and *intensity*—to contextualize how principles such as *periodization*, as well as the related phenomena of *overreaching* and *overtraining*, may apply to meditation practice. For a visual summary of meditation-related programming, see Figure 2.

Fig. 2

Programming within Meditation—A Summary of Training Variables and an Example Program

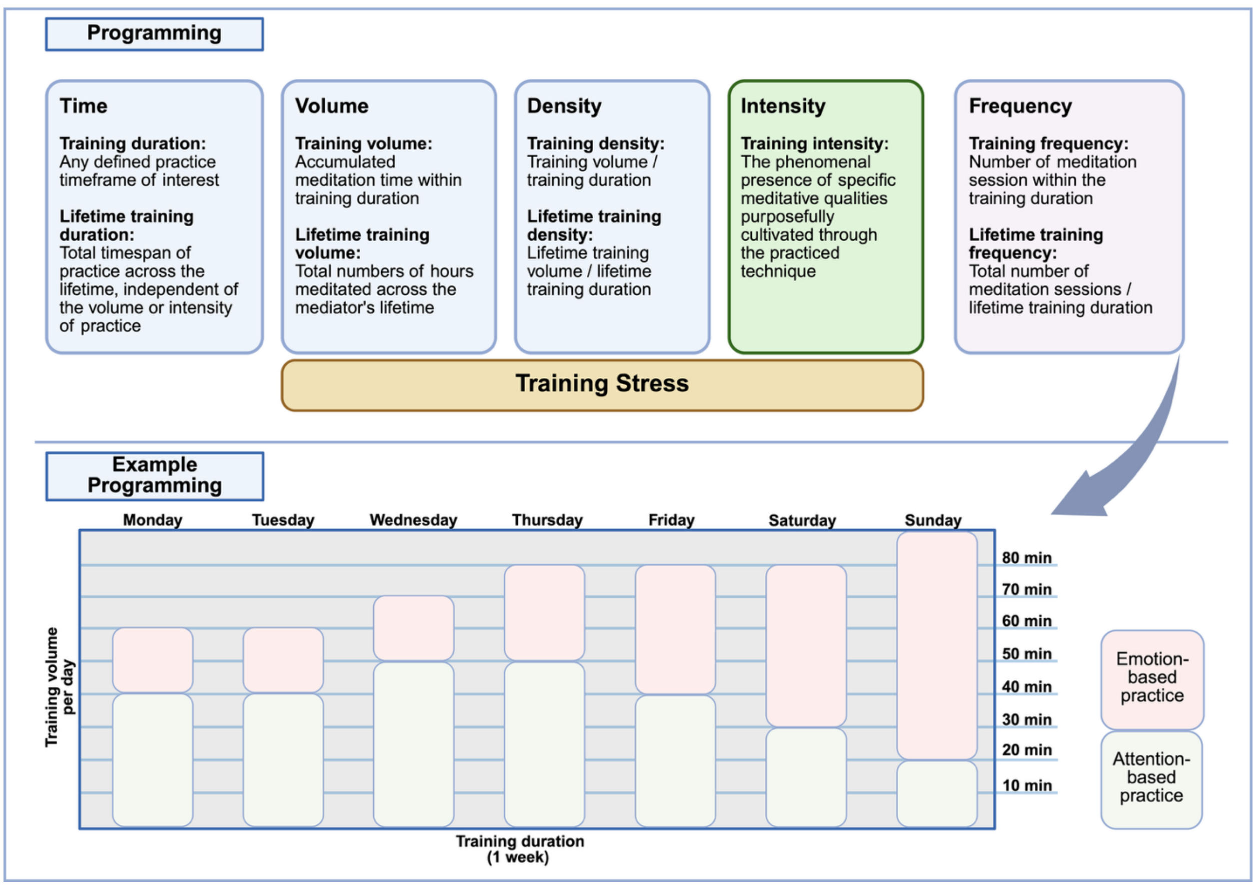

Figure Legend. The top panel of this figure summarizes all major meditation-related *training variables*—time, volume, density, intensity, frequency—and highlights the most important variables for creating the composite metric of *training stress*. In the bottom panel, an example of programming for a single training week is illustrated. This program relies on two *training activities*, an attention-based and an emotion-based practice. The *training frequency* is daily throughout the one-week *training duration*, with *training density* increasing over time, suggesting progressively greater *training stress*. The relative composition of the daily *training volume* changes, with attention-based practices predominating for the first half of the week and emotion-based practices for the latter half. Within-day *training frequency* and structuring cannot be discerned from this figure.

