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ORIGINAL PAPER

# Validation of the Comprehensive Inventory of Mindfulness Experiences (CHIME) in Portuguese Children

**Sofia Magalhães**[1] · **Teresa Limpo**[1]

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## Abstract

**Objectives** Despite the increasing interest in mindfulness, there are few multifaceted mindfulness measures for children, mainly in Portuguese. Thus, this study developed the Portuguese version of the Comprehensive Inventory of Mindfulness Experiences (CHIME). Because this scale was initially created for adolescents, we also aimed to adapt it to children.

**Methods** After translating the original CHIME to Portuguese and adapting the wording for children, the instrument was administered to 223 9–10-year-olds, along with self-report measures of affect and quality of life, teacher-rated measures of inhibition, inattention, and emotional lability, and a performance-based attentional measure. We examined CHIME's factorial validity, inspected facets' reliability, and tested convergent, discriminant, and predictive validity.

**Results** Confirmatory factor analyses (CFA) supported a 7-factor structure of the scale, after removing the accepting and non-judgmental attitude facet. Factor loadings (> .34) and reliability indices (> .54) were acceptable, though the average variance extracted was less than desirable. Correlations with external correlates provided support to CHIME's convergent and divergent validity (*r*s range .13–.55, *p*s < .05). Finally, evidence of predictive validity was found with a regression analysis showing that external awareness ($b = -.16$) and openness to experience ($b = -.17$) predicted academic achievement.

**Conclusions** This study provided preliminary validity and reliability evidence on the Portuguese CHIME. This instrument can provide relevant insights about the mindfulness facets and offer useful indications for the development of evidence-based interventions in childhood.

**Keywords** Dispositional mindfulness · Multifaceted mindfulness · Self-report measure · Comprehensive Inventory of Mindfulness Experiences · CHIME · Portuguese children

In the last decade, research on mindfulness among child populations experienced a considerable increase across clinical and educational contexts (Felver et al., 2017) . In general, findings have been confirming the link between mindfulness and a variety of socio-emotional, cognitive, and behavioral indicators of well-being in childhood (Kallapiran et al., 2015; Roeser et al., 2020). Despite the empirical evidence supporting this claim, research on mindfulness in children is still scarce and presents some methodological limitations (Dunning et al., 2019). A critical limitation is associated with the lack of culturally appropriate mindfulness measures, which are needed to achieve reliable scores and support valid inferences (Gomis, 2018). Several self-report measures have been developed to assess mindfulness in adults. However, there are few psychometrically sound instruments assessing mindfulness in childhood, mainly for non-English speakers (Goodman et al., 2017). Self-report mindfulness measures for children in the Portuguese context are particularly scant. Moreover, the only one available relies on a unidimensional approach to mindfulness, leaving aside important facets underlying this construct (Johnson et al., 2017). Multifaceted measures are critical for a fine-grained analysis of how mindfulness develops across developmental stages (Calvete & Royuela-Colomer, 2016).

Operational definitions of mindfulness are needed for developing valid instruments and investigating the psychological processes involved in mindfulness (Bishop et al., 2004; Brown & Ryan, 2003). However, there are several definitions of mindfulness in the literature, which limits the systematic study of this construct. Mindfulness can be defined as a state, an educable skill, or a trait (Roeser

✉ Sofia Magalhães
up201204833@edu.fpce.up.pt

[1] Faculty of Psychology and Education Sciences, University of Porto, Rua Alfredo Allen, 4200-392 Porto, Portugal

et al., 2020; Schonert-Reichl et al., 2015). State mindfulness refers to the capacity of an individual to cultivate a particular state of mind "that emerges through paying attention on purpose, in the present moment, and non-judgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). This state of mind is experienced not only by meditators during meditation practice, but also by non-meditators in daily life (Brown & Ryan, 2003). As an educable skill, mindfulness corresponds to the sustained use of meditation-based practices, such as sitting meditation or mindful eating (Roeser et al., 2020). Trait or dispositional mindfulness refers to a relatively stable quality (Bergomi et al., 2013; Brown et al., 2007), characterized by individuals' tendency to focus and keep their attention on internal and external experiences (Brown & Ryan, 2003). This dispositional tendency toward mindfulness has been found to predict several aspects of mental health (Ciesla et al., 2012; Tomlinson et al., 2018).

Different uni-, bi-, and multifaceted approaches to dispositional mindfulness have been proposed. Brown and Ryan (2003) conceptualized mindfulness as a unidimensional construct, where emotive and attentive factors cannot be separated. Bishop et al. (2004) presented an operational definition of mindfulness with two facets: self-regulation of attention focused on the immediate experience (mindful awareness), and orientation to experience with an attitude of curiosity, openness, and acceptance (mindful orientation). Based on this twofold definition, several authors proposed a multifaceted approach, in which these facets are divided into several dimensions, such as internal awareness, external awareness, non-judgmental attitudes, non-identification with experiences, and insightful understanding (Brown & Ryan, 2004; Kabat-Zinn, 2003; Lau et al., 2006). This multifaceted approach allows a detailed measurement of mindfulness by gauging its different facets (Calvete & Royuela-Colomer, 2016). This fine-grained analysis seems particularly important to understand mindfulness in children, as those facets may develop differently with age or in response to varying types of mindfulness training (Lawlor et al., 2014).

There is a consensus about the importance of measuring different mindfulness facets (Calvete & Royuela-Colomer, 2016). However, most of the research on childhood adopted unidimensional approaches to examine the link between dispositional mindfulness and external correlates, such as indicators of mental health and well-being (Ciesla et al., 2012; Tomlinson et al., 2018). Research has indicated that mindfulness in children was positively associated with positive affect and negatively related to negative affect (Mestre et al., 2019; Tomlinson et al., 2018). Mindfulness has also been positively associated with indicators of quality of life, such as physical and psychological well-being, autonomy, relationship with parents, and social support or school environment (Clevenger et al., 2018; Greco et al., 2011). There is also empirical evidence relating mindfulness and enhanced cognitive and socio-emotional skills, such as the regulation of attention (Oberle et al., 2012) and emotion (Shin et al., 2016; Tomlinson et al., 2018). High levels of mindfulness have also been associated with higher academic achievement (Caballero et al., 2019). Higher levels of dispositional mindfulness seem to have these many benefits because they may help children to focus attention, to cultivate awareness and step back from situations, to recognize the subjective and transient nature of thoughts and emotions, and to endorse non-judgmental attitudes toward themselves and others (Brown & Ryan, 2003; Brown et al., 2007). Yet, the exact mechanisms through which mindfulness operates are relatively unknown. The use of valid and reliable means to assess dispositional mindfulness can be of great help to unravel them (Goodman et al., 2017).

Mindfulness is typically assessed through self-report or behavioral measures (Goodman et al., 2017). As mindfulness is typically deemed an internal experience that can be verbalized, self-report measures, in particular questionnaires, are often the preferred means to assess dispositional mindfulness in children (Gomis, 2018). Questionnaires allow for flexible and quick administration, requiring few resources and expediting data collection. Typically, questionnaires measuring dispositional mindfulness ask individuals to reflect and report on the degree to which they are aware of their own actions, adopt specific attitudes toward internal experiences, and focus on the present moment.

Goodman et al. (2017) identified six self-report dispositional mindfulness instruments for young populations. Two of these instruments are single-factor measures, grounded on a unidimensional definition of mindfulness: Child and Adolescent Mindfulness Measure (CAMM; Greco et al., 2011; despite being proposed as a unidimensional measure, some research found a two-factor structure; de Bruin et al., 2014) and Mindful Attention Awareness Scale for Children (MAAS-C; Lawlor et al., 2014) and Adolescents (MAAS-A; Brown et al., 2011). The other instruments include several factors, as they are grounded on multifaceted definitions of mindfulness: Mindful Thinking and Action Scale for Adolescents (MTASA; four factors; West et al., 2005), Mindfulness Scale for Pre-Teens, Teens, and Adults (MSPTA; four factors; Droutman, 2015), Mindfulness Inventory for Children and Adolescents (MICA; five factors; Briere, 2011), and Comprehensive Inventory of Mindfulness Experiences—Adolescents (CHIME-A; eight factors; Johnson et al., 2017). Among these instruments, the most complete one is the CHIME-A, which targets eight dimensions of mindfulness.

Based on the CHIME version for adults (Bergomi et al., 2014), Johnson et al. (2017) developed the CHIME-A, which is a dispositional mindfulness measure for adolescents, validated with 12–14-year-old students. This instrument is composed of 25 items organized into eight facets:

accepting and non-judgmental attitude, internal awareness, external awareness, acting with awareness, decentering and non-reactivity, openness to experience, relativity of thoughts, and insightful understanding (Johnson et al., 2017). The 8-factor structure of the CHIME-A achieved a good model fit and its facets were found to have good internal consistency ($\alpha = 0.65–0.77$). Moreover, there was evidence that all facets were positively correlated with another mindfulness instrument (viz., CAMM) and measures of well-being, and negatively correlated with measures of difficulties in emotion regulation, perfectionism, negative affect, weight and shape concerns, depression, and anxiety (Johnson et al., 2017). Despite the good psychometric properties of this English-language instrument, it has never been validated in other languages, including in Portuguese.

