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Research Article

Clinical Improvement in Adult Patients with Attention-Deficit/Hyperactivity Disorder Under Psychopharmacological Treatment: Influence on Personality Traits and Mind-Wandering

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Abstract

Background: ADHD is a neurodevelopmental disorder that affects adolescents and, less frequently, adults. Mind-wandering (MW) is a transdiagnostic construct commonly observed in individuals with (ADHD). Although it is not included in diagnostic classifications, it has a functional impact on patients with ADHD.

Aim of the Study: To provide a detailed analysis of the differences in the effects of ADHD after six months of pharmacologic treatment versus treatment as usual, focusing on MW, quality of life, and personality dimensions. It is hypothesized that MW decreases with treatment, and that certain personality dimensions may also change as a result of the intervention.

Methods: First, a review of studies on MW indexed in PubMed is conducted. Subsequently, two groups of individuals with ADHD-those receiving pharmacological treatment and those receiving treatment as usual-are compared. The analysis focuses on differences in quality of life, MW and personality dimensions after six months.

Result: Significant differences were observed between the treatment and non-treatment ADHD groups in terms of quality of life, particularly regarding life productivity. Both groups showed a decrease in MEWS (Mind Excessively Wandering Scale) scores after six months, although the reduction was more pronounced in the treatment group. Openness to experience showed a positive correlation with scores on the MEWS. Conversely, conscientiousness showed a negative correlation with MEWS. Additionally, a predominance of hyperactivity was associated with higher levels of extraversion. Interestingly, a negative ADHD diagnosis was linked to increased agreeableness scores, highlighting potential personality differences based on diagnostic status.

Conclusion: Patients with ADHD who receive stimulant treatment show improvements in quality of life and reductions in MW, as well as some changes in personality dimensions when compared to those receiving treatment as usual. These findings underscore the important role that MW plays in ADHD, both as a clinically relevant symptom and as a potential treatment target.

Keywords: *ADHD; Mind-Wandering; Personality Dimensions; Quality of Life*

Introduction

ADHD is a chronic neuropsychiatric disorder that manifests in childhood and can persist into adulthood; it affects approximately 5.9% of youths and 2.5% of adults worldwide [1,2]. ADHD is associated with neurobiological dysfunctions, particularly in the regulation of the dopaminergic and noradrenergic systems, as well as functional deficits in executive control and attention networks [3-5].

MW is a multi-dimensional construct or the process of shifting your attention away from the external environment to focus on your thoughts or feelings; it is a common occurrence in everyday life and constitutes up to 50% of each waking day [6-11].

Subsequently, a comprehensive review of MW is conducted, addressing its neurobiology, phenomenology, clinical relevance, and treatment approaches, as well as its association with the most frequently related psychiatric disorders, including ADHD. This review is based on articles published in PubMed.

Mind wandering

MW has been used to describe several different but related cognitive processes including thoughts that are self-generated, task-unrelated, task-related, or stimulus independent, as well as intentional (deliberate, voluntary) and unintentional thoughts (spontaneous, involuntary) [9,12,13]. MW as an umbrella term for heterogeneous thought constructs [12], including terms such as daydreaming, rumination, and off-task thoughts. However, the most commonly used term has been MW [13,14].

This phenomenon is characterized by an inability to focus on the current task and is a state of consciousness that occurs spontaneously during wakefulness. It involves occupation with internal mental representations rather than thoughts determined by subjective conscious decisions. Researchers have suggested that MW is closely related to attention and control [15] and that differences in the content and frequency of MW reflect interindividual differences in levels of these traits [16].

Other definition of MW is a spontaneous cognition, may be any mental content that is activated or retrieved automatically, that is, immediately, effortlessly, without conscious deliberation or intent [17-19].

MW can be conceptualized along three key dimensions: spontaneous, unintentional thought; deliberate, intentional MW; and becoming aware of task-unrelated thought [20].

MW was shown to occur in the form of inner speech, mental imagery (or sounds), or both, and to refer to future plans, problem-solving, and past recollections (e.g. daydreaming [21]; spontaneous thoughts that wander are characterized by wander moving from one subject to another without purpose [22]. No consensus exists on the definition of MW [12].

MW content tends to be drifting rather than stable [23].

Christoff., *et al*. [22] considered thought dynamics as the defining criterion of MW: Spontaneous thought arises relatively freely, unregulated by deliberate (i.e. cognitive control) or automatic (i.e. affective and sensory salience) constraints on its content and transitions. MW according to the dynamic view, is best defined by its dynamics: Thoughts wandering quickly from one topic to another without a definite course or goal.