4. Periodization in Meditation—Long-Term Structuring of Training and Training Stress

Setting aside differences in philosophy, ethics, and doctrine, meditation—viewed as systematic mental training—arguably varies most across traditions in the *types of practices* employed (Sparby & Sacchet, 2022) and *how they are structured over time*. One clear example involves how *mental tranquility*—a state of calmness and stillness—is cultivated in Theravāda Buddhist traditions (Anālayo, 2011). Tranquility, typically developed through concentrative techniques, in which attention is *focused* on a single object, stabilizes the mind, which in turn is thought to facilitate subsequent insight practices aimed at investigating mental experience (Sparby & Sacchet, 2022).

Different Theravāda traditions place varying emphasis on concentration training before engaging in insight practices. Some prescribe little to none, regardless of the meditator's experience; others advocate brief periods of concentration; and still others require extensive mastery developed over years prior to engaging in insight practice. These differences can be understood as variations in *periodization*—distinct long-term training strategies, each proposing that a specific sequencing and duration of practices yields optimal results.

Despite its importance for meditative development, *periodization* remains understudied. Existing research typically examines differences in meditative outcomes by assessing the effects of specific meditative inductions on neurobiological measures (Ooishi et al., 2021) or by comparing pre-existing populations, such as novices versus long-term meditators (Ehmann et al., 2025c, 2025d). However, these approaches do not address how the sequencing and structural composition of a meditative routine impact outcomes. Furthermore, many recent designs are limited by their inability to distinguish state, trait, and interaction effects, complicating interpretations on how training structure may have influenced outcomes (Ehmann et al., 2025c).

To provide a concrete example, intervention studies could investigate whether distributing meditation across different ratios of practice types leads to superior well-being outcomes for a target population while maintaining an equal *training volume* and *frequency*. Such studies should be theory-driven, given the near-infinite permutations of practice structures that could be tested. For instance, prior work suggests that attention-focused and emotion-focused practices may exhibit *opponent-processing dynamics*, implying that carefully balancing and sequencing these practices could yield greater benefits than practicing one in isolation or in disproportionate amounts (Ehmann et al., 2025c, 2025d). See Figure 3 for an illustration of periodization and how this might be implemented in an example intervention. Next, we will outline the relevance of *periodization* for maximizing one's adaptational capacities for *training stress*.

