**The relationship between mindfulness and impulsivity: The role of mindfulness practice**

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**Abstract**

**Objectives:** Mindfulness and impulsivity traits are considered important elements in wellbeing and health. While impulsivity is considered a risk factor for involvement in negative behaviors, mindfulness is considered a protective factor against such behaviors and as a factor that strengthens mental well-being and encourages productive behaviors. This study aimed to examine the relationship between mindfulnessand impulsivity, taking into account the role of mindfulness meditation practice as a moderating factor.

**Methods:** 174 healthy young adults were assigned to either a non-meditation group or a meditation group based on their experience in meditation practice. The MAAS and FMI were administered to evaluate mindfulness and the BIS-11 and DII were administered to evaluate trait impulsivity.

**Results:** Attentional impulsivity consistently emerged as a stronger predictor of mindfulness compared to meditation practice. All impulsivity indices were significant predictors of mindfulness on the MAAS, with a significant interaction between non-planning impulsivity and meditation practice. In contrast, meditation practice demonstrated greater predictive power on the FMI compared to impulsivity indices. These findings emphasize the multidimensional nature of impulsivity and the varying impact of impulsivity subscales and meditation practice on different aspects of mindfulness.

**Conclusions:**

Up to 250 words

**Keywords: Mindfulness, Impulsivity, Meditation**

**Introduction**

The personality characteristics of mindfulness and impulsivity are considered important elements in wellbeing and health, partly because they are both strongly related to attentional control processes in charge of guiding behavior in a goal-driven manner to deal efficiently with obstacles and challenges that life entails (Schuman-Olivier et al., 2020; Stratton, 2006). Mindfulness as a trait is described as a relatively stable characteristic of an individual that reflects an inherent ability to remain mindful across different situations and contexts (Baer et al., 2006). It also refers the acceptance and awareness of thoughts, emotions, physical senses, and external experiences at the present time without judging and trying to control and suppress them (Terres-Barcala et al., 2022). In contrast, trait impulsivity, in its broad definition, is defined as a predisposition to take quick and unreflective actions in response to internal and/or external stimuli despite the negative consequences (Leshem, 2007, 2016; Moeller et al., 2001).

While impulsivity is considered a risk factor for involvement in negative behaviors (e.g., addictions, violence, delinquency), mindfulness is considered not only as a protective factor against such behaviors, but also as a factor that strengthens mental well-being and encourages productive behaviors. The importance of mindfulness for adjustive behaviors is reflected in the continued growth of mindfulness-based intervention programs in the general and clinical population (Peters et al., 2011). Mindfulness skills may reduce impulsivity in several ways. Improving awareness of internal experiences may facilitate the monitoring of impulses and the reduction of impulsive behaviors, which are characterized by a lack of reflection and thoughtful intention (Peters et al., 2011). The cultivation of mindfulness skills through meditation practice, for example, precludes impulsive thought and behavior through the maintenance of attention on the present moment and the qualities of acceptance, openness, and curiosity (Stratton, 2006).

Research on meditation increased significantly in the last quarter of the 20th century in an attempt to examine the effects of meditation on human behavior and mental well-being (Behan, 2020). In addition to conceptualizing mindfulness as a trait, it can be defined as a learnable skill (Kotze ;REF), a form of mental training that aims to improve an individual’s core psychological capacities, such as attentional and emotional self-regulation (Kabat-Zinn, 2003, 2009; Tang et al., 2015) through a variety of methods (Murphy et al., 1997; REF). While there are many ways to meditate, the common denominator for all meditation techniques is the practice of concentration and self-regulation, learning to focus the mind and controlling impulsive and reactive responses. Specifically, various meditation methods have been found to enhance and strengthen cognitive and emotional functions (Chiesa et al., Jakobsen, 2013; Goyal et al., 2014; Sedlmeier et al., 2012), such as inference processes, conflict resolution, and behavioral regulation, which are also involved in both personality traits—mindfulness and impulsivity (Gill et al., 2020; Nigg, 2017; Stahl et al., 2014; Tan et al., 2017). One of the various practices that have been applied to multiple mental and physical health conditions and have received much attention in psychological research is mindfulness meditation. Mindfulness meditation is often described as nonjudgmental attention to present-moment experiences, a nonreactive and observant stance toward one’s emotions, thoughts, and body states, as well as the self-regulation of attention (Bishop et al., 2004; Tang et al., 2015). Accordingly, studies report that practicing mindfulness is positively correlated with trait mindfulness (Alhawat-meh et al., 2021; Himichi et al., 2021; Kiken et al., 2016). On a conceptual basis, mindfulness meditation may be thought to confer benefits for improving behavioral control and reducing impulsivity. However, evidence that meditation is effective in reducing impulsivity is sparse (Korponay et al., 2019).

The aim of the present study is to examine the relationship between mindfulness and impulsivity traits. Since meditation practice strengthens and enhances cognitive functions related to mindfulness and impulsivity traits, we will investigate the relationship between these traits, taking into account experience in mindfulness meditation practice. Such an examination will help to gain a deeper understanding of the relationship between mindfulness and impulsivity.

Mindfulness is usually defined as a state of consciousness that refers to the ability to purposely pay attention to present moment experience in a nonjudgmental way to the unfolding of experience (Kabat-Zinn, 2003). Yet, there is a conceptual diversity and differences among practitioners and researchers from different schools of thought, in terms of understanding exactly what mindfulness is, including the number of behavioral dimensions involved and the emphasis placed on certain aspects of the concept (Bergomi et al., 2013). For example, Baer et al. (2004, 2006) suggest a multidimensional model of mindfulness comprising five subcomponents: observing, describing, acting with awareness, accepting (or allowing) without judgment, and nonreactivity. Among the researchers who adopt a one-dimension approach, some define mindfulness as a state of mind that is commonly experienced by meditators during their practice, as well as by non-meditators in daily life, with the key dimension of awareness of the present moment experience (e.g., Brown & Ryan, 2003), whereas others emphasize the acceptance, present focus, and non-judgmental components (Cardaciotto et al., 2008; Hyland, Lee, & Mills, 2015).

Despite difficulties in conceptualizing and operationalizing trait mindfulness, most definitions emphasize the attentional component that incorporates a particular quality of attentional focus and mindful awareness of the internal and external experience of the present moment, and accepting orientation to experience in that whatever arises is acknowledged )Bishop et al., 2004; Chambers, Lo, & Allen, 2008; Hyland et al., 2015)

Similarly, trait impulsivity encompasses several cognitive, emotional, and motor components and has been conceptualized in numerous ways (Whiteside & Lynam, 2001), reflecting its complex and multidimensional nature (Leshem & Glicksohn, 2007). One of the well-established definitions conceptualizes impulsivity as a set of discrete subcomponents of cognitive functioning: acting on the spur of the moment (motor activation), not focusing on the task at hand (attention), and not planning and thinking carefully (lack of planning) (Patton et al., 1995). Another definition of impulsivity, coined by Dickman (1990, 2000), distinguishes between two types: dysfunctional and functional. Dysfunctional impulsivity is characterized by rapid information processing with little thought leading to negative outcomes, whereas functional impulsivity refers to a fast information processing rate with little thought leading to positive outcomes. That is, functional impulsivity is related to making quick and accurate decisions in risky situations or under certain reward conditions.