Currently, there is a noticeable lack of self-report instruments to measure dispositional mindfulness in Portuguese-speaking young populations. To the best of our knowledge, there is only one valid and reliable questionnaire, which is the CAMM (Cunha et al., 2013). This is one of the most frequently used measures of dispositional mindfulness (Calvete & Royuela-Colomer, 2016), probably due to its shortness (i.e., 10 items). However, some limitations have been identified. It is not clear whether CAMM measures the same construct at different developmental levels and its abstract items may be hard to understand by children (Pallozzi et al., 2017). Moreover, though findings on its factorial structure are mixed, the CAMM does not seem to capture more than two mindfulness dimensions (de Bruin et al., 2014; Mohsenabadi et al., 2020). Due to the limitations of this uniquely available measure of dispositional mindfulness in Portuguese children, it seems of the utmost importance to provide researchers and practitioners with further instruments, capable of discriminating among the many facets of mindfulness.

Given the lack of multifaceted measures to assess dispositional mindfulness in Portuguese children, this study was aimed to develop and validate a Portuguese version of the CHIME-A, hereafter referred to as CHIME-Cpt, and to test its suitability for 9–10-year-old children. For that, we examined its factorial validity, inspected factors' reliability, and tested their convergent/discriminant validity between CHIME-Cpt factors and between these and external correlates. We expected CHIME-Cpt facets to be correlated with (a) children-rated positive and negative affect and quality of life, (b) teacher-rated measures of inhibition, inattention, and emotional lability, and (c) performance in an attentional measure. We also examined CHIME-Cpt predictive validity, by examining the degree to which CHIME-Cpt factors predicted academic achievement. Despite evidence relating to overall mindfulness and academic achievement, no hypotheses were advanced because there is no evidence about the relative contribution of different mindfulness facets to children's academic achievement.

## Method

### Participants

A priori power analysis using G*Power ($1-\beta = 0.80$, $\alpha = 0.05$) revealed a required $N = 193$ to find small-to-moderate correlations between CHIME-Cpt and external correlates (Johnson et al., 2017), and $N = 213$ to detect a small amount of variance explained in academic achievement by mindfulness (Caballero et al., 2019). However, Wolf et al. (2013) recommended $N = 220$ for confirmatory factor analyses (CFA) testing models with three or more factors with three or four indicators with loadings of 0.65, as found by Johnson et al. (2017) . In line with these indications, participants were 223 students in Grade 4 from three public clusters of schools in the North of Portugal ($M = 9.36$ years, $SD = 0.43$; 49% girls). In this sample, mothers' educational level was slightly above that of the national context (presented within parenthesis, and extracted from Fundação Francisco Manuel dos Santos, 2020): 5% (20%) finished Grade 4; 36% (26%) completed Grade 9; 23% (22%) completed high school; 31% (24%) completed college or postgraduate studies; and 5% (8%) was unknown. All students were authorized by their legal guardians and agreed to participate in the study, which was approved by the Ethics Committee of the authors' university.

### Procedures

All students were asked to fill in questionnaires measuring mindfulness, affect, and quality of life in classroom groups of about 15–25 students, in September 2020. The experimenter explained the overall procedure and indicated that there were no right or wrong answers. Items were read aloud to students, who completed the instruments simultaneously and one item at a time. Teacher-rated inhibition, inattention, and emotional lability scales were completed online by students' respective teachers. A group of 54 students were additionally asked to perform the Attention Network Task (ANT). As this study was conducted during the COVID-19 pandemic, we were not able to collect this data for the full sample. ANT was administered individually in a quiet room by a trained research assistant, who provided detailed instructions to children. They were asked to feed a fish (target stimulus) centrally presented on the computer screen as fast and accurate as possible. For that, they should press the right or left mouse button, according to the direction pointed by the fish. The fish could be alone (neutral flanker) or with other fishes on the side pointing in the same or different directions (congruent and incongruent flanker, respectively). The target could also be preceded by warning cues

that appear in the center of the screen (center cue), above and below central fixation (double cue), and above or below central fixation (orient cue), or by no warning cue.

## Measures

### Development of CHIME-Cpt

As described before, the original CHIME is a 25-item questionnaire with eight subscales (Johnson et al., 2017): accepting and non-judgmental attitude (i.e., being kind toward own mistakes and weaknesses), internal awareness (i.e., being aware of emotions), external awareness (i.e., being aware of the environment), acting with awareness (i.e., being aware of the present moment without being caught up in thoughts), decentering and non-reactivity (i.e., stepping back and avoid reacting to difficult emotions and thoughts), openness to experience (i.e., allowing the presence of difficult emotions and thoughts), relativity of thoughts (i.e., recognizing thoughts as subjective and temporary), and insightful understanding (i.e., recognizing that the interpretation of situations can create or worsen difficulties). Respondents are asked to indicate how often a set of situations described occur, in a 6-point scale, ranging from 1 (*almost never*) to 6 (*almost always*).

The original English version of the instrument was independently translated into Portuguese by two Portuguese-native speakers fluent in English. Because the items were originally developed for adolescents, to make the content easily understood by younger children, we simplified items' wording and added examples (e.g., the original item "I notice the emotions I am feeling as they are happening" was changed to "I notice the emotions I am feeling as they are happening [for example, I notice when I am becoming angry]"). After discussing the translated versions, a single version was obtained and pilot-tested with four fourth graders to check if the items were understandable. Besides minor wording-related changes introduced in response, all children understood the meaning of the items properly. The revised version was then back-translated into English by an English-native speaker, fluent in Portuguese. All items achieved semantic equivalence with the original ones. This final version was then used in the study.

### Self-Report Measures

To measure students' affect, we administered the Positive and Negative Affect Schedule for Children (Laurent et al., 1999; Portuguese version: Carvalho et al., 2004; $\alpha = 0.76$ for positive affect, and $\alpha = 0.83$ for negative). This is a 20-item self-report questionnaire with two subscales (positive and negative affect), with 10 items each. Participants are asked to describe their reactions and behaviors during the past month, in a 3-point scale (1 = *not at all*; 2 = *sometimes*; 3 = *many times*). For each subscale, higher scores reflect greater positive or negative affect. In this sample, McDonald's omega were 0.72 for positive affect and 0.82 for negative affect.

To measure students' quality of life, we used the self-report version of the KIDSCREEN-27, which is the mid-length version of the KIDSCREEN instruments. This is a European cross-cultural and standardized instrument that assesses different dimensions of children's quality of life. It is embedded within the KIDSCREEN-52 (Ravens-Sieberer et al., 2008; Portuguese version: Matos & Gaspar, 2008; $\alpha = 0.60$–$0.88$) and consists of 27 items that measure five dimensions: physical well-being (5 items), psychological well-being (7 items), autonomy and relationship with parents (7 items), social support and peers (4 items), school environment (4 items). Respondents are asked to describe their reactions and behaviors during the last week. Each item is scored on a 5-point scale from 1 (*not at all*) to 5 (*very much*). Higher scores indicate better health-related quality of life and well-being. In this sample, McDonald's omega were as follows: 0.68 for physical well-being, 0.72 for psychological well-being, 0.60 for autonomy and relationship with parents, 0.74 for social support and peers, and 0.75 for school environment.

### Teacher-Report Measures

We collected three measures: inhibition, inattention, and emotional lability. For inhibition, we used the 6-item inhibition subscale of the Children Executive Functions Inventory (Thorell & Nyberg, 2008; $\alpha = 0.85$ for the inhibition subscale; Portuguese version: Moura et al., 2019). Teachers are asked to indicate how well a statement is true for each child on a 5-point scale, ranging from 1 (*strongly disagree*) to 5 (*totally agree*), with higher scores indicating larger inhibition deficits. In this sample, McDonald's omega was 0.94. For inattention, we used the 9-item inattention subscale of the Vanderbilt Attention-Deficit Hyperactivity Disorder Diagnostic Teacher Rating Scale (Wolraich et al., 1998; Portuguese version: Oliveira et al., 2019; $\alpha = 0.84$ for the inattention subscale). Teachers are asked to indicate how often they identify a given behavior in children, on a 4-point scale, ranging from 0 (*never*) to 3 (*very often*). Higher scores indicate larger attention deficits. In this sample, McDonald's omega was 0.96. For emotional lability, we used the 15-item lability and negativity subscale of the Emotion Regulation Checklist (Shields & Cicchetti, 1997; $\alpha = 0.90$ for lability/negativity; Portuguese version: Alves & Cruz, 2011). Items are rated on a 4-point scale assessing the frequency of a set of behaviors, from 1 (*never*) to 4 (*almost always*). Higher scores indicate larger emotional regulation deficits. In this sample, McDonald's omega was 0.89.

