



Mind-wandering, depression, anxiety and ADHD: Disentangling the relationship

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ABSTRACT

Background: Mind Wandering (MW) has been associated with ADHD in a very small number of studies with adults and children. However, anxiety and depression have also been associated with MW and both are often comorbid with ADHD. The aim of this study was to investigate the role of anxiety and depression in MW in patients with ADHD.

Methods: The Mind Excessively Wandering Scale (MEWS) compared the levels of MW controlling for the presence of anxiety and depression symptoms in 78 adolescents (53 males and 25 females) comprising ADHD, clinical controls and typically developing individuals. Correlational analysis between MEWS score, demographic variables, ADHD, anxiety and depressive symptoms was performed using simple and multiple linear regression analysis demonstrating that only anxiety predicted MW scores. On a second analysis, we compared Anxiety and Non-Anxiety as well as ADHD and non-ADHD groups.

Results: Levels of MW were significantly correlated with anxiety symptoms, but not with depression. In addition, there were no differences in ADHD and non-ADHD groups regarding MW levels.

Conclusions: Our results suggest MW is associated with anxiety levels, independently of an ADHD diagnosis.

1. Introduction

The *dynamic* nature of thoughts [also referred as “daydreaming” (Singer, 1966), “stimulus-independent thought” (Antrobus, 1968), “task-unrelated thought” (Giambra, 1989) and “mind-wandering” (Antrobus et al., 1970)] had been studied for decades, but only in the past fifteen years Mind Wandering came into focus in cognitive neuroscience. Smallwood & Schooler (2015) defined Mind Wandering as a shift in the contents of thought away from an ongoing task and/or from events in the external environment.

Mind Wandering (MW) is a universal human experience, occurring in about 24–50% of the waking hours in the general population (Song and Wang, 2012; Seli et al., 2015). MW maybe either deliberate (conscious) or unintentional/spontaneous (unconscious) and this last form has been considered as a consequence of executive dysfunction (Seli et al., 2015). The deliberate MW refers to a self-generated internal thought that is intentional, such as a person planning the night activity while driving a car. The spontaneous MW is an unintentional shift of thought state, such when the mind drifts off during a lecture or other activity needing sustained attention (Mowlem et al., 2016).

Spontaneous MW is often associated with work and academic impairment (McVay and Kane, 2009)

Spontaneous MW has been associated with Attention-Deficit Hyperactivity Disorder (ADHD) symptoms: inattention (Smallwood and Schooler, 2006), hyperactivity (Seli et al., 2013) and impulsivity (Cheyne et al., 2011). A recent literature review (Lanier et al., 2019) identified only 11 studies on the association between MW and ADHD, 10 of them with adults (mainly non-referred samples) and 1 with children.

Mowlem et al., 2016. developed the Mind Excessively Wandering Scale (MEWS), a 12-item self-report questionnaire that measures spontaneous MW, encompassing the sensation of the mental excessively activity, multiples thoughts occurring in the same time, thoughts that jump or flit from one topic to another and frequently sensation of confused mind. The excessively spontaneous MW can be felt like a mental restlessness, which is frequent in ADHD: adults commonly refer thoughts on the go, thoughts that jump or flit from one issue to another, and multiple lines of thoughts at the same time (Asherson, 2005). Although WM has been demonstrated in different disorders, a number of studies has suggested that it is more frequently found in ADHD

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(Franklin et al., 2014; Seli et al., 2015).

Besides the very small number of studies, there are a few shortcomings in current literature. First, the vast majority of studies have investigated MW in non-clinical adult samples and there is no data on adolescents or even clinical samples. Second, MW has been correlated with ADHD symptomatology, not ADHD diagnosis. Third, there are no studies controlling for common comorbid conditions like anxiety and depression which are also associated with MW and have high comorbidity rates with ADHD. This last aspect makes conclusions about the correlation between MW and ADHD hard to interpret.

The aim of this study was to investigate the contributing role of anxiety and depression to MW in adolescents with ADHD. For this purpose, we evaluated individuals with ADHD, clinical controls and typically developing individuals using the Brazilian Portuguese version of MEWS previously validated in Brazilian Portuguese by our group (Figueiredo et al., 2018). Our hypothesis is that MW is not correlated to ADHD, but with anxiety and /or depression levels in adolescents with ADHD.

