

Application of Mindfulness in Test Anxiety Intervention: A Postprint from the Perspective of the NIH Stage Model

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Date: 2023-10-09T00:00:00+00:00

Abstract

Test anxiety leads to numerous adverse consequences, while traditional intervention models have yielded unsatisfactory outcomes. Following extensive validation of mindfulness efficacy, the academic community has introduced it into test anxiety interventions. The NIH Stage Model (National Institutes of Health stage model) delineates six stages in the development of psychological interventions: basic research, intervention generation/refinement, efficacy testing, hybrid “efficacy-effectiveness” testing, effectiveness testing, implementation, and dissemination, with its original aim being to facilitate intervention implementation and dissemination. Based on this model, we first analyze the mechanisms through which mindfulness influences test anxiety, then review existing mindfulness intervention studies for test anxiety along three orientations: “preliminary efficacy testing,” “refining and optimizing intervention models,” and “promoting implementation and dissemination.” Finally, aligning with the model’s original intention and considering the specific characteristics of mindfulness interventions, we propose that future research should prioritize exploring efficacy mechanisms, strengthening pragmatic research, and remain attentive to fundamental issues in mindfulness interventions (including: complete mindfulness practice should incorporate open monitoring, collecting intervention adherence data, emphasizing the learning of mindfulness attitudes, and considering the influence of different “self-concepts” between Eastern and Western cultures), in order to better promote intervention implementation and dissemination.

Full Text

Preamble

Mindfulness in the Intervention of Test Anxiety: A Perspective Based on the NIH Stage Model

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Abstract: Test anxiety leads to numerous adverse consequences, yet traditional intervention models have yielded less-than-ideal outcomes. Following widespread validation of mindfulness efficacy, researchers have introduced it into test anxiety interventions. The NIH stage model (National Institutes of Health stage model) divides psychological intervention development into six stages: basic research, intervention generation/refinement, efficacy testing, mixed “efficacy—effectiveness” testing, effectiveness testing, and implementation/dissemination. Based on this model, we first analyze the mechanisms through which mindfulness influences test anxiety, then review existing mindfulness intervention studies for test anxiety from three orientations: “preliminary efficacy testing,” “refinement and optimization of intervention models,” and “promoting implementation and dissemination.” Finally, in light of the model’s original intent and the specific characteristics of mindfulness interventions, we propose that future research should prioritize exploring efficacy mechanisms, strengthen pragmatic research, and remain sensitive to fundamental issues in mindfulness interventions—including the necessity of including open monitoring in complete mindfulness practice, collecting adherence data, emphasizing the learning of mindful attitudes, and considering the influence of different “self-concepts” between Eastern and Western cultures—to better facilitate intervention implementation and dissemination.

Keywords: test anxiety, mindfulness, NIH stage model, mechanisms of influence, pragmatics

1.1 Concept and Intervention Status of Test Anxiety

Test anxiety refers to a series of phenomenological, physiological, and behavioral responses that individuals experience in testing or other evaluative situations

due to fear of failure outcomes (Sieber et al., 1977). Individuals experiencing test anxiety tend to perceive testing situations as threatening, which subsequently reduces their self-efficacy and leads to failure expectations and self-deprecation, accompanied by corresponding emotional experiences and physiological arousal.

Test anxiety can be distinguished as either trait or state. Trait anxiety represents a relatively stable, personality-based anxiety tendency with individual differences, whereas state anxiety refers to temporary anxiety experiences triggered by testing situations along with physiological arousal. Consequently, test anxiety can also be understood as a situation-specific personality trait—namely, an individual's predisposition to experience anxiety reactions in examination contexts (Spielberger & Vagg, 1995).

Although individuals may exhibit similar reactions in other evaluative situations such as sports competitions or artistic performances, current research remains primarily focused on traditional academic testing contexts. Zeidner (1998) recommends maintaining “test anxiety” as the standard terminology, and the scope of this paper is likewise limited to test anxiety in traditional academic settings.

Test anxiety directly impairs academic performance and can even lead to extreme consequences such as dropping out, self-harm, or suicide, making the development of effective interventions critically important. Existing methods either emphasize behavioral techniques (e.g., systematic desensitization, relaxation training, biofeedback), cognitive techniques (e.g., rational-emotive therapy, cognitive restructuring), or cognitive-behavioral approaches (e.g., cognitive-behavioral modification, stress inoculation training). Additionally, there are interventions focusing on learning and test-taking skills to compensate for academic deficiencies (Ergene, 2003). However, these methods all target individual components of test anxiety and fail to achieve satisfactory outcomes (von der Embse et al., 2013).

1.2 Meaning and Characteristics of Mindfulness

Mindfulness originated as a consciousness training method in Buddhist meditation. Since the 1980s, researchers have extracted it from the Buddhist framework, secularized it, and designed Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT). Only after the efficacy of these programs was extensively validated did mindfulness gain enthusiastic attention from the academic community, and its scientific connotation was thoroughly examined.