To the best of our knowledge, there are no studies to date that have examined the relationship between mindfulness and the two types of impulsivity described by Dickman. It is possible, that mindfulness is positively correlated with functional impulsivity due to the shared cognitive component of rapid processing of information in the "here and now" that may be beneficial for a person with a high level of impulsivity in certain situations (Claes, Vertommen, & Braspenning, 2000). For example, when an experimental task is very simple, the errors made by the rapid responding of people with high levels of impulsivity have little cost (Dickman, 1985). When the time available for making a decision is extremely brief, people with high impulsivity levels are actually more accurate than low impulsives (Dickman & Meyer, 1988). Thus, people who focus more on what is happening in the present moment, without the past or the future of immediate concern to them, can be characterized either in terms of mindfulness (Dane, 2011) or impulsivity (Evenden, 1999; Gassen et al., 2019), especially functional impulsivity. This is despite the fact that the mechanisms underlying this state of consciousness are completely different between the two traits (e.g., impulsivity, as opposed to mindfulness, is a mere focus on external events to the exclusion of internal processes, with low levels of present-focused awareness)

Continuing this line of reasoning, both mindfulness and impulsivity emphasize orientation to the present, reflecting a person’s emphasis (or overemphasis) on “living in the here and now” (Murphy & MacKillop, 2012), however, they assume to be natural reciprocal. Although both relate to how prone a person is to acting on impulse, they are opposites in that greater mindfulness reflects a decreased likelihood of acting on an impulse, and greater impulsivity reflects a greater likelihood of doing so (Murphy & MacKillop, 2012). If impulsivity is defined as a swift action without conscious planning or awareness, and rapid emotional reactivity, mindfulness is the contrary. Specifically, mindfulness is often contrasted with behaving automatically and without awareness of one’s actions. In this regard, one aspect of mindfulness describes the non-judgmental, present-focused awareness experienced in any given moment (Bishop et al., 2006; Lau et al., 2006; Tanay & Bernstein, 2013) whereas impulsivity is characterized by a present focus with little awareness and forethought.

Conceptually, mindfulness and impulsivity can also be viewed as two concepts on a continuum, with mindfulness at one end, which includes action with thought and the ability to observe and reflect, while impulsivity—at the other end—includes action with little thought and a certain degree of automaticity, without considering the possible consequences (Wittmann et al., 2015).

Although there are studies that show that mindfulness and impulsivity are generally negatively correlated (Lattimore et al., 2011; Murphy & MacKillop, 2012; Rajesh Ilavarasu, & Srinivasan, 2013: REF), there are a few studies that report positive correlations between them (Lu & Huffman, 2014; Vinci et al., 2016; Wittmann et al., 2015). These inconclusive findings emphasize the difficulties of operationalizing both impulsivity and mindfulness, and the necessity of examining the relationship between them from a multidimensional point of view, and to qualify the findings accordingly to the tested components (Blanke & Brose, 2016). This broadens and deepens the examination of the relationship between these traits, which can vary at the subcomponent level.

The constructs of mindfulness and impulsivity share an emphasis on present-moment focus. However, the decisions and subsequent consequences following engagement in mindful versus impulsive processes vary greatly (Murphy & MacKillop, 2011). Mindfulness meditation integrates the qualities of awareness or attention to the present moment through which one practices observing thoughts and emotional reactions that occur at each moment by distancing from them (decentering), without reacting before their presence in the usual, automatic way (Chambers et al., 2008; Krishnakumar & Robinson, 2015; Peters et al., 2015), thus breaking the typical thinking-feeling-acting pattern that characterizes trait impulsivity (Franco et al., 2016), alongside heightening state mindfulness over time, which in turn increases trait mindfulness (Kiken et al., 2015). Specifically, mindfulness meditation is known to enhance cognitive control, including attentional focus and inhibitory control, and cultivates self-awareness by promoting introspection and the observation of one's thoughts, emotions, and impulses. By practicing meditation, people can train their mind to maintain focus and resist impulsive responses, and to gain insight into the relationship between their thoughts, feelings, and actions. They can thus become more adept at managing and redirecting their thoughts and behaviors, including regulate and redirect their impulsive behaviors.

Further research is needed to explore the underlying mechanisms and potential interventions targeting impulsivity to enhance mindfulness.

To date, the literature on mindfulness meditation focusing on non-clinical populations is limited compared to the literature on clinical populations, and the majority of studies on the effects of mindfulness meditation practice are on mental-health (e.g., depression, anxiety, stress) and physical outcomes (Hyland et al., 2015). Additionally, most studies refer to the link between meditation and impulsivity indirectly, with reference to clinical disorders, especially ADHD (Krisanaprakornkit et al., 2010; Mitchell et al., 2015; Santonastaso et al., 2020,). Korponay et al., (2019) investigated the effect of an 8-week mindfulness intervention on impulsivity and its neurobiological correlates in healthy adults. The overall results showed that the mindfulness intervention did not reduce impulsivity, nor did it produce changes in the neural correlates of impulsivity compared to active (meditation-naïve participants) or wait-list control groups. However, looking at impulsivity subscales and the duration of meditation practice revealed that long-term meditators had lower attentional impulsivity and higher motor and non-planning impulsivity scores on the BIS-11 self-report questionnaire than meditation-naïve participants. Their study illustrates the need to consider the sub-components of trait impulsivity when examining its relationship to mindfulness. Also, investigating differences in the relationships between the trait-level subcomponents of mindfulness and impulsivity might contribute to a future understanding of the effects of meditation (and resultant mindfulness trait) on impulsivity.

