



A Mindfulness-Based Intervention for Adolescents with Behavior Disorders: Controlled Trial with Partial Randomization

Benjamin Roux^{1,2} · Marbella Pérez-Peña^{1,2} · Pierre Philippot^{1,2}

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Abstract

Objectives Mindfulness-based interventions (MBIs) are widely used with adults and children to treat anxiety and depressive symptomatology. However, only few studies with a rigorous design have been conducted among adolescents with behavior disorders even though this population suffers from symptoms that can be addressed by MBIs such as inattention and hyperactivity. The present study investigated the effect of a MBI on internalizing and externalizing symptoms in adolescents with behavior disorders.

Methods A sample of adolescents with behavior disorders ($N=129$) living in a residential service for youth were allocated to one of three treatment conditions: a treatment as usual condition, a health psychoeducation condition, and a MBI condition. The three groups were compared over a period of three assessment points plus a 1-year follow-up on self-report questionnaires, questionnaires rated by adolescents' educators, and behavioral tasks. To test the MBI efficacy, multilevel analyses were performed, controlling for gender and medication.

Results All groups improved on most measures, likely due to the intensive institutional care provided by default. The MBI significantly improved attentional capacities, but had no significant differential impact on depressive symptomatology, mindfulness, impulsivity, hyperactivity, or oppositional behaviors in comparison to the other conditions.

Conclusions MBIs may help adolescents with behavior disorders at the attentional level. Further research is needed to determine the potential benefits of mindfulness on externalizing and internalizing symptoms in this population.

Keywords Mindfulness-based intervention · Adolescents · Behavior disorders · Externalizing symptomatology · ADHD · Controlled trial

Disruptive, impulse-control, and conduct disorders are widespread disorders that can affect one in five adolescents (American Psychiatric Association, 2013; Merikangas et al., 2010). These disorders mainly refer to attention deficit hyperactivity disorder (ADHD), intermittent explosive disorder (IED), oppositional defiant disorder (ODD), and conduct disorder (CD) diagnoses and will be labeled as “behavior disorders” in this article. Adolescents who suffer from a behavior disorder experience many psychological difficulties compared to other adolescents. For example,

children with ADHD present emotional difficulties such as a low emotional threshold, loss of control in the face of intense emotions, and slow return to baseline (Bunford et al., 2018). Behavior disorders are characterized by externalizing symptoms that can be divided into three core symptom clusters: (1) inattention (e.g., difficulty sustaining attention), (2) hyperactivity (e.g., inability to wait quietly), and (3) oppositional behaviors (e.g., aggressiveness). Although there are overlaps between these clusters, the first two are very specific to the ADHD diagnosis while oppositional behaviors are more specific to the diagnoses included in the disruptive disorder category such as IED, ODD, and CD.

As reflected by network analyses, inattention during adolescence is mainly characterized by distraction and forgetfulness (Martel et al., 2017). These difficulties are very common among adolescents with behavior disorders and constitute a constraining impairment of cognitive functioning. Overall, a higher level of inattention is a significant

✉ Benjamin Roux
benjamin.roux@uclouvain.be

¹ Psychological Sciences Research Institute,
University of Louvain, Place Cardinal Mercier, 10,
B-1348 Louvain-la-Neuve, Belgium

² Laboratory for Experimental Psychopathology, University
of Louvain, Louvain-la-Neuve, Belgium

predictor of depression, academic impairment, social impairment, oppositional behaviors, and hyperactivity (Servera et al., 2016). It even impacts the ability to recognize facial affect (Sinzig et al., 2008). More importantly, self-reported inattention in pre-adolescence predicts a poorer quality of peer relationships in middle adolescence even after controlling for depression and peer relationship quality at baseline (Connors et al., 2012). Individuals who have the ability to sustain their attention can consider their experience in more detail than those who present distractibility. In the same way, selective attention can lead to a better control of the environment thanks to an improvement in the ability to choose stimuli of interest. Thus, inattention appears as a central symptom in the development of behavior disorders and must be taken into consideration in therapeutic care.

Hyperactivity also plays a fundamental role in behavior disorders. It refers to excessive motor activity and includes a series of symptoms such as overactivity, fidgeting, inability to stay seated, intruding into other people's activities, or inability to wait (American Psychiatric Association, 2013). At a theoretical level, hyperactivity can be separated from impulsivity (Martel et al., 2017). Indeed, impulsivity refers to a hasty attitude and reaction occurring in the moment without forethought, which may potentially harm the individual. This lack of inhibition occurs not only at the behavioral level but also at the emotional and cognitive levels (e.g., being aggressive in the face of a deception). From this perspective, impulsivity is considered a psychological process that underlies hyperactivity, as well as other core symptom clusters such as inattention and oppositional behaviors (Billieux, 2012). For example, the impulsivity of children facing external distractions in a classroom might push them to leave their seats. This latter behavior can be considered a symptom of hyperactivity but impulsivity is the psychological process causing this observable behavior (hyperactivity symptom). Importantly, hyperactivity and impulsivity in early adolescence are associated with future antisocial behavior, major depressive disorder, and alcohol abuse (Giannotta & Rydell, 2016; Hamilton et al., 2019; Meinzer et al., 2013). Hence, particular attention should be paid to identifying and treating these symptoms.

The third core symptom cluster, oppositional behaviors, is characterized by irritability (e.g., stubbornness, bad mood, bad temper) and defiance (e.g., argues, disobeys at home, disobeys in school; Ollendick et al., 2018). It can also be accompanied by aggressiveness and violent behaviors in their most severe form such as those observed in CD (Evans et al., 2019). Without an adequate care, oppositional behaviors can quickly lead to general dysfunction. More specifically, it has been shown that the irritability dimension could lead to internalizing symptoms, such as depression and anxiety, while defiant behaviors could lead to externalizing symptoms such as antisocial behaviors (Waldman et al.,

2018). The same pattern was found for aggressiveness which is a precursor of psychosocial difficulties, delinquency, and antisocial behaviors (Van Stralen, 2016).

In addition to these three main clusters, it is also important to note that, in the long term, externalizing symptoms may lead to internalizing symptoms (Flouri et al., 2019). Further, the psychological suffering caused by harassment or social exclusion may become as significant as the initial externalizing symptoms.

In this context, psychological interventions for children who suffer from behavior disorders should target these three symptom clusters and, to a lesser extent, internalizing symptoms such as anxiety and depression. Because of the large number of specificities inherent in the interventions conducted in the field (e.g., peer interventions, cognitive training, neurofeedback training), it is also difficult to isolate the therapeutic processes that affect these symptoms. In addition, few studies use a high-quality design, such as a randomized controlled trial (RCT), and large samples to test the effects of their interventions.