2. Methods

2.1. Participants

This study is part of a larger study on clinical and neuropsychological aspects of ADHD and Learning Disabilities. Seventy-eight subjects (53 males and 25 females) were either referred by health professionals or schools and were sorted in two groups: a) clinical controls (patients with learning disabilities, depressive and/or anxious symptoms, all of them without ADHD) and typically developing individuals; b) ADHD individuals with or without comorbidities (learning disabilities, depressive and/or anxious symptoms). For the purposes of this study individuals with ADHD comorbid with Autism Spectrum Disorder were not included.

Exclusionary criteria were patients with IQ lower than 80, any Communication Disorder, psychiatric disorders other than anxiety and depression. Diagnoses were made by board certified psychiatrists based on clinical, neuropsychological and clinical data based on the DSM-5.

All participants provided a written informed consent to participate; this study was approved by the Ethics Committee of Instituto D'Or de Pesquisa e Ensino (IDOR), Rio de Janeiro, Brazil. Overall, individuals studied in private schools and most came from a high socioeconomic stratum according to CCEB (Brazilian Economic Classification Criteria) classification.

2.2. Instruments and measures

The Brazilian Portuguese adaptation of Mind Excessively Scale (MEWS) was administered to all participants. We opted to use the same cut-off from the original version (total score ≥ 15) to define the excessively mind wandering. IQ scores were calculated using the Brazilian adapted version of the Wechsler Intelligence Scale for Children (WISC-IV). Anxiety symptoms were addressed with the Child Anxiety Related Emotional Disorders (SCARED) questionnaire (Birmaher et al., 1999), using the 25-point cutoff. Depressive symptoms were investigated with Child Depression Inventory (CDI) (Kovacs, 1992), using the 12-point cutoff.

We administered the Parent Rating Scale [Swanson, Nolan and Pelham-IV (SNAP-IV) questionnaire] developed to investigate ADHD symptoms (Swanson, 1992) adapted to Brazilian Portuguese by Mattos et al. (2006). The instrument contains 26 items that evaluate Inattention (9 items), Hyperactivity/Impulsivity (9 items) and Opposition (8 items). For the purpose of this study, only the first 9 items (addressing inattention symptoms) were included in our analyzes.

2.3. Statistical analysis

We adopted a 0.05 two-tailed significance threshold (α) for all statistical tests, using SPSS 20.0. The assumption of normality was checked for all variables using the Smirnov—Kolmogorov test.

When normality assumption could not be attained, we performed *bootstrapping* with 5000 samples, as suggested by others (Efron and Tibshirani, 1993).

Our statistical analysis comprised three consecutive steps:

- correlation of MEWS, anxiety, depression, inattention symptoms, IQ and age (continuous variables) in the entire sample; this aimed to investigate which variables were correlated to MW (MEWS). We chose to report Spearman's correlation, as it does not require data to be normally distributed, and could also be applied to non-linear relationship, a limitation of Pearson's correlation (Liu et al., 2016).
- regression analysis based on findings from (a); this aimed to investigate whether anxiety, depression and inattention symptoms could predict MW. Multicollinearity was assessed according to previously suggested criteria (Myers, 1990). When the assumption of homogeneity of variance (homoskedasticity) could not be attained, we used heteroskedasticity-consistent standard error estimators (Hayes and Cai, 2007) to reduce the effects of heteroskedasticity on inference, as it does not assume homoskedasticity.
- group comparisons (ADHD and non-ADHD; anxiety and non-anxiety). First, we investigated if there are any gender differences among dependent variables (using chi-square test). Then, we performed *t*-test to compare groups. For the ADHD x non-ADHD comparison, the independent variable was ADHD diagnosis and dependent variables were MEWS, SCARED, CDI, SNAP-IV, IQ and age. For the Anxiety x Non-Anxiety, these subgroups were based on SCARED cutoff (Anxiety with higher anxious symptoms and Non-Anxiety with lower anxious symptoms). In this last comparison, the independent variable was SCARED and dependent variables were MEWS, CDI, SNAP-IV, IQ and age.

3. Results

The demographic characteristics of all subjects ($n = 78$) is shown in Table 1. The groups did not differ on age, gender, educational level in years and IQ (Table 2). Participants were predominantly Caucasian (97%).

Correlation analysis showed a significant positive correlation for MW (MEWS scores) and inattention $r = 0.40$, $p = .001$, as expected. There was also a significant positive correlation between MW and anxiety scores (SCARED) $r = 0.48$, $p < .001$; there was also a significant positive correlation for MW and depression scores (CDI) $r = 0.40$, $p < .001$. Results from the correlation analysis of MW levels with IQ and age were non-significant (Table 2). Following the correlational

Table 1
Demographics characteristics of the subjects.

