

**The Longitudinal Association between Mindfulness and School Performance: The
Moderating Role of Sex**

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Word of thanks

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Abstract

Previous cross-sectional and experimental studies have associated increased levels of mindfulness in adolescents with several positive effects, including improved school performance. This longitudinal quantitative study additionally examined the potential mediator attention during homework and whether the effects of mindfulness on school performance and attention during homework differed for boys and girls. A sample of 835 participants ($M_{\text{age}} = 12.69$, $SD_{\text{age}} = 0.75$, 50.3% girls, 49.7% boys) from six secondary educational schools completed self-reported questionnaires three times during a school year in 2014/2015. The study showed that adolescents with higher levels of mindfulness performed better at school. This relationship seemed to be partly explained by attention during homework because higher levels of mindfulness predicted better attention during homework which in turn predicted better performance in school. The effect of mindfulness on both attention during homework and school performance did not differ for boys and girls. The results suggest that schools need to become more aware of the potential positive effects of mindfulness, as it can be a promising way to improve adolescent's performance in school. A relevant direction for future research would be exploring further underlying mechanisms of the relationship between mindfulness and school performance.

Abstract

Eerder cross-sectioneel en experimenteel onderzoek heeft een verhoogde mate van mindfulness onder adolescenten in verband gebracht met betere prestaties op school. Deze longitudinale en kwantitatieve studie heeft daaraan toevoegend onderzocht wat de rol is van de potentiële mediator focus tijdens huiswerk en of het effect van mindfulness verschilt voor jongens en meisjes. De sample van 835 participanten ($M_{\text{leeftijd}} = 12.69$, $SD_{\text{leeftijd}} = 0.754$, 50.3% meisjes, 49.7% jongens) van zes middelbare scholen heeft drie keer in een schooljaar (2014/2015) een zelf-gerapporteerde vragenlijst ingevuld. Deze studie toonde aan dat leerlingen met een hogere mate van mindfulness beter presteerde op school. Deze relatie lijkt gedeeltelijk verklaard te kunnen worden doordat een hogere mate van mindfulness leidde tot betere focus tijdens het maken van huiswerk, wat weer leidde tot betere prestaties op school. Het effect van mindfulness op focus tijdens huiswerk en school prestaties verschilde niet voor jongens en meisjes. Deze resultaten suggereren dat scholen zich meer bewust moeten worden van de mogelijke positieve effecten van mindfulness, want het kan een veelbelovende manier zijn om schoolprestaties van adolescenten te verbeteren. Het zou relevant zijn voor vervolgonderzoek om ook andere onderliggende mechanismen voor de relatie tussen mindfulness en schoolprestaties te onderzoeken.

The Longitudinal Association between Mindfulness and School Performance: The Moderating Role of Sex

In recent years, mindfulness has gained much popularity in the Netherlands (RTL Nieuws, 2018), and specifically among adolescents (RTL Nieuws, 2020). According to Brown and Ryan (2003, p. 113), mindfulness can be described as: “the state of being attentive to and aware of what is taking place in the present”. Mindfulness is often used for stress reduction (Cheek et al., 2017; Morton et al., 2020) and to increase (mental) wellbeing among adolescents (Brown and Ryan, 2003). Moreover, there is also a possible link between mindfulness and school performance. Previous research has indeed shown that higher levels of mindfulness among adolescents are related to better school performance (Bakosh et al., 2016; Beauchemin et al., 2008; Caballero et al., 2019).

To improve the understanding of the relationship between mindfulness and school performance, it is important to examine possible underlying mechanisms such as attention during homework. Specifically, Lu et al. (2016) state that the relationship between mindfulness and school performance is mediated by executive functions. According to Diamond (2013, p. 136), executive functions can be described as: “a family of top-down mental processes needed when you have to concentrate and pay attention, when going on automatic or relying on instinct or intuition would be ill-advised, insufficient, or impossible”. Executive functions are needed for attention during homework. However, the positive effects of mindfulness on school performance may not be the same for all adolescents. Kang et al. (2019) state that the positive effects of mindfulness are greater for girls than for boys. The current longitudinal study examines the relationships between mindfulness, attention during homework and school performance over time and how these relationships differ among boys and girls. This is important because it can provide more insight into factors that positively contribute to adolescents' performance in school.

Mindfulness and School Performance

Several studies have examined the relationship between mindfulness and school performance. These studies were mainly cross-sectional (Caballero et al., 2019) and experimental (Franco et al., 2010). In general, mindfulness was positively related to school performance. For example, the cross-sectional study of Caballero et al. (2019) examined the relationship between the level of mindfulness and objective academic achievement among early adolescents. They found a significant positive relationship between mindfulness and academic performance (i.e., achieved school grades). In addition, the experimental study of Franco et al. (2010) examined the effect of a mindfulness program on academic performance

among adolescents aged between 16 and 18. This study found that the mindfulness training resulted in a significantly greater growth in academic performance in the experimental group compared to the control group.

One possible underlying explanation for the relationship between mindfulness and school performance is the improved attentional capacity caused by better emotion regulation. According to Cicchetti et al. (1991, p. 5) emotion regulation can be defined as: “the capacity to adjust one’s emotional arousal levels so that an optimal intensity of engagement with one’s environment is achieved”. Mindfulness helps a person to regulate emotions and build attentional capacity to become aware of, and less likely to, immediately take action in response to various experiences (Metz et al., 2013). So, people with higher levels of mindfulness are better able to regulate emotions, which is linked to improved attention (Frank et al., 2017; Metz et al., 2013). This makes it easier to set goals and try to achieve them and, therefore, improve school performance (Frank et al., 2017).

The Mediating Role of Attention During Homework

One specific possible underlying mechanism in the relationship between mindfulness and school performance is adolescents’ attention during homework. Specifically, higher levels of mindfulness may result in higher attention during homework, which in turn improves adolescents’ academic performance. Vago and David (2012) described the effect of mindfulness on attention during a task in different steps. An increased degree of mindfulness leads to a greater intention to work with a task, in this case homework. As a result, when the attention shifts from their homework, adolescents are better able to notice this and respond to it. In addition, adolescents feel less satisfaction with engaging in distracting tasks. Because adolescents are more aware of and able to resist possible distractions, they are better able to concentrate during homework. As a result of better concentration during homework tasks, adolescents may achieve higher school grades. Maltese et al. (2012) suggest that when a student is focused on a homework task, the student gets deeper into the study materials. As a result, the student has a better understanding of the study materials, which can lead to higher school grades when the study materials are tested (Maltese et al., 2012).