Currently, research suggests that behavioral therapies remain the most effective treatment for behavior disorders (Evans et al., 2018). In particular, interventions that involve parents have received considerable evidence in the treatment of externalizing symptoms (Epstein et al., 2015; Evans et al., 2018). However, the therapeutic benefits of these interventions are less prominent in adolescent populations compared to children populations (Evans et al., 2018). It is possible that, with age, parenting has less influence on children (Cecil et al., 2012). Moreover, a significant proportion of adolescents with behavior disorders, such as those living in certain institutions (e.g., psychiatric institutions, orphanages, residential services for youths), cannot rely on parental support. Therefore, further investigation is required to evaluate psychological interventions, specifically for adolescents, that target inattention, hyperactivity, and oppositional behaviors. In particular, mindfulness-based interventions (MBIs) that focus on emotional awareness and non-reactivity may be useful for the treatment of behavior disorders.

MBIs aim at developing awareness of the present moment through breathing meditations, body scan exercises, and mindful hatha yoga. A large body of research has demonstrated the positive effect of MBIs on mental health mostly in non-clinical populations (Dunning et al., 2018; Klingbeil et al., 2017; Maynard et al., 2017; Zoogman et al., 2015). Overall, the results of meta-analyses suggest a small to moderate effect size on general mental health outcomes with consistent effects on mindfulness and attention measures as well as on depression and anxiety. In light of the positive results found among children with low levels of psychopathology, it can be expected that children and adolescents who suffer from more severe symptoms could benefit from MBIs.

Notably, MBIs are potentially promising interventions for treating behavior disorders because they specifically target the psychological processes encountered in these disorders such as impulsivity and emotion dysregulation (Bunford et al., 2015).

A meta-analytic review on eleven studies conducted by Xue et al. (2019) among individuals with ADHD supports this assertion. MBIs have a significant impact on inattention (Hedges' $g = -0.82$) and hyperactivity (Hedges' $g = -0.67$) among participants with a diagnosis of ADHD in comparison to a control group. The effect is similar for mindfulness (Hedges' $g = 0.53$). However, these results must be interpreted with caution. Firstly, only 30.79% of the participants were children and the rest were adults. Secondly, there was a high heterogeneity among studies on a number of variables such as participants' age, type of control condition, or study design quality. Thirdly, this meta-analytic review only reports data on individuals with ADHD without covering the full spectrum of behavior disorders that includes ODD, IED, or CD. Three other meta-analyses were conducted among children with ADHD (Cairncross & Miller, 2016; Chimiklis et al., 2018; Zhang et al., 2018). To note, four studies overlap because they were included in different meta-analyses. Their findings indicate weaker effect sizes of MBIs on inattention and hyperactivity symptoms (small to moderate effect size) than the meta-analysis of Xue et al. (2019). More importantly, Chimiklis et al. (2018) reported a significant moderation effect of the study design quality. The studies using a non-randomized controlled design showed a large, significant effect of the intervention on ADHD symptoms, while studies using an RCT design reported a small or insignificant effect. In addition, very few RCTs were included in this meta-analysis (only two studies out of eleven) and only two studies included more than 41 participants.

When looking at individual studies that are of specific interest (i.e., studies that are not case studies, that include children or adolescents with behavior disorders, and that strictly use MBIs), four studies used no control group and a mindfulness training for parents (Bögels et al., 2008; Haydicky et al., 2015; Van de Weijer-Bergsma et al., 2012; Van der Oord et al., 2012) and three studies used a control group and no training for parents (Abdolazadeh et al., 2016; Muratori et al., 2020; Roux & Philippot, 2020). More specifically, in the study by Haydicky et al. (2015) among adolescents with ADHD between the ages of 13 and 18 ($n = 18$), results suggested no improvement during the intervention while a reduction of inattention, conduct problems, and peer relation problems was observed after the MBI and maintained after 6 weeks. The study by Van de Weijer-Bergsma et al. (2012), conducted among adolescents with ADHD between the ages of 11 and 15 ($n = 10$), indicated an improvement in attention tests after the mindfulness training

while no changes were observed in mindfulness, externalizing and internalizing symptoms. Van der Oord et al. (2012) found similar results in a population of children with ADHD between the ages of 8 and 12 ($n = 18$) on attention with an improvement noticed by both parents and teachers. However, an improvement in hyperactivity was only observed by parents and no changes were found for oppositional behaviors. Finally, Bögels et al. (2008) found an improvement in personal goals, externalizing and internalizing symptoms reported by the children but not by the parents, self-reported attention, attention tests, and mindfulness in a population of adolescents between the ages of 11 and 18 suffering from behavior disorders ($n = 14$).

Concerning the three other studies, the study conducted by Abdolazadeh et al. (2016) in adolescents with ADHD (between the ages of 15 and 18) found an improvement in mindfulness and ADHD symptoms in the MBI group ($n = 15$) compared to the control group ($n = 15$). In a younger population of children between the ages of 8 and 12 with ADHD or ODD, Muratori et al. (2020) found a positive effect of an MBI on hyperactivity, attention, and psychological flexibility ($n = 25$) compared to a control group ($n = 25$) while no differences were found in aggressive behaviors and mindfulness. Finally, Roux and Philippot (2020) found a decrease in impulsivity and general externalizing symptoms among adolescents with ADHD, ODD, or CD between the ages of 12 and 19 who participated in an MBI ($n = 24$) compared to a control group ($n = 24$) but no differences were observed for depressive symptoms. In light of these findings, this study aims to deepen the understanding of the effect of MBIs on adolescents who suffer from behavior disorders by applying a high-quality design with one experimental group and two control groups. Both gender and medication were controlled for. It was hypothesized that the MBI would decrease externalizing and internalizing symptoms and increase mindfulness and prosocial behaviors compared to active and inactive control groups. Self-report and other-report measures, as well as behavioral tasks, were used. In addition, exploratory analyses investigated whether participants' baseline characteristics (e.g., age, gender, externalizing symptomatology) predicted psychological improvement during the treatment phase. Finally, it was hypothesized that participants who continued their mindfulness practice at a 1-year follow-up would show more benefits than participants who stopped practicing.

Method

Participants

Participants were 141 adolescents recruited from two residential services for youths with behavior disorders