There are phenomena related to MW, including rumination and maladaptive daydreaming.

Rumination is primarily characterized by its perseverative nature and negative content, including negatively biased memories and worries about the future [24]. It may be considered a form of MW [25] it has also been considered distinct from MW [22] or as thought to share some features with it [26].

There are differences between more freely moving MW from rumination (past-focused) and worry (future-focused). While both (MW and perseverative negative thinking (PNT) are task-unrelated, MW is characterized by a free flow of thoughts across topics, whereas PNT involves repetitive fixation on the same negative theme [22,27]. Thus, the main difference between MW and ruminative thinking is that MW is a form of free, unguided, internal thought, whereas rumination includes cognitions that focus on a specific topic [22,23].

A particularly notable and pervasive phenomenon is the decline in task performance over time, known as the vigilance decrement [28-30]. Importantly, current theoretical accounts of the vigilance decrement have emphasized the involvement of MW in the decline of performance over time-on-task According to these theories, the vigilance decrement occurs because available attentional resources are diverted from the primary task to the MW process, which itself requires and consumes cognitive resources [14,31,32].

The "resource-control" model proposed by Thomson., *et al.* [33], which offers a compelling framework for understanding performance decline over time on cognitive tasks-especially as it relates to MW. MW is conceived as the default cognitive state. To stay focused during vigilance tasks, individuals must exert executive control to suppress this tendency and keep task goals active. Over time, this control weakens, allowing the default state (MW) to re-emerge and impair performance.

MW is more prevalent during easy tasks because these tasks demand less cognitive control, leaving more resources available for off-task thoughts. Additionally, unintentional MW-arising without conscious intent-is more frequent than intentional MW, regardless of task difficulty, suggesting that lapses in executive control are a primary driver of MW [34-36]. An alternative theory is that the experience of a lapse is an attentionally resource-demanding process [14,37].

Intentional MW tends to occur during tasks that are monotonous, repetitive, and cognitively undemanding. Because such tasks require minimal executive control, individuals may choose to disengage and direct their attention inward, unlike unintentional MW, which results from lapses in control.

Cognitive models suggest that individuals with higher cognitive abilities are more effective at regulating MW in response to task demands. They are less likely to experience involuntary attentional lapses and more capable of sustaining goal-directed attention during cognitively demanding tasks [38-40].

Cognitive approaches to MW generally take one of two positions. The first, known as the executive-control failure hypothesis, posits that MW does not require executive resources to occur. Instead, MW is seen as a spontaneous, disruptive process that interrupts ongoing task performance. According to this view, executive control processes are needed to inhibit MW and maintain task-relevant focus. When these control mechanisms are weakened-due to fatigue, low motivation, or increased cognitive load-MW is more likely to intrude, resulting in lapses of attention and diminished task performance [41,42]. In contrast, proponents of the decoupling hypothesis [14] assert that cognitive resources are necessary and consumed when MW enters conscious awareness. This perspective views MW as an active process that involves shifting attention away from external tasks toward internally generated thoughts, which requires the engagement of executive resources to maintain and manipulate these thoughts. A core principle of this perspective is that distancing oneself from the current environment and experiencing a sort of 'cognitive hijacking' of executive resources helps to support other goals that are personally meaningful [14]. The executive process may also be essential for MW because MW itself is a process that consumes resources, as proposed by the Executive Control Hypothesis [14]. Recent research has also combined these two perspectives on the role of executive processes, both of which support the initiation and continuation of MW through the Process-Occurrence Framework [43]. This framework reconciles the two approaches by distinguishing between the cognitive processes involved in MW-specifically activation and maintenance-and associating only the maintenance process with resource demands [43]. Although the executive-control failure and

decoupling hypothesis suggests that MW experiences can be triggered or activated automatically [14,44], the remaining conflict lies in how the two hypotheses perceive the cognitive demands involved in MW experiences. By focusing on the dynamics of thought over its content, this model aligns with the Dynamic Framework of Thought [22,27], which conceptualizes MW as thoughts moving rapidly from topic to topic without a definite course or purpose [23,45]. Such a process may be at the root of distraction and inattention [46-48].

The increase in MW in response to sustained attention demands in ADHD suggests a problem of resource allocation when facing heightened demands for sustained attention. This finding is consistent with the cognitive-energetic model [49,50].

As attentional demands increase, more frequent MW would be associated with a reduced capacity to allocate cognitive resources, thereby impairing task performance.