Several studies have examined the relationship between mindfulness and attention during homework (Anderson et al., 2007; Vago and David, 2012) and between attention during homework and school performance (Maltese et al., 2012; Rodríguez et al., 2019). However, less is known about the mediating role of attention during homework between mindfulness and school performance. Only one study examined this mediating role of attention during homework. The cross-sectional study of Lu et al. (2016) examined the

relation between self-reported mindfulness and academic performance (i.e., school grades) and if this relationship is mediated by executive functions (which is needed to focus on homework) among early adolescents. Participants with the highest levels of mindfulness scored highest on the Chinese, mathematics and English tests. So, there was a positive relationship between mindfulness and academic performance. By adding executive functions to the analysis, the relationship between mindfulness and academic performance became insignificant. Thus, the relationship between mindfulness and academic performance was fully mediated by executive functions.

The Moderating Role of Sex

One possible moderator for the relationships between mindfulness and school performance and between mindfulness and attention during homework is sex. During early adolescence, girls are, on average, twice as likely to have mental problems compared to boys (Kang et al., 2019). Girls have more negative thoughts about themselves and experience more negative moods compared to boys. Increased levels of mindfulness have been linked to improved (mental) wellbeing. Thus, for girls, mindfulness training may have more impact compared to boys, because girls have more mental problems (Kang et al., 2019).

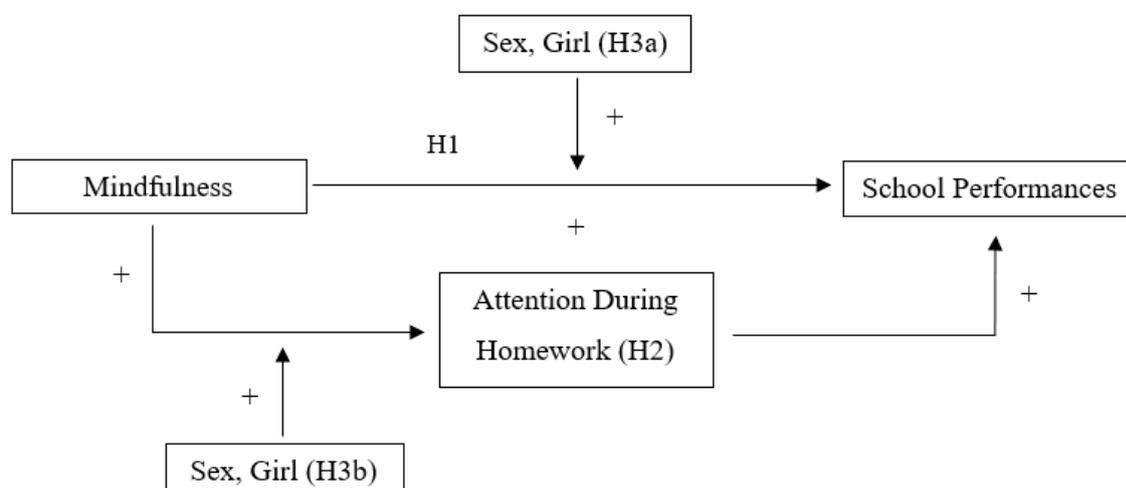
Earlier experimental studies (Kang et al., 2019; van de Weijer-Bergsma et al., 2014) disagree whether the effect of mindfulness is different for boys and girls. While some studies show a stronger effectiveness of mindfulness for girls compared to boys (e.g., Anderson et al., 2007; Kang et al., 2019), other studies suggest that there is no difference for boys and girls (e.g., Chambers et al., 2008; van de Weijer-Bergsma et al., 2014). The experimental study of Kang et al. (2019) examined sex differences in the effectiveness of a school-based mindfulness training intervention among early adolescents. The experimental groups received a six-week mindfulness meditation intervention and the control group did not. Girls from the experimental group scored significantly higher on emotional wellbeing compared to girls from the control group, for boys this effect was not found. In contrast, the experimental study of van de Weijer-Bergsma et al. (2014) did not find a difference for the significant main effect of mindfulness training on, in this case, mental health for boys and girls aged between 8 and 12. Despite that, in this study the assumption is that the effect of mindfulness is greater for girls than for boys because the sample of Kang et al. (2019) better matches the research group of this study compared to the sample of van de Weijer-Bergsma et al. (2014).

The Current Study

This longitudinal study will examine (1) whether a higher degree of mindfulness is related to a better school performance (school grades) over time, (2) whether this relationship

is mediated by attention during homework and (3) if the effect of mindfulness on attention during homework and school performance is moderated by sex (see figure 1.).

Figure 1. The Research Model.



Note. Hypothesis 1 (H1): A higher level of mindfulness is related to better school performance over time. Hypothesis 2 (H2): The relationship between mindfulness and school performance is mediated by attention during homework. Hypothesis 3a (H3a): The relationship between mindfulness and school performance is expected to be stronger for girls. Hypothesis 3b (H3b): The relationship between mindfulness and attention during homework is expected to be stronger for girls.

Methods

Design

Data of the Survey Media Multitasking longitudinal Study conducted in 2014/2015 by a research team of the University of Amsterdam (van der Schuur et al., 2020) was used. Data was collected in three waves during one school year among students in the first and second class of secondary education. The survey was about the possible causal relation between media multitasking and several aspects of early adolescents' functioning.

Participants

The population consisted of Dutch secondary education students aged between 11 and 15 years. Overall, a total of 1443 participants of seven schools participated in this research ($M_{\text{age}} = 12.61$, $SD_{\text{age}} = 0.749$, 49.1% girls, 50.9% boys). However, in total, 608 participants were removed because of missing data on the questions needed for this study or when they

did not participate in all three waves. One school did not provide the research team with the school grades of the students. As a result, all participants of this school were removed in wave 1. In total, 478 cases were removed in wave 1, 112 cases were removed in wave 2 and 18 cases were removed in wave 3. Attrition occurred mainly due to illness, busy school schedules and student numbers that could not be matched (van der Schuur et al., 2020). To examine possible differences between participants and dropouts in wave 2, an attrition analysis was conducted with a linear regression analysis. No significant difference between the participating group and dropouts was found for attention during homework (W2). This attrition analysis was repeated for wave 3. Again, no significant difference was found between the participating group and the dropouts in wave 3 for school performance (W3).