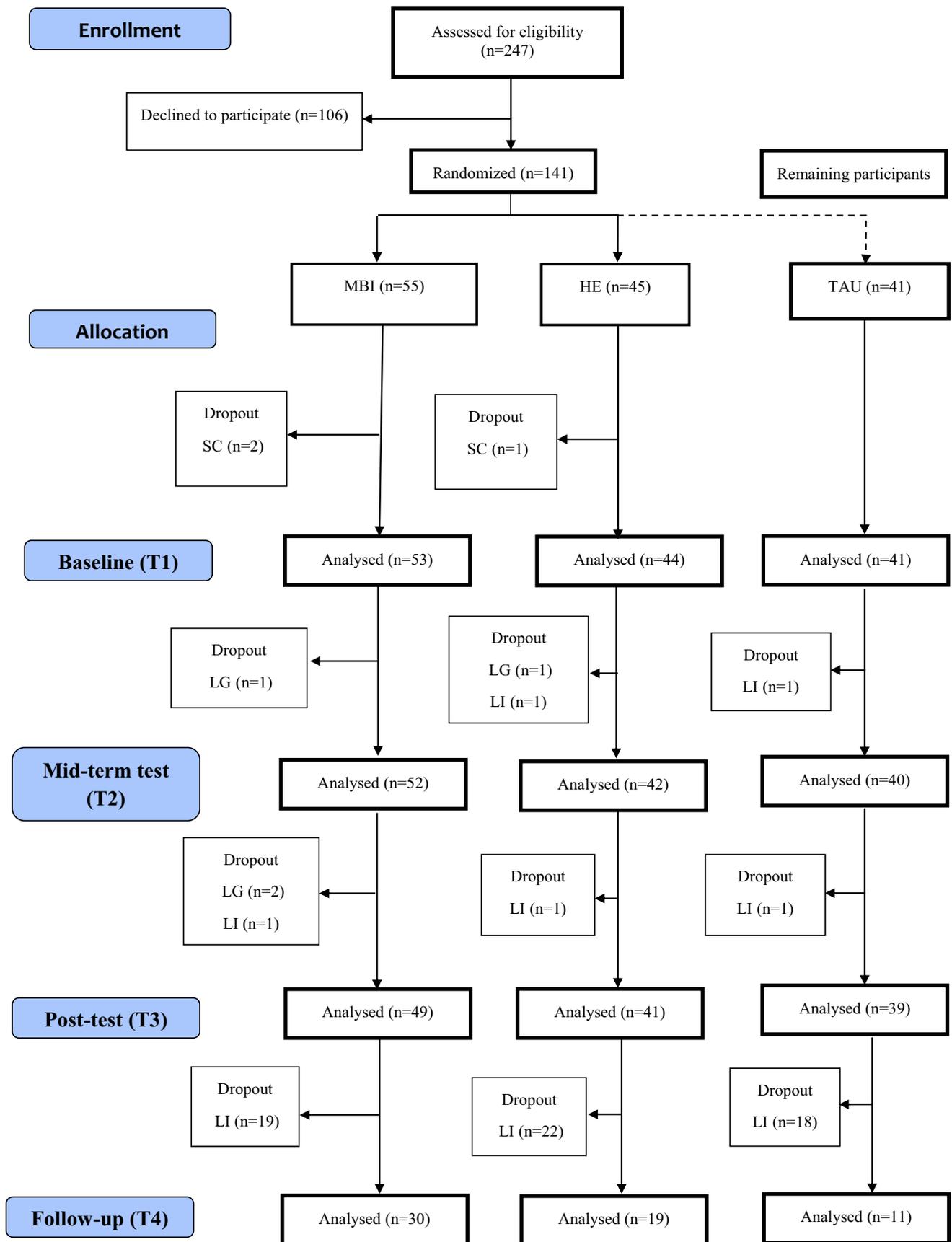


Fig. 1 Flow of participants throughout the trial. Note. SC, scheduling conflict; LG, leaving the group; LI, leaving the institution

(RSY), one for boys and one for girls. Both institutions host adolescents who present behavior disorder symptoms that can be accompanied by a mild to moderate intellectual disability. This population is characterized by a low socio-economic status and family difficulties that require institutional care. Inclusion criteria included the following: being 11 to 19 years old, expressing a motivation to participate in the study, and being fluent in French. The only exclusion criterion was the impossibility to attend more than 50% of the sessions. The mean age was 14.05 ($SD = 1.87$), 86 of the participants were boys (66.7%), and 39 were taking psychotropic medications (30.2%). No formal diagnoses were given by psychiatrists but, considering the score on the Child Behavior Checklist completed by the institutions' educators (Achenbach, 1991), 85.27% of the adolescents met the clinical cutoff for externalizing symptoms at baseline which confirms that this population is indeed suffering from behavior disorders while 41.08% of them met the clinical cutoff for internalizing symptoms. The remaining 14.73% of adolescents who did not meet the clinical cutoff for externalizing symptoms had higher scores on internalizing symptoms ($t(125) = 2.30, p = 0.023$; 68.4% met the clinical cutoff for internalizing symptoms) and lower scores on impulsivity ($t(125) = 2.51, p = 0.013$) than the adolescents with externalizing symptoms. To explore whether the inclusion of adolescents with low levels of externalizing symptoms introduced a bias to the results, results obtained from both groups were compared.

Procedure

After an information session, the researcher conducted individual interviews with the adolescents interested in participating in the research in order to assess whether participants met the inclusion criteria and in order to conduct the baseline assessment. The RSY allowed the creation of 20 subgroups over a 2-year period (five adolescents with the same gender per group). Three treatment conditions were designed: a treatment as usual condition (TAU), a health psychoeducation condition (HP), and a MBI condition. The initial plan was to have 10 MBI subgroups and 10 HP subgroups. However, one of the institutions asked to replace one HP group by an MBI group for internal organization reasons. Hence, 11 subgroups were assigned to the MBI condition and 9 subgroups to the HP condition. Each year, a list was compiled of all participants who wished to participate in the study. From this list, participants were randomly selected to complete the HP and MBI groups. The remaining

participants on the list were assigned to the TAU group. Furthermore, through access to the adolescents' medical records, the number of psychotropic medications used was recorded for each group.

Among the adolescents motivated to participate ($N = 141$), 55 were randomly allocated to the MBI condition and 45 to the HP condition. The remaining 41 participants were assigned to the TAU condition. All groups completed four assessment points: one at baseline (T1), a second after the first six sessions (T2), a third at the end of the program (T3), and the final one a year after the end of the program (T4). The four assessments consisted of three self-report questionnaires and one attentional task. While the evaluations were conducted over a 3-week period just before the program, the beginning of the sessions (T1) was the same for all participants. One of the present article's co-authors and students in psychology administered the questionnaires. Since the co-author in question was involved in the facilitation of the groups and in the allocation of participants, this study cannot be considered a double-blind study. Educators helped in finding the most suitable time slots for the groups and completed the questionnaires while psycho-motor therapists helped with group facilitation in the HP and MBI groups. In addition, two questionnaires rated by the educators were completed at T1, T2, and T3 (institutional constraints did not allow an assessment at T4). During the first year of the experiment, the limited nature of paper-and-pencil questionnaires was identified in terms of validity in this population (e.g., social desirability, comprehension difficulties). Therefore, three behavioral tasks, especially designed for the present study, were added at T2, T3, and T4 starting with the second year of the experiment. A subsample of 89 participants completed the tasks at T2 and T3, and 39 participants at T4.

Over the 2 years, 129 participants completed the questionnaires at T3 (91.5%) while 60 of them completed the questionnaires at T4 (46.5%). Figure 1 displays the flow of participants throughout the trial.

Intervention

All adolescents of the institution received TAU, irrespective of their assignment to a condition. TAU consisted of the standard care provided by the RSY, which includes psychotherapy, psychomotricity, speech therapy, and medication when appropriate. The design comprised three treatment conditions.