Kabat-Zinn (2003) defined mindfulness from a practice perspective as “the awareness that arises from paying attention, on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment.” This definition implies that mindfulness is a special state of consciousness. As research has progressed, the meaning of mindfulness in scientific psychology has become increasingly diversified. Lin et al. (2022) suggest that from a construct operationalization perspective, mindfulness can be understood in four ways: (1)

mindfulness state—the degree to which an individual is in a mindful state at a specific time point; (2) mindfulness trait—an individual’s innate tendency to be in a mindful state; (3) mindfulness skills—a set of skills and their operational proficiency acquired through sustained and long-term mindfulness practice; and (4) mindfulness training—the cultivation of mindful attitudinal qualities through prospective practice and conscious application of meditation techniques, including both Buddhist meditation practices and mindfulness-based clinical intervention programs (such as MBSR and MBCT).

Although “mindfulness” has multiple meanings in research contexts, its core features are generally considered to be: (1) attention to and awareness of present-moment internal experience, and (2) an open and accepting attitude toward internal experience (Creswell, 2017).

In recent years, researchers have introduced mindfulness into test anxiety interventions, either by directly applying mindfulness training, MBSR, and MBCT, or by designing structured curriculum programs that include mindfulness training, or through self-help interventions using recorded multimedia courses and digital technology. We collectively refer to these interventions as Mindfulness Interventions for Test Anxiety (MI-TA). It should be noted that mindfulness-related interventions (such as Dialectical Behavior Therapy (DBT) and Acceptance and Commitment Therapy (ACT)), while conceptually related to mindfulness, have their own clear and systematic philosophical foundations or do not include formal mindfulness training (Chiesa & Malinowski, 2011) and are therefore not discussed in this paper.

2 The NIH Stage Model

To address the difficulty of implementing and disseminating laboratory-based interventions in real-world settings, Onken et al. (2014) proposed the NIH stage model. This model conceptualizes intervention development as a continuum from basic science to implementation science, comprising six stages (see Figure 1 [Figure 1: see original paper]): Stage 0 (basic research on behavior change mechanisms) → Stage 1 (initial design/refinement and testing of interventions) → Stage 2 (efficacy testing in research settings, or pure “efficacy” testing) → Stage 3 (efficacy testing in community settings, or mixed “efficacy—effectiveness” testing) → Stage 4 (effectiveness testing in community settings) → Stage 5 (implementation and dissemination). Stage 3 represents the model’s most distinctive innovation: in real-world community settings that are not laboratory-controlled, it ensures internal validity by controlling intervention fidelity while simultaneously enhancing external validity by having community clinicians deliver the intervention, thereby bridging the gap between laboratory efficacy research and real-world effectiveness research to promote the development of highly implementable interventions.

The NIH stage model has three important characteristics. First, it emphasizes that intervention development should be built on a clear understanding of behav-

ior change mechanisms and encourages exploration and testing of efficacy mechanisms at each stage. Second, it consistently focuses on promoting real-world implementation, advocating for early consideration of implementation and dissemination during intervention development, and encouraging equal attention to efficacy and effectiveness at every stage to ultimately produce outcomes with both strong efficacy and implementability. Third, the stages are not strictly linear but rather iterative and recursive; each stage can focus on enhancing implementability (the work of Stage 1) and exploring and confirming behavior change mechanisms (the work of Stage 0), with the ultimate goal of producing implementable and disseminable interventions.

When designing randomized controlled trials (RCTs) in clinical research, researchers typically distinguish between explanatory and pragmatic studies. The former are conducted under ideal research conditions to maximize assessment of intervention efficacy (efficacy), while the latter focus on implementation and dissemination, testing intervention effectiveness in real-world settings (Hu & Zhan, 2018). In practice, explanatory and pragmatic approaches are not mutually exclusive but rather represent two ends of a continuum, with most RCTs possessing attributes of both designs but varying in emphasis (Thorpe et al., 2009).

The NIH stage model essentially provides further subdivision of clinical psychological intervention research along the “explanatory—effectiveness” continuum. Based on this, research design attributes can be categorized into five types: mechanism exploration, intervention design, efficacy testing, effectiveness testing, and implementation/dissemination. A single study can possess multiple attributes, differing only in the degree of emphasis on each.

Inspired by this model, we begin at Stage 0 by first analyzing the mechanisms through which mindfulness training influences test anxiety. We then align with the five research design attributes to summarize existing MI-TA studies under three orientations: “preliminary efficacy testing” (emphasizing Stages 1 and 2), “refinement and optimization of intervention models” (emphasizing Stages 1, 3, and 4), and “promoting implementation and dissemination” (emphasizing Stages 4 and 5). Finally, from the perspective of the stage model and in combination with fundamental issues common to mindfulness interventions, we summarize limitations in existing research and propose directions and specific methods for future improvements to promote the implementation and dissemination of MI-TA.

3 Mechanisms Through Which Mindfulness Training Influences Test Anxiety

Current research exploring the mechanisms of mindfulness training’s effect on test anxiety is limited, which substantially restricts the potential effectiveness of intervention design. This paper synthesizes existing theories to first construct a model of the test anxiety occurrence process, then conceptualizes the mecha-

nisms through which mindfulness training influences test anxiety through target analysis (see Figure 2 [Figure 2: see original paper]), providing a reference for future intervention design.