The final sample consisted of 835 participants aged between 11 and 15 years ($M_{\text{age}} = 12.69$, $SD_{\text{age}} = 0.754$, 50.3% girls, 49.7% boys). Of the total sample, 392 participants were in first class of secondary education and 443 participants were in the second class.

Procedure

Before the start of the Media Multitasking Study, ethical approval was obtained from the ethical committee of University of Amsterdam (van der Schuur et al., 2020). Secondary schools were then approached via email. Seven secondary schools agreed to participate in the study and six of these schools also agreed to share school grades for Dutch, English, and mathematics. The questionnaires were conducted three times in a school year, namely in November 2014, March 2015 and June 2015. These moments were chosen because they fell at the end of a school term.

In the Media Multitasking Study, passive informed consent was obtained of the parents and the adolescent. Both the parents and the adolescent received information about the study. In this, it was made clear that participation was completely confidential and voluntary. The online questionnaires were completed in the classroom under the supervision of someone from the research team and the teacher. Completing the questionnaire took about 30 minutes per wave. For participating in a wave, participants received a small incentive (monetary value around € 0.45).

Materials and Instruments

A Dutch questionnaire developed by the research team (van der Schuur et al., 2020) was used in this study. It was a self-reported questionnaire filled out by the students.

Mindfulness

The independent variable, mindfulness, was measured by the validated Mindfulness Attention Awareness Scale-Adolescents (MAAS-A; Brown et al., 2011). The questionnaire

included a selection of 5 items with the highest factor loadings (van der Schuur et al., 2020). Examples of items are: ‘I think it is difficult to keep my attention on what is going on at the moment.’ and ‘I do activities in a hurry without really paying attention to them.’. The questions were answered on a 5-point scale, ranging from 0 = *never* to 4 = *very often*. To make sure that higher scores indicate higher levels of mindfulness, all items were reverse-coded. The reliability of the selection of 5 items from the MAAS-A was very good (Cronbach’s $\alpha = .829$).

School Performance

The dependent variable, school performance, was measured by achieved school grades, ranging between 1 and 10 (van der Schuur et al., 2020). A school grade of 5.5 is considered as sufficient. Higher scores indicate better school performance.

Attention During Homework

The mediating variable, attention during homework, was measured by a self-developed scale based on the SchoolVragenlijst (SVL) by Smits and Vorst (2008). This scale consisted of four items. An example item is: ‘I think it is difficult to keep my mind on homework all the time.’. The questions were answered on a 5-point scale, 0 = *totally untrue* to 4 = *totally true*. To make sure that higher scores indicate higher levels of attention during homework, some items were reverse-coded. The reliability of this scale, based on the SVL, was very good (wave 1: Cronbach’s $\alpha = .873$; wave 2: Cronbach’s $\alpha = .824$).

Sex

The moderating variable, sex, was measured by one question: ‘Are you a boy (coded as 0) or a girl (coded as 1)?’.

Age

The control variable, age, was measured by one question: ‘What is your age?’. The answer options were 11, 12, 13, 14, 15 and other, namely.

Analyses

This study examined the effect of adolescents’ mindfulness on school performance over time. The moderating role of sex and the mediating role of attention during homework were also examined. To test the three hypotheses, multiple regression analyses were conducted. In all analyses an alpha level of .05 was used. Age and (when possible) the wave 1 measure of the wave 2 and wave 3 variables were used in all analyses as control variables.

Before interpreting the results of the multiple regression analyses, the assumptions were checked. The normal distribution of residuals was checked by a normal P-P Plot of the standardized residuals. The residuals were normally distributed. Homoscedasticity and

linearity were checked by a scatterplot. The residuals were equally distributed and the assumption of linearity seemed to be met. Multicollinearity was checked with the VIF values. No values above 5.00 were found. In addition, the correlations between variables were lower than .80 (see Table 2), thus the assumption of multicollinearity was met.

To assess the direct relationship between mindfulness and school performance (hypothesis 1), mindfulness (W1) was used as an independent variable and school performance (W3) as a dependent variable.

To assess the mediating role of attention during homework on the relationship between mindfulness and school performance (hypothesis 2), four multiple linear regression analyses were conducted using the Baron and Kenny method. First, the direct relationship between mindfulness (W1) as independent variable and school performance (W3) as dependent variable was examined. Second, the relationship between mindfulness (W1) as independent variable and attention during homework (W2) as dependent variable was examined. Third, the relationship between attention during homework (W2) as independent variable and school performance (W3) as dependent variable was examined. Lastly, the relationship between attention during homework (W2) and school performance (W3) controlled for the direct effect of mindfulness was examined.

To assess the moderating role of sex (hypothesis 3) on the relationships between mindfulness (W1) as independent variable and school performance (W3) as dependent variable (hypothesis 3a) and mindfulness (W1) as independent variable and attention during homework (W2) as dependent variable (hypothesis 3b), two multiple linear regression analyses were conducted. Sex was used as control variable and the interaction term between mindfulness (W1) and sex was used as a moderating variable.

Results

Descriptive Statistics

All descriptive statistics are shown in table 1. The total sample ($N = 835$) had a mean of 2.71 on mindfulness, which is a bit above the midpoint of the scale. On the other hand, the sample scored under the midpoint of the attention during homework scale (W1: $M = 1.97$, $SD = 0.89$; W2: $M = 1.99$, $SD = 0.85$). The mean score of school performance decreased slightly from wave 1 ($M = 6.88$, $SD = 0.95$) to wave 3 ($M = 6.72$, $SD = 0.97$).

Table 1

Descriptive Statistics of the Total Sample (N = 835)

Variables	Minimum	Maximum	<i>M</i>	<i>SD</i>
Age	11.00	15.00	12.69	0.75
Mindfulness W1	0.00	4.00	2.71	0.76
Attention during Homework W1	0.00	4.00	1.97	0.89
Attention during Homework W2	0.00	4.00	1.99	0.85
School Performance W1	3.17	9.57	6.88	0.95
School Performance W3	3.20	9.43	6.72	0.97

All correlations between the variables are shown in table 2. Mindfulness and school performance were significantly related in the expected direction, namely higher scores on mindfulness were related to higher scores on school performance. As expected, higher scores on mindfulness were significantly related to higher scores of attention during homework and attention during homework was significantly related to higher scores on school performance. The control variable age was significantly related to the dependent variable school performance W1 and W2, but not to the independent variables mindfulness W1 and attention during homework W1 and W2.