Parameter	ADHD ($n = 38$)	Non-ADHD ($n = 40$)	Anxiety ($n = 43$)	Non-anxiety ($n = 35$)
Age, yr (mean + SD)	13.87 (1.65)	14.21 (1.61)	13.82 (1.45)	14.34 (1.81)
Sex,% (M/F)	29/9	24/16	25/18	24/11
Race,%				
White	89	92.5	95.3	94.2
Black	10.5	7.5	4.6	5.7
Asian	0	0	0	0
Other	0	0	0	0
Educational level, years (mean + SD)	7.05 (1.91)	7.74 (1.88)	7.51 (1.86)	7.24 (1.93)
IQ (mean + SD)	100.2 (9.51)	107.43 (10.7)	106.35 (10.9)	101.38 (11.28)

Table 2

Correlational analysis results between sociodemographic variables and anxiety, depression and mind-wandering symptoms. The SCARED score shows higher correlation with MEWS score compared to the other parameters.

Measure	1	2	3	4	5	6
1. MEWS Score	–					
2. SCARED Score	.48**	–				
3. CDI Score	.40**	.56**	–			
4. Inattention (SNAP-IV)	.40*	.14	.20	–		
5. IQ	–0.07	.05	.19	–0.31*	–	
6. Age	.21	–0.04	.21	.01	–0.05	–

* Significance level at $p < .01$.

** Significance level at $p < .001$.

IQ = intelligence quotient. CDI = Child Depression Inventory. SCARED = Screen for Child Anxiety Related Emotional Disorders. MEWS = Mind Excessively Wandering Scale.

analysis, a simple linear ordinary least-squares regression analysis was conducted to predict MW symptoms (MEWS scores) based on anxiety symptoms (SCARED scores), which had the highest correlation with WM on the previous step. A significant regression was found [$F(1, 78) < 23.74$; $p < .001$] with a R^2 of 0.233. MEWS score was equal to $11.22 + 0.28$ (SCARED score) points.

However, when inattention symptoms (SNAP-IV) was included in our model also as a predictor, along with SCARED scores, a significant regression was found [$F(2, 77) = 19.48$; $p < .001$], resulting in an adjusted R^2 of 0.336, accounting for 10.3% extra variance of the dependent variable. In this model, MEWS score was equal to $6.37 + 0.25$ (SCARED score) + 1.00 (SNAP-IV) points. Fig. 1 shows the relationship between SCARED and SNAP-IV with MEWS scores.

Depressive symptoms (CDI scores) also significantly correlated with MEWS scores ($p < .01$). When included in the model as a predictor along with SCARED scores and SNAP-IV, it resulted in a significant regression [$F(3, 76) = 13.82$; $p < .001$]. However, including the

Table 3

T-test results between ADHD and Non-ADHD groups.

Groups	ADHD (<i>n</i> = 38)	Non-ADHD (<i>n</i> = 40)			
Variables	Mean (S.D.)	Mean (S.D.)	<i>t</i>	df	<i>p</i> -value
Age	13.87 (1.65)	14.21 (1.61)	–0.94	78	.35
IQ	102.11 (9.83)	105.43 (10.26)	–1.48	78	.14
CDI Score	12.76 (5.92)	14.58 (8.68)	–1.34	72	.18
SCARED Score	25.74 (11.89)	27.57 (12.12)	–0.68	78	.50
Inattention (SNAP-IV)	6.16 (2.09)	5.33 (2.38)	1.64	78	.11
MEWS Score	19.92 (6.75)	17.67 (7.08)	1.45	78	.15

S.D. = Standard Deviation. IQ = intelligence quotient. CDI = Child Depression Inventory. SCARED = Screen for Child Anxiety Related Emotional Disorders. MEWS = Mind Excessively Wandering Scale.

variable in the model resulted in an adjusted R^2 of 0.353, indicating its addition explained only 1.7% more additional variation in the data than would be expected from an unrelated variable. In addition, although the regression model was significant ($p < .001$), depressive symptoms only resulted in a non-significant predictor ($p = .16$). Thereby, we decided not to include it in our model.