MBI Condition The MBI condition consisted of six 50-min sessions devoted to emotion psychoeducation and 10 50-min sessions of mindfulness practice. Because externalizing symptoms make it difficult to practice mindfulness (e.g.,

Table 1 Details of the mindfulness-based intervention (sessions' topic and exercises)

	Theme	Main objectives	Main exercises
Part 1: Emotion psychoeducation			
Session 1	Presentation and introduction	Introduction to group rules Get to know each other Explain objectives of the program	Photolanguage
Session 2	Stay aware	Develop sensation awareness Stay attentive during one's interaction with others	The Thief's game (a game developing noise awareness)
Session 3	Introduction to emotions	To learn what is an emotion and how it works	The walk of emotions
Session 4	Calm the mind	To stay calm and relax	Relaxation exercises
Session 5	Concentration and relaxation	To develop concentration To stay calm and relax	Mikado game
Session 6	Introduction to body awareness	Exploring the Five Senses To understand the link between body reactions and emotions	Five senses game
Part 2: Mindfulness-based intervention			
Session 1	Mindfulness and automatic pilot	To train awareness in daily life	Raisin exercise
Session 2	Mindfulness and body awareness (1)	To enhance body awareness	Mirror game
Session 3	Mindfulness and body awareness (2)	To enhance body awareness	Body scan
Session 4	Mindfulness and focused attention	To develop focused and open attention	Meditation of sounds
Session 5	Mindfulness and non-judgment (1)	To be able to recognize judgments	Is it a fact or a judgment?
Session 6	Mindfulness and non-judgment (2)	To be able to disengage from judgments	Mindful walk
Session 7	Mindfulness and thoughts (1)	To identify the thoughts in the mind and their relationship with emotions	Film extracts (Inside-out, Peaceful Warrior)
Session 8	Mindfulness and thoughts (2)	Develop the capacity to accommodate thoughts and emotions	Thoughts meditation
Session 9	Mindfulness and acceptance	Accept things that are not under our control	Let it go meditation
Session 10	This is only the beginning	State what they have learned and what is important to remember	Review of the program

inability to stay seated), the first part of the intervention was designed to prepare participants for future formal practice. In addition to the group sessions, participants in the MBI groups were assigned weekly homework (i.e., meditation practice). The MBI program is depicted in Table 1. It was inspired by two others programs for adolescents: the adolescent mindfulness-based intervention for enhancing emotional regulation (Deplus & Lahaye, 2015; Deplus et al., 2016) and the Taming the Adolescent Mind program (TAM program; Tan & Martin, 2012). More specifically, our program followed the session themes proposed by Deplus and Lahaye (2015) such as exploring body sensations, non-judgment, or thoughts observation, but also included exercises from the TAM program such as discussion of examples of difficulties experienced in the week and how mindfulness may be utilized in these instances. The combination of the two interventions allows for a more complete program in comparison to the five-session program proposed by Tan and Martin (2012). Furthermore, our combined program contains more adolescent-tailored activities than the program of Deplus and Lahaye (2015), which focuses on children. The sessions

were delivered by a certified mindfulness-based cognitive therapy instructor and a psycho-motor therapist who is also a certified mindfulness instructor for adolescents and who works in the institute.

Health Psychoeducation (HP) Condition The HP condition was designed as an active control group, benefiting from an intervention similar in terms of investment and interest to the MBI condition, but with no impact on the mindfulness processes. It consisted of 16 50-min sessions in which health topics related to tobacco, nutrition, sleep, hygiene, alcohol/drugs, stress management, conflict management, and social networks were discussed (two sessions of 50 min by topic, one session per week). Pictures, short movies, and games were used to help adolescents adopt healthy behaviors. They also had to complete the same amount of homework assignments as in the MBI condition.

TAU Condition The TAU condition exclusively proposed the institutional TAU, as detailed above. It should be noted that this treatment is already intensive, consisting of several hours of weekly care.

Measures

Child Behavior Checklist (CBCL)

Institution educators who were also the participants' direct referents completed the internalizing ($\alpha=0.78$) and externalizing ($\alpha=0.91$) behavior subscales of the CBCL for youth 4 to 18 years of age at T1, T2, and T3 (Achenbach, 1991). These two subscales contain 118 items rated on a three-step scale (0 to 2). The externalizing problems subscale captures externalizing symptoms such as cruelty, bullying, meanness to others, breaking the rules, or using substances, whereas the internalizing problems subscale captures internalizing symptoms such as crying, having fears or nightmares, being unhappy, or having worries. All Cronbach's α reported in this paper were computed on the present data.

Multiscore Depression Inventory for Children (MDI-C)

Self-reported internalizing symptomatology was obtained by the French version of the MDI-C (Berndt & Kaiser, 1999). This 79-item questionnaire has eight scales but only the total score was used to measure general internalizing symptomatology of the youth. Adolescents completed this questionnaire at each assessment point. The global Cronbach's alpha for this scale was good ($\alpha=0.90$). Self-reported oppositional behaviors were assessed by the Defiance subscale of the MDI-C with an acceptable Cronbach's alpha ($\alpha=0.66$). Two other subscales were used in order to measure self-reported internalizing symptomatology: the Anxiety subscale ($\alpha=0.62$) and the Sad-Mood subscale ($\alpha=0.74$). While the Cronbach's alpha for the Sad-Mood scale is acceptable, the Cronbach's alpha for the Anxiety subscale is somewhat low, and hence, results should be interpreted cautiously.

Swanson, Nolan, and Pelham-IV (SNAP-IV)

This SNAP-IV was used to measure inattention, hyperactivity, and oppositional behaviors (Swanson, 1995; Swanson et al., 2001). Educators completed the SNAP-IV at T1, T2, and T3. The French 26-item version (MTA-version; Caci, 2008) was rated on a 4-point Likert scale ranging from 0 (not at all) to 3 (very much). This instrument includes three subscales: Inattention ($\alpha=0.89$), Hyperactivity ($\alpha=0.89$), and Oppositional behaviors ($\alpha=0.86$).

Focused Attention Test-Revised (d2-R)

In addition to the three subscales of the SNAP-IV, one attentional task was used to measure sustained attention capacities and, thus, gives another type of measure of attention. Participants completed the d2-R test at each assessment

point (Brickenkamp et al., 2015). This pencil-and-paper test consists of crossing out the relevant letters ("d" with two dashes) and ignoring the irrelevant, but similar, ones (e.g., "d" with only one dash or "p"). The d2-R lasts 4 min and 40 s (timed task). The score used in this study is the concentration performance (CP) (i.e., the number of crossed-out target objects minus the number of commission/omission errors).

The Waiting Task

Another behavioral task, created especially for this study, was also added at T2, T3, and T4 in order to measure hyperactivity: the "Waiting task." At the end of the evaluation, participants were asked to sit as long as possible on a chair with their eyes closed, without moving or speaking (3 min maximum). As soon as the participant opened his/her eyes or interrupted the task with movements, the time was recorded (in seconds) and the next task was performed. The task was presented as a game. When a participant asked how much time it would take, the researcher answered that the maximum time would be 5 min in order to accentuate the perceived difficulty; however, the task always ended after 3 min. This task was used to assess participants' ability to sit quietly as well as their capacity to inhibit their agitated behaviors.