### Academic Achievement

We used students' grades for two core subjects, namely, Portuguese and Mathematics. Grades are assigned by teachers at the end of each term on a scale ranging from 1 (*lowest score*) to 5 (*highest score*). Because this study took place at the beginning of the academic year, we used the most recent grades assigned to students, which were given at the end of the previous academic year. To obtain a global score we calculated the mean between Portuguese and Mathematics grades ($r = 0.79$).

### Performance-Based Measures

To measure students' attention, we used the children's version of the ANT (Fan et al., 2002) developed by Rueda et al. (2004). Based on the tripartite model of attention (Posner & Petersen, 1990), this task assesses three networks: alerting (i.e., ability to maintain a state of vigilance to environmental stimuli), orienting (i.e., ability to direct and limit attention to specific stimuli), and executive attention (i.e., ability to resolve conflicts among responses). The ANT is composed of 24 practice trials, followed by three blocks of 48 test trials each. Test trials represented one out of 12 conditions: 3 Flankers (neutral, congruent, and incongruent) × 4 Cues (none, central, double, and orient). Mean reaction time (RT) in milliseconds and mean accuracy were extracted for each condition, using an Excel macro (Fan et al., 2001) following the guidelines of Conners et al. (2000). To quantify the three attention networks, we compared mean RT between no cue and double cue conditions (alerting), central cue and orient cue conditions (orienting), and congruent and incongruent flanker conditions (executive attention). Whereas lower scores in alerting and orienting indicate faster cue-related performance, higher scores in executive attention indicate worst performance.

## Data Analyses

All analyses were performed with SPSS (v. 27), except the Confirmatory Factor Analyses (CFA), which were conducted with R (v. 4.1.0) (https://www.R-project.org).

### Confirmatory Factor Analyses

CFA models were fit using the robust variant of weighted least squares-mean and variance adjusted (WLSMV) estimator in Lavaan (Rosseel, 2012), as recommended for models with categorial data (Li et al., 2016). So that all factor loadings could be freely estimated, latent variables were scaled by imposing unit of loading identification constraints (i.e., factors' variance was constrained to 1). First, we tested a non-hierarchical 8-factor model with 25 items, in which the eight facets were allowed to intercorrelate. In case of non-convergence or misfit, we identified the sources of the problem, re-specified the model accordingly, and re-ran the analyses. To assure this non-hierarchical model provided the best fit to the data, we additionally tested a hierarchical model with CHIME-Cpt factors as second-order factors loading on a single first-order factor, and a unifactorial model with all items loading on a single mindfulness factor. To evaluate model fit, the following fit indices were examined (Kline, 2016): chi-square statistic ($\chi^2$) along with $\chi^2$/df statistic, confirmatory fit index (CFI), Tucker-Lewis index (TLI), root-mean-square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR). We used $\chi^2$/df values $< 2$ and 3, CFI and TLI values $\geq 0.95$ and 0.90, RMSEA $\leq 0.06$ and 0.10, and SRMR values $< 0.06$ and 0.09 as indicators of acceptable and good model fit, respectively (Hu & Bentler, 1999; Schermelleh-Engel et al., 2003). For the model presenting the best-fit indices, we examined items' factor loadings, McDonald's omega, and item-total correlations. We also made a stringent test to factors' internal structure by computing the average variance extracted (AVE), with values above 0.50 indicating good convergent validity. To test discriminant validity between the CHIME-Cpt subscales, each AVE's factor was compared with the squared correlation of that with other factors, with superior AVE indicating good discriminant validity (Hair et al., 2010).

### Correlation Analyses

To examine the convergent and discriminant validity of CHIME-Cpt and external correlates, we conducted correlations between all CHIME-Cpt facets with the children-rated positive and negative affect as well as five quality of life dimensions, the teacher-rated measures of inhibition, inattention, and emotional lability, and the performance-based attentional measures extracted from ANT. For these analyses, we computed Pearson's correlations coefficients, except for the accuracy-based ANT measures. Due to severe deviations from the normal distribution in some conditions ($Sk > |3|$ and/or $Ku > |10|$), Spearman's rank-order correlations were used instead.

### Regression Analyses

To examine the degree to which mindfulness facets predicted academic achievement, we conducted a two-step regression analysis. In the first step, we introduced gender, mother's educational level, and age as predictors. In the second step, we added the CHIME-Cpt facets.

## Results

### Confirmatory Factor Analyses

The first CFA on the non-hierarchical 8-factor model revealed that the covariance matrix of latent variables was not positive definite, due to correlations above 1 involving the accepting and non-judgmental attitude facet. This was also found to have items with low factor loadings (all < 0.42), and an unacceptable index of internal consistency ($\omega$= 0.40). Based on these findings, we removed this facet and conducted a new CFA. Results on the non-hierarchical 7-factor model with 22 items revealed a good model fit: $\chi^2$ (188, $N$ = 223) = 236.06, $\chi^2$/df = 1.256, CFI = 0.96, TLI = 0.95, RMSEA = 0.03 [90% CI: 0.02 to 0.05], and SRMR = 0.05. The hierarchical 7-factor model also presented an acceptable model fit: $\chi^2$ (202, $N$ = 223) = 269.98, $\chi^2$/df = 1.337, CFI = 0.94, TLI = 0.94, RMSEA = 0.04 [90% CI: 0.03 to 0.05], and SRMR = 0.06 (similar to what happened with the non-hierarchical 8-factor model, the hierarchical 8-factor model did not converge). Unacceptable fits were found for the unidimensional model either with all items, $\chi^2$ (209, $N$ = 223) = 400.75, $\chi^2$/df = 2.609, CFI = 0.84, TLI = 0.82, RMSEA = 0.06 [90% CI: 0.06 to 0.07], and SRMR = 0.08, or without the three items of the accepting and non-judgmental attitude facet, $\chi^2$ (275, $N$ = 223) = 482.45, $\chi^2$/df = 1.162, CFI = 0.84, TLI = 0.83, RMSEA = 0.06 [90% CI: 0.05 to 0.07], and SRMR = 0.08. In sum, the non-hierarchical model presented the best fit and was considered in the subsequent analyses. Still, as the hierarchical model also fitted the data well, this model was only used to test the reliability of a total mindfulness score.

Table 1 presents descriptive statistics for all items and facets of the 7-factor CHIME-Cpt, including factor loadings, which ranged from 0.34 to 0.80 (all $p$s < 0.001). As detailed in Table 2, McDonald's omega varied between 0.54 and 0.79; item-total correlations varied between 0.32 and 0.67; AVE was below 0.50 for all facets (range = 0.28–0.49), except for the external awareness facet (0.54); and the squared correlations between facets were below AVE for all facets, except for the decentering and non-reactivity facet as well as the relativity of thoughts facet. Table 3 presents the correlations among CHIME-Cpt facets, which ranged from 0.11 (between external awareness and acting with awareness) to 0.55 (between decentering and non-reactivity and relativity of thoughts). To analyze the adequacy of using a total score of mindfulness, we additionally examined the internal consistency of the higher-order factor of the hierarchical model. As recommended by Flora (2020), we computed the *omega-higher-order* ($\omega_{ho}$), which represents the proportion of total-score variance that is due to the higher-order factor. The reliability of the total score with respect to the overall construct of mindfulness was 0.75.

### Correlation Analyses

The associations between CHIME-Cpt facets and external correlates are presented in Table 3. Overall, we found that CHIME-Cpt facets were positively related to positive affect ($r$s range = 0.25–0.38, $p$s < 0.05), except openness to experience and acting with awareness, which were negatively related to positive ($r$ = −0.35) and negative affect ($r$ = −0.22), respectively. Moreover, results showed that all quality of life dimensions were positively correlated with external awareness ($r$s range = 0.28–0.37, $p$s < 0.05), and negatively correlated with openness to experience ($r$s range = −0.32–0.26, $p$s < 0.05). There were positive associations between the majority of the quality of life dimensions and decentering and non-reactivity as well as relativity of thoughts ($r$s range = 0.15–0.21, $p$s < 0.05). There were only a few significant correlations between CHIME-Cpt facets and teacher-rated measures, all of them with low magnitude ($r$ < |.16|). Concerning the correlations among CHIME-Cpt facets and ANT measures (cf. Table 4), major findings involved the external awareness facet. This was positively correlated with alerting attention and RT in no cue and incongruent flanker conditions ($r$s range = 0.27–0.34, $p$s < 0.05), and negatively correlated with accuracy in center cue ($r$ = −0.27) and congruent flanker ($r$ = −0.28) conditions.