Continuous thoughts have mostly been studied through the lens of the 'what' and 'when'-that is, the content of thoughts and the situations in which they arise, respectively [51]. Less attention has been paid to an equally important dimension of thoughts: the 'how'-that is, the manner in which thoughts fluctuate and evolve over time. In the Dynamic Framework of Spontaneous Thought, Christoff and colleagues [22] proposed that the dynamics of thoughts are shaped by various types of constraints acting upon them.

Maladaptive daydreaming

It is more deliberate, more aware, and more coherent or guided than MW. Dorsch (2015) [45] further clarified the differences between MW and daydreaming by introducing the concept of a "focused daydream"-a deliberate withdrawal from the surrounding environment to engage in a structured narrative of imaginary events, consciously crafted with heightened mental agency. According to Dorsch, MW is described in contrast as segmented, quite spontaneous, with reduced agency and lack of unity.

Dreaming, MW, and daydreaming may lie along a continuum, sharing similar brain mechanisms and functional structures. A possible alternative interpretation is that individuals who engage in more frequent daydreaming may be more attuned to their internal states and subjective experiences. Such heightened introspective awareness may aid in the encoding and recall of dream experiences [52,53].

According to Klinger (1971) [54], a daydream is an imaginative thought with elaborate content, unlikely to occur in real life, arising more volitionally than spontaneously, and intended to provide distraction, mental escape, or amusement.

External distractions occur when salient external events disrupt our engagement in the task. Finally, one can be off-task while not being able to report any specific object of thought (no daydream and no particular event in the environment), and this is what we single out as blank [55].

Daydreaming is a kind of intense MW with fantastical dream-like qualities. Daydreaming disorder, more commonly referred to as maladaptive daydreaming, characterises a mental condition in which individuals frequently engage in episodes of excessive and absorbing daydreaming. This often leads to functional impairment, goal-neglect and in particular, heightened levels of negative emotion [56].

There are several differences: the spontaneous, nondeliberate nature of the thoughts interrupting other engagements in MW, compared with the often purposeful activation of the daydreaming state in MD.

What differentiates MW from maladaptive daydreaming (MD) is its lack of guidance, the scattered nature of thought content, and the way thoughts unfold without conscious attentional effort to monitor or direct them MW content tends to be drifting rather than stable

[23]. Maladaptive daydreaming (MD), on the other hand, may be more appropriately classified as a dissociative disorder or a behavioral addiction, rather than simply an attentional impairment [57]. One of the off-task states distinct from both MW and MD is blank.

Blank

One of the off-task states is blank. Operationally, we define blank as the absence of any content in mental reports (together with off-task orientation). The absence of reportable content is not necessarily equivalent to absent mindedness.

Blank being the more profound disconnection from the task at hand, external distraction and daydream an intermediate level, TRI and Focus demonstrating two levels of deeper connection with the task [55].

Hyperfocus

Another attention related concept involving narrowing of focus and immersion into a specific stimulus associated with ADHD is the concept of hyperfocus [58]. Like dissociative absorption, hyperfocus is also characterized by an intense engrossment in one's subject of interest while disregarding other goals, commitments, and even body feelings.

However, hyperfocus is often associated with external rather than internal subjects of interest, which can vary [59].

As an externally directed shift of attention, it differs quite significantly from shifting one's focus toward internally generated content.

Developmental trajectory of MW across age

A recent meta-analysis [60] suggests that laboratory studies investigating age-related differences in MW consistently reveal a robust reduction in MW among older adults compared to younger adults. These findings support the conclusion that MW tends to decrease with age.

Factors such as task difficulty, conscientiousness, task interest, and the amount of current concerns may be key contributors to age-related differences in the frequency of MW. Task demand is only one of many factors-including task interest, alertness level, sleepiness, and physiological and mental states-that contribute to unintentional MW [60].

Obsessive-compulsive disorder (OCD)

Certain obsessive-compulsive thoughts can be conceptualized as an uncontrollable and unwanted form of MW, characterized by their persistent, intrusive, and distressing nature [34,61]. The frequency of spontaneous, future-oriented MW may serve as a predictor of obsessive-compulsive (O-C) symptoms. MW is not exclusive to ADHD; it is also prevalent in clinical depression and OCD [34,62,63]. MW involves a shift of attention from external stimuli to internal cognitive processes-such as memories, daydreams, semantic knowledge, and future-oriented thoughts. Similarly, OCD tendencies often involve spontaneous and intrusive internal experiences, and both phenomena can arise unexpectedly [34,64]. More specifically, the intrusive nature of OC thoughts parallels the concept of spontaneous MW, which refers to cognitions that emerge involuntarily and with minimal control over their content [22].

