

Mindfulness Skills Training & Assessment and Intelligence

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Abstract—Three key attentional mechanisms, attentional orienting (curiosity, openness and acceptance), engaging attention and sustaining-monitoring attention are the core skills on-target in any mindfulness-based program. Mindfulness skills are inherently related to top-down processes, such as awareness and reflection as well as bottom-up processes, such as emotional reappraisal, thus they can improve one's cognitive and emotional regulation. Practitioners become more responsive, calm, and focused while experiencing less stress and distractions. Furthermore, mindfulness has been proven to foster stress resilience and create a great sense of interconnectedness so that it diminishes one's possible involvement in impulsive behaviors. In addition, these techniques have multiple applications in modern medicine, working environments and school psychology, supported by ICTs to enhance practitioners' health status. Research has been focused on practitioners' mindfulness skills training and assessment through smartphones as a cost-effective and usable, every day treatment.

Keywords—self-regulation, awareness, self-efficacy, mindfulness skills, metacognition

1 Introduction

Mindfulness is tied to executive functioning and thus it can be used as a means for one's overall cognitive improvement. Executive functions are the physical substrate of cognition encompassing attention, emotion regulation, cognitive flexibility, inhibitory control, organization, initiation, reasoning, problem solving, planning, self-monitoring as well as working memory. Mindfulness is a multifaceted construct encompassing the self-regulation of attention toward, and nonjudgmental awareness of, present moment experiences [33]. Stemming from religious and spiritual roots, mindfulness draws on an explicit value system that emphasizes wholesome attitudes including generosity, kindness, equanimity, compassion and appreciative joy [1]. In addition, it has been proved that mindfulness skills have a transfer effect on the aforementioned cognitive and psychological functions. In the current research, both well-established and innovative methods of training and assessing mindfulness skills

will be presented with special emphasis on their efficacy and the need for cost-effective and tailor-made interventions supported by ICTs.

Mindfulness-based cognitive therapy (MBCT) focuses on participants' awareness of their relationship to their thoughts and feelings and it may include guided body scans, sitting and walking meditations, mindful movement (based on Hatha yoga), 3-minute breathing spaces as well as focused awareness on routine daily activities [2]. Mindfulness-based stress reduction (MBSR) [3] was developed as a mainstream mindfulness practice for chronic pain management and control of other life challenges [4]. MBSR includes three different techniques: the body scan, which involves a gradual movement of attention of the body from head to feet focusing on any sensation or feeling in the body; sitting meditation, which involves both attention on the breath and a state of nonjudgmental awareness of the thoughts and distractions that continually arise in the mind; and Hatha yoga practice, which includes breathing exercises and simple stretches [5].

Recently, mindfulness has been more widely accepted in modern medicine and included in medical context as well as school psychology [6, 7]. A recent randomized controlled trial (RCT) reported preliminary evidence that mindfulness training was associated with increased smoking cessation rates as compared to another leading, widely disseminated and validated smoking cessation treatment [8]. In that trial, home mindfulness practice was also found to reduce the association between craving and smoking [9]. Relationships between cognitive/affective self-regulation and academic outcomes have been supported by research in neuroscience and educational psychology [10, 11, 12]. Mindfulness-based interventions have been associated with numerous beneficial outcomes in emotional regulation, including decreased anxiety [13] depression [14] and anger expression reduction [15, 16, 17].

Mindfulness-based approaches teach students “from the inside out” to cultivate self-management of attention and increase self-awareness by focusing on intrapsychic experiences such as thoughts, emotional states, the breath, and other bodily sensations [18]. In addition, it has been suggested that many schools adopt mindfulness approaches because the techniques are easy to learn and may help students become more responsive, calm, and focused while experiencing less stress and distractions (Garrison Institute report, 2004).

A range of mindfulness programs is taking place nowadays in schools as, for example, the Mindfulness Based Wellness Education (MBWE) of Toronto University, the Mindfulness in Schools Project (MISP) in England, the Inner Kids Program, Cultivating Awareness and Resilience in Education (CARE) and Stress Management and Relaxation Techniques (SMART) in the USA. In Spain, it is worth noting the TREVA Program [19], Aulas Felices [20] and the Meditación Fluir Program [21].