### Regression Analyses

Step 1 of the regression analysis was significant, $R^2$ = 0.23, $F$(3, 205) = 19.82, $p$ < 0.001. Only mothers' educational level was found to predict academic achievement ($b$ = 0.49). When CHIME-Cpt facets were included on Step 2, there was a significant increase in the amount of variance explained, $R^2$ = 0.28, $F_{change}$(7, 198) = 2.25, $p$ = 0.03. In addition to mothers' educational level ($b$ = 0.48), two CHIME-Cpt facets were found to uniquely predict academic achievement, namely, external awareness ($b$ = −0.16), and openness to experience ($b$ = −0.17). Complete results are presented in Table 5.

## Discussion

Despite the increasing interest in studying mindfulness in childhood, valid and reliable multifaceted measures of dispositional mindfulness are scant (Calvete & Royuela-Colomer, 2016), especially in the Portuguese context. This study aimed to develop the Portuguese version of the 8-factor CHIME-A (Johnson et al., 2017), and test its suitability for 9–10-year-olds.

**Table 1** Descriptive statistics and factor loadings of the 22-item CHIME-Cpt with 7 facets

| Subscales | *M* | *DP* | *Sk* | *Ku* | *λ* |
|---|---|---|---|---|---|
| Internal awareness | 3.57 | 1.28 | 0.06 | −0.68 | |
| 1. When my mood changes (for example, I am happy and suddenly become sad), I notice it straight away | 2.58 | 1.70 | 0.89 | −0.49 | .41 |
| 2. When I talk to other people, I notice what emotions I am feeling (for example, if I am angry or happy) | 3.94 | 1.83 | −0.30 | −1.31 | .69 |
| 3. I notice the emotions I am feeling as they are happening (for example, I notice when I am becoming angry) | 4.18 | 1.64 | −0.37 | −1.12 | .63 |
| External awareness | 4.73 | 1.24 | −0.80 | −0.14 | |
| 4. I notice details in nature (like the color of the sky, or the shape of trees and clouds) | 4.72 | 1.45 | −0.84 | −0.36 | .69 |
| 5. I pay attention to the feeling of things like the wind in my hair or sunshine on my face | 4.70 | 1.52 | −0.91 | −0.35 | .78 |
| 6. I notice the sounds around me, such as birds chirping or cars passing | 4.77 | 1.50 | −0.94 | −0.39 | .74 |
| Acting with awareness | 4.01 | 1.23 | −0.36 | −0.64 | |
| 7. I break or spill things because my thoughts are elsewhere (in other words, I am distracted) | 4.32 | 1.65 | −0.80 | −0.54 | .49 |
| 8. I get distracted about past events (such as a grade I got) or future ones (like the present I want to get) | 3.24 | 1.73 | 0.09 | −1.29 | .72 |
| 9. At school, when I walk from the classroom to other places (for example, canteen/gym) my mind is elsewhere | 4.48 | 1.65 | −0.84 | −0.55 | .47 |
| Decentering and non-reactivity | 3.60 | 1.44 | 0.07 | −0.94 | |
| 10. I am able to back off from bad thoughts and feelings, when I realize I am paying them too much attention | 3.95 | 1.79 | −0.18 | −1.43 | .68 |
| 11. I am able to notice my thoughts and feelings without getting tangled up in them | 3.69 | 1.86 | −0.07 | −1.44 | .63 |
| 12. I notice my thoughts and feelings and can observe them as if they were from somebody else | 3.17 | 1.88 | 0.30 | −1.38 | .64 |
| Openness to experience | 2.85 | 1.37 | 0.46 | −0.70 | |
| 13. I try to stay busy to keep certain thoughts or feelings out of my mind | 3.21 | 1.71 | 0.22 | −1.17 | .68 |
| 14. When I feel difficult emotions, I try to do something for them to disappear | 2.70 | 1.73 | 0.57 | −1.00 | .80 |
| 15. Since I don't like to be angry or scared, I try to make those feelings disappear | 2.78 | 1.80 | 0.54 | −1.10 | .68 |
| 16. Whenever possible, I try to avoid the feelings that give me pain | 2.74 | 1.78 | 0.54 | −1.11 | .61 |
| Relativity of thoughts | 3.81 | 1.19 | −0.11 | −0.59 | |
| 17. I realize my thoughts aren't always facts (in other words, they only exist only in my head) | 3.80 | 1.69 | −0.18 | −1.20 | .50 |
| 18. I realize that my point of view is not always based on facts (that is, what happens in real life) | 3.37 | 1.58 | 0.31 | −0.92 | .51 |
| 19. I am aware that my point of view could change | 4.27 | 1.64 | −0.53 | −0.89 | .62 |
| Insightful understanding | 2.85 | 1.33 | 0.44 | −0.67 | |
| 20. When I notice that I have made things more complicated than they really are, it makes me smile | 2.79 | 1.82 | 0.61 | −1.04 | .34 |
| 21. When I have given myself a hard time without needing to, I can laugh about it | 3.23 | 1.99 | 0.19 | −1.55 | .65 |
| 22. I am able to smile to myself, when I have made a big deal out of a small problem (for example, when I threw a tantrum for no reason) | 2.52 | 1.75 | 0.84 | −0.66 | .55 |

The accepting and non-judgmental attitude facet of the original CHIME-A was removed. The items were freely translated to English

**Table 2** Reliability (McDonald's omega), item-total correlations range, average variance extracted (AVE), and highest square correlation (HSC) of the CHIME-Cpt facets

| Subscales | ω | Item-total correlations range | AVE | HSC |
|---|---|---|---|---|
| Internal awareness | .61 | .35–.46 | .34 | .29 |
| External awareness | .78 | .59–.64 | .54 | .23 |
| Acting with awareness | .58 | .35–.43 | .32 | .15 |
| Decentering and non-reactivity | .68 | .45–.54 | .42 | .30 |
| Openness to experience | .79 | .50–.67 | .49 | .23 |
| Relativity of thoughts | .56 | .37–.37 | .30 | .30 |
| Insightful understanding | .54 | .32–.39 | .28 | .18 |

Overall, the results confirmed the multifaceted nature of CHIME-Cpt for Portuguese children. However, the analyses led us to drop the accepting and non-judgmental attitude facet. The original authors have already suggested that the eight mindfulness dimensions assessed by the CHIME-A could not be present in younger children (Johnson et al., 2017). Still, we do not think this is the case for the accepting and non-judgmental attitude facet, which was already found to be present in younger participants. For example, other mindfulness measures tested with 10–17-year-olds found evidence for a 2-factor mindfulness structure, being one of the facets accepting without judgment (Greco et al., 2011). We believe that this CHIME facet may have not worked properly, likely due to the content and wording of the items. On the one hand, as suggested by Baer et al. (2006), the content of those items may be inadequately capturing the quality of accepting and being non-judgmental. These authors

**Table 3** Correlations between CHIME-Cpt facets and the self-report measures of affect and quality of life, as well as the teacher-rated measures of inhibition, inattention, and emotional lability

| | *M* | *SD* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mindfulness | | | | | | | | | | | | | | | | | | |
| 1. Internal awareness | 3.57 | 1.28 | | | | | | | | | | | | | | | | |
| 2. External awareness | 4.73 | 1.24 | **.41** | | | | | | | | | | | | | | | |
| 3. Acting with awareness | 4.01 | 1.23 | **−.23** | −.11 | | | | | | | | | | | | | | |
| 4. Decentering and non-reactivity | 3.60 | 1.44 | **.54** | **.40** | **−.17** | | | | | | | | | | | | | |
| 5. Openness to experience | 2.85 | 1.37 | **−.48** | **−.48** | **.14** | **−.50** | | | | | | | | | | | | |
| 6. Relativity of thoughts | 3.81 | 1.19 | **.43** | **.36** | **−.29** | **.55** | **−.42** | | | | | | | | | | | |
| 7. Insightful understanding | 2.85 | 1.33 | **.37** | **.27** | **−.38** | **.43** | **−.42** | **.39** | | | | | | | | | | |
| Affect | | | | | | | | | | | | | | | | | | |
| 8. Positive | 2.53 | 0.31 | **.26** | **.38** | −.05 | **.29** | **−.35** | **.25** | **.25** | | | | | | | | | |
| 9. Negative | 1.40 | 0.36 | .04 | −.03 | **−.22** | .02 | .07 | <.001 | −.04 | **−.20** | | | | | | | | |
| Quality of life | | | | | | | | | | | | | | | | | | |
| 10. Physical | 4.35 | 0.57 | .10 | **.37** | .08 | **.17** | **−.29** | .10 | **.17** | **.56** | **−.24** | | | | | | | |
| 11. Psychological | 4.52 | 0.48 | .02 | **.28** | **.19** | .12 | **−.26** | .09 | .03 | **.45** | **−.50** | **.55** | | | | | | |
| 12. Autonomy and parents | 4.20 | 0.61 | .09 | **.28** | .04 | **.20** | **−.32** | **.18** | **.21** | **.50** | **−.30** | **.49** | **.62** | | | | | |
| 13. Social support | 4.49 | 0.65 | **.15** | **.31** | −.03 | .13 | **−.31** | **.21** | .11 | **.36** | **−.23** | **.38** | **.47** | **.42** | | | | |
| 14. School environment | 4.50 | 0.59 | .13 | **.29** | .10 | **.21** | **−.31** | **.17** | .09 | **.59** | **−.31** | **.50** | **.56** | **.56** | **.37** | | | |
| Teacher-rated measures | | | | | | | | | | | | | | | | | | |
| 15. Inhibition | 2.39 | 0.99 | .01 | <−.001 | −.07 | −.06 | .08 | −.03 | −.03 | **−.21** | **.22** | −.08 | **−.15** | **−.18** | −.09 | **−.40** | | |
| 16. Inattention | 1.84 | 0.70 | .02 | .02 | −.10 | **−.15** | **.16** | −.01 | −.03 | **−.29** | **.22** | **−.15** | **−.21** | **−.30** | −.09 | **−.46** | **.69** | |
| 17. Emotional lability | 2.25 | 0.48 | .02 | −.01 | −.13 | −.10 | .07 | −.04 | .04 | **−.14** | **.18** | −.04 | −.13 | −.13 | −.01 | **−.33** | **.76** | **.62** |