In this study, we used the two most widely used measures of trait mindfulness in research: the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) and the FMI (Buchheld et al., 2001). These questionnaires emphasize different components of mindfulness, with the MAAS focusing on awareness and attention, and the FMI focusing on 4 distinct components (mindful presence, non-judgmental acceptance, openness to experiences, and insight), but do not differ in their scale (i.e., mindfulness treated as a general structure) (REF). The MAAS was designed for the general population with or without familiarity with mindfulness, whereas the FMI requires some degree of familiarity with mindfulness practice (REF). We predicted that trait mindfulness as measured by the MAAS and the FMI would be negatively correlated with impulsivity as measured by BIS-11 and Dickman’s dysfunctional impulsivity. Since this is the first study to examine the relationship between functional impulsivity and trait mindfulness, if any connection was found between them, we expected that high functional impulsivity would be associated with high mindfulness. This association would be due to the shared cognitive component of rapid processing of information in the "here and now" leading to positive outcomes. As a part of this examination, we also investigated whether mindfulness meditation practice would attenuate the (negative) relationship between impulsivity and mindfulness traits. Although the relationship between meditation practice and impulsivity is unclear and still requires further investigation, the relationship between meditation practice and mindfulness is well-established and supported by empirical evidence. Given that meditation practice is associated with facilitation of reflective processes and the enhancement of conscious processes over automatic processes, we predicted that mindfulness meditation will significantly moderate and mitigate the impact of impulsivity on mindfulness. In addition, we predicted that individuals with meditation practice experience would be high in trait mindfulness and a low in impulsivity compared to those who did not meditate.

Method

Participants

174 adults participated in the study (128 female; *M*age = 28.08, *SD* = 7.23; age range: 21-45 years(. No history of neurological, psychiatric illnesses, or language-related disorders, including attention deficit hyperactivity disorder, was reported.

An a priori power analysis was conducted using G\*Power version (MISSING VERSION NUMBER) (Faul et al., 2007, 2009) to determine the minimum sample size required to test the study hypotheses. The results indicated that for Exact: Correlation: Bivariate normal model, the required sample size to achieve 95% power for detecting a medium effect, at a significance criterion of α = .05, was N = 115. For an independent samples t-test the required sample size to achieve 95% power for detecting a medium effect, at a significance criterion of α = .05, was *N* = 152. For linear multiple regression of a fixed model, *R*2 deviation from zero design with two predictors, the required sample size to achieve 95% power for detecting a medium effect, at a significance criterion of α = .05, was n = 107. Thus, the obtained sample size of n = 174 is adequate to test the study hypotheses.

The study was approved by the university’s human subject protection Institutional Review Board and all participants provided signed informed consent.

Measures

The Barratt Impulsiveness Scale (BIS-11; Patton et al., 1995). This questionnaire was designed to assess the trait impulsivity. The scale is comprised of 30 items, each scored on a 4-point Likert scale ranging from 1 (Rarely/ Never) to 4 (Almost Always/Always). The questionnaire comprises three subscales: motor impulsiveness (MI; motor, perseverance); non-planning impulsiveness (NPI; self-control, cognitive complexity); and attentional impulsiveness (AI; attention, cognitive instability). The BIS-11 provides a total score serving as a global impulsivity measure, ranging from 30 to 120. A total score between 52 and 71 is considered within normal limits for impulsiveness. A total score of ≥72 is used to classify an individual as highly impulsive (Stanford et al., 2009). The BIS-11 has adequate reliability (α = 0.83; Stanford et al., 2009). The Hebrew version had adequate reliability (α = .79) in this study, similar to reliability scores reported in previous studies (α = 0.72 - 0.79; Glicksohn & Nahari, 2007; Leshem & Glicksohn, 2007; Leshem, 2016; Leshem & Yefet, 2019).

The Dickman Impulsivity Inventory (DII; Dickman, 1990). A self-report questionnaire developed to measure two types of impulsivity: functional and dysfunctional impulsivity. It consists of 23 items to be answered with a true/false answer format, of which 11 items measure functional impulsivity (e.g., "Most of the time, I can put my thoughts into words very rapidly"), and 12 items measure dysfunctional impulsivity (e.g., "I often buy things without thinking if I can really afford it financially"). The functional and dysfunctional impulsivity scales have adequate reliability (α = .74, α =. 85, respectively). The Hebrew version of the functional and dysfunctional scales had adequate reliability (α=76, α=.80, respectively) in this study, similar to reliability scores reported in a previous study by Hadad, 2014 (α = .78, α =. 81, respectively).

The Mindful Attention and Awareness Scale (MAAS; Brown & Ryan, 2003). This is a 15-item scale designed to assess the core characteristic of mindfulness: a receptive state of mind in which attention, informed by a sensitive awareness of what is occurring in the present, simply observes what is taking place. Response options ranged from 1 (almost never) to 6 (almost always) (e.g., "I find it difficult to stay focused on what is happening in the present"). A higher score indicates a greater degree of mindfulness. A validated translation to Hebrew was utilized and had adequate reliability (α = .85) in this study.

The Freiburg Mindfulness Inventory short form (FMI; Walach et al., 2006). This is a 14- item scale examining mindfulness components that relate nonjudgmental present-moment observation and openness to negative experience (e.g., ‘I am open to the present moment’; ‘I am able to smile when I notice how I sometimes make life difficult’), utilizing a Likert scale ranging from 1 (rarely) to 4 (almost always). The short version proved to be semantically independent from knowledge of a Buddhist or meditation context and was found to measure the core of the mindfulness construct and captures all aspects of the long form (for the full form of 30 items see Buchheld et al., 2001) with a reliability of α = .79−.86 (Kohls et al., 2009; Pfeifer et al., 2016; Trousselard et al., 2010). The questionnaire was translated into Hebrew by the researcher for the purposes of the present study, and then was re-translated and compared by two independent professional translators. The translated questionnaire had adequate reliability (α = .87).

Procedure

The research was carried out using Qualtrics, a dedicated software platform for conducting academic surveys online. We used it to collect data from university students, and from members of social networks dedicated to groups of meditation practitioners. Before filling out the questionnaires, all participants were asked to sign an informed consent form stating that participation in the study was voluntary and that they could withdraw from the study at any time.

Statistical analyses

SPSS™ version 28 was used for statistical analysis. Seven indices of predictors were calculated as followed: the BIS-11 (Barrat impulsiveness scale) total score, BIS attentional, motor, and non-planning subscales score, and the DII (Dickman impulsivity inventory) functional and dysfunctional scores. A dichotomous moderator variable of meditation practice was used to divide the participants into two groups based on their experience with meditation practice. Participants without any meditation practice were assigned to the non-meditation group (coded as 0) with a total of 121 participants, and participants with at least 50 hours of meditation practice (*M*meditation = 920, *SD* = 1276) were assigned to the meditation group (coded as 1) with a total of 53 participants. To evaluate the outcome measure, mindfulness trait, two dependent indices were calculated by the total scores on the MAAS and FMI.