Fig. 3

Periodization within Meditation—A Four-Week Example Intervention

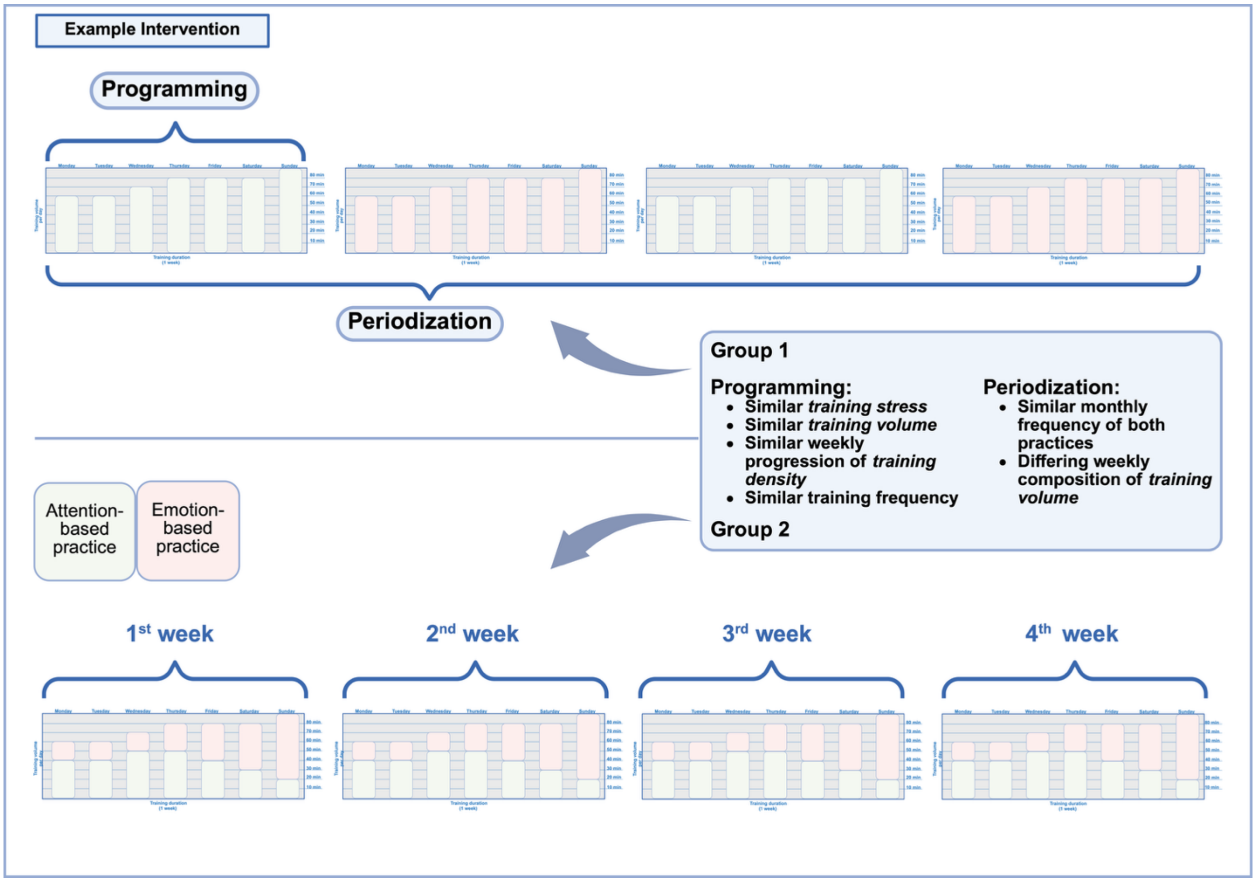

Figure Legend. This figure illustrates a four-week intervention comparing two groups with different *periodization* paradigms. Group 2 replicates the *programming* example from Figure 2, repeating the same weekly structure across all four weeks. Group 1, by contrast, shares identical *programming* variables—including *total training volume*, *training frequency*, and weekly progression of *training density*—but differs in the temporal composition of *practice types* across weeks. Specifically, while Group 2 maintains a dynamic weekly balance of attention-based and emotion-based practices, Group 1 alternates between the two, focusing on one practice each week. This example demonstrates how *periodization* can be used to vary the temporal structuring of training across longer timescales without altering core programming variables. In more complex designs, periodization can involve systematic changes in weekly structure—for instance, one group may progressively increase weekly *training volume*, while another maintains a stable average across the entire intervention, even if both groups have identical monthly training volumes. *Programming* is thus nested within *periodization*, with *periodization* choices affecting *programming* decisions.

4.1. Overreaching and Overtraining

In high-performance athletic contexts, maximizing the ability to recover from and adapt to *training stress* is essential, as this enables athletes to continually improve their performance (Zatsiorsky et al., 2020). For recreational practitioners, the goal is typically to maximize outcomes with minimal effort, prioritizing *efficiency*. In contrast, elite athletes aim to maximize outcomes by training at their highest sustainable workload, prioritizing *effectiveness*—pursuing the greatest possible gains, even when doing so demands significant effort and careful recovery management.

When training stress temporarily exceeds recovery capacity, athletes may experience *overreaching*—a short-term plateau or decline in performance that, with sufficient rest, can trigger a *supercompensatory rebound*, where performance not only recovers but temporarily surpasses the original baseline. However, if excessive training continues without sufficient recovery, *overtraining* may develop, marked by a chronic performance decline that can require months of rehabilitation (Kreher & Schwartz, 2012). *Overtraining*, a clinical diagnosis, is associated with diverse pathophysiological mechanisms and adverse health outcomes. To mitigate these risks, *periodization* has emerged as a systematic approach to varying *training variables* and *activities*, optimizing the balance between *training stress* and *adaptive capacity* while reducing the likelihood of *overtraining* (Cunanan et al., 2018; Fry et al., 1992).

In contemplative science, emerging research suggests that meditation practice can similarly be related to *adverse effects* in a notable proportion of practitioners (Britton et al., 2021; Goldberg et al., 2022; Van Dam et al., 2025; Wright et al., 2024). These may include mild cognitive, affective, and social disturbances, as well as unpleasant somatic sensations in contexts with relatively lower *training stress* (Cebolla et al., 2017; Farias et al., 2020; Lindahl et al., 2017; Lomas et al., 2015). More severe events, such as psychosis, suicidality, and mania, are rare but have been documented, typically during retreat settings, where *training density* and, therefore, *training stress* are very high.

Although the stimulus–recovery–adaptation dynamics of meditation likely differ from those in athletic training, these phenomena may follow similar patterns of *overreaching* and *overtraining*. As in sport, where training stress is ideally tailored to the athlete's individual work capacity, meditative training likely benefits from *training stress* adjustments specific to the practitioner's needs. While inexperienced athletes or meditators may tolerate excessive workloads, such approaches are often neither efficient nor effective for long-term adaptation.