Correlations above |.13| are significant at alpha level of .05 and signaled in bold

**Table 4** Descriptive statistics of ANT measures and correlations with CHIME-Cpt facets

| | Descriptives | | Correlations[a] with CHIME-Cpt facets | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | Internal awareness | External awareness | Acting with awareness | Decentering and non-reactivity | Openness to experience | Relativity of thoughts | Insightful understanding |
| Reaction times (ms) | | | | | | | | | |
| Flanker | | | | | | | | | |
| Congruent | 771.89 | 101.35 | .001 | .19 | .04 | .13 | −.11 | .13 | .14 |
| Incongruent | 862.22 | 109.02 | .09 | .32* | .03 | .22 | −.07 | .13 | .18 |
| Neutral | 751.04 | 97.08 | .02 | .25 | .03 | .20 | −.13 | .09 | .13 |
| Cue | | | | | | | | | |
| No | 861.18 | 98.62 | .02 | .34* | .13 | .18 | −.12 | .16 | .17 |
| Double | 764.48 | 100.44 | .01 | .18 | −.01 | .18 | −.10 | .10 | .11 |
| Center | 798.49 | 107.91 | .02 | .25 | .01 | .20 | −.15 | .16 | .11 |
| Orient | 756.04 | 103.39 | .10 | .25 | .01 | .17 | −.05 | .04 | .21 |
| Accuracy | | | | | | | | | |
| Flanker | | | | | | | | | |
| Congruent | 0.96 | 0.06 | −.24 | −.28* | .14 | −.22 | .23 | −.06 | −.29* |
| Incongruent | 0.94 | 0.07 | −.22 | −.07 | .22 | −.18 | .11 | −.24 | −.05 |
| Neutral | 0.96 | 0.06 | −.22 | −.08 | .27* | −.12 | .07 | −.03 | −.22 |
| Cue | | | | | | | | | |
| No | 0.94 | 0.07 | −.24 | −.18 | .27* | −.12 | .04 | −.16 | −.22 |
| Double | 0.96 | 0.06 | −.33* | −.10 | .23 | −.30* | .24 | −.14 | −.12 |
| Center | 0.96 | 0.06 | −.19 | −.27* | .12 | −.11 | .16 | −.21 | −.12 |
| Orient | 0.96 | 0.06 | −.18 | −.04 | .21 | −.16 | .10 | −.01 | −.22 |
| Attention networks (based on reaction times) | | | | | | | | | |
| Orienting | 42.45 | 60.51 | −.13 | .02 | <.001 | .07 | −.19 | .21 | −.15 |
| Alerting | 96.71 | 57.08 | .01 | .27* | .25 | −.01 | −.04 | .10 | .10 |
| Conflict | 90.33 | 69.66 | .15 | .23 | −.01 | .15 | .05 | .03 | .09 |

[a] Pearson's correlation coefficients were computed, except for correlations involving accuracy, in which Spearman's rank-order correlation was used

* $p < .05$

**Table 5** Parameter estimates for the regression model predicting academic achievement

| Predictors | *B* | *b* | *t* |
|---|---|---|---|
| Step 1 | | | |
| Gender | −0.05 | −.03 | −0.48 |
| Mothers' educational level | 0.31 | .49 | 7.68*** |
| Age | 0.17 | .08 | 1.19 |
| Step 2 | | | |
| Internal awareness | −0.01 | −.02 | −0.26 |
| External awareness | −0.11 | −.16 | −2.30* |
| Acting with awareness | 0.06 | .10 | 1.45 |
| Decentering and non-reactivity | 0.09 | .15 | 1.84 |
| Openness to experience | −0.10 | −.17 | −2.13* |
| Relativity of thoughts | −0.06 | −.09 | −1.21 |
| Insightful understanding | −0.02 | −.03 | −0.44 |

* $p < .05$. ** $p < .01$. *** $p < .001$

reported problems in measuring this dimension even in adults. On the other hand, the wording of the items using abstract terms (e.g., "I notice my mistakes without getting annoyed/angry with myself" or "Even when I make a big mistake, I am kind and patient with myself.") may require high levels of metacognition, perhaps not yet present in 9–10-year-olds (Greco et al., 2011). Moreover, in line with Piaget's (1965) moral development theory (for a review see Rook et al., 2021) , up to 10 years of age, children believe that, due to its negative consequences, misdeeds are automatically punished (i.e., immanent justice). This reasoning may make it hard for them to conceive of the idea that people can be uncritical toward mistakes, which is at the core of the accepting and non-judgmental attitude facet. Although the items were properly understood in the pilot testing, it should be noted that this only involved four children, interviewed under controlled situations, and stimulated to reflect more deeply on the items. In the main study, the scale was administered to children in full-range classrooms, provided with minimal assistance.

Thus, additional work seems needed to identify the best items to adequately measure this facet in children.

After removing that facet, results showed that the non-hierarchical 7-factor CHIME-Cpt composed of 22 items achieved an acceptable model fit. Although this model presented the best-fit indices than the hierarchical model, the fit of the latter was also acceptable supporting the use of an overall mindfulness score, which achieved good internal consistency ($\omega_{ho} = 0.75$). All facets were also found to have adequate internal consistencies (ranging from 0.54 to 0.79) and item-total correlations (ranging from 0.32 to 0.67), suggesting acceptable reliability of each facet, similarly to what was found with the original CHIME-A (Johnson et al., 2017). Moreover, correlations between facets ranged from low to moderate, indicating that the instrument measures distinct facets of mindfulness in young children. However, a stringent test to the convergent and discriminant validity of the facets—via an examination of AVE and its comparison with the squared correlations between facets—produced less than desirable results. Except for the external awareness facet, AVE for all others was below 0.50. Also, except for two facets (viz., decentering and non-reactivity, relativity of thoughts), the squared correlations between facets were below AVE values. These less than perfect results can be related to the young age of the participants as well as to some degree of overlap between mindfulness dimensions (Greco et al., 2011). Future studies should conduct further tests on CHIME-Cpt and inspect whether AVE-related issues were specific to this sample or if item modifications are warranted.

Regarding the correlations of CHIME-Cpt with external correlates, we found that most CHIME-Cpt facets were positively associated with adaptive traits, such as positive affect and quality of life dimensions, and were negatively associated with maladaptive traits, such as negative affect, which is consistent with previous studies (for similar results, see Ciesla et al., 2012; Cortazar & Calvete, 2019; Cunha et al., 2013; Johnson et al., 2017). Two worth-mentioning findings were that children who scored higher on external awareness reported a higher positive affect and quality of life; and children who scored higher on acting with awareness reported a lower negative effect. This pattern of results is one of the most consistent ones in the literature relating to dispositional mindfulness and psychological health (Baer et al., 2006; Cortazar & Calvete, 2019; Johnson et al., 2017).