Initial screening of the data was conducted to determine whether there were statistically significant differences between the two groups in age and gender distribution. For age, an independent-samples t-test revealed that participants in the non-meditation group (*M* = 24.98, *SD* = 4.55) were significantly younger than the participants in the meditation group (*M* = 35.15, *SD* = 7.27), *t*(172) = -9.40, *p* < .001. To test whether age was correlated with the study variables, a Pearson correlation coefficient analysis was performed showing positive correlations between age and MAAS, *r* = .22, *p* = .004, and age and FMI, *r* = .24, *p* = .002. A Chi square test revealed a significant relationship between gender and meditation practice, χ²(1) = 5.00, *p* = .025, with 79% women in the no meditation group compared to 62% women in the meditation group. To test whether there were differences between women and men on the study variables, separate independent-samples t-tests were performed, showing no significant difference (*p*s > .3). Based on these results, age was included in the regression analyses.

We conducted Pearson correlations to examine the correlations between scores on the mindfulness and impulsivity self-reported questionnaires. Next, independent-samples t-test was performed to examine the differences between the meditation and non-meditation groups on the mindfulness and impulsivity indices. Lastly, hierarchical regression analyses were conducted with MASS and FMI as the outcome variables (*y*). Each regression equation had three steps whereby age was entered as an independent variable in the first step. The BIS-11 subscales and totalscores and the DII functional and dysfunctional scores were entered as independent variables (*x*) in the second step, together with the meditation practice variable. The interactions between each of the independent variables: BIS-11, DII functional and dysfunctional scores, and meditation practice variable were entered in the third step. Each of the independent variables was entered separately into the regression model.

**Results**

**Observed correlations between impulsivity and mindfulness**

Correlations between the BIS subscales and total score and DII dysfunctional and functional scales were examined separately for the MAAS and FMI (see Table 1). The MAAS was negatively correlated with BIS subscales and total score, and the DFI scale. The FMI was negatively correlated with the BIS AI subscale and BIS total score, and the DFI scale. Also, the FMI was positively correlated with the FI scale.

Table 1. Means, standard deviations, and correlations.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Variable | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|  |  |  |  |  |  |  |  |  |  |  |  |
| 1. MAAS | 56.99 | 11.01 |  |  |  |  |  |  |  |  |  |
| 2. FMI | 38.14 | 6.68 | .54\*\* |  |  |  |  |  |  |  |  |
| 3. BIS sum | 60.93 | 9.67 | -.48\*\* | -.27\*\* |  |  |  |  |  |  |  |
| 4. BIS AI  | 17.10 | 4.01 | -.70\*\* | -.49\*\* | .69\*\* |  |  |  |  |  |  |
| 5. BIS MI | 20.49 | 4.02 | -.28\*\* | -.04 | .80\*\* | .35\*\* |  |  |  |  |  |
| 6. BIS NPI | 23.34 | 4.65 | -.15\* | -.10 | .80\*\* | .26\*\* | .50\*\* |  |  |  |  |
| 7. FI | 14.43 | 2.64 | .13 | .34\*\* | .07 | -.14\* | .24\*\* | .07 |  |  |  |
| 8. DFI | 12.12 | 2.23 | -.33\*\* | -.25\*\* | .57\*\* | .35\*\* | .49\*\* | .46\*\* | .15\* |  |  |

Note: MAAS = Mindful Attention and Awareness Scale; FMI = Freiburg Mindfulness Inventory; BIS-11=Barratt Impulsiveness Scale; MI=motor impulsivity subscale; NPI=non-planning impulsivity; AI=attentional impulsivity;FI = functional impulsivity; DFI = dysfunctional impulsivity.

\* *p* < .05. \*\* *p* < .01.

**Differences between the meditation groups in mindfulness and impulsivity**

T-tests for independent variables between meditation and non-meditation groups on MAAS, FMI, BIS-11 subscales and total score, DII functional and dysfunctional impulsivity scales are shown in Table 2. Regarding mindfulness traits, there were higher MAAS and FMI scores in the meditation than in the non-meditation groups. As for trait impulsivity, there were lower BIS AI and higher BIS NPI scores in the meditation than in the non-meditation group. Lastly, there was a marginally (p=.052) higher FI score in the meditation than in the non-meditation group.

Table 2. Independent-samples **t**-**tests** for the meditation and non-meditation groups on mindfulness and impulsivity.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
| **Variables** |  **Meditation practice** | ***n*** | ***M*** | ***SD*** | ***t*** | **Cohen's *d*** |
|  |  |  |  |  |   |  |
| **MAAS** | **No** | 121 | 55.65 | 10.55 | *t*(172) = -2.77, *p* = .006 | 10.72  |
|  | **Yes** | 53 | 60.55 | 11.10 |  |  |
|  |  |  |  |  |  |  |
| **FMI** | **No** | 121 | 36.43 | 6.35 | *t*(172) = -5.35, *p* < .001 | 6.32 |
|  | **Yes** | 53 | 42.00 | 6.25 |  |  |
|  |  |  |  |  |  |  |
| **BIS-11**  |  |  |  |  |  |  |
| Total score | **No** | 121 | 60.61 | 10.35 | *t*(172) = -1.21, *p* = .230 | 9.55 |  |
|  | **Yes** | 53 | 62.28 | 7.41 |  |  |
|  |  |  |  |  |  |  |
| AI | **No** | 121 | 17.47 | 3.97 | *t*(172) = 2.30, *p* = .023 | 3.94 |
|  | **Yes** | 53 | 15.98 | 3.86 |  |  |
|  |  |  |  |  |  |  |
| MI | **No** | 121 | 20.31 | 4.28 | *t*(172) = -1.40, *p* = .164 | 3.84 |
|  | **Yes** | 53 | 21.04 | 2.56 |  |  |
|  |  |  |  |  |  |  |
| NPI | **No** | 121 | 22.83 | 4.43 | *t* (172) = -3.38, *p* = .001 | 4.36 |
|  | **Yes** | 53 | 25.26 | 4.21 |  |  |
|  |  |  |  |  |  |  |
| **DII** |  |  |  |  |  |  |
|  FI | **No** | 121 | 14.31 | 2.76 | *t*(172) = -1.96, *p* = .052 | 2.68 |
|  | **Yes** | 53 | 15.17 | 2.50 |  |  |
|  |  |  |  |  |  |  |
| DI | **No** | 121 | 12.37 | 2.44 | *t*(172) = 1.71, *p* = .090 | 2.28 |
|  | **Yes** | 53 | 11.79 | 1.86 |  |  |

Note: MAAS = Mindful Attention and Awareness Scale; FMI = Freiburg Mindfulness Inventory; BIS-11=Barratt Impulsiveness Scale; MI=motor impulsivity subscale; NPI=non-planning impulsivity; AI=attentional impulsivity;FI = functional impulsivity; DI = dysfunctional impulsivity.

**The effects of trait impulsivity and mindfulness practice on MAAS.**

Hierarchical regression models were used to test whether meditation practice moderates the relationships between BIS total score, BIS subscales, FI, or DFI, and MAAS. Age was entered into the regression in the first step because of the differences in age according to the meditation variable (see table 4).