3.1 Components and Occurrence Process of Test Anxiety

Environmental vulnerability factors and intrapersonal vulnerability factors interact to cause individuals to experience a sense of test threat before examinations. Environmental vulnerability factors include high parental expectations, teacher emphasis on grades, competitive peer atmosphere, and the importance and difficulty of the specific exam. Intrapersonal vulnerability factors include students' intelligence level, learning ability, test-taking skills, academic self-efficacy, and trait anxiety (Lowe et al., 2008; Segool et al., 2014). Academic achievement carries significant weight in both self-evaluation and external evaluation, serving as an important component of self-concept construction (Marsh & Martin, 2011). Consequently, the sense of test threat is largely a fear triggered by the risk of devalued self-worth (Covington, 1992).

The sense of test threat triggers cognitive, emotional, and behavioral responses (von der Embse et al., 2021). Cognitive responses include worry and cognitive interference. Worry refers to intrusive negative thoughts related to exam failure, such as parental disappointment and punishment, teacher and peer contempt, decreased class status, and bleak future prospects. Cognitive interference refers to task-irrelevant worry thoughts occupying attentional resources, depleting working memory, and reducing executive function, thereby impairing cognitive performance (Eysenck et al., 2007; Spielberger & Vagg, 1995). Emotional responses include physiological indicators of emotion and tension. The former refers primarily to physiological manifestations triggered by the autonomic nervous system under stress, such as sweaty palms, increased heart rate, and rapid breathing (Lowe et al., 2008). The latter refers to the subjective discomfort experienced phenomenologically in response to these physiological indicators. Based on cognitive and emotional responses, individuals also exhibit behavioral reactions to test anxiety, such as academic procrastination, exam avoidance, and other negative self-handicapping behaviors (Zeidner, 1998).

These cognitive, emotional, and behavioral responses extend into pre-exam review and test-taking processes, weakening individuals' cognitive performance and severely interfering with information reception, storage, and retrieval during studying and answering questions (Eysenck et al., 2007). Consequently, existing knowledge cannot be adequately demonstrated in the exam, increasing the likelihood of failure. Exam failure triggers self-denigration, leading to damaged self-worth and weakened academic self-efficacy. Trait anxiety and other environmental variables that make individuals vulnerable to test anxiety may also be reinforced, ultimately causing individuals to experience higher levels of test threat in the future and reactivating the test anxiety cycle (Spielberger & Vagg, 1995; Zeidner, 2007).

3.2 Analysis of Mindfulness Training Targets

Existing RCT studies using self-report measures have explored the effects of mindfulness training on different components of test anxiety, finding that it can reduce worry thoughts, task-irrelevant thinking, emotionality, physiological indicators (Dundas et al., 2016), and perceived stress (Sampl et al., 2017) while increasing positive thoughts (Cho et al., 2016), strengthening cognitive-emotion regulation (Shahidi et al., 2017), promoting more active coping styles (i.e., more problem-solving oriented, less emotional and avoidant) (Zandi et al., 2021), and enhancing self-esteem (Dundas et al., 2016) and general self-efficacy (Dundas et al., 2016; Sampl et al., 2017). Based on this evidence and the mechanisms and processes of mindfulness training, we conduct a target analysis below.

Mindfulness training, through awareness and acceptance of bodily sensations, may help alleviate the physiological indicators and tension of test anxiety while promoting emotion regulation. When individuals experience physiological indicators of test anxiety, habitual automatic judgment typically leads them to directly experience these as tension. Mindfulness training emphasizes curiously and keenly observing bodily sensations, letting go of habitual automatic judgment, and maintaining an open and accepting attitude while bringing breath to areas of intense sensation to release tension (Teasdale et al., 2014). This process strengthens parasympathetic activation (Wu & Lo, 2008), promotes the relaxation response (Amutio et al., 2015), and to some extent blocks automatic judgment of bodily sensations, thereby alleviating tension and promoting emotion regulation.

Mindfulness training, through awareness and acceptance of thoughts and emotions, may help reduce worry thoughts and cognitive interference while maintaining cognitive performance. When test anxiety triggers cognitive interference and negative emotions, mindfulness training emphasizes that when thoughts or emotions arise in the mind, one simply notices them promptly and observes them with an open and accepting attitude, waiting for them to naturally dissipate rather than further identifying with or clinging to them. This prevents the formation of negative thought and emotion chains, facilitates the rapid release of attentional resources (Sumantry & Stewart, 2021) and working memory (Jha et al., 2019), protects executive function (Mak et al., 2018), reduces cognitive interference, and maintains cognitive performance. Simultaneously, the ability to shift attention from task-irrelevant thoughts to the current task also means individuals are less likely to adopt self-handicapping coping strategies.

Mindfulness training can promote dereification and self-compassion, potentially helping to counteract the self-denigration triggered by test anxiety and protect self-worth. When test anxiety damages self-worth and reduces academic self-efficacy, mindfulness training emphasizes, on the one hand, dereification of thoughts—recognizing that thoughts are merely mental events rather than objective self-representations, thereby minimizing self-denigration and protecting self-worth. Long-term practice also helps individuals see how the “self” is sub-

jectively constructed in their own minds, leading to an understanding of the impermanent nature of self and reducing excessive identification with beliefs about “self,” making it possible to reduce distress related to “self” (Hölzel et al., 2011). On the other hand, mindfulness training promotes self-compassion, leading individuals to be tolerant and understanding rather than harshly self-critical when facing exam failure, and potentially viewing their experiences as part of the broader human experience (Germer & Neff, 2019), thereby protecting self-worth at a deeper level and breaking the vicious cycle of test anxiety.