Studies examining the impact of mindfulness on cognitive functions in the developing brain have been especially scarce, although existing research supports the notion that mindfulness can enhance cognitive functioning on basic as well as on higher-order levels [22, 23]. Furthermore, mindfulness training provides children with ADHD the opportunity to observe internal and external stimuli that enter their awareness, without automatically acting on them so as to reduce the symptoms of hyperactivity and/or impulsivity as well as motivation loss [57, 76].

More recently, evidence indicates that the central mechanism involved in meditative style techniques is attention. Three key attentional mechanisms are attentional orienting (curiosity, openness and acceptance), engaging attention and sustaining-monitoring attention [24]. Hence, remembering the hand-on task and returning attention to it is also a key skill. Therefore, our ability to function efficiently is very much linked to attention and working memory in terms of concentration and remembering of information to be held and manipulated in order to perform a task or decision. Baddeley's working memory model may be integrated in mindfulness and other related meditation techniques for the benefit of the practitioner [25].

Existing studies in adults vary in their inclusion of control groups (active/passive), in their design (cross-sectional/training study), in participants' expertise (novices/experts), the length/intensity of trainings and in the operationalization of dependent variables [22]. Similar to the studies conducted with adults, the generally promising evidence regarding children and adolescents is limited by several methodological shortcomings, among them the diversity of study samples, variation in implementation and exercises, negligence of objective outcome measures and lack of active control groups [26, 27, 28, 16].

Although mindfulness training for children and adolescents seems to be a promising approach, significantly more research is needed to examine its effectiveness with different populations and in different settings, its mechanisms of change, the specific components needed for successful implementation, and possible concerns or contraindications for its use [23]. This suggests the demand for and utility of a mindfulness training smartphone application. By sampling behavior and experience in real time, it is possible to minimize recall bias, maximize ecological validity and document change over time [29].

2 Mindfulness and Cognition

Luberto et al. [30] associated the greater use of the mindfulness skills with greater coping self-efficacy as well as emotion regulation. More specifically, the specific mindfulness skills investigated were observing, describing, acting with awareness and accepting without judgement. Mindfulness skills were connected to emotion regulation mainly through coping self-efficacy. Greater levels of coping self-efficacy as one's ability to successfully manage stressful situations and emotions were found to partially mediate the relationship between mindfulness skills and emotion regulation. In the present study, mindfulness skills are conceptualized as present moment awareness and acceptance (mindfulness-based cognitive therapy, mindfulness-based stress reduction) and were measured by the Kentucky Inventory of Mindfulness Skills. Therefore, clinicians should focus on mindfulness skills as a synergistic technique for improving one's emotional functioning and health, mainly, through promoting coping self-efficacy.

Sipe et al. [31] made a review study on Mindfulness-based cognitive therapy (MBCT), which extolled its therapeutic stance through enhancing individuals' metacognitive awareness. MBCT has been proven to increase acceptance, self-

compassion, present-moment awareness and ability to selectively deploy one's attention, while enhancing cortical regulation of limbic circuits and attentional control involved in affective disorders. In addition, mindfulness training may also enhance working memory capacity, which is a resource for willingly guided behavior and a means for overcoming emotionally intrusive thoughts in cognitive or emotional demanding situations.

Kalmendal [32] measured the effects of short-term meditation on individuals' working memory through the digit span backwards as well as their overall health status through their level of stress and levels of depression and anxiety. The Kentucky Inventory of Mindfulness Skills scale (KIMS) was used to measure the participants' level of mindfulness. Meditation consisted of two recorded visualizing guided meditations; Loving Kindness (11min), which was practiced once and Lake Meditation (11min), which was practiced twice. Both recordings started with quick explanations of the session followed by a mindful breath meditation, being mindful of your breath in body, noticing temporary feelings and thoughts in a non-judgmental and accepting way. Participants showed significantly positive effects on the overall level of mindfulness as well as on reducing the level of stress. However, brief mindfulness sessions did not have a significant effect on the digit-span test.

Wimmer et al. [22] implemented Bishop et al.'s (2004) [33] two-component model of mindfulness with an active and a passive control group in order to measure its effects on 10-11 year-old students. The first component is the self-regulation of attention, so that attention remains focused on the immediate present experience. The second component, orientation toward experience, can be described as an attitude of curiosity for, openness to, and acceptance of the present moment. The mindfulness training was based on the Mindfulness-Based Stress Reduction approach by Kabat-Zinn (2005) [3] and its cognitive effects, sustained attention, cognitive flexibility, cognitive inhibition, and data-driven information processing were measured by well-established cognitive tasks. Results suggested that the mindfulness training specifically improved cognitive inhibition and data-driven information processing.