Table 2

Bivariate Correlations Between All Variables.

Variables	1	2	3	4	5	6	7
1. Sex	1.00						
2. Age	-.004	1.00					
3. Mf W1	.038	-.055	1.00				
4. ADH W1	-.051	-.054	.502**	1.00			
5. ADH W2	-.069*	-.064	.459**	.746**	1.00		
6. SP W1	.135**	-.301**	.169**	.172**	.140**	1.00	
7. SP W3	.147**	-.069*	.201**	.177**	.192**	.566**	1.00

Note. Mindfulness W1 was used as the independent variable and school performance W3 as dependent variable. Attention during homework W2 was used as mediating variable and sex as moderating variable. As control variables attention during homework W1, school performance W1 and age were used. * $p \leq .05$, ** $p \leq .01$

Mindfulness and School Performance

A multiple linear regression analysis was conducted to predict school performance from the level of mindfulness. School performance was expected to be higher with higher levels of mindfulness. The control variables school performance W1 and age significantly predicted 33.2% of the variance in school performance W3, $F(2, 832) = 206.71, R^2 = .33, p < .001$ (see table 3). The addition of the independent variable mindfulness W1 in step 2 predicted another 1.2% of the variance of school performance W3, $\Delta F(1, 831) = 14.57, \Delta R^2 = .01, p < .001$. In combination, the three predictors explained 34.1% of the variance in school performance W3, $F(3, 831) = 144.91, R^2 = .34, \text{adjusted } R^2 = .34, p < .001$. In addition, there was a small significant positive effect of mindfulness on school performance W3, $B = .14, t(834) = 3.82, p < .001, 95\% \text{ CI} = [0.07, 0.21], \Delta \text{Cohen's } f^2 = 0.02$. Thus, adolescents with higher levels of mindfulness seem to perform better at school over time.

Table 3

Regression Analysis Summary for Mindfulness Predicting School Performance.

Variable	R^2	Adj. R^2	R^2 change	Cohen's f^2	F	df	p	B	[95% CI]	β
Step 1	0.33	0.33	0.33	0.49	206.71	(2, 832)	< .001			
SP W1							< .001	.61	[0.52, 0.67]	0.60
Age							< .001	.14	[0.07, 0.22]	0.11
Step 2	0.34	0.34	0.01	0.51	144.91	(3, 831)	< .001			
SP W1							< .001	.59	[0.53, 0.65]	0.58
Age							< .001	.14	[0.07, 0.22]	0.11
Mf W1							< .001	.14	[0.07, 0.21]	0.11

Note. Step 1 Predictors: school performance (SP) W1 and Age (control variables). Step 2 added the independent variable Mindfulness (Mf) W1.

The Mediating Role of Attention During Homework

Three multiple linear regression analyses with the Baron and Kenny method were conducted to examine the mediating role of attention during homework on the relationship between mindfulness and school performance over time. Against the backdrop of the significant main effect of mindfulness on school performance, the relationship between mindfulness and attention during homework was examined. The control variables attention during homework W1 and age and the independent variable mindfulness W1 explained 56.5% of the variance in attention during homework W2, $F(3, 831) = 362.48$, $R^2 = .57$, adjusted $R^2 = .57$, $p < .001$ (see table 4). In addition, there was a small positive effect of mindfulness on attention during homework, $B = .13$, $t(834) = 4.24$, $p < .001$, 95% CI = [0.07, 0.18], Δ Cohen's $f^2 = 0.06$. So, adolescents with higher levels of mindfulness seem to have better attention during homework.

Table 4

Regression analysis summary for Mindfulness Predicting Attention during homework.

Variable	R^2	Adj. R^2	R^2 change	Cohen's f^2	F	df	p	B	[95% CI]	β
Step 1	0.56	0.56	0.56	1.27	524.01	(2, 832)	< .001			
ADH W1							< .001	.71	[0.67, 0.76]	0.75
Age							.304	-.03	[-0.08, 0.02]	-0.02
Step 2	0.57	0.57	0.01	1.33	362.48	(3, 831)	< .001			
ADH W1							< .001	.66	[0.61, 0.71]	0.69
Age							.368	-.02	[-0.07, 0.03]	-0.02
Mf W1							< .001	.13	[0.07, 0.18]	0.11

Note. Step 1 predictors: attention during homework (ADH) W1 and age (control variables). Step 2 added the independent variable mindfulness W1.

Next, the relationship between attention during homework and school performance was examined. The control variables attention during homework W1, school performance W1 and age and the independent variable attention during homework W2 explained 58.8% of the variance in school performance W3, $F(4, 830) = 109.51$, $R^2 = .35$, adjusted $R^2 = .34$, $p < .001$ (see Table 5). There was a also small positive effect of attention during homework on school performance, $B = .14$, $t(834) = 2.97$, $p = .003$, 95% CI = [0.48, 2.36], Δ Cohen's $f^2 = 0.03$. So, adolescents with higher levels of attention during homework seem to perform better at school.

Table 5

Regression Analysis Summary for Attention During Homework Predicting School Performance.