Groups' comparison results (anxiety versus non-anxiety; ADHD and non-ADHD) are shown in Tables 3 and 4. First, we compared an anxiety group and a non-anxiety group. No significant difference in gender frequency between groups was found [$\chi^2(1, N = 80) = 0.44$, $p = .63$]. T-test results showed that anxiety groups had a significant higher score on the MEWS scale.

We compared ADHD group (all patients with an ADHD diagnosis) and a clinical non-ADHD group, both without high SCARED scores. No significant differences in gender frequency between groups was found [$\chi^2(1, N = 80) = 0.42$, $p = .63$]. T-test results showed that patients MEWS scores did not significantly differ between groups.

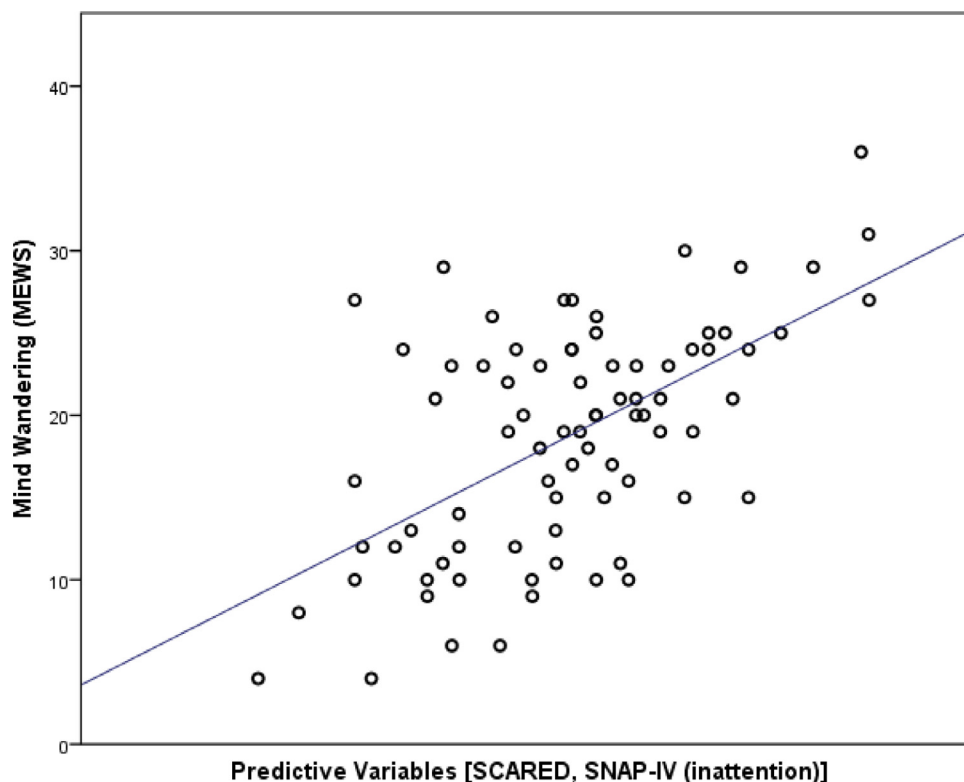


Fig. 1. Scatterplot of MEWS Scores with SCARED Scores and SNAP-IV inattention symptoms. Regression line shows the relationship of anxiety and inattention symptoms with mind wandering [$F(2, 77) = 19.48$; $p < .001$].

Table 4

T-test results between Anxiety and Non-Anxiety groups.

Groups	Anxiety (n = 43)	Non-Anxiety (n = 35)			
Variables	Mean (S.D.)	Mean (S.D.)	t	df	p-value
Age	13.82 (1.45)	14.34 (1.81)	-1.38	64	.17
IQ	104.42 (10.73)	103.11 (9.42)	0.57	78	.57
CDI Score	17.09 (8.09)	9.91 (4.36)	4.74**	70	<.001
Inattention (SNAP-IV)	6.00 (2.12)	5.37 (2.43)	1.23	78	.22
MEWS Score	20.44 (5.98)	16.54 (7.61)	2.57*	63	.02

S.D. = Standard Deviation. IQ = intelligence quotient. CDI = Child Depression Inventory. MEWS = Mind Excessively Wandering Scale.

* Significance level at $p < .05$.

** Significance level at $p < .001$.

4. Discussion

The aim of this study was to investigate the contributing role of anxiety and depression to Mind Wandering (MW) in adolescents with ADHD, since there is a high comorbidity rate among these disorders. To our knowledge, this is the first study to investigate MW in a clinical sample of adolescents diagnosed with ADHD according to DSM-5 criteria.