At the same time, advanced meditators sometimes report deep existential transformations that arise precisely while engaging with challenging experiences (Sparby & Sacchet, 2025a). Through direct encounter with unpleasant experiences, the meditator may gain insight into the nature of suffering itself. By learning to dissociate unhelpful reactive patterns from sensate experiences, the meaning and experience of suffering—as well as one's perceptual and existential relationship to it—are transformed, as suffering now becomes a site of realization and freedom (Ehmann et al., under review). Meditative development is thus, by nature, a non-linear process that may include periods of difficulty as potentially essential components of growth (Sparby & Sacchet, 2025a).

Future research should explore how principles of *programming* and *periodization* might help practitioners skillfully navigate such phases, including how to discern when training has surpassed a safe or productive threshold—or, paradoxically, when increasing meditative *training stress* may induce potent non-linear threshold effects that induce meditative breakthroughs and yield surprising new plateaus of capability and development (Sparby et al., 2024). The following section examines how advanced meditative development already engages, implicitly or explicitly, with such principles to facilitate transformative outcomes.

5. The Study of Advanced Meditation and Meditative Development

In the contemplative science field, lifetime meditative development is typically approximated through measures of practice experience, such as *lifetime training volume* or *lifetime training duration*. While these metrics likely correlate with meditative development, they are insufficient for capturing the skill-based and phenomenological aspects that characterize advanced meditative proficiency (Ehmann et al., 2025d). Emerging research suggests that these skill-based markers are more closely associated with improvements in well-being than *lifetime training duration* (Nair et al., 2018). In scientific terms, a skill is typically defined as the competent, voluntary, and accurate performance of an activity (Cundey, 1978). Applied to advanced meditation, *meditative skills* can be understood as the mastery of accessing advanced meditative states, stages, and endpoints (Sacchet et al., 2024). As such, they must be indexed by demonstrated *proficiency* rather than by *training volume* alone. Preliminary evidence supports a connection between *volume-based* and *proficiency-based* measures. For instance, one study found that individuals with higher *lifetime training volume* exhibited greater non-dual awareness—a construct often associated with advanced meditation that reflects a reduction in subject–object structuring of perception—as well as higher equanimity during a breath-watching task, compared to those with less or no prior training (Malipeddi et al., 2024). Nonetheless, even long-term practitioners have been shown to make incremental gains in flourishing, non-dual awareness, and compassion through structured Tibetan mind–body practice, where program design—not *training frequency*—predicted outcomes (Ehmann et al., 2025b). This suggests that later-stage meditative development may depend more on skill refinement than on accumulated *training volume*. In what follows, we will lay out the relationship of *meditative skills* to *programming* and *periodization* within meditation, aiming to provide a comprehensive vision that can accommodate the objective measurement of *training variables* and the multidimensional phenomenological nature of advanced meditation.

As visualized in Figure 1, systematic training encompasses both the *science of training*, which includes the objective structuring and measurement of how the athlete engages with training itself, and the *art of training*, which refers to how the athlete enacts the *training activity*. Due to space constraints, we decided not to elaborate on the systematic classification of meditative activities (Sparby & Sacchet, 2022). However, to understand the placement of *meditative skills*, such as concentration and equanimity, within systematic training, we need to ask about the relation between the *mental activity* and the *skill* that is required or cultivated as part of it.

In traditional Buddhist literature, meditation is framed from the outset as training specific faculties or skills, which function as tools to work with mental activity (Anuruddha & Anuruddha, 2000). Through repeated and deliberate practice, it is thought that meditative skills gradually and sometimes suddenly transform the quality of the mental activity itself. *Mental activities* and *meditative skills* thus engage in a reciprocal causal loop: initial skills actively shape the quality of the mental activity, while the resulting changes in the mental activity create supportive conditions for those skills to stabilize and deepen. These feedback loops evolve, modulate, and at times appear to invert as the path progresses, highlighting the complex, non-linear character of meditative development. Over time, progressively deeper meditative states emerge, marked by the intentional cultivation of specific experiential qualities. Full access to such states presupposes the development of requisite skills, just as possession of those skills reliably predicts the capacity to enter and sustain these states. Together, these mutually reinforcing criteria characterize advanced or highly proficient meditators. *Training intensity*—understood here as the graded experiential presence of specific meditative qualities and simultaneous absence of counteractive qualities—can therefore serve as a useful proxy for the depth and quality of predefined meditative states. It thus also reflects the bidirectional relationship between meditative skills and mental activity. When properly operationalized, *training intensity* may thus provide a time- and development-sensitive measure of meditative proficiency. To better understand this process, we will next outline the traditionally proposed meditative skills as they relate to meditative development.