Despite this overall alignment with prior research, providing further support to CHIME-Cpt validity, an unexpected finding was found: openness to experience was negatively related to positive affect and quality of life dimensions. In other words, children who reported avoiding the presence of difficult emotions and thoughts seemed to experience higher positive feelings and quality of life. This result is not aligned with those reported by Johnson et al. (2017). We believe this discrepancy may be due to a combination of our child sample with the facet itself, which was fully composed of reversed items (e.g., "I try to stay busy to keep certain thoughts or feelings out of my mind."; "Whenever possible, I tried to avoid the feelings that caused me pain."). Despite their advantages (e.g., reduced acquiescence bias), reversed items may not be measuring the same construct as positively worded items (Reise & Waller, 2009) and may create confusion among respondents, mainly in children (Józsa & Morgan, 2017). Due to their developing verbal and cognitive skills, children may struggle to interpret reversed items. Likely, this is even more problematic when measuring abstract concepts, such as openness to experience, dependent upon respondents' metacognitive abilities. Future research seems needed to inspect whether these reversed items are negatively impacting the interpretation of the facet, particularly in child respondents. Other sources for a potential misinterpretation of this facet should be inspected as well. Indeed, although the correlational nature of our study impedes us to make inferences about the direction of the relationships, it might well be the case that children with higher levels of positive affect and quality of life rarely have negative emotions or thoughts. Being this the case, it would be not surprising to see 9–10-year-olds interpreting this lack of negative inner experiences as avoidance.

Concerning the correlations of CHIME-Cpt with teacher-rated measures (inhibition, inattention, and emotional lability), we found a handful of low correlations. These findings were not aligned with past studies, showing links between mindfulness and these cognitive and emotional dimensions (Shin et al., 2016; Tomlinson et al., 2018). Still, we advise caution in interpreting the absence of these relationships as a threat to CHIME-Cpt validity. Actually, we believe this lack of findings is explained by contextual factors. Due to the COVID-19 pandemic, when we collected all measures (September 2020), children and teachers had been in 6 months without face-to-face classes. Therefore, it might have been a mismatch between teacher and children's ratings, with teachers using old information as a reference to fill in the questionnaires.

Further analyses with a subsample examined the link between CHIME-Cpt facets and ANT measures. Due to the reduced sample size ($n = 54$), these analyses were slightly underpowered and thus of exploratory nature. Findings revealed only a few correlations, with two noteworthy findings involving RT and accuracy. Concerning RT, we found that higher external awareness was associated with lower RT in the no cue and incongruent conditions and with higher alerting attention. This means that children who were more aware of the environment performed worst in difficult conditions requiring sustained attention (such as the absence of a cue to signal the appearance of the target). However, they performed better in the presence of an alerting cue, which redirected their attentional focus. Rueda et al. (2004)

already reported this attentional pattern in younger children. Concerning accuracy, we found that higher external awareness (in the congruent and center cue conditions) and higher internal awareness (in the double cue condition) were associated with less accurate responses. Caution is needed when interpreting these findings due to the reduced sample and very high accuracy rates (average of 96%), probably indicating ceiling effects, as suggested by past studies (Felver et al., 2017). Clearly, more research with larger samples is needed to understand the associations between CHIME-Cpt and ANT measures.

To test CHIME-Cpt predictive validity, we examined the degree to which its facets predicted academic achievement, above and beyond gender, mother's educational level, and age. Consistent with previous studies, mothers' educational level predicted better academic achievement (Zupančič et al., 2016). Notably, mindfulness facets also contributed to academic achievement, after controlling for these socio-demographic factors (for similar findings, see Caballero et al., 2019). Specifically, the two CHIME-Cpt facets with predictive value were external awareness and openness to experience. However, the association was negative. Children who considered themselves as being more intentionally aware of environmental stimuli or as being more able to allow the presence of difficult emotions and thoughts achieved poorer grades in school. These findings raise questions about the advantages of having high levels of external awareness and openness to experience, and, consequently, of implementing interventions to increase those levels. This is not a new issue (Maynard et al., 2017).

Tharaldsen (2012) found that, after a mindfulness intervention with fourteen 90-min sessions aimed to increase, for example, awareness and acceptance of inner experiences, adolescents experienced a deterioration in life satisfaction and psychological symptoms. The author suggested that the mindfulness-related practice increased adolescents' focus on troublesome emotions and the use of maladaptive coping strategies. It may be the case that some facets of mindfulness may be more confusing than beneficial for young people (see also Maynard et al., 2017). This may be related to their reduced, if any, meditation experience along with their insufficient cognitive skills to properly apply mindfulness practices and benefit from them (Greco et al., 2011). For example, high levels of external awareness may be helpful in school if children orient their attention toward the teacher, but they may have a detrimental effect if attention is directed to what is happening outside. Despite becoming a key area of inquiry, the potential disadvantages of having (or promoting) high levels of some mindfulness facets warrant future investigation. Multifaceted and brief self-report measures, such as the CHIME-Cpt, can be particularly useful to that end.

## Limitations and Future Directions

When interpreting current findings, at least four limitations should be kept in mind. First, because our study was cross-sectional and correlation in nature, no developmental conclusions or causal inferences can be made. It would be important to conduct longitudinal and intervention studies to examine the link between mindfulness facets, external correlates, and academic achievement. These studies could help us to understand some unexpected findings, such as those involving the openness to experience facet. Despite the mindfulness-based assumption that avoiding inner experiences is always bad (i.e., fallacy of uniform efficacy), it has been suggested that the efficacy of regulatory behaviors may vary across time and contexts (Bonanno & Burton, 2013). In other words, depending on the situation, low levels of openness to experience may actually be helpful for children to deal with some negative emotions and thoughts. Though our design impedes us to test this hypothesis, this certainly is an interesting research avenue for scholars in the field to pursue.

Second, we do not know if our child participants had experience with mindfulness, despite the inclusion of mindfulness practice in Portuguese school contexts being very rare. Some facets are particularly sensitive to mindfulness practice, which can change their interpretation and links with other constructs (Greco et al., 2011). More research is needed to understand whether mindfulness experience may affect CHIME-Cpt facets. This can eventually help in the interpretation of some unexpected findings here reported.

Third, academic achievement was only measured through Portuguese and Mathematics grades. Despite being the main subjects in Portuguese primary schools, other subjects may be more related to some facets of mindfulness. Indeed, previous findings suggested that the role of mindfulness in academic achievement may vary across subjects. For example, in Grades 1–4, Bakosh et al. (2018) found that a 90-day mindfulness intervention with 10-min daily practice improved students' grades in Mathematics and Social Studies, but not in Science. Therefore, to deepen our understanding about the link between mindfulness facets and academic achievement, future investigations should consider different school subjects.

Finally, we only provided preliminary validity evidence of the CHIME-Cpt in a sample of 9–10-year-olds. We did not administer other well-established mindfulness measures (e.g., CAMM or MICA) and did not test temporal stability. Future research should gather more evidence on the psychometric properties of this instrument. There is a need for more evidence on CHIME-Cpt's convergent/divergent validity, including on its facets' association with behavioral measures of mindfulness, such as the Breath Counting Task (Gomis, 2018). Additionally, it would be relevant to administer this scale to other age groups and examine its temporal stability as well as its sensitivity to detect treatment effects.

In future tests, particularly, attention should be given to the items measuring the accepting and non-judgmental attitude facet (removed after CFA) and to the openness to experience facet (fully composed of reversed items). The scale here validated also represents a starting point for fine-grained analyses to deepen our knowledge about mindfulness among Portuguese-speaking children and encourage cross-cultural comparisons. Given its multifaceted nature, CHIME-Cpt can provide insights into the mindfulness facets linked to well-being and academic outcomes and give useful indications for the development of evidence-based interventions capable of increasing children's quality of life.

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## Declarations

**Conflict of Interest** The authors declare no competing interests.

## References

Alves, D. & Cruz, O. (2011). Reações Parentais às Emoções Negativas dos filhos (RPEN): Um questionário de avaliação da meta-emoção parental. *VIII Congresso Iberoamericano de Avaliação Psicológica/XV Conferência Internacional Avaliação Psicológica: Formas e Contextos*, Lisboa, Portugal.