4 Orientation Toward Preliminary Efficacy Testing of MI-TA

4.1 Effects of Single-Session Brief Mindfulness Practice on Test Anxiety

Researchers have first confirmed the efficacy of simple and feasible single-session brief mindfulness practice for test anxiety. Colangelo and Audet (2020) recruited 50 college students, with the intervention group completing a 20-minute sitting meditation and the control group completing a paper-folding task. Results showed that with no pre-test differences, the intervention group’s post-test state test anxiety scores were significantly lower than the control group’s ($d = 1.33$). Another study with 36 college students established three groups for comparison: mindful breathing, non-focused breathing (free mind-wandering without focusing on any specific target), and worry practice (deeply thinking about a series of anxiety-inducing questions). After inducing test anxiety through an arithmetic test, results showed that the mindful breathing group reported a calmer mood before the test ($d^2 = 0.10$) and demonstrated significantly better accuracy on the subsequent arithmetic test than both the non-focused breathing group ($d = 0.56$) and the worry group ($d = 0.76$) (Brunyé et al., 2013). However, neither study included an active control group, making it impossible to compare the effects of mindfulness practice with other conventional interventions.

When other brief interventions were used as active control measures, single-session brief mindfulness practice did not demonstrate superior effects. One study had the intervention group practice 15 minutes of mindful breathing while the control group spent 15 minutes writing about their feelings regarding the exam. Results found both groups had positive effects in reducing state anxiety and improving performance, with no significant differences between them (Clinton & Meester, 2019). Another researcher used 15 minutes of Mandala pattern coloring to induce a mindful state, with free drawing of equal duration as the control group, conducting a series of studies with primary, secondary, and university students. Similarly, both groups effectively alleviated test anxiety with no significant differences in outcomes (Carsley et al., 2015; Carsley & Heath, 2018, 2019, 2020).

4.2 Effects of MBSR and MBCT on Test Anxiety

Multiple studies have confirmed the positive effects of MBSR or MBCT on test anxiety (Ahmadi et al., 2016; Arjunan & Joxy Joseph, 2016; Malehmir et al., 2021; Seidi & Ahmad, 2018; Shahidi et al., 2017). Among these, the study by Dundas et al. (2016) is particularly representative. This study administered MBSR to 70 college students with test anxiety and selected 90 ordinary students as a blank control group. Results showed that although the two groups differed significantly on test anxiety, state anxiety, self-esteem, and general self-efficacy before the intervention, these differences were no longer significant after the intervention. Notably, while trait anxiety in the intervention group improved, it remained significantly different from the control group, suggesting that MBSR is insufficient to fundamentally affect test anxiety at the trait level. Additionally, follow-up results showed that MBSR's effects on test anxiety were maintained over two years. Multiple other studies have also verified that MBCT effectively reduces test anxiety compared to blank control groups (Zandi et al., 2021; Hong & Wu, 2020), with effects maintained up to six months (Kaviani et al., 2011).

However, these studies also share the limitation of not including active control groups, making it impossible to determine whether mindfulness practice is superior to other conventional interventions for test anxiety. The study by Meng (2013) partially addresses this deficiency by designing a 7-week intervention program integrating MBSR and MBCT, with a control group undergoing progressive relaxation exercises of equal duration. Results showed that mindfulness practice was superior to progressive relaxation (post-hoc comparison mean difference = 9.03, $p < 0.01$).

4.3 Comparison of Two MI-TA Practice Components: The Importance of Maintaining Practice Integrity

Based on reported effect sizes and comparisons with active control groups, MBSR and MBCT show more consistent effects on test anxiety than single-session brief interventions. Obviously, the former has absolute advantages in practice duration, instructor guidance and explanation, group support, and psychoeducation. Furthermore, differences in mindfulness practice components between the two types of interventions warrant deeper consideration.

Single-session brief interventions generally lack open monitoring components, neglecting the integrity of mindfulness practice. Mindfulness practice includes two fundamental methods—focused attention (FA) and open monitoring (OM). The former selects a specific target (typically the breath) as the center of attention, repeatedly bringing attention back to the selected target when mind-wandering occurs, thereby training concentration. The latter sets no specific target, suspends judgment, and observes all phenomena arising in consciousness as they are (Lutz et al., 2008), also called choiceless awareness, which is considered the core and essence of mindfulness. Reviewing the methods used in the aforementioned single-session brief interventions, except for the sitting meditation used

by Colangelo and Audet (2020), which transitioned from FA to OM, the others employed breath observation or Mandala coloring (both FA), whereas MBSR and MBCT include both types of practice and feature a gradual progression from FA to OM (Lutz et al., 2015; Santorelli et al., 2017).