Grensman et al. [34] explored if persons' with burnout enhanced their Health Related Quality of Life (HRQoL) after a traditional yoga program (TY) and a mindfulness-based cognitive therapy (MCBT) or a Cognitive Behavioral Therapy (CBT) (control). Participants practiced various practical skills, such as formulating a self-motivated day-to-day activity chart as well as planning and executing a micro-pause as homework, which helped patients come into closer contact with how they feel and how things are affecting them. One of the ways to encourage patients to replace experiential avoidance is with mindfulness acceptance. This is to accept real experiences, emotions and thoughts as they are. It is an intentional behavior that alters the function of inner experiences from events to be avoided, to a focus on interest, curiosity, and observation as part of living a valued life. The Swedish health-related quality of life survey 1.0 (SWED-QUAL) was used to assess the outcome variable HRQoL. Treatments improved emotional well-being, cognitive function and sleep, in severely sick patients on sick leave because of burnout.

Greenberg et al. [35] posited that mindfulness training, which emphasizes present moment awareness, may be an effective way to reduce proactive interference, in part

through its impact on hippocampal structure. Overcoming proactive interference is critical for high level cognitive processing, such as reasoning and problem solving [36]. In addition, proactive interference stems from past and currently irrelevant material and is associated with the hippocampus. The research team contrasted the effects of a 4-week web-based mindfulness program with a similarly structured 4-week web-based creative writing active control program on proactive interference in working memory. In addition to completing a task that measures proactive interference (Recent Probes task), a subset of participants underwent MRI scanning before and after the programs. The first 2 weeks were devoted to focused-attention meditation in which attention was focused solely on the breath or body sensations (body scan); the second 2 weeks were devoted to “open monitoring”, in which attention was centered on the present experience without predetermining a specific object of focus. The observed reduction in proactive interference in working memory following mindfulness training may in part underlie improvements in improved problem solving [37], increased sustained attention [38] and other cognitive capabilities [39].

Feicht et al. [40] investigated the effects of online happiness training on individual happiness and satisfaction with life. More specifically, they examined whether the aforementioned training reduces stress-related symptoms in an occupational setting. According to this, their primary goal was psychosocial wellbeing in connection with satisfaction (with life) and stress coping. The occupational health in a company training contained exercises on mindfulness as studies have shown, mindfulness training enhances the functioning of attention networks [6]. They used the Freiburg Mindfulness Inventory (FMI) for measuring mindfulness, whereas they used the Attention Network Test (ANT) to assess possible effects on attention regulation. In addition, to determine if the training reduced stress at an objectively measurable level, they collected saliva samples to measure the stress hormones alpha-amylase and cortisol [41, 42, 43, 44]. The results of the study showed that the happier the participants were, the fewer stress warning symptoms they described. However, no effects were found on attention stemming from the training. Overall, it seems that participants got in touch with themselves and their surrounding and may have realized that they can influence and control, at least to some extent, their environment.

Gouda et al. [17] introduced a mindfulness-based intervention to both students and teachers by offering them parallel MBSR courses. In essence, mindfulness has been regarded as a trainable capacity [45] that contributes to stress resilience by strengthening the “top-down” regulatory pathway while simultaneously mitigating the “bottom-up” stress reactivity pathway [46]. In particular, top-down processes are defined as awareness and reflection processes that allow for (i) a more elaborate consideration of the situation and context factors and (ii) an emotional reappraisal that also involves the skills of psychological disidentification, cognitive flexibility and inhibitory control. As a result, different aspects of self-regulation covering cognitive, emotional, physiological and behavioral components in conjunction with fewer interpersonal difficulties are associated with students, who believe more in their abilities to engage in learning processes and social situations. Thus, their sense of competence and relatedness is enhanced through students’ school-related self-efficacy

[47]. Moreover, the results support the assumption that not only does mindfulness constitute one such resource in itself; it may also assist teachers in tapping other interpersonal resources that the school setting offers as well as it can reduce students' stress, interpersonal problems and promote their self-regulation and self-efficacy.