An extensive body of Buddhist literature outlines sets of skills required to access specific meditative states, stages, and endpoints (Anuruddha & Anuruddha, 2000; Ingram, 2018; Sayadaw, 1971, 1994). A well-characterized example involves the advanced concentrative absorption meditation states known as the *jhānas* (ACAM-J), which are described as progressive stages of intentional and effortless absorption (Sparby & Sacchet, 2024; Yang et al., 2024). Within ACAM-J practice, the meditator actively cultivates distinct cognitive-affective factors, including initial and sustained attention, mental unification, and the sequential emergence of bliss, joy, tranquility, and equanimity, while simultaneously dropping effort and centralized focus. Access to these states is generally understood to require prolonged and consistent training, with deeper stages believed to depend on high *training volumes* and *densities* of practice. This reveals a key contrast with exercise science: whereas in physical training, high acute *training density* tends to induce fatigue and suppress performance (Figure 1), in meditation, increased *training density* may actually facilitate performance improvements, as skill acquisition accelerates with deepening familiarity and refinement. Consequently, *programming* for advanced meditation is typically driven more by the skills a practitioner aims to acquire than by physiological recovery times. This is because threshold effects often determine whether a given meditative state can be accessed at all. In this context, the concept of *minimum effective volume*—which in exercise science refers to the minimal amount of training required to produce a given adaptation—can be extended to meditation as the minimal *training volume* necessary to develop the skills required for accessing and stabilizing deep meditative states such as ACAM-J.

In addition to acute state-related skills, modern adaptations of Theravāda Buddhist practice propose stage-like developmental models for practices centered on the deep investigation of experience, or what we have called advanced investigative insight meditation (AIIM) (Sparby &

Sacchet, 2025a, 2025b; Yang et al., 2025). These models suggest that insight-oriented meditation unfolds through identifiable phases—Stages of Insight (SoI)—each marked by characteristic shifts in perception, affect, and cognitive processing, as well as in the existential relationship to and structural interpretation of phenomena. Such frameworks aim to map the progressive refinement of meditative skills involved in observing impermanence, unsatisfactoriness, and non-self—core phenomenological insights central to Buddhist traditions. Both traditional adaptations (Ingram, 2018) and empirical accounts (Abdoun et al., 2025; Ehmann et al., 2025c, 2025d) emphasize the importance of interactions between meditative states and stages, as well as between transient states and enduring traits, in understanding meditative development. For example, cultivating ACAM-J during challenging meditative stages differs substantially from cultivating it during periods characterized by equanimity (Sparby & Sacchet, 2025a).

Supporting this, recent research using the Lyon Assessment of Meditation Phenomenology (LAMP) tracked six experiential domains during a 10-day retreat and found distinct, non-linear developmental trajectories (Abdoun et al., 2025). While some dimensions, such as relaxation and meta-cognitive insight, progressed steadily, others, like attentional stability, peaked early, and core traits like equanimity and dereification emerged later, likely reflecting the demands of specific techniques and advanced proficiency. *Lifetime training volume* predicted higher baseline levels of meta-awareness and dereification, underscoring interaction effects. These findings highlight the dynamic, context-sensitive nature of meditative skill development. They also suggest that skills evolve in a highly non-linear, multidimensional fashion, with different capacities progressing at different rates and interacting in complex ways (Galante et al., 2023). This complexity should be taken into account when interpreting fluctuations in *training intensity*. It also underscores the likely benefits of *periodization* in advanced meditative training—where specific *meditative activities* are emphasized and *training variables* are strategically modified based on the evolving needs, capacities, and goals of the meditator.

Within advanced meditation, both state-based and stage-like developmental models emphasize the importance of meditative endpoints—what have been called, for example, enlightenment, awakening, and liberation—even during the early phases of skill acquisition (Anuruddha & Anuruddha, 2000; Ingram, 2018; Sayadaw, 1971, 1994; Sparby & Sacchet, 2024; Yang et al., 2024). As such, comprehensive guiding frameworks have been developed to outline the necessary core skills to achieve these endpoints. One of the most prominent is the Theravāda Buddhist model of the *Seven Factors of Awakening*, which identifies a set of interrelated skills to be cultivated as enduring dispositions throughout the meditative path (Ingram, 2018). These include mindfulness, investigation, energy, rapture, tranquility, concentration, and equanimity. Rather than being understood as isolated traits, these factors function as mutually reinforcing capacities, whose development is often at least partly sequential, guiding the meditator through progressive stages of development. More modern models seeking to outline core skills that are cultivated along long-term mindfulness-based meditative development have described three interdependent skills: (1) flexible concentration—the capacity to sustain and direct attention while modulating attentional aperture; (2) equanimity—an ability to allow experience to come and go without interfering,; and (3) sensory clarity—the resolution and detectability of sensory phenomena (Young, 2016a, 2016b). For both traditional and modern approaches, the trait-like cultivation of these skills is thought to support both the stabilization of meditative states and the emergence of insight, forming a developmental arc that guides multiple dimensions of practice in service of meditative development (Ehmann et al., 2025a).