OM and FA may target different components of test anxiety, with the latter being irreplaceable by the former. From a practice perspective, FA, typically achieved through breath observation, may primarily affect the physiological arousal and tension components of test anxiety but is less effective in directly addressing worry and cognitive interference. OM, in contrast, emphasizes observing internal mental events with curiosity and acceptance—freeing oneself from habitual automatic judgment without further reaction—which itself creates important prerequisites for cognitive reappraisal (Garland et al., 2015; Hanley et al., 2021), thereby facilitating positive processing and regulation of worry and cognitive interference. Although no studies have directly compared the effects of FA versus OM on test anxiety, Cho et al. (2016) compared breath observation with cognitive reappraisal for test anxiety and found that breath observation was not superior to cognitive reappraisal ($d = 1.42$ and 1.23 , respectively). This result suggests that FA intervention alone cannot replace cognitive reappraisal in addressing worry and cognitive interference components, perhaps indirectly validating the importance of OM for MI-TA efficacy. Indeed, research has found that even with extended practice duration, mindfulness interventions including only FA may struggle to demonstrate specific effects (Kindlon, 1983).

Buddhist meditation, based on extensive practice experience, emphasizes the dialectical unity of FA and OM. Some scholars correspond FA and OM to “calming” (*samatha*) and “insight” (*vipassanā*) in Buddhist meditation (Liu, 2016; Peng, 2020), which are considered “like the two wheels of a cart, the two wings of a bird.” Buddhist meditation holds that insight requires a solid foundation in calming—that is, one must first possess stable and concentrated attention capacity before developing choiceless awareness. This advanced process typically requires sufficient practice duration.

Thus, from the perspective of achieving optimal effects, FA and OM may be different components of complete mindfulness practice, each with distinct operations and functions and practiced in sequential stages. If influenced by “reductionist” habits, artificially separating them may raise questions about whether such practices can still be called “mindfulness” interventions, warranting in-depth academic discussion. Future research could use dismantling strategies to design multi-arm RCTs to further test this hypothesis, confirming the specific roles of different intervention components and the organic connection between FA and OM. This is crucial for revealing MI-TA efficacy mechanisms and designing efficient, implementable interventions.

Additionally, it is evident that neither type of intervention directly addresses the self-deprecation component of test anxiety. Based on the previous target analysis, future intervention designs could incorporate practices involving self-compassion, such as loving-kindness meditation, to enhance the overall effective-

ness of MI-TA.

5 Orientation Toward Refining and Optimizing MI-TA Models

Meta-analytic research by Ergene (2003) found that interventions integrating conventional psychotherapy with test anxiety-specific coping skills were most effective. However, the studies in Section 4.2 directly used MBSR or MBCT as interventions without incorporating content specifically designed to address test anxiety. Therefore, some researchers have combined test anxiety intervention components with mindfulness training to design interventions that refine and optimize MI-TA models.

5.1 Intervention Model Integrating DBT Mindfulness Skills

Compared with MBSR and MBCT, DBT's mindfulness module translates mindfulness concepts into step-by-step, easily operational skill practices for specific problem situations. Based on this, Lothes et al. (2021, 2017) integrated DBT's mindfulness module with mindfulness practices from MBSR to design MI-TA. This 8-week course includes weekly 1-hour group sessions. Week 1 introduces the course, weeks 2-4 sequentially teach the three "What" skills from DBT (observe, describe, participate), weeks 5-7 teach the three "How" skills (non-judgmentally, one-mindfully, effectively), and week 8 concludes the course. Additionally, participants complete 10-20 minutes of daily mindfulness practice, including sitting meditation, body scan, mountain meditation, lake meditation, etc., and record their practice. In weekly group sessions, instructors first review participants' progress from the previous week, answer questions about practice, then teach DBT skills for that week. The core component involves discussing how to apply these skills to cope with test anxiety, ending with a 10-minute mindfulness practice. An RCT with 37 college students found that compared with a waitlist control group, this course effectively reduced test anxiety ($\eta^2 = 0.65$). Among nine students followed up at six months, effects were even stronger than at post-test ($\eta^2 = 1.14$), possibly because these students had high acceptance of and adherence to the course, consistent with the cumulative effect of mindfulness practice.

5.2 Intervention Model Integrating Self-Leadership Strategies

Sampl et al. (2017) argue that exams are not isolated events but part of overall academic life, and that effectively addressing test anxiety requires effective coping with heavy academic pressure. Therefore, based on theoretical and practical connections between self-leadership strategies and mindfulness, they integrated both to design Mindfulness-Based Self-Leadership Training (MBSLT). This 10-session course meets once per week for 2 hours, delivered in groups of 10-15 people by experienced coaches through lectures, group assignments,

and guided practice. Participants also complete homework assignments and record their practice progress and experiences. The course combines five mindfulness modules and three self-leadership strategies. The mindfulness modules are adapted from MBSR and include: (1) learning to attend to and be aware of internal experience through basic mindfulness practices (such as breath practice and body scan) and integrating mindfulness into daily life; (2) developing conscious and flexible attention-shifting capacity; (3) developing acceptance of unchangeable events and learning to cope with failure and daily annoyances; (4) non-judgmentally experiencing the momentum of thoughts and realizing that the mind consists of fluctuating thoughts; and (5) decentering from thoughts and learning to observe them non-judgmentally, thereby separating oneself from aversive thoughts.

The self-leadership strategies follow recommendations from Neck and Manz (2013), the originators of self-leadership theory. The specific course structure and content are shown in Table 1. An RCT with 109 college students found that compared with a waitlist control group, the MBSLT course effectively improved test anxiety ($d = 0.96$) (Sampl et al., 2017).