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*(1), 27–45. https://doi.org/10.1177/1073191105283504

Bakosh, L. S., Tobias Mortlock, J. M., Querstret, D., & Morison, L. (2018). Audio-guided mindfulness training in schools and its effect on academic attainment: Contributing to theory and practice. *Learning and Instruction, 58*, 34–41. https://doi.org/10.1016/j.learninstruc.2018.04.012

Bergomi, C., Tschacher, W., & Kupper, Z. (2013). The assessment of mindfulness with self-report measures: Existing scales and open issues. *Mindfulness, 4*, 191–202. https://doi.org/10.1007/s12671-012-0110-9

Bergomi, C., Tschacher, W., & Kupper, Z. (2014). Konstruktion und erste validierung eines fragebogens zur umfassenden erfassung von achtsamkeit [Construction and initial validation of a questionnaire for the comprehensive investigation of mindfulness]. *Diagnostica, 60*, 111–125. https://doi.org/10.1026/0012-1924/a000109

Betts, J., Gullone, E., & Allen, J. S. (2009). An examination of emotion regulation, temperament, and parenting style as potential predictors of adolescent depression risk status: A correlational study. *British Journal of Developmental Psychology, 27*, 473–485. https://doi.org/10.1348/026151008X314900

Bishop, S. R., Lau, M., Shapiro, S., Carlson, L., Anderson, N. D., Carmody, J., Segal, Z. V., Abbey, S., Speca, M., Velting, D., & Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice, 11*(3), 230–241. https://doi.org/10.1093/clipsy.bph077

Bonanno, G. A., & Burton, C. L. (2013). Regulatory flexibility: An individual differences perspective on coping and emotion regulation. *Perspectives on Psychological Science, 8*(6), 591–612. https://doi.org/10.1177/1745691613504116

Briere, J. (2011). *Mindfulness inventory for children and adolescents*. Unpublished assessment inventory.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84*(4), 822–848. https://doi.org/10.1037/0022-3514.84.4.822

Brown, K. W., & Ryan, R. M. (2004). Perils and promise in defining and measuring mindfulness: Observations from experience. *Clinical Psychology: Science and Practice, 11*(3), 242–248. https://doi.org/10.1093/clipsy.bph078

Brown, K. W., Ryan, R. M., & Creswell, J. D. (2007). Mindfulness: Theoretical foundations and evidence for its salutary effects. *Psychological Inquiry, 18*(4), 211–237. https://doi.org/10.1080/10478400701598298

Brown, K. W., West, A. M., Loverich, T. M., & Biegel, G. M. (2011). Assessing adolescent mindfulness: Validation of an adapted Mindful Attention Awareness Scale in adolescent normative and psychiatric populations. *Psychological Assessment, 23*(4), 1023–1033. https://doi.org/10.1037/a0021338

Caballero, C., Scherer, E., West, M. R., Mrazek, M. D., Gabrieli, C. F. O., & Gabrieli, J. D. E. (2019). Greater mindfulness is associated with better academic achievement in middle school. *Mind, Brain, and Education, 13*(3), 157–166. https://doi.org/10.1111/mbe.12200

Calvete, E., & Royuela-Colomer, E. (2016). Measurement of dispositional mindfulness in children and adolescents: A review of available self-report measures in Spanish. *Mindfulness & Compassion, 1*(2), 58–67. https://doi.org/10.1016/j.mincom.2016.11.001

Carvalho, M., Baptista, A., & Gouveira, J. (2004). Análise da estrutura factorial de uma medida de auto-avaliação da afectividade negativa e positiva para crianças e adolescentes [Analysis of the factorial structure of a self-assessment measure of negative and positive affect for children and adolescents]. In C. Machado, L. S. Almeida, M. Gonçalves, & V. Ramalho (Orgs.), *Avaliação Psicológica: Formas e Contextos*. Psiquilíbrios Edições.

Ciesla, J. A., Reilly, L. C., Dickson, K. S., Emanuel, A. S., & Updegraff, J. A. (2012). Dispositional mindfulness moderates the effects of stress among adolescents: Rumination as a mediator. *Journal of Clinical Child and Adolescent Psychology, 41*(6), 760–770. https://doi.org/10.1080/15374416.2012.698724

Clevenger, K. A., Pfeiffer, K. A., Yee, K. E., Triplett, A. N., Florida, J., & Selby, S. (2018). Mindfulness and children's physical activity, diet, quality of life, and weight status. *Mindfulness, 9*(1), 221–229. https://doi.org/10.1007/s12671-017-0765-3

Conners, C. K., March, J. S., Frances, A., Wells, K. C., & Ross, R. (2000). Treatment of attention-deficit/hyperactivity disorder: Expert consensus guidelines. *Journal of Attention Disorders, 4*(1), 7–13. https://doi.org/10.1177/108705470000401s02

Cortazar, N., & Calvete, E. (2019). Dispositional mindfulness and its moderating role in the predictive association between stressors and psychological symptoms in adolescents. *Mindfulness, 10*(10), 2046–2059. https://doi.org/10.1007/s12671-019-01175-x

Cunha, M., Galhardo, A., & Pinto-Gouveia, J. (2013). Child and Adolescent Mindfulness Measure (CAMM): Estudo das características

psicométricas da versão portuguesa. [Child and Adolescent Mindfulness Measure (CAMM): Study of the psychometric characteristics of the Portuguese version]. *Psicologia: Reflexão e Crítica, 26*, 459–468. https://doi.org/10.1590/S0102-79722013000300005

de Bruin, E. I., Zijlstra, B. J. H., & Bögels, S. M. (2014). The meaning of mindfulness in children and adolescents: Further validation of the Child and Adolescent Mindfulness Measure (CAMM) in two independent samples from the Netherlands. *Mindfulness, 5*(4), 422–430. https://doi.org/10.1007/s12671-013-0196-8

Droutman, V. (2015). Mindfulness scale for pre-teens, teens and adults. In In R. J. Semple (Chair), *Clinical applications of mindfulness*. Research symposium conducted at the Bridging the Hearts and Minds of Youth: Mindfulness and Compassion in Clinical Practice, Education, and Research conference in San Diego, CA.

Dunning, D. L., Griffiths, K., Kuyken, W., Crane, C., Foulkes, L., Parker, J., & Dalgleish, T. (2019). Research review: The effects of mindfulness-based interventions on cognition and mental health in children and adolescents - A meta-analysis of randomized controlled trials. *Journal of Child Psychology and Psychiatry,* 60(3), 244–258. https://doi.org/10.1111/jcpp.12980

Fan, J., McCandliss, B. D., Sommer, T., Raz, A., & Posner, M. I. (2002). Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience, 14*(3), 340–347. https://doi.org/10.1162/089892902317361886

Fan, J., Wu, Y., Fossella, J. A., & Posner, M. I. (2001). Assessing the heritability of attentional networks. *BMC Neuroscience, 2*(1), 14. https://doi.org/10.1186/1471-2202-2-14

Felver, J. C., Tipsord, J. M., Morris, M. J., Racer, K. H., & Dishion, T. J. (2017). The effects of mindfulness-based intervention on children's attention regulation. *Journal of Attention Disorders, 21*(10), 872–881. https://doi.org/10.1177/1087054714548032

Flora, D. B. (2020). Your coefficient alpha is probably wrong, but which coefficient omega is right? A tutorial on using R to obtain better reliability estimates. *Advances in Methods and Practices in Psychological Science, 3*(4), 484–501. https://doi.org/10.1177/2515245920951747

Fundação Francisco Manuel dos Santos. (2020). *PORDATA, Base de dados Portugal contemporâneo [PORDATA, Contemporary Portugal Database]*. http://www.pordata.pt/

Gomis, C. (2018). Mindfulness in children: Exploring measures beyond self-report [Undergraduate Honors Thesis, University of Colorado Boulder]. http://scholar.colorado.edu/downloads/70795815b

Goodman, M. S., Laila, A. M., & Semple, R. J. (2017). Measuring mindfulness in youth: Review of current assessments, challenges, and future directions. *Mindfulness, 8*(6), 1409–1420. https://doi.org/10.1007/s12671-017-0719-9

Greco, L. A., Baer, R. A., & Smith, G. T. (2011). Assessing mindfulness in children and adolescents: Development and validation of the Child and Adolescent Mindfulness Measure (CAMM). *Psychological Assessment, 23*(3), 606–614. https://doi.org/10.1037/a0022819

Hair, J. F., Jr., Anderson, R. E., Babin, B. J., & Black, W. C. (2010). Multivariate data analysis: A global perspective (7th ed.). Pearson education. http://lib.ugent.be/catalog/rug01:001321386

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1–55. https://doi.org/10.1080/10705519909540118

Hu, T., Zhang, D., Wang, J., Mistry, R., Ran, G., & Wang, X. (2014). Relation between emotion regulation and mental health: A meta-analysis review. *Psychological Reports, 114*(2), 341–362. https://doi.org/10.2466/03.20.PR0.114k22w4

Johnson, C., Burke, C., Brinkman, S., & Wade, T. (2017). Development and validation of a multifactor mindfulness scale in youth: The Comprehensive Inventory of Mindfulness Experiences-Adolescents (CHIME-A). *Psychological Assessment, 29*(3), 264–281. https://doi.org/10.1037/pas0000342

Józsa, K., & Morgan, G. (2017). Reversed items in Likert scales: Filtering out invalid responders. *Journal of Psychological and Educational Research, 25*(1), 7–25.

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice, 10*(2), 144–156. https://doi.org/10.1093/clipsy.bpg016

Kallapiran, K., Koo, S., Kirubakaran, R., & Hancock, K. (2015). Review: Effectiveness of mindfulness in improving mental health symptoms of children and adolescents:a meta-analysis. *Child and Adolescent Mental Health, 20,* 182–194. https://doi.org/10.1111/camh.12113

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). The Guilford Press.