Impulsive Behavior Scale (UPPS-P)

Adolescents completed the French version of the 20-item UPPS-P adapted for youth at each assessment point (Billieux et al., 2012; Catale et al., 2014; Whiteside & Lynam, 2001). The answers are self-reported and scored on a 4-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree). This questionnaire assesses the global score of impulsivity ($\alpha=0.54$) via four dimensions: Urgency ($\alpha=0.59$), Lack of Premeditation ($\alpha=0.57$), Lack of Perseverance ($\alpha=0.52$), and Sensation Seeking ($\alpha=0.57$). These psychometric features indicate a poor reliability in the present sample.

The Cookies Task

In addition, a variant of the marshmallow task, the cookies task, was used at T2, T3, and T4 to assess behavioral impulsivity and delay of gratification (Mischel et al., 1972). After completing the battery of questionnaires, participants were given a cookie as a reward for the time spent on the evaluation. They could win another cookie by waiting two more minutes during which time they had to observe, touch, and smell the cookie without eating it. If they succeeded, another deal was proposed to them. They could leave with the two cookies or choose to wait 1 week in order to have four cookies instead. Finally, if they refused to wait 1 week

to obtain the four cookies, a final proposition was made by offering them immediately one cookie, instead of two, but with a gain of two cookies after a week. The score on this task was based on the number of cookies received (one, two, three, or four). Participants who did not like cookies did not take the test ($n = 1$ (MBI); $n = 1$ (HP); $n = 2$ (TAU)).

Child and Adolescent Mindfulness Measure (CAMM)

Participants completed the CAMM at each assessment point (Roux et al., 2019). This 10-item questionnaire is rated on a 5-point Likert scale (0 = never true to 4 = always true) and was designed to assess mindfulness as a unique dimension defined by a focus on the present moment and by nonjudgmental awareness (Greco et al., 2011). Adolescents with externalizing and emotional difficulties could have difficulty answering questions about self-awareness. From this perspective, the internal consistency of this questionnaire is acceptable ($\alpha = 0.63$).

The Lottery Task

Prosocial behaviors and generosity were assessed by using a behavioral task, especially created for this study, at T2, T3, and T4: the lottery task. In this task, participants reported what they would do if they hypothetically won €100 from the national lottery. They could allocate variable amounts of this sum to six categories: three self-focused categories (buy something they want, do a fun activity, save money) and three other-focused categories (give to family, give to the institution, invite a friend over for a drink). The sum for each category was recorded. Different versions of this task already exist (see, for example, Van Cappellen et al., 2016).

Data Analyses

To test the efficacy of the MBI across the four assessment points (three assessment points for the CBCL, the SNAP-IV, and the behavioral tasks), a two-level multilevel linear model for repeated measures was applied (Hox et al., 2017). Multilevel models are more robust than ANOVAs when there are more than two assessment points. Moreover, multilevel analysis can include incomplete cases, which is an advantage for dealing with missing values (Field & Wright, 2011).

In this study, the level-1 units consisted of the repeated measures for each subject (Time), while the level-2 unit was the individual. The level-2 equation is presented below:

$$\begin{aligned} \gamma_{it} = & \gamma_{00} + \gamma_{10}(\text{Time})_{it} + \gamma_{01}(\text{Group})_i + \gamma_{02}(\text{Gender})_i \\ & + \gamma_{03}(\text{Medic})_i + \gamma_{11}(\text{Time} * \text{Group})_{it} \\ & + \gamma_{12}(\text{Time} * \text{Group} * \text{Gender})_{it} \\ & + \gamma_{13}(\text{Time} * \text{Group} * \text{Medic})_{it} + u_{0i} + e_{it} \end{aligned}$$

where y_{it} is the outcome (e.g., depression, hyperactivity) at time t for individual i , γ_{00} is the intercept, $\gamma_{10}(\text{Time})_{it}$ is the main effect of Time (T1, T2, T3, T4), $\gamma_{01}(\text{Group})_i$ is the main effect of the group (TAU, HP, MBI), $\gamma_{02}(\text{Gender})_i$ is the main effect of gender (boy or girl), $\gamma_{03}(\text{Medic})_i$ is the main effect of taking medication (yes or no), u_{0i} is a random effect of the intercept, and e_{it} is the residual error. The interactions between Time, Group, and Medication or Gender were also added.

When a significant Group*Time interaction was observed in the model, another analysis was conducted between T2 and T3 in order to explore the specific effect of the MBI for the experimental group. In the same way, when a significant main effect of Time was observed for one variable, post hoc comparisons, based on the Bonferroni correction, were used to identify when the change occurred (i.e., looking at the significance of the Time effect between each assessment point).

Further analyses investigated whether participants' psychological profiles at baseline predicted an improvement during the treatment phase. The Reliable Change Index (RCI) proposed by Jacobson and Truax (1991) was used to calculate an improvement score between T2 and T3. This index is a reliable tool to assess clinical change with greater accuracy than a simple subtraction of scores. In order to limit the number of analyses, the RCIs of several variables were added together yielding three overall variables. Externalizing symptoms were dissociated from internalizing symptoms. In addition, the attention dimension was separated from externalizing symptoms to avoid grouping too many variables and also because this dimension can play an independent role in behavior disorders. Therefore, the three global variables were as follows: (1) externalizing symptoms improvement (mean of the RCIs of impulsivity (UPPS-P), externalizing symptoms (CBCL), hyperactivity (SNAP-IV), and oppositional behaviors (SNAP-IV)), (2) internalizing symptoms improvement (mean of the RCIs of the self-report measure (MDI-C) and the other-report measure (CBCL) of internalizing symptoms), and (3) attentional level improvement (mean of the RCIs of mindfulness (CAMM), inattention (SNAP-IV), and the attention test (d2-R)). Separate linear regression models were run with the three global improvement scores as outcome measures and baseline variables (T1) as predictors.

Finally, in order to test the effects of continued practice, t -tests comparing the RCIs of participants who maintained their practice for 1 year to the RCIs of participants who did not were conducted between T3 and T4. Variables assessed included the MDI-C, CAMM, UPPS-P, and d2-R.

The statistical power of the present design to detect moderate or large effect is difficult to ascertain because no consensus has been reached in the literature about power analyses in multilevel modeling (Field & Wright, 2011). However, based on the recommendations of Arend and Schäfer (2019),

our study design (i.e., parameters: $L1 = 3$, $L2 = 125$, intra-class correlation coefficient = 0.62) could identify moderate and large effect size for fixed effects, but might lack power for identifying interaction effects.