Nearly all newly developed mindfulness interventions reflexively borrow from MBSR's structure or content. However, formal borrowing of "what is" rarely fundamentally fits all problems and situations from the ground up; grasping MBSR's "why"—its internal principles—is key to truly adhering to mindfulness intervention fidelity.

The core principle or teaching purpose of MBSR is to teach participants to approach internal experience in a new (mindful) way. This new approach embodies the Eastern wisdom of "non-doing," which stands in stark contrast to the conventional problem-solving mindset that views "symptoms" as problems to be eliminated. This paradoxical solution represents both the characteristic and the challenge of mindfulness interventions. Consequently, MBSR emphasizes that teaching must be based on participants' and instructors' direct experiences gained through formal and informal mindfulness practice—this is the core feature and requirement of MBSR's teaching methodology. MBSR's course structure, themes, and practice items are all explicitly designed to serve and comply with this core purpose and pedagogical requirement.

McCown et al. (2010), drawing on extensive teaching and research experience, identified five implicit teaching intentions that progressively focus MBSR's course structure, themes, and practice items: experiencing new possibilities, discovering embodiment, cultivating awareness, moving toward acceptance, and growing compassion. They argue that these teaching intentions work together internally to achieve the core teaching purpose. They further propose that when designing, adapting, and optimizing intervention models for specific problems and implementation contexts, the key is to use these five teaching intentions as the kernel for organizing course structure and content.

From this perspective, although Lothes et al.'s (2021) intervention includes

mindfulness practices from MBSR, the course arrangement remains focused on teaching and discussing DBT mindfulness skills. It fails to explicitly articulate and emphasize how to integrate teaching intentions with DBT skill learning based on practice experience; mindfulness practice appears merely as an auxiliary means to help participants understand and master the “what” and “how” skills, and the sequencing of mindfulness practices does not correspond to the internal order of teaching intentions. In contrast, mindfulness modules 1, 3, and 5 in MBSLT clearly embody the teaching intentions of discovering embodiment, cultivating awareness, and moving toward acceptance, while modules 4 and 5 directly support MBSR’s core purpose, with sequencing that aligns with MBSR’s teaching intentions. This indicates that MBSLT better grasps the internal kernel of mindfulness interventions. However, the course only emphasizes that both mindfulness and self-leadership strategies have stress-reduction and self-regulation promotion effects; it fails to further clarify how the two components are organically connected in teaching operations, appearing as a mechanical addition of two intervention components. Moreover, the course is time-consuming and complex to implement, requiring instructors to have considerable experience in both mindfulness interventions and self-leadership strategies. Since mindfulness interventions inherently promote self-management, it may be possible to appropriately simplify the self-leadership component by focusing on teaching intentions to enhance implementability.

In summary, both intervention models have considerable room for improvement in adhering to teaching intention kernels, emphasizing practice experience, achieving organic integration of intervention components, and enhancing implementability. Future optimization of MI-TA models should accurately grasp the teaching intention kernel of mindfulness interventions, organically combine components specifically targeting test anxiety, and comprehensively weigh course structure against specific implementation contexts to produce interventions with both strong efficacy and implementability.

6 Orientation Toward Promoting MI-TA Implementation and Dissemination

The aforementioned studies primarily design and test interventions in ideal research settings, with participants mostly being conveniently sampled college students. However, real-world implementation of mindfulness interventions faces numerous challenges: the 8-week course cycle is too long, leading to participant attrition; intervention fidelity places high demands on implementers’ practice experience and qualifications; extensive home practice outside sessions is required, making participants prone to slackness; practice forms and content can seem monotonous, causing participants to lose interest; classic MBSR and MBCT intervention models have poor suitability for primary/secondary school students or other special populations; and primary/secondary school students, who are more significantly affected by test anxiety, face constraints such as tight teaching schedules and limited school support, making classic mindfulness interven-

tion models difficult to implement. Therefore, some researchers have focused on MI-TA implementation and dissemination, conducting studies grounded in real-world settings.

6.1 Promoting Implementation and Dissemination by Targeting Real-World Populations

Most studies use convenient sampling and focus on college students who are closer to research settings. In reality, primary/secondary school students (von der Embse et al., 2013), medical and nursing students (Quek et al., 2019), and other special populations suffer more severely from test anxiety due to developmental or academic burdens, making their need for MI-TA more urgent.

Addressing the needs of domestic primary/secondary school student populations, Chinese scholars have conducted series of studies showing that interventions specifically designed for real-world settings can effectively fit implementation contexts and alleviate test anxiety in these students (Cai, 2017; Guo & Sun, 2019; Meng, 2013; Sun, 2021; Tian, 2019; Xu, 2021; Xu, 2018). Among these, Sun (2021) noted the phenomenon that subclinical Attention Deficit Hyperactivity Disorder (ADHD) symptoms are common among primary school students and subsequently lead to test anxiety, and specifically developed an 8-week MI-TA course. Adapting to children's characteristic thinking in images, this course flexibly modified traditional mindfulness practices (e.g., "Mindful Breathing: Practice Sitting Like a Frog"). An RCT ($n = 63$) found that compared with a blank control group, the course effectively alleviated test anxiety ($d = 0.77$) with no significant difference from cognitive-behavioral training effects ($d = 0.85$), indicating the course's promising potential.