Spontaneous, but not deliberate, MW was found to predict both the type and extent of OCD symptoms in a non-clinical student population [34].

Additionally, future-oriented MW has been linked to important functions like goal-directed thinking and creativity [80,109]. Therefore, maladaptive future-oriented MW may play a significant role in the difficulties faced by individuals living with OCD symptoms.

Consequences of MW

The consequences of MW focused on the future showed an association with a subsequent improvement in mood, suggesting that positive and future-oriented MW may tend to occur together [65].

Conversely, past-focused MW was associated with reports of negative mood, indicating past and negative-MW may come close to one another [65,66].

Also, there are association between MW and negative consequences such as deficits in reading comprehension [67-69], disruptions in working memory [70,71], car accidents [72,73] and problems with workplace functioning [74] MW can have a negative impact on a person's overall mood and their ability to perform tasks that require intense concentration. It can also be associated with feelings of guilt and low mood (e.g. negative fantasizing) and poor attention control (e.g. difficulty concentrating on current tasks) types. Frequent MW increases unhappiness [8,75,76].

Several positive functions of MW have been reported, such as its contributions to creativity [77,78], problem solving [79,80], autobiographical planning and adaptation to changing situations and long-term goals [74,80] and facilitating future planning, helping us make successful long-term plans, as goal-directed cognitions [81].

Many adaptive functions of MW, such as supporting prospective memory [83], escaping boredom during undemanding tasks [80,74] and creative insights [13,84].

Musical activities can facilitate spontaneous cognitive phenomena, such as MW and creative thinking [22,27].

The content of MW also significantly influences the emotions that follow. MW helps to create and maintain an integrated and meaningful sense of self [174].

Intentional MW is, at times, associated with beneficial functions like the ability to reflect on one's inner experiences in a non-reactive manner. and creativity [86].

MW relates to personal differences such as meta-awareness [14,87] or emotional state [8,88].

MW and ADHD

People who are diagnosed with ADHD are at increased risk for experiencing task unrelated thoughts [93], specifically MW [18,89].

MW spontaneous is a nondeliberate mental activity of changing thoughts with little awareness to their ongoing occurrence. MW commonly does not involve meta-awareness. how the relationship between ADHD and MW was mediated by the lack of awareness, suggesting decreased metacognition and little sense of agency when the mind wanders [14].

The dynamic perspective on MW suggests it is best described as thoughts that shift quickly from one topic to another without a clear direction or purpose [23]. It is marked by three key features often linked to ADHD, the first being: (1) spontaneous, involuntary thoughts that disrupt ongoing activities. Indeed, this uncontrolled shift of attention inward was found to be more strongly associated with ADHD than a self-initiated shift to different unrelated thoughts [89]. (2) Lack of awareness or decreased meta-cognition. ADHD is reported to be characterized by zoning out or structure [67]. Indeed, a lack of meta-awareness mediated the relationship between ADHD and MW [90]; that is, scattered thought contents. MW thoughts evolve without attentional conscious effort to keep track of the content and thus tend to be drifting rather than stable [23]. Such a dynamic thought pattern is considered the prototypical distraction pattern characterizing ADHD [91].

ADHD is strongly associated with "spontaneous MW," that is, spontaneous thoughts that lack intentionality, purpose, and coherence [89]. Moreover, it is argued chat MW cannot be considered as both roaming-free thoughts and an agentic, controlled action [92].

MW share a common mechanism, the presence of MW exacerbates ADHD symptoms and other cognitive functions, leading to higher levels of psychopathology, increased emotional dysregulation, and reduced quality of life [63].

Individuals with ADHD-particularly those with inattentive symptoms-typically aren't caught up in repetitive thoughts. Instead, they tend to experience mental restlessness, often described as excessive MW, where multiple thoughts, including off-task ones, occur simultaneously [63,91]. Continuous mental activity lacking the stability of a topic as well as consistency in content [93]. These findings align with the observation that the physical restlessness seen in individuals with pronounced hyperactive symptoms often becomes internalized in adulthood [93,94]. This internalization is reflected in the experience of racing thoughts [94]. This type of MW is thought to be a core feature of ADHD, contributing to the disorder's characteristic symptoms and impairments [63].

Both excessive MW and maladaptative dreaming (MD) may result in an overlap with some ADHD inattention symptoms (e.g. Frequently has trouble maintaining attention, often appears not to listen when spoken to directly, regularly fails to follow through on instructions or complete tasks, commonly struggles with organizing tasks and activities, and is easily distracted by unrelated stimuli) [95].