3 Face-to-Face Mindfulness-Meditation Training Practices and Techniques

In Swedish elementary schools, studies has been conducted with a mindfulness-based program called *Compas* (Compassion and Attention in the Schools), in which positive results with mindfulness meditation, visualization of compassion, and reflection and mentalization enhanced pupils' well-being, social relations and self-regulations [7]. The program *Compas* comprised three phases. Phase 1: breath meditation (11 min); it starts with relaxation (visualization and bodyscan, 3 min), followed by mindful breath meditation (focusing on breath, being mindful of breath in body, noticing passing thoughts and feelings, 7 min) and finally, instructions to become aware of the body and the surroundings (1 min). Phase 2 is a guided visualization practice focusing on compassion and inspired by Paul Gilbert (11 min) [48]. The third phase comprised mindful reflection and mentalization (RM) of areas such as friendship, well-being, and compassion (15–20 min).

Buttle [25] reviews into a number of psychological therapies, such as mindfulness-based stress reduction, mindfulness-based cognitive therapy, dialectical behavior therapy, acceptance and commitment therapy, and relapse prevention [49, 50, 51, 52, 53, 2]. In Vajrayana Buddhism (often associated with Tibetan Buddhism), complex visualizations and mantra recitations are frequently used [54]. In mindfulness practices, the need for remembering a task as well as the use of relevant visuo-spatial and verbal aspects is indispensable. Verbal techniques enhance concentration, whereas visual techniques improve focused visual attention. The concurrent use of mantra and visualization is likely to involve the visuospatial sketch pad and the phonological loop, conjointly. Therefore, it might be the case that the loading of the working memory slave systems allows the attentional supervisory system (central executive) to come to rest. In addition, Van Dillen and Koole (2007) [55] provide evidence that working memory can be utilized as a tool for overcoming negative emotions. After extensive mindfulness practice, minimal effort is needed to sustain attentional focus and focused attention training may be associated with a significant decrease in emotionally reactive behaviors that are incompatible with stability of concentration [24].

Semple et al. [23] reviewed on the following mindfulness-based, school programs: Inner Explorer (IE), Master Mind (MM) and Moment Program (MP), Mindfulness and Mind-Body Skills for Children (MMBS), Mindful Schools (MS), Resilient Kids (RK), Still Quiet Place (SQP), Stress Reduction and Mindfulness Curriculum (SRMC) and Mindful Moment (MM), as well as Wellness and Resilience Program (WRP). The programs' common key components constituted in mindfulness education (neurobiology and communication of mindfulness), mindful breathing,

body scan, mindful eating, mindful movement-muscle relaxation, awareness of thought and emotions, guided imagery. However, these programs have not undergone scientific scrutiny. Individual program evaluation was supported by high recruitment and retention rates (SRMC), qualitative feedback from teachers (IE, MM, MP, SRMC) and students (MM, MP, SRMC), broad program dissemination (IE, MS, RK, SQP, SRMC), and long-term sustainability (MMBS).

Franco et al. [56] made an intervention study, which consisted in a mindfulness training program with a daily technique called “Meditación Fluir” for 15 min [21] and the performance of body-scan exercises [57] with the aim to reduce high-school children’s impulsivity and aggressiveness. It was verified that the practice of mindfulness can help students reduce obsessive ruminations, enhance the experience of positive emotions and compassion for both the self and others, thus, foster a great sense of interconnectedness as well as diminish the probability of involvement in impulsive behaviors. In this way, it is suggested that the capacity to regulate attention and emotion are forms of self-regulation that support dispositions conducive to learning and maintaining positive social relationships [58].

Samp et al. [59] built up the Mindfulness-Based Self-Leadership Training (MBSLT) for improving students’ perceived stress, test anxiety, academic self-efficacy and performance. The first mindfulness module (M1) consisted of several basic exercises (e.g., breathing exercises, body scan) in which participants developed a feeling for their body and learned how to integrate mindfulness into their daily lives. In this module, participants learned to keep attention on one experience. The second module (M2) expanded the first module and consisted of attention exercises to develop the ability to intentionally switch from one aspect to another flexibly. The third mindfulness module (M3) emphasized the acceptance of unchangeable events. In this module, participants learned how to deal with failure and daily hassles. The thematic priority of the fourth mindfulness module (M4) was the realization and nonjudgmental comprehension of the momentum of thoughts. In this phase, participants could discover that the mind consists of a continual coming and going of thoughts. Based on the previous modules, the fifth module (M5) consisted of exercises dealing with the dissociation from thoughts. In this last module, participants learned to detach themselves from undesired thoughts by focusing on the present moment with a nonjudgmental attitude. Trait mindfulness was measured with the 15-item Mindful Attention and Awareness Scale (MAAS) [60]. Mindfulness was found to enhance the effects of self-leadership on promoting performance as it improves self-regulation [61, 62].