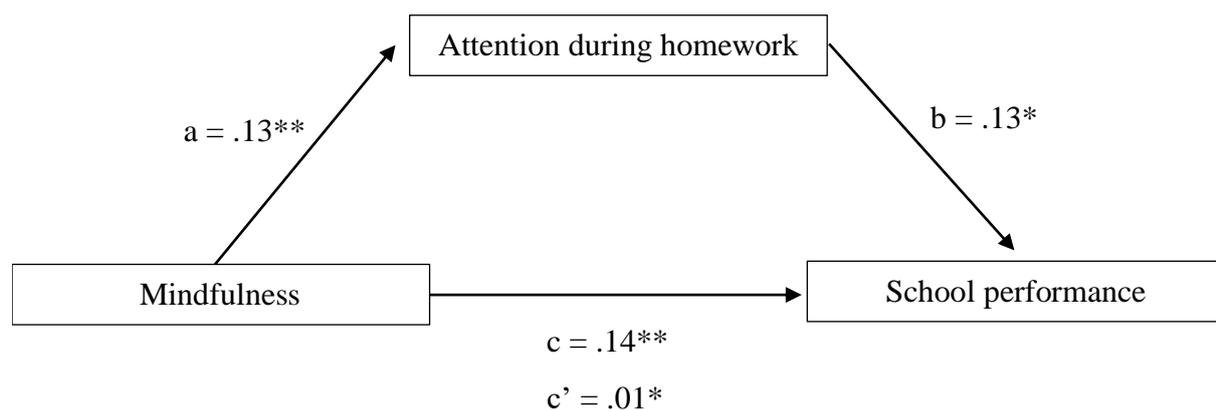
Variable	R^2	Adj. R^2	R^2 change	Cohen's f^2	F	df	p	B	[95% CI]	β
Step 1	0.34	0.34	0.34	0.51	141.75	(3, 831)	< .001			
SP W1							< .001	.60	[0.54, 0.66]	0.57
ADH W1							.004	.09	[0.03, 0.15]	0.08
Age							< .001	.14	[0.07, 0.22]	0.11
Step 2	0.35	0.34	0.01	0.54	109.51	(4, 830)	< .001			
SP W1							< .001	.60	[0.54, 0.66]	0.59
ADH W1							.796	-.01	[0.54, 0.71]	-0.01
Age							< .001	.15	[-0.10, 0.08]	0.11
ADH W2							.003	.14	[0.05, 0.24]	0.13

Note. Step 1 predictors: attention during homework (ADH) W1, school performance (SP) W1 and age (control variables). Step 2 added the independent variable attention during homework (ADH) W2

Lastly, the relationship between attention during homework and school performance controlled for mindfulness was examined. Attention during homework W1, school performance W1 and age significantly predicted 33.9% of the variance in school performance W3, $F(3, 831) = 141.75, R^2 = .34, p < .001$ (see table 6). The addition of mindfulness W1 predicted another 0.6 % of the variance in school performance W3, $\Delta F(1, 830) = 7.64, \Delta R^2 = .01, p < .001$. The next addition of attention during homework W2 predicted another 0.5 % of the variance in school performance W3, $\Delta F(1, 829) = 6.76, \Delta R^2 = .01, p < .001$. In combination, the five predictors explained 34.6% of the variance in school performance W3, $F(5, 829) = 89.22, R^2 = .35, \text{adjusted } R^2 = .35, p < .001$.

In addition, mindfulness and attention during homework were significant predictors of school performance in step 3 (see table 6). Attention during homework had a significant positive effect on school performance, $B = .13, t(834) = 2.60, p < .001, 95\% \text{ CI} = [0.03, 0.22]$ Mindfulness had also a significant positive effect on school performance, $B = .10, t(834) = 2.37, p < .001, 95\% \text{ CI} = [0.02, 0.18]$. A Sobel-test suggested that the mediation effect was significant ($p = .025$). As can be seen in figure 2, the relationship between mindfulness and school performance was partially mediated by attention during homework.

Figure 2. The Partially Mediated Relationship Between Mindfulness and School Performance by Attention During Homework.



Note. * $p \leq .05$, ** $p \leq .01$

Table 6

Regression Analysis Summary for Attention During Homework Predicting School Performance Controlled for the Main Effect of Mindfulness.

Variable	R^2	Adj. R^2	R^2 change	Cohen's f^2	F	df	p	B	[95% CI]	β
Step 1	0.34	0.34	0.34	0.51	141.75	(3, 831)	< .001			
SP W1							< .001	.60	[0.54, 0.66]	0.59
ADH W1							.004	.09	[0.03, 0.15]	0.08
Age							< .001	.14	[0.07, 0.22]	0.11
Step 2	0.35	0.34	0.01	0.54	109.01	(4, 830)	< .001			
SP W1							< .001	.59	[0.53, 0.65]	0.58
ADH W1							.243	.04	[-0.03, 0.11]	0.04
Age							< .001	.14	[0.07, 0.22]	0.11
Mf W1							.006	.12	[0.03, 0.20]	0.09
Step 3	0.35	0.35	0.01	0.54	89.22	(5, 829)	< .001			
SP W1							< .001	.59	[0.53, 0.65]	0.58
ADH W1							.386	-.04	[-0.14, 0.05]	-0.04
Age							< .001	.15	[0.07, 0.22]	0.11
Mf W1							.018	.10	[0.02, 0.18]	0.08
ADH W2							.010	.13	[0.03, 0.22]	0.11

Note. Step 1 predictors: attention during homework (ADH) W1, school performance (SP) W1 and age (control variables). Step 2 added the independent variable mindfulness W1. Step 3 added the mediating variable attention during homework W2.

The Moderating Role of Sex

To test if the relationship between mindfulness and school performance is stronger for girls compared to boys, a multiple linear regression analysis was conducted. The centered variable $\text{sex} \times \text{mindfulness}$ was not a significant predictor of school performance W3, $B = .11$, $t(834) = 1.54$, $p = .399$, 95% CI = [-0.03, 0.25] (see table 7). This suggest that there is no difference for boys and girls in the effect of mindfulness on school performance.

In addition, it was tested whether the relationship between mindfulness and school performance was stronger for girls compared to boys. Again, the centered variable $\text{sex} \times \text{mindfulness}$ was not a significant predictor of attention during homework W2, $B = .07$, $t(834) = 1.31$, $p = .190$, 95% CI = [-0.03, 0.17]. There seems to be no difference for boys and girls in the effect of mindfulness on attention during homework.

Table 7

Regression Analysis Summary for Mindfulness Predicting School Performance and the moderating role of sex.