The regression models with the MAAS as the outcome measure showed that age was significant in the first step. In the second step, BIS-11 total score, BIS subscales, and DFI scale score significantly predicted MAAS, such that a decrease in impulsivity predicted an increase in trait mindfulness. Moreover, meditation group significantly predicted MAAS only with BIS total score but not with the other measures, showing that meditation training predicted an increase in trait mindfulness. In the third step, there was a significant interaction between meditation group and the BIS-11 NPI subscale indicating a significant negative correlation between NP impulsivity and MAAS among participants in the non-meditation group (β=-.422, p<.001) (see figure 1). No significant correlation was found between non-planning impulsivity and MAAS among participants with meditation training (β=.031, p=.826). There were no other significant interactions (ps >.3).

Table 4. Moderation analysis of impulsivity to MAAS, as moderated by meditation practice

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
| **Step** | **Main Variables** | **B** | **SE.B** | **β** | **p** | **ΔR²** | **R²** |
|  |  |  |  |  |  |  |  |
| **1** | **age** | 0.328 | 0.112 | 0.217 | .004 | 4.7%\*\* | 4.7%\*\* |
| **2** | **age** | 0.204 | 0.124 | 0.135 | .103 |  |  |
|  | **BIS-11 total score** | -0.606 | 0.072 | -0.530 | <.001 |  |  |
|  | **Meditation practice** | 3.832 | 1.952 | 0.162 | .050 | 28.7%\*\*\* | 33.4%\*\*\* |
| **3** | **age** | 0.188 | 0.125 | 0.125 | .134 |  |  |
|  | **BIS-11 total score** | -0.646 | 0.079 | -0.565 | <.001 |  |  |
|  | **Meditation Practice** | -9.618 | 11.620 | -0.406 | .409 |  |  |
|  | **Interaction: BIS total score x Meditation practice**  | 0.220 | 0.187 | 0.584 | .242 | 0.5% | 33.9%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.328 | 0.112 | 0.217 | .004 | 4.7%\*\* | 4.7%\*\* |
| **2** | **Age** | -0.029 | 0.109 | -0.020 | .788 |  |  |
|  | **AI** | -1.895 | 0.153 | -0.691 | <.001 |  |  |
|  | **Meditation practice** | 2.371 | 1.683 | 0.100 | .161 | 45.5%\*\*\* | 50.2%\*\*\* |
| **3** | **Age** | -0.021 | 0.110 | -0.014 | .850 |  |  |
|  | **AI** | -1.980 | 0.180 | -0.722 | <.001 |  |  |
|  | **Meditation practice** | -2.643 | 5.812 | -0.112 | .650 |  |  |
|  | **Interaction: AI x Meditation practice** | 0.300 | 0.333 | 0.211 | .369 | 0.2% | 50.5%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.328 | 0.112 | 0.217 | .004 | 4.7%\*\* | 4.7%\*\* |
| **2** | **Age** | 0.203 | 0.140 | 0.135 | .148 |  |  |
|  | **MI** | -0.907 | 0.201 | -0.319 | <.001 |  |  |
|  | **Meditation practice** | 3.490 | 2.200 | 0.147 | .114 | 10.8%\*\*\* | 15.5%\*\*\* |
| **3** | **Age** | 0.171 | 0.142 | 0.113 | .229 |  |  |
|  | **MI** | -1.013 | 0.217 | -0.356 | <.001 |  |  |
|  | **Meditation practice** | -12.645 | 12.467 | -0.534 | .312 |  |  |
|  | **Interaction: MI x Meditation practice** | 0.786 | 0.598 | 0.706 | .190 | 0.9% | 16.4%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.328 | 0.112 | 0.217 | .004 | 4.7%\*\* | 4.7%\*\* |
| **2** | **Age** | 0.306 | 0.143 | 0.203 | .034 |  |  |
|  | **NPI** | -0.730 | 0.181 | -0.300 | <.001 |  |  |
|  | **Meditation practice** | 3.552 | 2.226 | 0.150 | .112 | 9.0%\*\*\* | 13.7%\*\*\* |
| **3** | **Age** | 0.239 | 0.143 | 0.158 | .096 |  |  |
|  | **NPI** | -1.027 | 0.207 | -0.422 | <.001 |  |  |
|  | **Meditation practice** | -22.864 | 9.743 | -0.966 | .020 |  |  |
|  | **Interaction: NPI x Meditation practice** | 1.101 | 0.396 | 1.199 | .006 | 3.8%\*\* | 17.5%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.328 | 0.112 | 0.217 | .004 | 4.7%\*\* | 4.7%\*\* |
| **2** | **Age** | 0.192 | 0.150 | 0.127 | .203 |  |  |
|  | **FI** | 0.272 | 0.309 | 0.067 | .381 |  |  |
|  | **Meditation practice** | 2.706 | 2.314 | 0.114 | .244 | 1.2% | 5.9%\* |
| **3** | **Age** | 0.192 | 0.151 | 0.127 | .204 |  |  |
|  | **FI** | 0.309 | 0.360 | 0.077 | .391 |  |  |
|  | **Meditation practice** | 4.858 | 10.609 | 0.205 | .648 |  |  |
|  | **Interaction: FI x** | -0.144 | 0.692 | -0.094 | .836 | 0.0% | 5.9%\* |
|  | **Meditation practice** |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.328 | 0.112 | 0.217 | .004 | 4.7%\*\* | 4.7%\*\* |
| **2** | **Age** | 0.229 | 0.140 | 0.152 | .102 |  |  |
|  | **DFI** | -1.554 | 0.337 | -0.326 | <.001 |  |  |
|  | **Meditation practice** | 1.662 | 2.199 | 0.070 | .451 | 11.2%\*\*\* | 15.9%\*\*\* |
| **3** | **Age** | 0.229 | 0.140 | 0.152 | .103 |  |  |
|  | **DFI** | -1.614 | 0.379 | -0.339 | <.001 |  |  |
|  | **Meditation practice** | -1.932 | 10.280 | -0.082 | .851 |  |  |
|  | **Interaction: DFI x Meditation practice** | 0.302 | 0.843 | 0.153 | .721 | 0.1% | 16.0%\*\*\* |
|  |  |  |  |  |  |  |  |

Note: MAAS = Mindful Attention and Awareness Scale; FMI = Freiburg Mindfulness Inventory; BIS-11 = Barratt Impulsiveness Scale; MI= motor impulsivity subscale; NPI=non-planning impulsivity; AI=attentional impulsivity; FI = DII functional impulsivity; DFI = DII dysfunctional impulsivity; Meditation practice = 0 – non-meditation group, 1 – meditation group.

\* p<.05 \*\* p<.01 \*\*\* p<.001

Figure 1. An interaction between meditation group and the BIS-11 NPI subscale. There was a significant negative correlation between NPI and MAAS in the non-meditation group but not in the meditation group.