4 On-line and stand-on application delivered Mindfulness-Meditation Training Practices and Techniques

Long et al. [63] designed and evaluated a web-based, cognitive behavioral therapy (CBT) for adolescents with chronic pain and their parents. The teen program encompassed the following modules: introduction to pain signals, identification of stress and negative emotions, training in deep abdominal breathing and progressive

muscle relaxation, attention focusing, imagery, mental games and pleasant activity participation, identifying negative and catastrophizing thoughts, mindful observation, thought stopping, thought replacement, healthy eating and drinking, importance of uptime and physical activity, role of sleep, sleep calculator as well as tips for maintaining gains and facing problems in the future, review of strategies that have been helpful. The online program included video interviews, audio files, assignments at the end of the modules, individualized feedback and assessment tools for measuring the impact of the program on participants' level of pain. Although the usability of this program was substantially illustrated, future research should comprise predictors of compliance and Web site access in combination with associations between program usage and treatment outcomes via internet interventions.

Ly et al. [64] developed two smartphone-delivered treatments, a behavioral activation (BA) and a mindfulness treatment in order to measure and compare their impact on participants with depressive disorder. The mindfulness intervention consisted of a short web-based psychoeducation and a step-by-step mindfulness practice programme, administered via a smartphone application. The smartphone application for iPhone was an established and commercially available application that could be downloaded from the Internet and consisted of a number of audio tracks with exercises to facilitate the practice of mindfulness. The exercises were guided and unguided as well as in short (3 min) or long (30 min) format. The participants were also asked to write a weekly reflection to summarize their work and thoughts and send it to their therapist via email. The results of the study indicated that the smartphone format might increase patients' awareness of being in treatment in everyday settings. Therefore, a broader group of people can acquire direct incentive for treatment-related activities in their everyday life on account of the low-cost and individualized means of the proposed psychological therapy [65].

Garrison et al. [66] proposed mobile mindfulness training for smoking cessation. Participants learn three standard meditation practices: body scan, loving kindness, and breath awareness [67]. Body scan is practiced by bringing awareness to different parts of the body so as to foster awareness of body sensations that constitute cravings and affective states. Loving kindness is practiced by directed well-wishing in repeating phrases such as "may X be happy" and is considered to foster acceptance of oneself and others. Breath awareness is practiced by paying attention to the breath in the body and it is considered to help keep the mind away from habitually self-related thinking and towards a more present-centered awareness. Additional app features include (i) "Activity Feed"; (ii) "My Morning Stats", (iii) "Night Reflection", (iv) "Reminders Settings", (v) "My Quit Pact" and (vi) "Tracker". This RCT will provide a platform for large-scale clinical trials to compare mobile mindfulness training to active behavioral treatments for smoking cessation in combination with disseminating this treatment to the wider community.

Krusche et al. [68] wished to investigate whether an online mindfulness course has a significant positive effect on the self-reported stress ratings of participants as measured by the Perceived Stress Scale (PSS) and whether the online course produces similar benefits as the mindfulness courses delivered face-to-face, in groups. The online course consisted of 10 interactive sessions (body scan, mindful movement,

sitting meditation, three-minute breathing space) and informal mindfulness techniques (incorporating mindfulness into daily activities, such as mindful eating) through videos, assignments and emails. The course lasted for a minimum of 4 weeks, depending on when participants are able to complete the practice and homework logs. The changes in the PSS scores were comparable to face-to-face MBSR and cognitive therapy courses. Moreover, participants who were more stressed at the outset practiced more and their PSS scores decreased to match the remainder of the sample at the 1-month follow-up.