Results

Preliminary Analyses

ANOVAs indicated no differences between the TAU, the HP, and the MBI groups at baseline for all variables (all $p > 0.07$) and also at T2 (all $p > 0.08$). Participants who dropped out ($n = 9$) had significantly higher scores on the CBCL externalizing problems subscale than participants who remained in the study ($t(132) = 2.82$, $p = 0.005$). There were no differences between the RCI scores (T2 – T3) of participants without externalizing symptoms ($n = 19$) and the RCI scores of participants with externalizing symptoms. Correlations among the different variables are presented in Table 2. A high correlation between externalizing problems and oppositional behaviors reported by the educators was observed ($r = 0.82$, $p < 0.001$) whereas a very weak correlation was found between internalizing symptoms reported by the educators and depressive symptoms reported by the adolescents ($r = 0.12$, $p = 0.04$). Surprisingly, no correlation between the attentional task and mindfulness was found ($r = 0.03$, $p > 0.05$).

MBI Efficacy

General Level of Internalizing and Externalizing Symptomatology

Table 3 presents the results of the multilevel models. A significant main effect of Time was found for the externalizing problems subscale of the CBCL, revealing a decrease in externalizing symptoms between T1 and T2. Similarly, a main effect of Gender (boys had a higher score than girls) and a main effect of Medication (youth who took medication had higher scores than youth who did not) were found in addition to a significant interaction of Time*Group*Gender. More precisely, the analysis performed between T1 and T2 showed a significant interaction which reflected a decrease in externalizing symptoms for the HP group but only among girls ($F(2,118) = 4.26$, $p = 0.016$).

No effects were found for the internalizing problems subscale completed by the educators. In contrast, multilevel models performed on the overall score of the MDI-C indicated a significant main effect of Time. The post hoc comparisons between the different assessment points suggest a decrease in depressive symptoms for all groups between T1 and T3, ($F(2,240) = 4.77$, $p = 0.009$). Moreover, a main effect

of Gender was observed, indicating that girls had higher scores than boys.

Core Symptoms of Externalizing Problems

Inattention Concerning inattention, a main effect of Gender was found indicating that boys had a higher score than girls. In addition, the Time*Group interaction was significant, but the analysis specifically conducted between T2 and T3 revealed no significant Time*Group interaction ($F(2,115) = 1.52$, $p = 0.22$). However, a significant contrast was observed when the MBI group was compared to the two other groups ($C = -2.39$, $p = 0.018$, Cohen's $d = 0.25$). The MBI group maintained the same means between T2 and T3 ($M_2 = 8.54$, $SD_2 = 0.87$; $M_3 = 8.68$, $SD_3 = 0.85$) whereas the means of the HP group ($M_2 = 10$, $SD_2 = 0.98$; $M_3 = 11.02$, $SD_3 = 0.96$) and those of the TAU group ($M_2 = 10.56$, $SD_2 = 0.99$; $M_3 = 12.43$, $SD_3 = 0.97$) increased.

For the attentional task (d2-R test), multilevel models identified a significant effect of Time, indicating an improvement in performance between T1 and T3 for the three groups ($F(2,238) = 67.93$, $p < 0.001$). In addition, the Time*Group interaction was significant. The analysis performed between T2 and T3 confirmed a significant Time*Group interaction ($F(2,119) = 3.14$, $p = 0.047$). A trend was observed for the contrast comparing the MBI group and the two other groups ($C = 10.16$, $p = 0.07$, $d = 0.45$). Inspection of the means revealed that the three groups improved their scores but the increase observed in the MBI group ($M_2 = 107.02$, $SD_2 = 4.88$; $M_3 = 123.08$, $SD_3 = 4.63$, $\eta^2 = 0.32$) was larger than those observed in the HP group ($M_2 = 104.39$, $SD_2 = 5.27$; $M_3 = 108.61$, $SD_3 = 5.01$; $\eta^2 = 0.03$) and in the TAU group ($M_2 = 99.15$, $SD_2 = 5.41$; $M_3 = 107.39$, $SD_3 = 5.14$; $\eta^2 = 0.08$).

Hyperactivity and Oppositional Behaviors No significant effects were found for the Hyperactivity subscale nor for the Waiting task ($p > 0.05$). Concerning the oppositional behaviors subscale completed by the educators, the model showed a main effect of Time, indicating an overall decrease in oppositional behaviors for all groups between T1 and T2. Also, the model reported a main effect of Gender, indicating that boys had higher scores than girls. Finally, a main effect of Medication was also found indicating that youth who took medication had a higher score of oppositional behaviors than their peers. Concerning the Defiance subscale completed by the youth, only a main effect of Gender was found, indicating that girls reported higher Defiance scores than boys.

Core Symptoms of Internalizing Problems: Anxiety and Depressive Symptoms

The analyses on the anxiety subscale revealed a main effect of Time, suggesting an overall decrease between T2 and T3

Table 2 Correlations among all dependent variables (*N* = 129)

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Depressive symptomatology ^a	–											
2. Anxiety ^a	0.73***	–										
3. Sad-Mood ^a	0.72***	0.50***	–									
4. Defiance ^a	0.63***	0.41***	0.32***	–								
5. Impulsivity ^a	0.40***	0.34***	0.20***	0.50***	–							
6. Mindfulness ^a	–0.35***	–0.44***	–0.24***	–0.15**	–0.20***	–						
7. Attentional task	–0.27***	–0.23***	–0.21***	–0.14**	–0.03	0.03	–					
8. Internalizing symptoms ^b	0.12*	0.11*	0.14**	0.04	0.08	–0.04	0.03	–				
9. Externalizing symptoms ^b	0.01	0.04	–0.05	0.15**	0.24***	0.05	0.01	0.51***	–			
10. Inattention ^b	0.10	0.15**	0.05	0.04	0.11*	–0.13*	–0.17**	0.30***	0.42***	–		
11. Hyperactivity ^b	–0.02	0.02	–0.07	–0.02	0.05	0.04	0.02	0.35***	0.66***	0.53***	–	
12. Oppositional behaviors ^b	0.00	0.01	–0.03	0.07	0.14**	0.06	0.05	0.49***	0.82***	0.38***	0.66***	–

^aSelf-report questionnaires.

^bQuestionnaires completed by the educators of the institution.

**p* < 0.05.

***p* < 0.01.

****p* < 0.001.

MBI Efficacy.

Table 3 Results of the multilevel analyses for all variables (F -tests; $N = 129$)

	Inattention	Hyper	Oppositional behaviors	CBCL-Ext	CBCL-Int	Depression	Anxiety	Sad-Mood	Defiance	Impulsivity	Mindfulness	d2	Wait-T	Lottery-T	Cookies-T
Time	2.30	2.75	3.83*	3.43*	0.025	3.09*	4.08**	1.73	0.88	0.43	3.41*	53.83**	0.26	0.35	0.53
Gender	12.51**	3.01	6.06*	6.8*	0.085	5.99*	8.64**	2.85	13.65**	0.06	1.85	0.06	1.77	1.54	1.1
Group	0.16	0.36	0.09	0.17	0.59	1.17	1.07	0.74	1.39	0.37	0.60	2.8	0.05	2.03	0.29
Medication	1.03	3.48	4.82*	3.85*	0.66	0.03	2.93	0.85	1.53	1.8	4.73*	0.01	0.95	1.37	2.42
Time*Group	0.276*	1.38	1.69	2.17	1.58	0.71	0.37	1.68	1.13	1.38	0.32	2.9**	1.38	0.72	0.81
Time*Group*Medication	0.44	0.71	0.07	0.61	1.19	0.55	1.21	0.68	0.35	0.51	0.55	1.76	1.09	0.23	0.21
Time*Group*Gender	0.59	0.63	1.38	3.15**	1.22	0.67	1.03	0.98	0.55	0.81	0.62	2.07	0.89	0.97	0.83

Note. *Hyper*, Hyperactivity (SNAP-IV); *CBCL-Ext*, Externalizing problems subscale (CBCL); *CBCL-Int*, Internalizing problems subscale (CBCL); *Wait-T*, Wait task; *Lottery-T*, Lottery task; *Cookies-T*, Cookies task.