MW has been strongly associated with ADHD in previous studies, an association considered to be not only common but also impairing, “calling for more clinical and scientific attention to the subject” in a recent review (Lanier et al., 2019). However, MW has been also associated with different developmental stages (Maillet et al., 2018), medication use (Raymond et al., 2019) and even Alzheimer's disease (El Haj et al., 2019) and cannot be considered a “hallmark” of ADHD. The role of depression and anxiety in MW has also been emphasized in the literature and both are common comorbid disorders in ADHD. Disentangling the relationship between anxiety, depression and ADHD may contribute to a better understanding of MW. Of note, MW symptoms are quite similar to some DSM-5 defined anxiety symptoms: individuals presenting high anxiety levels experience more off-task thoughts and have greater difficulty to manage their minds (Aldao et al., 2010).

We documented higher scores in MEWS in those individuals presenting high scores of anxiety and depressive symptoms, *independently of the presence of ADHD*. Although anxiety may promote an adaptive state of improved vigilance and defense mobilization according to some studies (for example, Grillon and Charney, 2011), most studies agree that several cognitive functions may be impaired by higher levels of anxiety, including attentional lapses and weaker concentration among them (Robinson et al., 2011). Anxious individuals are often unable to stay focused on tasks and display impaired executive control mechanisms which help maintain goal-directed behaviors (Bishop, 2009).

In our sample, anxiety measured by a quantitative scale (SCARED) could predict 23.3% of MEWS variation. However, there were no differences between ADHD and non-ADHD regarding MEWS scores, an unexpected finding, in contrast to results from studies investigating adults and children with ADHD, albeit with different methodologies and statistical analyzes. Of note, most studies on ADHD and MW have used symptoms count instead of clinical diagnoses; we have used both strategies. Using clinical diagnosis according to DSM-5 criteria, there are no differences between ADHD and non-ADHD regarding MW. When we use symptoms count (inattention scores on SNAP-IV), there is a correlation between inattention and MW.

Our results suggest that anxiety levels are *mediator* of MEWS scores, even in individuals with ADHD. Because the most recent literature review (Lanier et al., 2019) on the subject emphasizes that MW is common in ADHD, one would expect that current treatment strategies for ADHD would indirectly impact MW. However, if MW is correlated with anxiety and not ADHD, a different outcome could be expected.

There are some suggestions that MW have a positive effect on planning and creativity, but the negative content of MW like rumination about errors have the potential to adversely impact mood (Smallwood et al., 2009). Rumination is a subtype of MW which is common in depression and correlated to maintenance and severity of the depressive episode (Robinson and Alloy, 2003; Nolen-Hoeksema, 1991). Increased negative rumination have been associated with higher risk of suicide (Morrison and O'Connor, 2008). In our study, depressive symptoms also significantly correlated with MEWS scores; a result similar to other studies (Raymond et al., 2019; El Haj et al., 2019; Jonkman et al., 2017). However, we could not predict additional variation in MW when anxiety is included in the model, because of multicollinearity.

Our study has some limitations. First, the sample size was small, limiting statistical power. A second limitation is the reliance on self-reported measures, which are prone to subjective variability among otherwise comparable individuals. However, this aspect is intrinsic to most psychiatric research.

This study is part of a larger study on clinical and neuropsychological aspects of ADHD and Learning Disabilities. We intend to investigate how MW correlates to communication abilities (in particular pragmatic language skills).

CRedit authorship contribution statement

Tiago Figueiredo: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Validation, Visualization, Writing - original draft, Writing - review & editing. **Gabriel Lima:** Data curation, Formal analysis, Investigation, Methodology, Software. **Pilar Erthal:** Investigation. **Rafael Martins:** Investigation. **Priscila Corção:** Data curation. **Marcelo Leonel:** Data curation. **Vanessa Ayrão:** Formal analysis, Investigation. **Dídia Fortes:** Formal analysis, Investigation. **Paulo Mattos:** Conceptualization, Formal analysis, Methodology, Project administration, Supervision, Writing - review & editing.

Declaration of Competing Interest

The authors Tiago Figueiredo, Gabriel Lima, Pilar Erthal, Rafael Martins, Priscila Corção, Marcelo Leonel, Vanessa Ayrão and Dídia Fortes does not have conflicts of interest.

Paulo Mattos reports personal fees from Shire, outside this study.

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