**The effects of trait impulsivity and mindfulness practice on FMI.**

Hierarchical regression models were used to test whether meditation practice moderates the relationships between BIS total score, BIS subscales, FI, or DFI, and FMI. Age was entered into the regression in the first step because of the differences in age according to the meditation variable (see Table 5).

The regression models were significant in the first step, showing that age predicts FMI. The second step was also significant, showing that the BIS AI subscale, NPI subscales, and total scores, and the FI and DFI scales predicted FMI. Specifically, a decrease in BIS AI, NPI, and total scores, and DFI predicted an increase in trait mindfulness as measured by the FMI, and an increase in FI predicted an increase in trait mindfulness as measured by the FMI. Moreover, meditation practice strongly predicted an increase in trait mindfulness as measured by FMI. In the third step, none of the interactions were significant.

Table 5. Moderation analysis of impulsivity to FMI, as moderated by meditation practice

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
| **Step** | **Main Variables** | **B** | **SE.B** | **β** | **p** | **ΔR²** | **R²** |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.224 | 0.070 | 0.238 | .002 | 5.7%\*\* | 5.7%\*\* |
| **2** | **Age** | -0.015 | 0.084 | -0.016 | .854 |  |  |
|  | **BIS-11 total score** | -0.199 | 0.048 | -0.280 | <.001 |  |  |
|  | **Meditation practice** | 6.060 | 1.315 | 0.411 | <.001 | 16.4%\*\*\* | 22.1%\*\*\* |
| **3** | **Age** | -0.008 | 0.084 | -0.008 | .925 |  |  |
|  | **BIS-11 total score** | -0.180 | 0.054 | -0.253 | .001 |  |  |
|  | **Meditation practice** | 12.461 | 7.841 | 0.846 | .114 |  |  |
|  | **Interaction: BIS-11 x Meditation practice** | -0.105 | 0.126 | -0.446 | .409 | 0.3% | 22.4%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.224 | 0.070 | 0.238 | .002 | 5.7%\*\* | 5.7%\*\* |
| **2** | **Age** | -0.110 | 0.079 | -0.117 | .164 |  |  |
|  | **AI** | -0.763 | 0.111 | -0.447 | <.001 |  |  |
|  | **Meditation practice** | 5.556 | 1.216 | 0.377 | <.001 | 27.3%\*\*\* | 33.0%\*\*\* |
| **3** | **Age** | -0.113 | 0.079 | -0.121 | .155 |  |  |
|  | **AI** | -0.733 | 0.130 | -0.429 | <.001 |  |  |
|  | **Meditation practice** | 7.299 | 4.207 | 0.495 | .085 |  |  |
|  | **Interaction: AI x Meditation practice** | -0.104 | 0.241 | -0.118 | .666 | 0.1% | 33.1%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.224 | 0.070 | 0.238 | .002 | 5.7%\*\* | 5.7%\*\* |
| **2** | **Age** | -0.013 | 0.088 | -0.014 | .882 |  |  |
|  | **MI** | -0.108 | 0.126 | -0.061 | .394 |  |  |
|  | **Meditation practice** | 5.781 | 1.377 | 0.392 | <.001 | 9.0%\*\*\* | 14.7%\*\*\* |
| **3** | **Age** | -0.013 | 0.089 | -0.014 | .887 |  |  |
|  | **MI** | -0.107 | 0.136 | -0.060 | .434 |  |  |
|  | **Meditation practice**  | 5.906 | 7.844 | 0.401 | .453 |  |  |
|  | **Interaction: MI x Meditation practice** | -0.006 | 0.376 | -0.009 | .987 | 0.0% | 14.7%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.224 | 0.070 | 0.238 | .002 | 5.7%\*\* | 5.7%\*\* |
| **2** | **Age** | 0.023 | 0.087 | 0.024 | .794 |  |  |
|  | **NPI** | -0.278 | 0.110 | -0.183 | .013 |  |  |
|  | **Meditation practice** | 6.013 | 1.357 | 0.408 | <.001 | 11.7%\*\*\* | 17.4%\*\*\* |
| **3** | **Age** | 0.015 | 0.089 | 0.016 | .865 |  |  |
|  | **NPI** | -0.312 | 0.129 | -0.206 | .017 |  |  |
|  | **Meditation practice** | 2.997 | 6.067 | 0.203 | .622 |  |  |
|  | **Interaction: NPI x Meditation practice** | 0.126 | 0.247 | 0.220 | .611 | 0.1% | 17.5%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.224 | 0.070 | 0.238 | .002 | 5.7%\*\* | 5.7%\*\* |
| **2** | **Age** | -0.077 | 0.085 | -0.082 | .363 |  |  |
|  | **FI** | 0.745 | 0.175 | 0.296 | <.001 |  |  |
|  | **Meditation practice** | 5.713 | 1.307 | 0.388 | <.001 | 16.9%\*\*\* | 22.6%\*\*\* |
| **3** | **Age** | -0.077 | 0.085 | -0.082 | .364 |  |  |
|  | **FI** | 0.748 | 0.203 | 0.297 | <.001 |  |  |
|  | **Meditation practice** | 5.875 | 5.992 | 0.399 | .328 |  |  |
|  | **Interaction: FI x Meditation practice** | -0.011 | 0.391 | -0.011 | .978 | 0.0% | 22.6%\*\*\* |
|  |  |  |  |  |  |  |  |
| **1** | **Age** | 0.224 | 0.070 | 0.238 | .002 | 5.7%\*\* | 5.7%\*\* |
| **2** | **Age** | -0.006 | 0.086 | -0.007 | .942 |  |  |
|  | **DFI** | -0.620 | 0.207 | -0.209 | .003 |  |  |
|  | **Meditation practice** | 5.274 | 1.347 | 0.358 | <.001 | 12.9%\*\*\* | 18.6%\*\*\* |
| **3** | **Age** | -0.006 | 0.086 | -0.007 | .942 |  |  |
|  | **DFI** | -0.621 | 0.232 | -0.209 | .008 |  |  |
|  | **Meditation practice** | 5.184 | 6.302 | 0.352 | .412 |  |  |
|  | **Interaction: DFI x Meditation practice** | 0.008 | 0.517 | 0.006 | .988 | 0.0% | 18.6%\*\*\* |
|  |  |  |  |  |  |  |  |

Note: FMI = Freiburg Mindfulness Inventory; BIS-11 = Barratt Impulsiveness Scale; MI= motor impulsivity subscale; NPI=non-planning impulsivity; AI=attentional impulsivity; FI = DII functional impulsivity; DFI = DII dysfunctional impulsivity; Meditation practice = 0 – non-meditation practice, 1 – meditation practice.