Variable	R^2	Adj. R^2	R^2 change	F	df	p	B	[95% CI]	β
Step 1	0.33	0.33	0.33	206.71	(2, 832)	< .001			
SP W1						< .001	.61	[0.55, 0.67]	0.60
Age						< .001	.14	[0.07, 0.22]	0.11
Step 2	0.34	0.34	0.01	144.91	(3, 831)	< .001			
SP W1						< .001	.59	[0.53, 0.65]	0.58
Age						< .001	.14	[0.07, 0.22]	0.11
Mf W1						< .001	.14	[0.07, 0.21]	0.11
Step 3	0.35	0.35	0.01	89.10	(5, 829)	< .001			
SP W1						< .001	.58	[0.52, 0.64]	0.57
Age						< .001	.14	[0.07, 0.22]	0.11
Mf W1						.101	.08	[-0.02, 0.18]	0.07
Sex						.399	-.17	[-0.56, 0.23]	-0.09
Sex*Mf						.125	.11	[0.03, 0.25]	0.17

Note. Step 1 predictors: school performance (SP) W1 and age (control variables). Step 2 added the independent variable mindfulness W1. Step 3 added the moderating variable sex. All variables used in this analysis were centered.

Table 8

Regression Analysis Summary for Mindfulness Predicting attention during homework and the moderating role of sex.

Variable	R^2	Adj. R^2	R^2 change	F	df	p	B	[95% CI]	β
Step 1	0.56	0.56	0.56	524.01	(2, 832)	< .001			
ADH W1						< .001	.71	[0.67, 0.76]	0.75
Age						.304	-.03	[-0.08, 0.02]	-0.02
Step 2	0.57	0.57	0.01	362.48	(3, 831)	< .001			
ADH W1						< .001	.66	[0.61, 0.71]	0.69
Age						.368	-.02	[-0.07, 0.03]	-0.02
Mf W1						< .001	.13	[0.07, 0.18]	0.11
Step 3	0.57	0.57	0.00	219.05	(5, 829)	< .001			
ADH W1						< .001	.65	[0.61, 0.70]	0.68
Age						.382	-.02	[-0.07, 0.03]	-0.02
Mf W1						.012	.10	[0.02, 0.17]	0.09
Sex						.087	-.25	[-0.53, 0.04]	-0.15
Sex*Mf						.190	.07	[-0.03, 0.17]	0.12

Note. Step 1 predictors: attention during homework (ADH) W1 and age (control variables). Step 2 added the independent variable mindfulness W1. Step 3 added the moderating variable sex. All variables used in this analysis were centered.

Discussion

In this study, the association between mindfulness and school performance including the mediating role of attention during homework and the moderating role of sex was examined. This research showed that higher levels of mindfulness were associated with better school performance. This relation was partly mediated by attention during homework. Thus, higher levels of mindfulness predicted better attention during homework, which in turn predicted better school performance. The effect of mindfulness on school performance and attention during homework did not differ for boys and girls.

Mindfulness and School Performance

A positive association between mindfulness and school performance was found. This implies that a higher level of adolescents' mindfulness was associated with better school performance over time. This finding can be compared to previous cross-sectional and experimental findings that showed a positive association between mindfulness and school performance as well (e.g. Caballero et al., 2019; Franco et al., 2010). This may be caused by the increasing concentration and focus associated with mindfulness, which makes adolescents better able to set goals and reach them (Frank et al., 2017; Metz et al., 2013). It is valuable that the results of this longitudinal study support the results of the cross-sectional and experimental studies, because hereby it seems to be confirmed that mindfulness and school performance are also related over a longer period of time and not just on a snapshot. In addition, this study has provided more insight into the effect of mindfulness in school performance specifically for the Netherlands.

The Mediating Role of Attention During Homework

In line with the second hypothesis, the relationship between mindfulness and school performance was (partly) mediated by attention during homework. Thus, a higher level of mindfulness was associated with better attention during homework, which in turn was associated with better school performance. According to Vago and David (2012), adolescents with higher levels of mindfulness are better able to resist distraction during homework and therefore go deeper into the lesson materials, which leads to better school performance.

The result of the current study is partly consistent with the previous study of Lu et al. (2017). In the study of Lu et al. (2017) the relationship between mindfulness and school performance was *fully* mediated by executive functions. The measurement executive functions may explain the difference in results between the two studies. Attention during homework, measured in the current study, is a small part of the overarching executive functions measured in the study by Lu et al. (2017). Despite that, also in this study the main effect after adding

attention during homework was very small, but still significant. This suggests that other underlying mechanisms are conceivable. This may be a relevant direction for future research.

The Moderating Role of Sex

Contrary to the expectations of the third hypothesis, there was no difference for boys and girls in the effect of mindfulness on school performance and attention during homework. The experimental studies of Anderson et al. (2007) and Kang et al. (2019) showed that the effect of mindfulness interventions was bigger for girls than for boys. One possible explanation for the deviating result of this study compared to the study of Kang et al. (2019) are the measurements. Kang et al. (2019) examined the differences in the effect of mindfulness training on *emotional wellbeing*, whereas this study examined the effect of mindfulness on school performance. Kang et al. (2019) suggested that the effect of mindfulness training for adolescent girls was greater than for boys, because girls have more emotional problems compared to boys. It may be that these emotional problems and emotional wellbeing are not related and comparable to school performance, what caused the different results. In addition, previous studies also did not fully agree on the moderating role of sex on the effect of mindfulness (e.g., Anderson et al., 2007; Chambers et al., 2008; Kang et al., 2019; van de Weijer-Bergsma et al., 2014). It can be concluded that not enough is known yet and that the moderating role of sex on the effect of mindfulness will need to be further investigated.

Strengths and limitations

This study has several strengths. First, this study is based on longitudinal data, which makes it possible to draw conclusions over time. Second, for the measurements only validated scales were used and this contributes to the internal validity of the data and the results. Third, an attrition analysis was conducted to control if the dropout groups differed from the participating groups. There were no differences between the groups what contributes to a non-biased sample.

However, the findings reported here face a number of limitations as well. First, participants were not randomly selected to participate, what makes this study less generalizable to the adolescent population aged between 11 and 15. The questionnaires were completed at seven secondary schools throughout the Netherlands. The current study included data from 6 of these schools. The Netherlands has many schools with their own educational vision and interpretation which attracts specific students (Rijksoverheid, n.d.). Therefore, it is likely that not everyone was represented in this sample. It is important to keep this in mind when drawing conclusions, because these results may give a distorted picture of reality.

Second, the quantitative research design makes it harder to focus on understanding the whole context of the problem. In this study a small part of the context is investigated without the opportunity to ask for further details such as ways in which homework is done, how much time they spend on their homework, whether they are actively engaged in mindfulness, how they are engaged in mindfulness etc. The ability to ask further questions helps to identify the problem even more precisely and it would provide a lot of additional information.