Time 4 was not assessed for the following measures: Inattention, Hyperactivity, Oppositional behaviors, CBCL-Ext, and CBCL-Int.

* $p < 0.05$.

** $p < 0.01$.

($F(1,120) = 8.43, p = 0.004$). A main effect of gender was also found (i.e., higher scores for girls than for boys). No effects were found for the Sad-mood subscale.

Impulsivity

No significant effects were found for the impulsivity total scores, its subscales, and the Cookies task ($p > 0.05$).

Mindfulness and Prosocial Behaviors

The analyses revealed a main effect of Time for the CAMM questionnaire, suggesting an increase in the mindfulness score between T2 and T3 for the three groups ($F(1,120) = 8.36, p = 0.005$). Also, a main effect of Medication was found indicating that the mindfulness score was higher among participants who did not take medication. No effects were found for the Lottery task ($p > 0.05$).

Psychological Profiles

No variables at baseline were found to predict an improvement between T2 and T3 for the MBI and the HP groups (see Table 4). However, in the TAU group, a lower score on oppositional behaviors predicted a greater improvement in externalizing symptoms while a lower level of mindfulness and a higher level of internalizing symptoms and hyperactivity predicted a greater improvement in internalizing symptoms and, finally, a higher level of externalizing symptoms and a lower level of oppositional behaviors predicted a better improvement in attentional capacities.

Continuity of Practice

Contrary to our hypothesis, no differences were found between the 15 participants who reported continued mindfulness practice (at least once a month) and the 13 participants who did not, for the MDI-C ($t(26) = 1.00, p = 0.32$), the CAMM ($t(26) = 0.94, p = 0.35$), the UPPS-P ($t(26) = 0.07, p = 0.94$), and the d2-R ($t(26) = 1.12, p = 0.24$).

Discussion

The aim of the present study was to explore the impact of an MBI on internalizing symptoms (i.e., depressive and anxiety symptomatology) and externalizing symptoms (i.e., inattention, hyperactivity, and oppositional behaviors) in a population of adolescents with behavior disorders.

In contrast to our hypotheses, there were no significant decreases in general levels of externalizing and internalizing symptomatology (as reported by educators) in the MBI group in comparison to the control groups. Results

Table 4 Results of the regression models (β) predicting the global improvement on the three types of variables between T2 and T3 for each group ($N=129$)

	Externalizing symptoms			Internalizing symptoms			Attentional level		
	MBI	HP	TAU	MBI	HP	TAU	MBI	HP	TAU
Intercept ^a	5.52	-11.54	-8.51	1.75	-3.17	3.49	0.38	2.85	-3.24
Age	-0.04	0.28	-0.007	-0.17	-0.01	-0.11	0.08	-0.09	-0.05
Gender	0.25	0.21	-0.35	0.31	0.000	0.09	0.30	0.15	0.18
MDIC	0.004	0.08	0.37	-0.18	0.18	-0.41	-0.02	-0.07	-0.04
UPPS	-0.21	0.10	0.09	0.09	-0.13	0.33	-0.11	-0.01	0.29
CAMM	-0.12	-0.07	-0.09	-0.03	0.09	-0.49*	0.03	-0.07	0.20
D2	0.001	0.13	0.010	0.14	0.47	-0.16	0.16	-0.00	-0.20
Internalizing	-0.19	-0.18	12	0.002	0.004	0.51*	-0.15	-0.04	-0.19
Externalizing	0.06	-0.16	0.78	0.22	-0.33	-0.01	-0.04	0.30	1.36**
Inattention	-0.08	-0.07	-0.04	0.18	0.03	-0.17	0.04	-0.16	0.03
Hyperactivity	-0.17	-0.08	0.38	-0.09	-32	0.62*	-0.00	0.03	0.13
Oppositional behaviors	0.23	0.26	-1.24**	-0.08	0.42	-0.56	0.12	-0.11	-1.05*

^aThe coefficient for the intercept is the *B* index (non-standardized) instead of the β .

* $p < 0.05$.

** $p < 0.01$.

concerning general externalizing symptomatology are in line with prior research on adolescents with ADHD, which found no reduction in externalizing symptomatology as reported by adolescents, mothers, or educators after an MBI (e.g., Van de Weijer-Bergsma et al., 2012). With regard to general internalizing symptomatology, the present study showed no changes in internalizing symptomatology as rated by educators and a decrease in internalizing symptomatology as rated by adolescents, but this decrease was observed in all three groups. This finding is in line with prior research (Bögels et al., 2008; Roux & Philippot, 2020).

With regard to attentional capacities, the present study found that levels of inattention as rated by the educators were maintained in the MBI group but deteriorated in the TAU and HP groups, suggesting a protective effect of the MBI. Furthermore, results from the attentional task (d2-R) showed a significant improvement in attentional capacities in all groups, but the change in the MBI group was the most significant with a larger effect size. Improvements in the TAU and HP groups may be attributed to learning resulting from repeated assessments and also the natural maturation of executive functions (Anderson et al., 2001). The finding that an MBI protects against the deterioration of inattention and may enhance attentional capacities is in line with prior research on youth with ADHD (Cairncross & Miller, 2016; Chimiklis et al., 2018). These results suggest that meditation exercises may help adolescents with behavior disorders to reduce their tendency to be distracted and have several clinical implications that could be tested in future studies. For instance, by enhancing attention, mindfulness exercises could help to boost adolescents' reading comprehension

abilities, numeracy skills, or other skills requiring concentration which may in turn improve their global academic performance. Enhanced attention via MBI may also increase adolescents' awareness of inner experience which may lead to improvements in emotion regulation.

For the second core symptom, results showed no effects of the MBI on hyperactivity as rated by the educators. Similarly, no effects were found for the Waiting task suggesting that the MBI was not effective in treating hyperactivity. This observation diverges from the literature that reports a small to moderate effect size on this outcome among youth with ADHD (Chimiklis et al., 2018; Muratori et al., 2020; Zhang et al., 2018). This difference may be due to the fact that, contrary to other studies, our sample did not only include adolescents with ADHD. Indeed, hyperactivity plays a more important role in ADHD than in the other behavior disorders such as ODD and CD.