In sum, the study of advanced meditation complicates—but does not invalidate—the framing of meditation as a form of systematic mental training. Much like high-level athletic disciplines, where a broad set of skills and foundational capacities are essential, advanced meditation emphasizes the mastery of various skills as a central component of meditative development. This emphasis introduces additional complexity, as skill acquisition in this context is multidimensional, bidirectional, non-linear, and likely embedded within multiple temporal layers (Figure 4 summarizes systematic training in advanced meditation). The acute enactment of a meditative activity interacts dynamically with baseline traits, the practitioner's current developmental stage, and their long-term intentions for skill cultivation. Given this dynamic nature, future research could explore different periodization paradigms aimed at enhancing both the accessibility and acceleration toward advanced meditative development. Such research could proceed inductively, through qualitative inquiry with expert practitioners, or deductively, through the experimental testing of structured training paradigms in novel interventions.

Fig. 4

Systematic Training in Advanced Meditation—The Relevance of Skill Mastery.

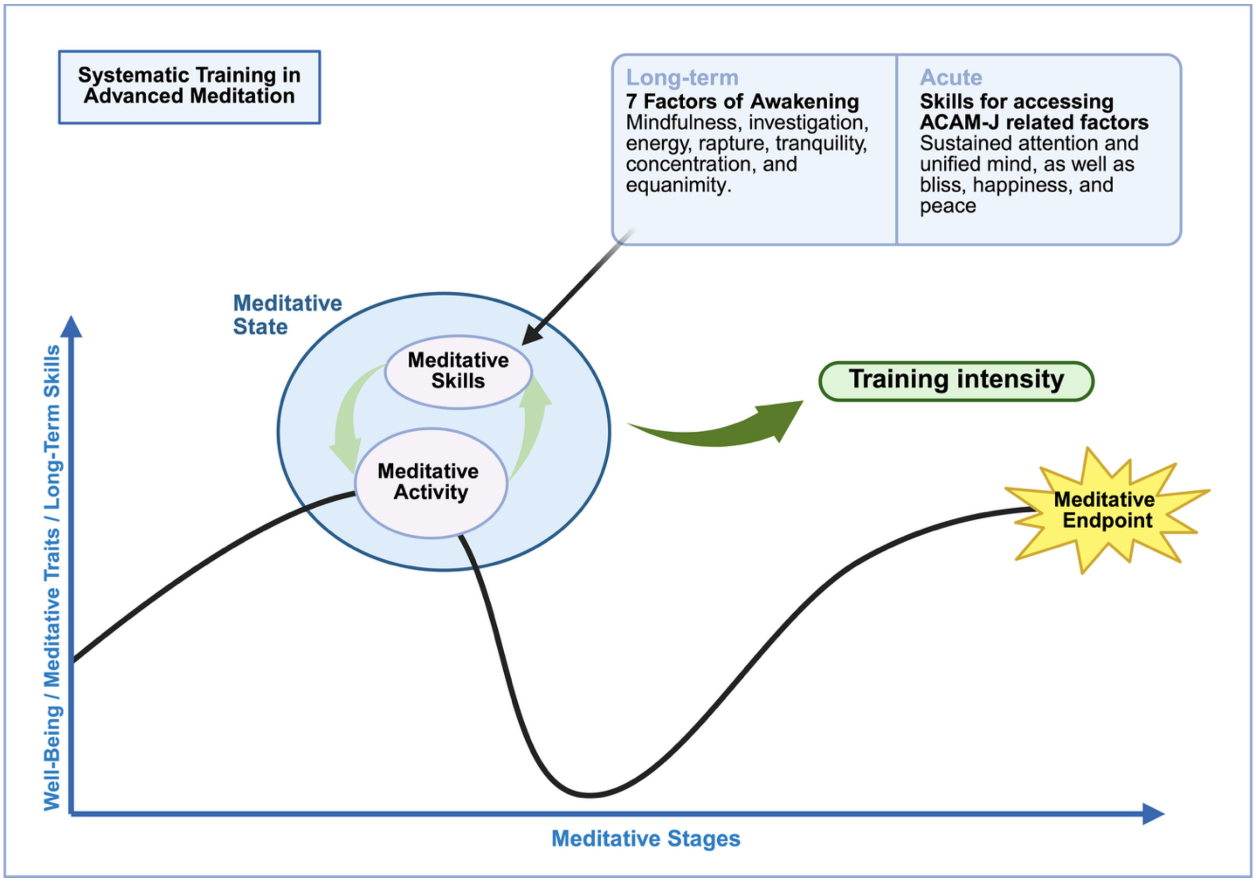

Figure Legend. This figure illustrates the multidimensional and nonlinear nature of meditative development. As part of systematic training, the practitioner enacts specific meditative activities that both rely on and cultivate meditative skills. This dynamic interaction gives rise to meditative states, which are always embedded within and modulated by the practitioner's baseline traits and current meditative developmental stage. When evaluated against a predefined normative standard, these meditative states can be assessed in terms of *training intensity*—defined as the graded phenomenal presence of specific meditative qualities. Over time, the development of meditative skills and the unfolding of meditative stages may lead toward *meditative endpoints*, understood as enduring psychological transformations rooted in sustained skill cultivation and cognitive-affective maturation. In this context, *programming* refers to the short-term structuring and modification of meditation training to cultivate skills associated with acute meditative states and stages, whereas *periodization* denotes the systematic, long-term manipulation of meditative training variables and activities to optimize progression through developmental stages and enhance access to meditative endpoints.

6. Practical Implications, Limitations, and Future Directions

We have proposed that the commonly used metaphor of meditation as systematic training is both appropriate and underexplored, despite its prominence in contemplative science and more generally. To better understand training-specific adaptations in meditative development, we argue that three key steps are necessary: (1) the systematic classification of *meditative activities*, (2) the precise assessment of *training-related variables*, and (3) the clear characterization and measurement of *meditative states, stages, and endpoints*—along with the specific skills required to access and stabilize them. This expanded framework is essential for building a comprehensive understanding of how systematic training shapes meditative development.