For medical and nursing student populations who experience high test anxiety due to heavy academic workloads and high graduation requirements, multiple studies have evaluated MI-TA implementability issues. For example, Teribury (2021) recruited 23 nursing students and used the well-known meditation mobile APP "Headspace" for intervention, finding significant relief in test anxiety scores. Moreover, when practice duration exceeded 200 minutes, mindfulness practice time and test anxiety scores showed a negative linear relationship ($r = -0.567$, $p = 0.022$), suggesting that more than 200 minutes of practice is needed to show effects. However, due to the small sample size and lack of a control group, this conclusion remains to be confirmed. Other studies have similar issues, such as small sample sizes (Nolan, 2021), lack of control groups, and intervention components limited to FA (Khentigan, 2021), leading to inconsistent results.

6.2 Promoting Implementation Through Multimedia Courses and Digital Self-Help Interventions

High demands on implementer experience and qualifications, substantial time and cost requirements, and monotonous intervention forms and content have

long been barriers to mindfulness intervention implementation and dissemination. Multimedia courses and digital self-help interventions, with their wide reach, simplicity, and low cost, can help overcome these obstacles, forming the basis for MI-TA implementation research.

In terms of multimedia courses, American senior mindfulness teachers Jack Kornfield and Tara Brach recorded the “Daily Mindfulness” audio course consisting of 40 sessions of approximately 10 minutes each. Xu (2018) confirmed this course’s positive effects and implementability for alleviating test anxiety in domestic high school liberal arts students through an RCT study. Quirk (2020) used the mindfulness audio course “A Still Quiet Place for Teens,” specifically developed for adolescents, as the intervention. This course includes three practices: Rest, Working with Thoughts, and STAR (Stop, Take a Breath, Accept, Resume). An RCT with 43 high school sophomores found that compared with a blank control group, the intervention group’s post-test scores on the emotional component of test anxiety were significantly lower ($\eta^2 = 0.24$), while the worry component showed no significant difference. As discussed in Section 4.3, this result likely occurs because the emotional component of test anxiety can be alleviated through the relaxation effect produced by FA practice, which can be achieved by following audio practice. The worry component, however, involves higher-order OM practice, and perhaps the course’s included OM practice was insufficient.

In terms of digital self-help interventions, in addition to Teribury’s (2021) study mentioned earlier, Chancey (2020) designed MI-TA using a mobile APP. The 8-week course included FA, OM, mindful eating, mindful walking, sitting meditation, and mindful compassion, plus instruction on applying mindfulness skills to test anxiety. Lecture videos were sent weekly with automatic practice reminders. However, the intervention group’s effects were not ideal, showing no significant difference from the blank control group. Two reasons may explain this: First, digital self-help interventions lack the important variable of a real implementer, and the degree to which effects are discounted warrants further discussion—this is a particular issue for future digital mindfulness intervention research. Second, although this study used digital self-help intervention with implementation and dissemination in mind, it did not select students experiencing test anxiety distress; the possibility of earning extra credit for participation may have been a more important motivator for participants. This results in weaker real-world attributes among participants and may lead to false reporting of daily practice engagement, potentially contributing to non-significant results.

These two approaches indicate that multimedia courses and digital technology are beneficial for overcoming barriers and promoting implementation, but they also tend to be insufficiently effective for the worry component of test anxiety—an area requiring special improvement in future course design based on real-world characteristics. The real world of MI-TA clinical practice is extremely broad, complex, and variable. Beyond the intervention itself, external environments (e.g., regional economic, social, and cultural factors), internal environ-

ments (e.g., school organizational characteristics, cultural atmosphere, communication features), stakeholders (e.g., intervention providers, school administrators, parents, and students' knowledge and beliefs), and implementation processes (including planning, engagement, execution, evaluation, and reflection) must all be considered. Therefore, MI-TA implementation and dissemination research remains a formidable task. Future research should vigorously conduct such studies within the implementation science framework (Qu et al., 2017) to continuously promote MI-TA implementation and dissemination.

7 Summary and Outlook

Riding the wave of mindfulness popularity in clinical psychology, researchers have applied it to test anxiety intervention, producing a number of representative studies across three orientations: preliminary efficacy validation, intervention model refinement, and implementation/dissemination promotion. However, compared with the NIH stage model's original intent to promote intervention implementation and dissemination, and considering fundamental issues that mindfulness intervention research often neglects, existing MI-TA studies have the following limitations that require future resolution.