The third core symptom addressed in this study was oppositional behaviors. Contrary to our hypotheses, no significant effect was observed in the oppositional behaviors dimension and in the Defiant subscale of the MDI-C in the MBI group in comparison to the control groups. Future studies could consider placing more emphasis on the topic of non-judgment and non-reactivity, which could help adolescents manage the frustration that leads to oppositional behaviors (non-judgment topic represents only two 50-min sessions in the program).

Regarding depression and anxiety, the core symptoms of internalizing problems, the present study found no significant reduction in depressive symptoms (as measured by the sad-mood subscale) or anxiety after an MBI in comparison

to the two control groups. No effects were observed on depressive symptoms and though a reduction was observed in anxiety, this was the case for all groups. Since most intervention studies that have investigated these variables in non-clinical populations have found the opposite results, it is possible that specificities exist for adolescents with behavior disorders. In particular, the difficulty of including formal practice, related to the agitated behaviors of the adolescents, may be a major limitation for this population.

For self-reported impulsivity and delay of gratification measured by the cookies task, no changes were observed. This result is consistent with the absence of significant results observed for hyperactivity.

Regarding mindfulness skills, results showed a significant increase in all groups. Contrary to our hypothesis, participants in the MBI condition did not show significant improvements in mindfulness skills in comparison to participants in the TAU or HP conditions. The fact that mindfulness improved in all groups may be attributed to the therapeutic care provided by and the rules set up by the staff of the institutions themselves. The staff encourages residents to avoid explosive emotional behaviors and to openly express their emotions. This may have contributed to improving participants' non-reactivity and non-judgment, which are skills measured by the mindfulness scale used in the present study. Without the support of the staff, it is assumed that it would have been unlikely to observe significant improvements in mindfulness in this population.

The MBI had no significant effects on prosocial behaviors measured by the lottery task. It may suggest that MBIs do not affect prosocial behaviors at all, as suggested by some studies (Bayot et al., 2018; Ridderinkhof et al., 2017), but it would also be at odds with other studies (Donald et al., 2019). The result in our study may be due to the fact that the program did not focus on the relationship between the participants and did not use loving-kindness meditation.

The present study also explored whether particular baseline characteristics (e.g., age, gender, baseline symptomatology) predicted improvements in attention, internalizing symptoms, and externalizing symptoms between T2 and T3. Results showed that none of the baseline characteristics predicted improvements in the aforementioned variables in the MBI and HP groups. This suggests that baseline variables may not play an important role in predicting improvement. Nonetheless, linear regression models for the TAU group found a significant predictive effect of several baseline characteristics. For instance, oppositional behaviors predicted a deterioration of externalizing symptoms and attention. Furthermore, and surprisingly, hyperactivity predicted an improvement in internalizing symptoms and mindfulness predicted an increase in internalizing problems. These results indicate that there is a natural increase in attentional and behavioral problems among adolescents who present

higher levels of oppositional behaviors, which the institutional treatment fails to stabilize.

Finally, there was no significant effect of continued mindfulness practice on outcome measures at a 1-year follow-up reported by the adolescents. However, the real and formal time of practice throughout the year was not measured. Therefore, some adolescents could have practiced once per month while others could have practiced several times per week. In the same way, the quality of practice was not considered and the small sample ($n = 30$) associated with this result prevents us from drawing definitive conclusions.

As a whole, the present study's results provide evidence for the positive impact of an MBI on attention capacities in adolescents with behavior disorders who are part of an institution. However, results do not provide evidence for the positive impact of an MBI compared to a control group on internalizing symptoms, hyperactivity, oppositional behaviors, impulsivity, mindfulness, and prosocial behaviors in this population.

Null findings may be explained by several important factors that may have impacted the quality and the benefits of the MBI. First, MBI instructors were confronted to group misbehavior (i.e., the agitated behavior of several adolescents), which sometimes prevented the practice of formal meditation. Behavior disorders could be an obstacle to the mindfulness practice, in terms of quality, and could require longer training. Second, the program may be too short (e.g., the dialectical behavior therapy for adolescents ranges from 12 to 24 sessions) (Freeman et al., 2016). Third, the variance explained by the institutional treatment could be very large and hide the effect of the MBI.

Limitations and Future Research

The current study has several limitations. Firstly, the poor psychometric quality of some questionnaires (e.g., UPPS-P) and the inherent biases of self-reported questionnaires limit the scope of the interpretations (Paulhus & Vazire, 2007). For example, numerous adolescents had difficulties understanding some questions, which is why the three behavioral tasks were added. However, these tasks were not validated and were completed by a small sample of participants resulting in a lack of statistical power or sensitivity. Moreover, the requirement for an additional group by the institution could have potentially added bias to the design as well as the fact that the current study is not double-blind. Secondly, since no formal diagnoses were made, it was not possible to distinguish the effect between the different types of behavior disorders. In addition, and contrary to numerous studies that use family interventions, peers were not directly involved in the intervention. This could have decreased the efficacy and quality of the MBI possibly explaining the small effects observed in this study.

Thirdly, adolescents with very high externalizing symptoms were not excluded and this could have affected the practice of mindfulness and, therefore, mitigated the benefits of the intervention. Since the amount of home practice was not assessed during the intervention, it was not possible to determine its potential influence on intervention outcomes. Finally, the intensity of the institutional treatment of the different groups was not evaluated precisely (in number of hours and type of psychotherapy). This factor may explain the changes observed in the different groups and, consequently, limits the validity of the results.

Overall, future studies should explore the efficacy of individual mindfulness sessions, the differences observed between different diagnoses (such as ADHD and ODD), and the differences between MBIs that involve parents and those that do not. In light of the present study's results, it can be assumed that MBIs mainly impact the attentional capacities of adolescents suffering from behavior disorders. From this perspective, other trainings exclusively based on cognitive and attentional exercises in a school setting may have the same effect as a MBI. Another possibility is that MBIs' effect may be frail in this population and may be moderated by several factors such as the design of the program (e.g., length of the intervention, individual or groups sessions, parental commitment) or the context of the intervention (e.g., institutional rules or group dynamic). For example, adolescents who benefit from shorter but more frequent sessions per week may have a greater improvement. In the same vein, one-on-one sessions might provide better benefits than group sessions because instructors would be able to customize the exercises to the needs of the youth. Overall, intervention studies that control for and compare these factors are needed to identify potential moderators. In addition, a particular emphasis should be placed on the use of high-quality designs, such as RCTs, to avoid overestimating the benefits of MBIs in this population.

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Author Contribution BR: designed and executed the study, performed data analyses, and wrote the paper.

MPP: collaborated in the writing and editing of the manuscript.

PP: designed the study, assisted in data analysis, writing and editing of the manuscript.

Data Availability De-identified data will be made available upon written request to the corresponding author.

Declarations

Ethics Approval All authors complied with ethical standards in the treatment of participants. The study was approved by the ethical committee of the University of Louvain and has therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. While this study did not use data repository, the data remains available upon request to the first author.

Informed Consent Informed consent was obtained from all participants included in the study and their parents.

Conflict of Interest The authors declare no competing interests.

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