Regarding the first key step, our *activity-based phenomenological classification system* provides a promising framework. It offers a clear differentiation of meditative activities and objects, as well as their corresponding experiential features, enabling researchers to define their object of study with less conceptual ambiguity (Sparby & Sacchet, 2022). We therefore recommend that future studies adopt this framework for characterizing meditative practices.

Second, to understand how *training variables* shape meditative outcomes, researchers should assess these variables prospectively in interventions or retrospectively in observational studies, with volume- and frequency-based metrics easier to capture retrospectively than intensity. This would allow for more precise correlations between objective training markers (e.g., *lifetime training volume*) and phenomenological indicators of *meditative proficiency*.

In this context, we proposed *training intensity* as a promising variable to bridge the gap between *meditative experience* and *meditative proficiency,* particularly for the study of advanced meditation. Operationalizing this construct requires training in precise phenomenological reporting. Prior work suggests that novice meditators may require 20–40 hours of practice to report their experiences with a level of specificity comparable to experts (Abdoun et al., 2019). Further research is needed to determine whether this generalizes to more nuanced experiential content and whether targeted phenomenological training can accelerate this process (Petitmengin et al., 2019).

As discussed in Section 3.2.2 on Training Intensity, attempts to quantify this construct risk distorting it. For this reason, we advocate for a breadth of methods, as well as a hybrid operationalization strategy that assesses intensity along both quantitative and qualitative axes. For this purpose, *meditative depth* may serve as a useful and general construct that cuts across meditative techniques. Recent findings show correlations between self-reported meditative depth and *lifetime training volume* (Malipeddi et al., 2024, 2025), echoing trends in exercise science, where more experienced athletes are capable of performing higher absolute intensities.

While novel psychometric tools, such as the LAMP questionnaire (Abdoun et al., 2025) and experience tracing (Jachs et al., 2022), have advanced temporal tracking of meditative phenomenology, we remain cautious about using them to index *training intensity*. This caution stems from the fact that intensity is not merely descriptive, but normative: it refers to the extent to which a given meditative activity expresses or cultivates its intended experiential qualities. Advanced meditation should thus not be defined only by general mastery of any meditative state, stage, or endpoint per se, but rather by the deliberate cultivation of definable activities and qualities associated with a given tradition or system. While we remain agnostic about the particular goals set by different traditions, our aim is to offer a flexible framework capable of accommodating both secular and non-secular systems of meditative training. At the same time, tracking more general meditative phenomenology, as in the aforementioned questionnaires, remains valuable, so long as such measures are distinguished from the more specific normative dimension of *training intensity*, with both approaches serving different but complementary contexts of inquiry.