\* p<.05 \*\* p<.01 \*\*\* p<.001

Discussion

The study aimed to examine the relationship between mindfulness and impulsivity in a normative adult population, referring to the multifactorial structure of these two traits, using self-report questionnaires. As part of examining the relationship between mindfulness and impulsivity, the effect of meditation practice on this relationship was tested. To this end, the participants were divided into two groups, one that included participants with experience in meditation practice and the other that included participants without experience in meditation practice.

The main findings revealed distinct relationships between mindfulness and impulsivity, depending on the multifaceted construct of these two traits, showing significant differences in mindfulness traits, as assessed by both the MAAS and the FMI, between the meditation and non-meditation groups. As for impulsivity, differences between the two groups were found only in some of the subscales that constitute trait impulsivity, as assessed by the BIS-11 and DII questionnaires. Also, an examination of the effect of meditation practice on the relationship between mindfulness and impulsivity, yielded only one significant interaction of the NPI sub-factor of impulsivity with meditation practice, whereby increases in NPI predicted decreases in MAAS scores only for the non-meditation group.

Consistent with the first prediction, the results showed that both MAAS and FMI were negatively correlated with BIS-11 total score and with DII dysfunctional impulsivity, suggesting that a high level of impulsivity is associated with a low level of mindfulness. These findings reinforce previous studies that have shown that trait mindfulness and impulsivity trait are inversely correlated (Lyvers et al., 2013).

Looking at the different subfactors of impulsivity and mindfulness, we found that while the MAAS was negatively correlated with the BIS-11 attentional, motor, and non-planning impulsivity subscales, and DII dysfunctional impulsivity scale, the FMI was negatively correlated with the BIS-11 attentional impulsivity and positively correlated with the DII functional impulsivity scale. Although there is convergent validity between MAAS and FMI, as can be seen in the positive correlation between them, the findings show that the two questionnaires capture different components of impulsivity trait.

The MAAS is a measure of momentary mindful states (Brown et al., 2007) and focuses mostly on (lack of) attentiveness to daily life and mindless states (Brown & Ryan, 2003; Grossman, 2008; Van Dam et al., 2010). These are one of the core characteristics of impulsivity, emphasized in BIS-11 (Barratt, 1995) and DII (Dickman, 1990) indices that can be constructed as a manifestation of “mindlessness” (Brown & Ryan, 2003; Lyvers et al., 2014). Specifically, attentional impulsivity is defined as an inability to focus attention or concentrate, motor impulsivity involves acting without thinking, and non-planning impulsivity involves a lack of ‘‘futuring” or forethought (Stanford et al., 2009). Thus, the correlations reported between the MAAS and these impulsivity subfactors may to some extent reflect the attentional functions that underlie both mindfulness and trait impulsivity The same goes for dysfunctional impulsivity which emphasizes the tendency to act with a little forethought (Dickman, 1990). These findings strengthen the argument that mindfulness and impulsivity refer to attention characteristics that are across the continuum, where the tendency to mindfulness with the ability to pay conscious attention and reflectivity is at one end, and the tendency to impulsivity with low attentiveness and automatic thought processes is at the other end (De Wit, 2009; Maltais et al., 2020; Murphy & MacKillop, 2012).

In accordance with our prediction, the FMI was positively correlated with the functional aspect of impulsivity, presumably because of the common component of rapid processing of cognitive information in the “here and now”, which characterizes both mindfulness (Hölzel et al., 2011; Jha et al., 2010) and functional impulsivity (Brunas-Wagstaff, Bergquist & Wagstaff, 1994; Dickman, 1990), and that allows for an optimal response. According to Brown et al. (2009) mindfulness is not deliberative in nature. It refers to the simple act of observing without scrutiny, making comparisons, or evaluating events and experiences and is thus dissimilar to ‘self-awareness’ or reflexive consciousness in other forms. Also, mindfulness concerns a non-interference with experience, suspending categorical judgments, which normally follow every perception rather quickly, and thus is not a cold, cognitive process (Walach et al., 2006; Kotzé, 2016(. The FMI measures aspects of mindfulness, such as openness to experience, and non-judgmental and accepting attitude (e.g., ‘I am open to the experience of the present moment’; ‘When I notice an absence of mind, I gently return to the experience’) that can converge with functional impulsivity (Whiteside & Lynam, 2001), resulting in a positive association between them. This leads to another, related point to be addressed in this context. There may be profound differences between respondents in their semantic understanding of scale items that reside in the definitions of “awareness,” “noticing,” “paying attention,” “judging,” and “present moment.” For those experienced in meditation, these terms in the FMI (that discriminate between experienced and novice meditators) may have relatively specific meanings that are at significant variance with the meanings attributed to them by most people who have never practiced mindfulness meditation (for more details see Grossman, 2008). Specifically, if the acquisition of an understanding of mindfulness is predicated on practicing mindfulness meditation there is a great chance that the words and phrases in inventory items may take on very different meanings depending on whether one has ever meditated, as well as on the extent of the meditation experience. Therefore, the presence or absence of mindfulness experience is likely to influence how items in these scales are understood and interpreted by the responders.

Looking at the role of meditation practice in mindfulness and impulsivity, the findings showed that participants with meditation practice had a higher score in both MAAS and FMI than those without meditation practice, thus strengthening the claim that mindfulness meditation practice involves paying sustained attention to one’s ongoing sensory, cognitive, and emotional experience, without giving in to the natural tendency to react, elaborate, or evaluate (Bishop et al., 2004; REf).

Regarding impulsivity, the findings obtained were mixed and partially supported the prediction that those with meditation practice would be lower in impulsivity compared to those without meditation experience. Namely, the significant differences observed between the two groups were on the attentional and non-planning impulsivity subscales. For attentional impulsivity, the meditation practice group had a significantly lower score than the no meditation group. This is in line with the prevailing claim in studies according to which people with meditation experience, compared to those with no experience, have better ability to concentrate and maintain attention as well to think ahead (Chimiklis et al., 2018; Goldberg et al., 2020), which are often considered to be weak and inadequate among those with high trait impulsivity (Korponay et al., 2019). In contrast, the non-planning impulsivity score was higher in the group with meditation practice compared to the group without meditation experience. This finding is supported by the study of Korponay et al. (2019) which showed that adult participants from the meditation practice were found to have a high score in non-planning impulsivity, compared to participants without experience in meditation practice. The researchers concluded that these participants resorted to meditation practice in order to reduce their level of impulsivity.