This study shows that mindfulness can positively affect school performance of adolescents. Schools should become more aware of this and respond to it. Students should be guided on how to increase their mindfulness so that they will perform better at school and profit from other positive effects (e.g. increased mental wellbeing). In addition to schools, for example parents, sports clubs, municipalities and the government can also play a role in increasing mindfulness among adolescents. They should be committed to help adolescents with increasing mindfulness. But, to properly help adolescents with this, further research is needed on strategies to increase adolescents' mindfulness.

In addition, It would be good to repeat the study with a randomized sample, what makes the results more generalizable to all adolescents. It is also relevant to explore other underlying mechanisms for the relationship between mindfulness and school performance. This study found that this relationship cannot yet be fully explained by attention during homework and that it would be helpful to investigate other aspects of executive functions (e.g. self-monitoring and working memory) as well.

Conclusion

There is growing knowledge about the positive effects of mindfulness for adolescents' wellbeing and school performance. This study found that higher levels of mindfulness seem to lead to better school performance and this relationship is mediated by attention during homework. Efforts to heighten awareness in schools about the positive effects of mindfulness should be made, because increasing mindfulness is a very promising way to improve adolescents' performance in school.

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Appendices

Appendix 1 Syntax

* Het verwijderen van missings

```
COMPUTE filter_$=(NMISS(MFN1, MFN2, MFN3, MFN4, MFN5, Nederlands_1,
    Engels_1, Wiskunde_1, CTH2, CTH1, CTH3, CTH4) <1).
VARIABLE LABELS filter_$ 'NMISS(MFN1, MFN2, MFN3, MFN4, MFN5, Nederlands_1,
    Engels_1, '+ 'Wiskunde_1, CTH2, CTH1, CTH3, CTH4) <1 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
```

```
COMPUTE filter_$=(NMISS(CTH1_2, CTH2_2, CTH3_2, CTH4_2)<1).
VARIABLE LABELS filter_$ 'NMISS(CTH1_2, CTH2_2, CTH3_2, CTH4_2)<1 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
```

```
COMPUTE filter_$=(NMISS(Nederlands_3, Engels_3, Wiskunde_3)<1).
VARIABLE LABELS filter_$ 'NMISS(Nederlands_3, Engels_3, Wiskunde_3)<1 (FILTER)'.
VALUE LABELS filter_$ 0 'Not Selected' 1 'Selected'.
FORMATS filter_$ (f1.0).
FILTER BY filter_$.
EXECUTE.
```

*Het ompolen van de attention variabelen, item 1, 2 en 3. Dit om ervoor te zorgen dat een hogere score een hogere mate van attetion is. Item 4 krijgt alleen een andere naam.

```
RECODE CTH1 CTH2 CTH3 (0=4) (1=3) (2=2) (3=1) (4=0) INTO Att1_1 Att2_1 Att3_1.
EXECUTE.
```

RECODE CTH4 (0=0) (1=1) (2=2) (3=3) (4=4) INTO Att4_1.
EXECUTE.

RECODE CTH1_2 CTH2_2 CTH3_2 (0=4) (1=3) (2=2) (3=1) (4=0) INTO Attention1_2
Attention2_2 Attention3_2.
EXECUTE.

RECODE CTH4 (0=0) (1=1) (2=2) (3=3) (4=4) INTO Attention4_2.
EXECUTE.

* Het ompolen van de mindfulness variabelen. Dit om ervoor te zorgen dat een hogere score een hogere mate van mindfulness is.

RECODE MFN1 MFN2 MFN3 MFN4 MFN5 (0=4) (1=3) (2=2) (3=1) (4=0) INTO
Mindfulness1_1 Mindfulness2_1 Mindfulness3_1 Mindfulness4_1 Mindfulness5_1.
EXECUTE.

* Mean score van mindfulness wave 1

COMPUTE Mindfulness_W1=(Mindfulness1_1 + Mindfulness2_1 + Mindfulness3_1 +
Mindfulness4_1 + Mindfulness5_1) / 5.
EXECUTE.

* Mean scores van school performance voor wave 1 en 3

COMPUTE SchoolP_W1=(Nederlands_1 + Engels_1 + Wiskunde_1) / 3.
EXECUTE.

COMPUTE SchoolP_W3=(Nederlands_3 + Engels_3 + Wiskunde_3) / 3.
EXECUTE.

*Attrition analysis

```
RECODE Attention_W2 (0 thru 4=1) (ELSE=0) INTO Dummy_Attention_W2.
EXECUTE.
```

```
REGRESSION
```

```
/DESCRIPTIVES MEAN STDDEV CORR SIG N
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT SchoolP_W1
/METHOD=ENTER Dummy_Attention_W2.
```

```
SELECT IF (NMISS(CTH1, CTH2, CTH3, CTH4, MFN1, MFN2, MFN3, MFN4, MFN5,
      Nederlands_1, Engels_1, Wiskunde_1)<1).
EXECUTE.
```

```
RECODE SchoolP_W3 (0 thru 10=1) (ELSE=0) INTO Dummy_SchoolP_W3.
EXECUTE.
```

```
REGRESSION
```

```
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT Dummy_SchoolP_W3
/METHOD=ENTER Attention_W2.
```

* Discriptive statistics voor de attention wave 1 en 2

```
DESCRIPTIVES VARIABLES=Attention_W2
/STATISTICS=MEAN STDDEV MIN MAX.
```

```
DESCRIPTIVES VARIABLES=Attention_W1
/STATISTICS=MEAN STDDEV MIN MAX.
```

* Betrouwbaarheids analyse voor attention Wave 1 en 2

RELIABILITY

```
/VARIABLES=Attention1_2 Attention2_2 Attention3_2 Attention4_2
/SCALE('ALL VARIABLES') ALL
/MODEL=ALPHA
/SUMMARY=TOTAL.
```

RELIABILITY

```
/VARIABLES=Att1_1 Att2_1 Att3_1 Att4_1
/SCALE('ALL VARIABLES') ALL
/MODEL=ALPHA
/SUMMARY=TOTAL.
```

* Descriptive statistics voor mindfulness wave 1

```
DESCRIPTIVES VARIABLES=Mindfulness_W1
/STATISTICS=MEAN STDDEV MIN MAX.
```