Third, to better understand advanced meditation's states, stages, and endpoints, we developed the 'Thin Model,' a model of the mind that enables the unification of contemplative theory with rigorous scientific investigation (Wright et al., 2023). Through its application, traditional goal states, experiential progressions, and transformation patterns associated with advanced meditative development can be reduced to scientific hypotheses, ultimately allowing empirical correlates to be established and associated with meditative practice (Wright et al., 2023). For example, when using the Thin Model for a nested analysis, attaining ACAM-J may be explained by cultivating sufficient mental unification, concentration, and cognitive control to enhance sustained attention and reduce distractions. This generates testable hypotheses related to changes in neural networks linked to cognitive control. The explanatory power of the Thin Model addresses key challenges in contemplative science, including oversimplified neuroimaging results, methodological weaknesses, and divergent research interpretations (Van Dam et al., 2018). Thus far, our group has uncovered neural correlates of ACAM-J (Chowdhury et al., 2025; Demir et al., 2025; Potash et al., 2025a, 2025b; Treves et al., 2024; Yang et al., 2024), AIIM (Yang et al., 2025), and meditative endpoints, such as cessations in consciousness (Chowdhury et al., 2023; van Lutterveld et al., 2024, 2025). These findings suggest that, despite the interdisciplinary nature of this field and the complexity of meditative development, rigorous empirical investigation is both possible and represents the next frontier in the study of advanced meditation.

There are several important limitations when applying systematic training to meditative development. First, the framework most clearly applies to formal practice. While adaptations for assessing informal practice are conceivable, the development of valid and reliable measures in this domain remains an open challenge. Second, although there is conceptual congruence between the principles of exercise science and meditation training, further research is required to determine where existing models can be directly applied, where they need modification, and where they may not be applicable at all. Foundational principles such as volume, specificity, transfer, adaptability, and recovery appear to map reasonably well onto meditation. However, more complex mappings—such as the mechanisms of adaptation and recovery—require empirical investigation. In particular, it remains unclear how stimulus–recovery–adaptation cycles function under high-dose meditative practice, and whether phenomena analogous to *overreaching* or *overtraining* occur in this context. Moreover, the construct of *training intensity* may require refinement when applied to advanced meditators. Certain stage progressions appear to involve the explicit presence of qualities ordinarily considered 'unwanted,' yet which represent markers of progress (e.g., the stage of Misery described in the Therāvadan SOI framework). Here, meditative development is shaped less by the simple presence or absence of qualities than by altered ways of relating to, perceiving, or existentially interpreting phenomena, rendering more sophisticated adaptations of *training intensity* necessary. Furthermore, certain aspects of meditative development may lie entirely outside the scope of training science. For example, meditative endpoints that involve profound epistemological or ontological shifts, often experienced as a cessation or culmination of the training process, have no clear counterpart in athletic or performance-based disciplines.

7. Conclusion

The idea of meditation as a form of systematic training is both intuitively compelling and widely used in empirical descriptions of meditative development. Yet, virtually no interdisciplinary dialogue has occurred between contemplative science and exercise science—the latter of which is focused on the principles and mechanisms that underlie training and its adaptive outcomes. In this paper, we sought to establish a preliminary step toward bridging these domains by providing a foundational mapping between key concepts and frameworks between these disciplines, principally integrating concepts from exercise science into the science of meditation.

We propose that meditative training can be viewed from both an applied-enactive and a theoretical-scientific perspective. The *applied side* is the embodied process of enacting meditative activities and cultivating associated skills. The *theoretical side* involves classifying, measuring, and manipulating the variables and structures that shape mental training. Building on prior classifications of meditative activities, we aimed to complement this work with an outline of core training variables and principles.

Specifically, we argue that volume-based metrics, including training duration, volume, and density, as well as training frequency, and training intensity, provide a sufficient net for objectively quantifying meditative training. Within this context, *programming* refers to the short-term structuring of these variables to optimize training outcomes, which, in the context of advanced meditation, refers to the skilled access to meditative states, stages, and endpoints. A novel contribution of this paper is our definition of *training intensity* as the graded phenomenal presence of specific meditative qualities and absence of unwanted experiential qualities referenced against a normative experiential standard. This construct may serve as a bridge linking objective training metrics related to meditative experience to meditative proficiency, understood as the mastery of skills that characterize advanced meditators.

Further theoretical and empirical work is needed to refine, test, and expand this interdisciplinary framework. In the meantime, we encourage contemplative researchers to adopt a unified semantic structure for training variables and to assess these constructs as rigorously as possible. Doing so will not only improve the precision of individual studies but also enable more integrative analyses across the field. Greater systematization and semantic clarity can enhance the rigor of contemplative science and, ultimately, support more effective and transformative practice.

Declaration of generative AI and AI-assisted technologies in the writing process
During the preparation of this work, the first author used ChatGPT-5 (OpenAI, 2025) to improve the clarity and style of the written content. The tool was not used to generate new content, ideas, or citations. After employing this service, the first author carefully reviewed and edited all text. All authors take full responsibility for the integrity and accuracy of the publication.

Data Code and Availability
As this article is a narrative review and does not involve the collection or analysis of original data, no datasets or code are associated with this work.

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