Lau, M. A., Bishop, S. R., Segal, Z. V., Buis, T., Anderson, N. D., Carlson, L., Shapiro, S., Carmody, J., Abbey, S., & Devins, G. (2006). The Toronto mindfulness scale: Development and validation. *Journal of Clinical Psychology, 62*(12), 1445–1467. https://doi.org/10.1002/jclp.20326

Laurent, J., Catanzaro, S. J., Joiner, T. E., Jr., Rudolph, K. D., Potter, K. I., Lambert, S., Osborne, L., & Gathright, T. (1999). A measure of positive and negative affect for children: Scale development and preliminary validation. *Psychological Assessment, 11*(3), 326–338. https://doi.org/10.1037/1040-3590.11.3.326

Lawlor, M. S., Schonert-Reichl, K. A., Gadermann, A. M., & Zumbo, B. D. (2014). A validation study of the Mindful Attention Awareness Scale adapted for children. *Mindfulness, 5*(6), 730–741. https://doi.org/10.1007/s12671-013-0228-4

Li, G., Yuan, H., & Zhang, W. (2016). The effects of mindfulness-based stress reduction for family caregivers: Systematic review. *Archives of Psychiatric Nursing, 30*(2), 292–299. https://doi.org/10.1016/j.apnu.2015.08.014

Matos, M., & Gaspar, T. (2008). *Qualidade de vida em crianças e adolescentes - versão portuguesa dos Instrumentos Kidscreen 52* [*Quality of life in children and adolescents – Portuguese version of Kidscreen 52 instruments*]. CMDT & FCT.

Maynard, B. R., Solis, M. R., Miller, V. L., & Brendel, K. E. (2017). Mindfulness-based interventions for improving cognition, academic achievement, behavior, and socioemotional functioning of primary and secondary school students. *Campbell Systematic Reviews, 13*(1), 1–144. https://doi.org/10.4073/CSR.2017.5

Mestre, J. M., Turanzas, J., García-Gómez, M., Guerra, J., Cordon, J. R., De La Torre, G. G., & Lopez-Ramos, V. M. (2019). Do trait emotional intelligence and dispositional mindfulness have a complementary effect on the children's and adolescents' emotional states? *Frontiers in Psychology, 10*(2817). https://doi.org/10.3389/fpsyg.2019.02817

Mohsenabadi, H., Shabani, M. J., Assarian, F., & Zanjani, Z. (2020). Psychometric properties of the child and adolescent mindfulness measure: A psychological measure of mindfulness in youth. *Iran Journal of Psychiatry and Behavioral Sciences, 14*(1), e79986. https://doi.org/10.5812/ijpbs.79986

Moura, O., Leite, M., Albuquerque, C., Vilar, M., Santos, M., Lopes, A., Pereira, M., & Simões, M. (2019). *Inventário de Funcionamento Executivo de Crianças (CHEXI) para pais e professores [The Childhood Executive Functioning Inventory (CHEXI) for parents and teachers]*. https://chexi.se/onewebmedia/CHEXI_Portuguese.pdf

Oberle, E., Schonert-Reichl, K. A., Lawlor, M. S., & Thomson, K. C. (2012). Mindfulness and inhibitory control in early adolescence. *The Journal of Early Adolescence, 32*(4), 565–588. https://doi.org/10.1177/0272431611403741

Oliveira, L., Pereira, M., Medeiros, T., & Serrano, A. (2019). Traducción y adaptación al portugués de la Vanderbilt ADHD Diagnostic Teacher Rating Scale: Un estudo piloto [Translation and

adaptation into Portuguese of Vanderbilt ADHD Diagnostic Teacher Rating Scale: A pilot study]. *Revista de Estudios e Investigación en Psicología y Educación, 6*, 56–67. https://doi.org/10.17979/reipe.2019.6.1.4910

Pallozzi, R., Wertheim, E., Paxton, S., & Ong, B. (2017). Trait mindfulness measures for use with adolescents: A systematic review. *Mindfulness, 8*(1), 110–125. https://doi.org/10.1007/s12671-016-0567-z

Piaget, J. (1965). *The Moral Judgment of the Child*. Harcout-Brace.

Posner, M. I., & Petersen, S. E. (1990). The attention system of the human brain. *Annual Review of Neuroscience, 13*, 25–42. https://doi.org/10.1146/annurev.ne.13.030190.000325

Ravens-Sieberer, U., Gosch, A., Rajmil, L., Erhart, M., Bruil, J., Power, M., Duer, W., Auquier, P., Cloetta, B., Czemy, L., Mazur, J., Czimbalmos, A., Tountas, Y., Hagquist, C., Kilroe, J., & KIDSCREEN Group (2008). The KIDSCREEN-52 quality of life measure for children and adolescents: Psychometric results from a cross-cultural survey in 13 European countries. *Value in health: the Journal of the International Society for Pharmacoeconomics and Outcomes Research, 114*, 645–658. https://doi.org/10.1111/j.1524-4733.2007.00291

Reise, S. P., & Waller, N. G. (2009). Item response theory and clinical measurement. *Annual Review of Clinical Psychology, 5*(1), 27–48. https://doi.org/10.1146/annurev.clinpsy.032408.153553

Roeser, R. W., Galla, B. M., & Baelen, R. N. (2020). Mindfulness in schools: Evidence on the impacts of school-based mindfulness programs on student outcomes in P-12 educational settings (Issue Brief). Edna Bennett Pierce Prevention Research Center, The Pennsylvania State University. https://www.prevention.psu.edu/uploads/files/PSU-Mindfulness-Brief-0223.pdf

Rook, S., Stephenson, N., Ortega, J., de Calvo, M., & Iyer-Eimerbrink, P. (2021). Morality development and its influence on emotion, attitudes, and decision making. *Psychology, 12*, 1722–1741. https://doi.org/10.4236/psych.2021.1210104

Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02

Rueda, M. R., Fan, J., McCandliss, B. D., Halparin, J. D., Gruber, D. B., Lercari, L. P., & Posner, M. I. (2004). Development of attentional networks in childhood. *Neuropsychologia, 42*(8), 1029–1040. https://doi.org/10.1016/j.neuropsychologia.2003.12.012

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online, 8*(2), 23–74.

Schonert-Reichl, K. A., Oberle, E., Lawlor, M. S., Abbott, D., Thomson, K., Oberlander, T. F., & Diamond, A. (2015). Enhancing cognitive and social–emotional development through a simple-to-administer mindfulness-based school program for elementary school children: A randomized controlled trial. *Developmental Psychology, 51*(1), 52–66. https://doi.org/10.1037/a0038454

Shields, A., & Cicchetti, D. (1997). Emotion regulation among school-age children: The development and validation of a new criterion Q-sort scale. *Developmental Psychology, 33*(6), 906–916. https://doi.org/10.1037//0012-1649.33.6.906

Shin, H. S., Black, D. S., Shonkoff, E. T., Riggs, N. R., & Pentz, M. A. (2016). Associations among dispositional mindfulness, self-compassion, and executive function proficiency in early adolescents. *Mindfulness, 7*(6), 1377–1384. https://doi.org/10.1007/s12671-016-0579-8

Tharaldsen, K. (2012). Mindful coping for adolescents: Beneficial or confusing. *Advances in School Mental Health Promotion, 5*(2), 105–124. https://doi.org/10.1080/1754730X.2012.691814

Thorell, L. B., & Nyberg, L. (2008). The Childhood Executive Functioning Inventory (CHEXI): A new rating instrument for parents and teachers. *Developmental Neuropsychology, 33*(4), 536–552. https://doi.org/10.1080/87565640802101516

Tomlinson, E. R., Yousaf, O., Vitterso, A. D., & Jones, L. (2018). Dispositional mindfulness and psychological health: A systematic review. *Mindfulness, 9*(1), 23–43. https://doi.org/10.1007/s12671-017-0762-6

West, A. M., Penix-Sbraga, T., & Poole, D. A. (2005). *Measuring mindfulness in youth: Development of the mindful thinking and action scale for adolescents.* Unpublished manuscript, Central Michigan University, Mt Pleasant, MI.

Wolf, E. J., Harrington, K. M., Clark, S. L., & Miller, M. W. (2013). Sample size requirements for structural equation models: An evaluation of power, bias, and solution propriety. *Educational and Psychological Measurement, 73*(6), 913–934. https://doi.org/10.1177/0013164413495237

Wolraich, M. L., Feurer, I. D., Hannah, J. N., Baumgaertel, A., & Pinnock, T. Y. (1998). Obtaining systematic teacher reports of disruptive behavior disorders utilizing DSM-IV. *Journal of Abnormal Child Psychology, 26*(2), 141–152. https://doi.org/10.1023/A:1022673906401

Zupančič, M., Kavčič, T., Slobodskaya, H. R., & Akhmetova, O. A. (2016). Broad and narrow personality traits predicting academic achievement over compulsory schooling: A cross-sectional study in two countries. *The Journal of Early Adolescence, 36*(6), 783–806. https://doi.org/10.1177/0272431615588954