Planning is a cognitive process that involves setting a predetermined course of action to achieve a goal and continuously monitoring the execution until the goal (Hayes-Roth & Hayes-Roth,1979; REF). Thus, a possible explanation is that the participants in the current study turned to meditation precisely because their difficulties in planning ahead, and the desire to overcome the tendency to act according to immediate rewards without considering future results. That is, they would meditate as a form of psychological “self- therapy” (Wittmann et al., 2015). This explanation requires further investigation as it relates to a specific component of impulsivity, and it is unclear why this does not apply to the other components of impulsivity. It is possible that the differences found regarding attentional impulsivity are due to the fact that this component is affected by the practice of meditation in a relatively short time, most likely because the practice of meditation acts directly and mainly on attention and concentration (REF Carter et al., 2005; Ivanovski & Malhi, 2007). This is in contrast to the planning and foresight component, which involves multiple cognitive steps, including determining a course of action in advance to achieve a future goal, along with continuous monitoring of the execution until the goal is achieved (Hayes-Roth & Hayes-Roth,1979), and may require a longer period of meditation practice before change can be seen. In this context, the cumulative duration of experience in meditation practice in the present sample is low to moderate relative to the cumulative duration of subjects defined as having a lot of experience in meditation in other studies in the field (for example, Berkovich-Ohana et al., 2012; Berkovich-Ohana et al., 2017; Wittmann et al., 2015).

Alternatively, as stated earlier, this difference may be due to an unintended side effect that lies in the possibility that people who practiced meditation interpreted certain items in the BIS-11 conceptually differently. It should be noted that similar to non-planning impulsivity, marginally significant differences were found in functional impulsivity, which may further strengthen the latter explanation. That is, functional impulsivity related to cognitive processes of fast and efficient cognitive information processing that leads to positive results similar to the practice of meditation, and thus, can create confounding.

The study explored the effects of impulsivity trait and meditation practice on mindfulness traits, as well as the potential mediating role of meditation practice in the relationship between impulsivity and mindfulness traits, as measured by the MAAS and FMI.

Regarding the MAAS, mindfulness was more strongly affected by trait impulsivity and dysfunctional impulsivity as measured by BIS-11 and the DII, respectively, than by meditation practice. Specifically, high scores in the impulsivity subscales and the overall total score, as well as score in the dysfunctional impulsivity scale predicted low score in mindfulness trait. In contrast, for the FMI, meditation practice was found to be the stronger predictor compared to specific impulsivity subscales (non-planning subscale and the total score of the BIS-11), except for attentional impulsivity. The motor impulsivity subscale and dysfunctional impulsivity did not demonstrate significant effects on the FMI. In addition, there was a relatively weaker but still significant effect of functional impulsivity suggesting that while meditation practice has a more substantial influence on the FMI, functional impulsivity also contributes to variations in mindfulness. This may suggest that engaging in meditation practice may have a more significant impact on individuals' mindfulness levels, specifically in terms of FMI.

Notably, the fact that attentional impulsivity was identified as a stronger predictor of mindfulness compared to meditation practice in both MAAS and FMI suggests that the attentional focus component of impulsivity (e.g., “I don’t pay attention") and mindfulness ( e.g., MAAS – “I rush through activities without being really attentive to them.”; FMI – “When I notice an absence of mind, I gently return to the experience of the here and now”) are distinct concepts, and that difficulties in sustaining attention may hinder the ability of mindful awareness to the present moment (Peters et al., 2011).

Relatedly, although mindfulness practice predicted a high level of mindfulness, no mediating effect was observed, except in the relationship between the non-planning impulsivity subscale and the MAAS. This interaction indicated a negative correlation between non-planning impulsivity and the MAAS in the non-meditation group. In other words, individuals with high score in non-planning impulsivity exhibited low levels of mindfulness trait, among those who did not engage in regular meditation practice. However, in the meditation group, there was correlation between non-planning impulsivity and scores on the MAAS. This indicates that the meditation practice group had a modifying effect on the relationship between non-planning impulsivity and mindfulness trait. Engaging in meditation practice seemed to weaken the negative impact of non-planning impulsivity on mindfulness levels, as measured by the MAAS. This may imply that meditation practice has an effect on difficulties in self-control, cognitive complexity, and thinking carefully (i.e., forethought) that make up the non-planning impulsivity subscale (Stanford et al., 2009). This converges with the finding in the present study that showed that non-planning impulsivity score was higher in the group with meditation practice compared to the group without meditation practice experience and that participants resorted to meditation practice in order to reduce the level of non-planning impulsivity (Korponay et al, 2019). No significant interactions were found for the FMI.

Together, the results suggest that mindfulness components of mindful attention and awareness, as measured by the MAAS are affected mostly by trait impulsivity, whereas mindfulness components of nonjudgmental present-moment observation, and openness to negative experience are more influenced by meditation practice. Indeed, the FMI is adapted to individuals with long-term experience in meditation (Kotzé & Nel, 2016). In this regard, it is possible that it takes time in order for mindfulness meditation practice to strengthen mindfulness. That is, mindfulness practice is known to have an effect on mindfulness state and related cognitive and consciousness processes, but in order to achieve an improvement in attentional functions over time, as expressed at the trait level, continuous and consistent practice is required (Jha et al., 2007; Kozasa et al., 2012; Lutz et al., 2009; Verhaeghen, 2021).

The findings reveals a complex pattern of differential effects of impulsivity subscales and meditation practice on the MAAS and FMI. Attentional impulsivity consistently emerged as a stronger predictor of mindfulness compared to meditation practice across both scales. While all impulsivity indices, including attentional, motor, and non-planning impulsivity, as well as the total score of the BIS-11 and dysfunctional impulsivity, were significant predictors of mindfulness on the MAAS, meditation practice demonstrated greater predictive power on the FMI compared to specific impulsivity indices. These findings emphasize the multidimensional nature of impulsivity and the varying impact of impulsivity subscales and meditation practice on different aspects of mindfulness.

**Limitations and future research**

The present study examined the effect of mindfulness practice on the relationship between mindfulness and impulsivity. However, this effect may depend on a given meditation method. One of the research neuropsychological issues examines whether different meditation methods have an overall effect on cognitive brain networks or whether meditation methods differentially affect these brain areas, depending on the mental skills unique to a certain meditation method (Yordanova et al., 2021). Therefore, the data in the current study can be attributed to mindfulness meditation. At the same time, there is an agreement that the different meditation methods, including mindfulness meditation, share a common denominator of strengthening attentional control processes (Lutz et al., 2008; Malinowski, 2013), which are relevant to mindfulness and impulsivitytraits.

Also, this study used self-reported questionnaires; however, surveys are not the sole methodology that has been employed in mindfulness research. Further research that incorporates diverse methods, such as diary study methodology, training or intervention (self-training mindfulness, MBSR, MBCT), and physiological markers (saliva cortisol samples), among others, can expand scientific knowledge regarding the relationship between mindfulness and impulsivity among both healthy and clinical populations. Moreover, given that the participants in the meditation group possessed limited to moderate experience, it is important for future research to include individuals who have extensive experience in meditation as well.

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Conclusion?