ADHD has been theoretically linked to greater fluctuations in thought content over time [22,96]. Specifically, individuals with higher levels of ADHD symptoms tend to experience more variability in their thoughts, with task-unrelated thoughts being more varied than those focused on the current task. This suggests that people with more pronounced ADHD symptoms are more likely to have off-task thoughts across different situations [93].

It is possible that hyperactive symptoms are more strongly associated with increased variability in thought content, likely due to their connection with mental restlessness, compared to inattentive symptoms [93,94,97,98]. The hyperactive traits of ADHD are also linked to difficulty in directing inner thoughts toward a specific topic [99] during rest [100] as well as during spontaneous and task unrelated thoughts [101].

In ADHD, racing thoughts tend to grow more intense as the day goes on [94].

Depression and MW

Research shows that when the mind drifts away from the present moment, it often predicts feelings of dysphoria, stress, reduced happiness, and lower overall well-being [8,102]. In depression, MW tends to focus more on negative, self-related, and past-oriented thoughts [103].

Depressed individuals often experience intrusive thoughts. with a stronger focus on the self and the past [104], which would manifest as a higher propensity to experience unwanted episodes of MW [62].

There may be a causal and bidirectional relationship between MW and depressed mood in both directions [62]. This two-way relationship may create a vicious cycle, potentially playing a role in the development of depressive disorders. Negative emotions are also linked to MW and to specific types of off-task thoughts, such as rumination, worry, obsessions, and distressing memories [105]. Unintentional MW, in particular, is thought to be a strong predictor of depression [62]. Freely flowing thoughts have been associated with more positive emotions [105,106] while task-unrelated thoughts have been linked to more negative emotions [105].

In depression, individuals who are more prone to unintentional MW tend to regulate their emotions through suppression, while those who are more inclined toward intentional MW are more likely to regulate emotions through rumination [103]. Additionally, individuals who were more aware of their thought patterns were more likely to use cognitive reappraisal as an emotion regulation strategy.

Suppression as an emotion regulation strategy may increase individuals' susceptibility to distraction by unintentional, task-unrelated thoughts [107]. These findings support the idea that people use MW as a way to manage negative emotions [108].

Postraumatic stress disorder (PTSD)

PTSD symptomatology has been found to be positively associated with unintentional MW and negatively associated with intentional MW. Unintentional MW emerged as the strongest predictor of PTSD symptoms, more so than intentional MW. A neural basis involving the default mode network (DMN) has been proposed for both types of MW [109,143], as well as for PTSD symptomatology [171].

Personality dimensions

MW is consistently linked to neuroticism [7,109,110]. A recent study found that neuroticism predicts episodes of unintentional MW and is negatively associated with meta-awareness of one's thought states [111].

Individuals with high levels of neuroticism reported more frequent and more negative thoughts during MW episodes, suggesting that greater neuroticism is linked to both an increased frequency and more negative content of these episodes [7,66].

People are more likely to experience MW when they are in anxious or negative emotional states [38]; thus, MW is more likely to occur in individuals who are emotionally unstable and high in neuroticism [112].

The harm avoidance dimension has been associated with the inattentive subtype of ADHD [113] and with the severity of inattentive symptoms [114,115].

Prior work investigating ADHD's relation with the Five Factor Model has suggested that inattention may be negatively associated with emotional stability (conceptualized in studies as neuroticism) and conscientiousness, whereas hyperactivity/impulsivity may be associated with higher extraversion and lower agreeableness [116].

Individuals with high levels of the trait openness were more likely to engage in intentional MW during easy tasks compared to those with lower levels. This is likely because people high in openness are generally more imaginative, tend to daydream, and enjoy creative thinking [117-121].

Individuals who scored higher in conscientiousness and emotional stability were less likely to experience unintentional MW and became aware of their wandering thoughts more quickly [122]. Additionally, other studies have found a negative relationship between conscientiousness and MW [120,123,124].

Levels of conscientiousness tend to increase slightly in older adults [125], a pattern that has been linked to changes in the frequency of MW Subjective MW decreases in middle and older age groups, which aligns with previous research findings [126,127]. With age, increases in agreeableness and conscientiousness, as well as decreases in neuroticism, have been observed [129,130].

A negative correlation has been observed between agreeableness and intentional MW [120], as well as with conscientiousness [7,120,128].