First, Stage 0 basic research exploring the mechanisms of mindfulness training's effect on test anxiety is scarce, resulting in an incomplete and inaccurate understanding of how mindfulness influences test anxiety. This leads to intervention designs that address symptoms superficially or without clear targets, hindering MI-TA implementation and dissemination to some extent. When designing interventions, existing RCTs each hold different perspectives on the underlying efficacy mechanisms, lacking clear and comprehensive explanations. In fact, although test anxiety has its specific characteristics, its components can be broken down into basic "bio-psycho-social" elements, and its process can be analyzed through fundamental neural, cognitive, and emotional mechanisms. Mindfulness' s therapeutic effects at the biological, psychological, and social levels, as well as the neural, cognitive, and emotional mechanisms through which it produces effects, have been relatively well-established—this is precisely why mindfulness interventions have transdiagnostic broad efficacy. Therefore, more comprehensive hypotheses about MI-TA efficacy mechanisms can be formulated based on these findings. The analysis in Section 3.2 of this paper represents such an attempt, aiming to provide references for future intervention design and efficacy mechanism exploration. The NIH stage model emphasizes that clarifying behavior change mechanisms is crucial for developing interventions with implementation and dissemination potential, and encourages testing efficacy mechanisms at every stage of intervention development. Therefore, future research should place greater emphasis on exploring efficacy mechanisms by carefully designing control conditions (Davidson & Kaszniak, 2015), balancing common therapeutic factors of mindfulness interventions across groups, isolating specific therapeutic factors, and continuously testing and clarifying MI-TA efficacy mechanisms according to basic criteria for confirming efficacy mecha-

nisms (Kazdin, 2009).

Second, there are many more explanatory studies emphasizing Stages 1 and 2, but fewer pragmatic studies emphasizing Stages 3, 4, and 5, limiting MI-TA implementation and dissemination. As previously noted, explanatory and pragmatic approaches represent two ends of a continuum in intervention research design, not an absolute dichotomy. However, researchers often lack clear purpose and reflexively favor explanatory designs—this is a common problem in current mindfulness intervention research (Dimidjian & Segal, 2015) that substantially limits intervention implementation and dissemination. In fact, with clear research purposes, the PRECIS-2 tool can be used to optimize various elements of research design according to objectives (Loudon et al., 2015). From the NIH stage model perspective, future research should emphasize pragmatic purposes and conduct more Stage 3, 4, and 5 studies. Specifically, in research design, alternative trial designs beyond classic RCTs can be flexibly employed, such as stepped-wedge designs, hybrid effectiveness-implementation designs, interrupted time series designs, and multiphase optimization strategies (Xie et al., 2020). In participant selection, students with high test anxiety traits can be screened for inclusion. In intervention models, MBSR's five teaching intentions can serve as the core, with course structure and content flexibly set according to implementation context specifics. For control conditions, other conventional interventions for test anxiety such as cognitive-behavioral therapy can be used as active controls. In measurement, real testing situations should be incorporated whenever possible, with follow-up assessments to observe durability of effects. For outcome indicators, in addition to test anxiety, academic achievement and other important indicators of concern to schools, parents, and students can be added.

Third, varying degrees of neglect regarding fundamental issues in mindfulness intervention research have led to insufficient and non-objective explanations of MI-TA efficacy, thereby affecting implementation and dissemination. Basic issues such as the integrity of mindfulness practice, cumulative practice effects and “dose-response” relationships, implementer qualifications, and cross-cultural suitability—though lacking definitive research conclusions (Wielgosz et al., 2019)—cannot be simplistically dismissed or ignored simply because of manualized implementation. They should be understood and addressed as thoroughly as possible. First, although single-session brief mindfulness practices of less than 30 minutes have demonstrated efficacy for test anxiety, such effects may primarily result from relaxation responses produced by FA practice. For novices, OM practice requires a substantial foundation of FA practice; therefore, to truly test mindfulness efficacy, interventions must ensure adequate practice duration and include both FA and OM components, rather than blindly pursuing implementability at the expense of practice integrity. Second, mindfulness practice corresponds to adjustments in activity states of specific brain regions, and achieving neural plasticity or trait-level effects requires cumulative practice as a foundation (Davidson & Kaszniak, 2015). Although precise “dose-response” relationships remain undetermined, adherence data such as participant acceptance,

willingness to practice, and homework completion are crucial for explaining efficacy. Third, mindfulness is an attention training method, but more importantly, it is a way of being (Lutz et al., 2015) and a life attitude. The methods are easy to grasp, but the attitudinal dimension may require substantial effort in “hearing, contemplating, and practicing” to comprehend. Teaching qualifications based on training ensure, to some degree, that implementers have mastered mindful attitudes, thereby facilitating participants’ learning and understanding. Although implementer qualifications can be objectively described, their mastery and comprehension of mindful attitudes are difficult to objectively measure and should be fully considered when explaining efficacy. Moreover, digital mindfulness intervention studies without real-time teacher-student interaction should particularly consider this factor. Finally, mindfulness originates from Eastern Buddhist culture, whose self-concept is “non-self” (Peng et al., 2011; Peng & Shen, 2012)—the self is to be continuously let go—whereas in Western cultural contexts, the opposite is true: the self needs to be continuously strengthened. Striving to stand out in exams is an important way to strengthen the self. What problems may arise when using a “non-self” culture to achieve “strong self” goals remains unclear, but maintaining sensitivity to cultural differences in intervention implementation is necessary for explaining efficacy. In summary, although these issues lack clear and quantifiable solutions, maintaining sensitivity to them and striving for balance between their poles in research design, intervention implementation, and results interpretation will better promote intervention implementation and dissemination. This is an essential focus for future MI-TA research.

Acknowledgments: The reviewers and editorial board provided valuable comments and highly beneficial insights that helped the authors deepen their thinking and improve the paper. We express our sincere gratitude and respect.

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