* Betrouwbaarheidsanalyse voor mindfulness wave 1

RELIABILITY

```
/VARIABLES=Mindfulness1_1 Mindfulness2_1 Mindfulness3_1 Mindfulness4_1
Mindfulness5_1
/SCALE('ALL VARIABLES') ALL
/MODEL=ALPHA
/SUMMARY=TOTAL.
```

* Descriptive statistics voor school performance wave 1 en 3

```
DESCRIPTIVES VARIABLES=SchoolP_W3
/STATISTICS=MEAN STDDEV MIN MAX.
```

```
DESCRIPTIVES VARIABLES=SchoolP_W1
  /STATISTICS=MEAN STDDEV MIN MAX.
```

*Assumpties controleren

REGRESSION

```
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT SchoolP_W3
/METHOD=ENTER SchoolP_W1 Attention_W1 Attention_W2 Mindfulness_W1 SEX
  AGE
/SCATTERPLOT=(*ZRESID ,*ZPRED)
/RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
```

REGRESSION

```
/MISSING LISTWISE
/STATISTICS COEFF OUTS R ANOVA COLLIN TOL
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT Attention_W2
/METHOD=ENTER SchoolP_W1 Attention_W1 Mindfulness_W1 SEX AGE SchoolP_W3
/SCATTERPLOT=(*ZRESID ,*ZPRED)
/RESIDUALS HISTOGRAM(ZRESID) NORMPROB(ZRESID).
```

* Correlation Matirx

CORRELATIONS

```
/VARIABLES=SEX Mindfulness_W1 Attention_W1 Attention_W2 SchoolP_W1
  SchoolP_W3
/PRINT=TWOTAIL NOSIG
/MISSING=PAIRWISE.
```

* Regressie H1

REGRESSION

```

/DESCRIPTIVES MEAN STDDEV CORR SIG N
/MISSING LISTWISE
/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT SchoolP_W3
/METHOD=ENTER AGE SchoolP_W1
/METHOD=ENTER Mindfulness_W1.

```

* Mediatie van attention during homework op relatie tussen mindfulness en school performance

REGRESSION

```

/DESCRIPTIVES MEAN STDDEV CORR SIG N
/MISSING LISTWISE
/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT SchoolP_W3
/METHOD=ENTER AGE SchoolP_W1
/METHOD=ENTER Mindfulness_W1.

```

REGRESSION

```

/DESCRIPTIVES MEAN STDDEV CORR SIG N
/MISSING LISTWISE
/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT Attention_W2
/METHOD=ENTER AGE Attention_W1
/METHOD=ENTER Mindfulness_W1.

```

REGRESSION

```

/MISSING LISTWISE
/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT SchoolP_W3
/METHOD=ENTER AGE SchoolP_W1 Attention_W1
/METHOD=ENTER Attention_W2.

```

REGRESSION

```

/DESCRIPTIVES MEAN STDDEV CORR SIG N
/MISSING LISTWISE
/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE
/CRITERIA=PIN(.05) POUT(.10)
/NOORIGIN
/DEPENDENT SchoolP_W3
/METHOD=ENTER AGE SchoolP_W1 Attention_W1
/METHOD=ENTER Mindfulness_W1
/METHOD=ENTER Attention_W2.

```

CORRELATIONS

```

/VARIABLES=Mindfulness_W1 Attention_W2
/PRINT=TWOTAIL NOSIG
/STATISTICS DESCRIPTIVES XPROD
/MISSING=PAIRWISE.

```

* Moderator analysis H3

```

DESCRIPTIVES VARIABLES=Mindfulness_sex Mindfulness_W1 SEX
/STATISTICS=MEAN STDDEV MIN MAX.

```

```

DESCRIPTIVES VARIABLES=AGE
/STATISTICS=MEAN STDDEV MIN MAX.

```

```
DESCRIPTIVES VARIABLES=SchoolP_W1  
/STATISTICS=MEAN STDDEV MIN MAX.
```

```
COMPUTE Mindfulness_sex=Mindfulness_W1 * SEX.  
EXECUTE.
```

```
COMPUTE Std_inter_Mind_sex=Mindfulness_sex - 1.3756.  
EXECUTE.
```

```
COMPUTE Std_Mind_T1=Mindfulness_W1 - 2.7056.  
EXECUTE.
```

```
COMPUTE Std_AGE=AGE - 12.69.  
EXECUTE.
```

```
COMPUTE Std_SchoolP_W1=SchoolP_W1 - 6.8762.  
EXECUTE.
```

```
COMPUTE Std_Att_W1=Attention_W1-1.97.  
EXECUTE.
```

```
COMPUTE Std_Att_W2=Attention_W2-1.99.  
EXECUTE.
```

REGRESSION

```
/DESCRIPTIVES MEAN STDDEV CORR SIG N  
/MISSING LISTWISE  
/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE  
/CRITERIA=PIN(.05) POUT(.10)  
/NOORIGIN  
/DEPENDENT SchoolP_W3  
/METHOD=ENTER Std_AGE Std_SchoolP_W1  
/METHOD=ENTER Std_Mind_T1
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/METHOD=ENTER SEX Std_inter_Mind_sex.

REGRESSION

/MISSING LISTWISE

/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE

/CRITERIA=PIN(.05) POUT(.10)

/NOORIGIN

/DEPENDENT Attention_W2

/METHOD=ENTER Std_Att_W1 Std_AGE

/METHOD=ENTER Std_Mind_T1

/METHOD=ENTER SEX Std_inter_Mind_sex.

REGRESSION

/MISSING LISTWISE

/STATISTICS COEFF OUTS R ANOVA

/CRITERIA=PIN(.05) POUT(.10)

/NOORIGIN

/DEPENDENT SchoolP_W3

/METHOD=ENTER AGE SchoolP_W1 Attention_W1

/METHOD=ENTER Attention_W2.

REGRESSION

/MISSING LISTWISE

/STATISTICS COEFF OUTS CI(95) R ANOVA CHANGE

/CRITERIA=PIN(.05) POUT(.10)

/NOORIGIN

/DEPENDENT SchoolP_W3

/METHOD=ENTER AGE SchoolP_W1 Attention_W1

/METHOD=ENTER Attention_W2.