Sleep

Poorer sleep quality correlates to some degree with higher frequencies of MW, with spontaneous thinking making it more difficult to focus on the task at hand and disrupting sleep [131,132].

MW and symptom rumination are significant predictors of insomnia, whose overactivation may lead to dysfunctional spontaneous thinking [133].

Neurobiology

MW in adults is commonly referred to as a "default" mode of self-referential processing linked to the activity of the DMN of the human brain [134].

The brain regions involved in MW within the DMN include the medial prefrontal cortex (mPFC), the posterior cingulate cortex/precuneus, and the posterior temporoparietal cortex [133,135].

Three brain regions are believed to be involved in task engagement and MW: (1) the central executive network (CEN), which is active during task-focused activities; (2) the DMN, which is linked to internal thoughts; and (3) the salience network (SN), which facilitates the switch between the CEN and DMN [136,138].

The DMN is known to be active during times of inward-focused thinking and self-referential thought [139]. The DMN has been linked to facilitating MW during wakefulness [140,141].

Thus, MW appears to entail a combination of DMN cognitive functions (e.g. attention control, content management). The frontoparietal network (FPN) exerts executive control over goal-directed cognitive functions (e.g. future planning, mentalizing) [133]. In combination, these two networks promote more deliberate MW (e.g. autobiographical planning), guiding attention shifts from external tasks to internal goal directed processes [142].

The involvement of other networks, such as the limbic (LMB) and salience networks, (i.e. insula), and visual networks [133], reflects the integrative nature of MW.

Excessive MW in ADHD patients may be associated with dysfunctional connections within the DMN due to abnormal cortical maturation related to age in ADHD [133]. This network shows increased metabolic activity when the mind is at rest and during internal thought processes, and decreases its activity during cognitively demanding tasks [53,85]. The DMN and the FPN are activated during MW. Increased coupling between the dorsal-medial subsystem (medial prefrontal cortex, anterior temporal cortex) and the medial-temporal subsystem (hippocampus, posterior cingulate cortex) of the DMN contributes to reduced engagement with external stimuli and task-unrelated thoughts (such as future planning) and detailed memory retrieval among young adults [85,133]; It has also found that MW recruits the dorsolateral prefrontal cortex (DLPFC) and the anterior PFC, which are part of the FPN [143]. These regions are associated with executive control processes, which hints at a negative correlation between executive functioning and MW [133,141,143].

Measurement of MW

There is evidence that adults with ADHD may not always provide accurate self-reports: they might overestimate their performance in activities such as driving [144] and underestimate the severity of their ADHD symptoms and related impairments [145]. To overcome these limitations, future studies might consider using informed co-informants in addition to self-report measures, as this approach has been shown to improve the accuracy of assessing symptom severity and impairment [146].

Additional support comes from studies that evaluated related aspects of thought dynamics through questionnaires. A strong positive correlation has been found between hyperactive and inattentive ADHD symptoms and the tendency to experience (1) constantly active thoughts, (2) thoughts rapidly shifting from one to another, and (3) multiple thoughts occurring simultaneously, as measured by the mind excessively wandering scale [91,147].

Reliable and valid tools are available to measure the frequency, characteristics, and awareness of MW episodes. The methodologies ranged from self-rating scales to experience sampling during daily life and in laboratory settings with or without attentional tasks. The most common method for measuring MW is through self-report questionnaires [147,148]. Using self-report questionnaires for assessment has some limitations, including recall bias, which makes them vulnerable to memory inaccuracies. They are also affected by selection bias and individual subjectivity. Additionally, these questionnaires rarely take into account how context influences the dynamic unfolding of thoughts over time.

MW, in this more specific sense, can be assessed using three established questionnaires: the Mind Wandering Questionnaire (MWQ) [149], the Mind Wandering: Spontaneous and Deliberate scales (MW-S and MW-D) [152], and the Four Factors of Mind Wandering Questionnaire (4FMW) [153].

The Mind Excessively Wandering Scale (MEWS) was developed by Philip Asherson in 2016 [149] to investigate the impact of MW on the development of ADHD and its potential role in diagnosis. It is a Likert-type self-report scale consisting of 12 items, which assesses the extent of MW in individuals with ADHD [150].

The Brief Mind Wandering Three-Factor Scale (BMW-3) assesses three dimensions of MW: unintentional, intentional, and meta-awareness (i.e. awareness of MW) [151].

Finally, the Four Factors of Mind Wandering Questionnaire (4FMW) [151] views spontaneous MW as a type of spontaneous thought [22].