5 The Role of Coaches' Experience in Teaching Mindfulness

Crane et al. [69] developed the Mindfulness-Based Interventions-Teaching Assessment Criteria (MBI: TAC) to address the effective assessment of mindfulness-based teaching integrity. Its structure is based on the revised Cognitive Therapy Scale, which divides competence into domains with a number of key features [70]. The MBI:TAC competence levels are based on the Dreyfus and Dreyfus (1986) model of skill acquisition, which was also used by Sharpless and Barber (2009) [71]. The scale has six competence levels and six domains. The main aspects of teaching integrity are embodiment, relational skills, interactive teaching and group holding in conjunction with the context of the course and the teaching styles followed by mindfulness-based teachers.

Ruijgrok-Lupton et al. [72] made a feasibility pilot study about the impact of mindfulness-based teacher training on participants' health. As no consensus exists on construct and operationalization of mindfulness and how to best assess it [73, 74], the research team focused on participants' well-being outcomes and participants' satisfaction. Longitudinal evaluations using online questionnaires measured participants' mindfulness and well-being before and after Mindfulness-Based Stress Reduction (MBSR) as well as participants' course satisfaction. Specifically, mindfulness was measured with the Five Facet Mindfulness Questionnaire (FFMQ) and self-compassion was measured with the Self-Compassion Scale-Short Form (SCS-SF). To evaluate specific changes in well-being, the Well-Being Questionnaire (WBI-5) was used in combination with the Perceived Stress Scale-10 Item (PSS). The results of the study verified that MBSR course participants taught by teachers with more advanced levels of mindfulness-based teacher training showed higher gains in well-being and significantly greater reductions in perceived stress than participants following courses by teachers with less training.

6 Conclusion

Mindfulness is both a metacognitive ability and a training technique for enhancing one's higher cognitive skills, self-regulation and self-consciousness [75]. Bishop et al.'s (2004) [33] two-component model of mindfulness comprise the self-regulation of attention, so that attention remains focused on the immediate present experience as well as the orientation toward experience and an attitude of curiosity for, openness to,

and acceptance of the present moment. Mindfulness skills have been related to self-regulation, self-leadership, self-awareness, attention, working memory, self-efficacy, metacognitive awareness, cognitive flexibility as well as cognitive inhibition, reasoning and problem solving.

The Mindfulness-based cognitive therapy (MBCT) and the Mindfulness-based stress reduction (MBSR) program have been proven to increase acceptance, self-compassion, present-moment awareness and ability to selectively deploy one's attention, while enhancing cortical regulation of limbic circuits and attentional control involved in affective disorders. In essence, mindfulness has been regarded as a trainable capacity [45] that contributes to stress resilience by strengthening the "top-down" regulatory pathway while simultaneously mitigating the "bottom-up" stress reactivity pathway [46]. In particular, top-down processes are defined as awareness and reflection processes that allow for (i) a more elaborate consideration of the situation and context factors and (ii) an emotional reappraisal that also involves the skills of psychological disidentification, cognitive flexibility and inhibitory control.

In general, mindfulness assists in healthy sleep, smoking cessation, academic improvement as well as in reducing anxiety, depression and anger. Compassion (Compassion and Attention in the Schools) as well as Mindfulness-Based Self-Leadership Training (MBSLT) have been related to pupils' well-being, self-leadership, social relations and self-regulations. Moreover, mindfulness skills training and assessment can be also applied to a range of people with variable executive function deficits as it can substantially influence individuals' "hot" and "cold" executive functions. It could also be a valuable tool in service of individuals looking for personal and professional development as employees of leaders who practice mindfulness have less emotional exhaustion, better work life balance and better job performance ratings [77]. Furthermore, mindfulness training has been shown to make practitioners more likely to respond compassionately to someone in need [78] and enjoy more satisfying personal relationships [79].

Mindfulness programs delivered through smartphone offer the interactivity and immediacy for a broader group of people acquiring direct incentive for treatment-related activities in their everyday life. In addition, such distance mindfulness-based programs provide researchers with more clear and ecologically valid assessment methodologies both in regard to the construct of mindfulness and to its operationalization. Their usability can be further improved through evidence-based research on the effectiveness of digital programmes and applications. Overall, the widespread implementation of innovative self-paced mindfulness techniques can lead to better brain function accompanied by better psychosocial function for personal and societal flourishing.

7 References

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