Moreover, no existing questionnaire allows for the evaluation of meta-awareness of MW as a distinct dimension. Only one item from the MW-S scale addresses this indirectly: the feeling of lacking control over one's MW.

Subjective experiences of MW are usually assessed using the experience sampling method called the thought-probe approach [154]. Experience sampling is a more detailed technique that involves asking questions about the focus of attention and the content of thoughts to explore a person's inner state [155].

Experience sampling is carried out during rest, everyday activities, or experimental tasks that usually demand sustained attention.

The Sustained Attention to Response Task (SART) also offers objective measurements [156]. Increased variability in responses from one trial to the next is believed to indicate moment-to-moment inconsistencies and lapses in attention, whether partial or complete. Additionally, commission errors (responding when no response is needed), particularly in the SART, may indicate a more automatic, mindless style of responding.

One of the most commonly used objective indicators of MW is variability in reaction time.

Treatment of MW

Changes in current motivational, emotional, and physiological states consistently lead to changes in MW [157,158].

Awareness and self-control over spontaneous thoughts can also be achieved by meditation and mindfulness practices that have been used for a long time as forms of behavioural therapy [172,173]. These practices can improve mental focus, creativity, resilience and responses to rewards by changing brain activity patterns [172,173]. As a result, mindfulness-based interventions overall-and mindfulness-based cognitive therapy specifically-can help reduce spontaneous MW [159-161].

Objectives of the Study

The primary objective of this study is to provide a detailed analysis of the differences in the effects of ADHD after six months of pharmacological treatment versus no pharmacological treatment. The first group receives pharmacological intervention, primarily with stimulants, while the second serves as a control group, following standard practices such as psychodiagnostic evaluation, cognitive-behavioral guidelines, physical exercise, and mindfulness. Patients attended the specialized adult ADHD outpatient clinic at the Sureste University Hospital between October 2021 and November 2024.

Participants were initially asked to review the consent page approved by the Institutional Review Board (IRB). At that point, they had the option to either agree to participate in the survey or choose not to take part. Each volunteer provided written informed consent prior to the beginning of the study.

Primary objectives

- To analyze the effect of psychopharmacological treatment in adult patients with ADHD on personality dimensions and MW.
- To examine changes in DIVA parameters and quality of life.

Secondary objectives

- To investigate whether MW and/or personality variables are predictors of ADHD treatment response.
- To conduct an analysis of follow-up data and its impact on the study population.

Hypothesis:

1. Pharmacological treatment improves MEWS scores and quality of life more than the control group over time.
2. There are changes in personality dimensions, with increased conscientiousness and decreased neuroticism in the pharmacological treatment group over time.

Materials and Methodology

The analysis begins with a description of the sample's sociodemographic data. To assess whether the treatment groups are homogeneous, the chi-square test and Fisher's exact test are used.

Statistical analysis

My thanks to the Research Support Unit, Pertica, for their assistance with the statistical analysis of the study.

For qualitative variables, the results of the chi-square statistic and Fisher's exact test are presented along with their frequencies. For quantitative variables, P-values were calculated using Student's t-test for parametric samples and the Mann-Whitney U test for nonparametric samples.

For the treatment follow-up, all variables are reanalyzed, before and after the six-month period, as well as separate descriptive tables segmented by treatment group and time.

Finally, linear models will be employed to explore the proposed relationships between the variables. The models will include interactions between time and treatment group. Statistical data related to the study are available upon request from the author.

Description of the patients included in the study

A statistical analysis was planned to evaluate the effects of ADHD treatment on different patients after six months.

The sample consists of 71 patients divided into two main groups: a control group with 21 patients and a pharmacological treatment group comprising the remaining 50 patients. All participants were required to complete a series of questionnaires at the start of the study and after six months.

The study received approval from the Institutional Review Board (IRB) of the General Universitary Gregorio Marañón Hospital.

Instruments:

- The NEO Five-Factor Inventory includes 240 items that participants rate themselves on a 5-point Likert scale, with higher scores reflecting higher levels of the corresponding personality trait [117].
- DIVA-5 The DIVA is a structured clinical tool Diagnostic Interview for ADHD used to diagnose ADHD in adults. It assesses symptoms of inattention, hyperactivity, and impulsivity based on established diagnostic criteria, as well as their impact on functioning.
- A psychiatrist blind to clinical assessments administered the Spanish version of the Diagnostic Interview for ADHD in Adults (DIVA) [163] Additional information was provided by a parent or close family member.

The DIVA is the gold-standard assessment for ADHD in adults, evaluating the severity of each of the 18 symptoms needed to meet the DSM-V diagnostic criteria for ADHD in both childhood and adulthood. Those symptoms must cause impairment in at least two settings and must not be better explained by another psychiatric disorder. The diagnosis is considered definite when six or more criteria are met for each of the symptom domains of hyperactivity-impulsivity and/or attention deficit.

MEWS The Mind Excessively Wandering Scale (MEWS) consists of 15 items [146]. MW: this scale is designed to measure two distinct phenomena-spontaneous (MW S) and deliberate (MW D) [152]. Each phenomenon has four items, and there is a minimum score for each scale.

The minimum score is 4 and the maximum is 28 (each scale is rated from 1 to 7). A higher total score indicates a greater tendency to spontaneously or deliberately mind-wander in daily life. Both scales have been shown to have good internal consistency ($\alpha > 0.80$) [152].

Quality of life QoL: Health-related quality of life (HRQoL), employment status, and work productivity and activity impairment characteristics were also assessed. Specifically, HRQoL was evaluated using the Adult Attention Deficit Hyperactivity Disorder Quality of Life (AAQoL) scale. The 29-item AAQoL scale includes four subscales-life productivity, psychological health, relationships, and life outlook [162]. The total and subscale scores ranged from 0 to 100, with a higher score indicating greater HRQoL.

Results

Of the 70 patients who completed this question, 55% were female and 45% male. Regarding ethnicity, 90% identified as Caucasian/European, while the remaining 10% belonged to other ethnic groups.

Educational levels were distributed as follows: 14% had completed primary education, 47% secondary education, and 39% held university degrees.

Regarding employment status, 47% of participants were actively employed, 7% were on medical leave, 23% were unemployed, and 25% were continuing their studies.

Regarding marital status, 60% of the sample were single, 35% were married, and 4% were divorced.

Clinical aspects related to ADHD, including self-injurious behavior, suicide attempts, and psychiatric hospitalizations.

Considering whether patients had a history of self-harm gestures, we analyzed differences between the control group and the treatment group. No statistically significant differences were found, χ^2 (Chi-square) = 0.10, $p > 0.05$.

Suicide attempts

Regarding suicide attempts, whether patients had a history of attempts or not, no statistically significant differences were observed between the treatment groups, p (Fisher's exact test) = 0.36.

Psychiatric hospitalization

Ninety percent of the sample reported no history of psychiatric hospitalization, while 10% indicated having been hospitalized. When comparing the control group and the pharmacological treatment group, no statistically significant differences were observed, with a p-value of 1 (Fisher's exact test).

Quality of life

This parameter will be broken down into four distinct domains: productivity, psychological health, life perspective, and relationships.

This analysis will examine whether the pharmacological treatment group shows any significant differences compared to the control group.

Quality of life, productivity

Regarding quality of life in the domain of productivity, near-significant differences were observed between the two treatment groups in patients' productivity-related quality of life, p (t-test) = 0.0887.

No significant differences were found between the treatment groups in psychological health quality of life, life perspective quality of life, or quality of life related to relationships.

DIVA

According to DIVA results, 63% of patients exhibit the combined presentation, 33% show predominantly inattentive presentation, and the remaining 3% have a predominantly hyperactive-impulsive presentation.

DIVA severity scale

On the DIVA severity scale, 93% of the study population is classified as having moderate ADHD, 6% as mild, and there is one case classified as severe.

Baseline NEO-PI-R data

This instrument assesses the primary personality traits, including neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Each factor is composed of six facets [117].

Follow-up: Quality of life-productivity domain

A significant difference was found between treatment groups at the 6-month follow-up. Based on the Wilcoxon test, p = 0.0397, we conclude that there are statistically significant differences between the treatment groups over time. Therefore, there is an improvement in life productivity.

MEWS follow-up

Furthermore, a decrease in MEWS scores was observed in both groups; however, the reduction was significantly greater in the pharmacological treatment group Using the Wilcoxon test, with a p-value of 0.03; the hypothesis is confirmed: there are statistically significant differences between the treatment groups over time.

Relationships between variables

Relationship with age

To begin, the relationship between age and other variables will be analyzed. Specifically, we will examine how age relates to agreeableness, conscientiousness, neuroticism, and MEWS scores. We see that, statistically, the relationship between agreeableness and age is not significant, nor is the relationship between conscientiousness or neuroticism and age.

Relationship with MEWS

MEWS vs. conscientiousness

An interaction between MEWS and time at the 6-months follow-up was observed in relation to conscientiousness, with a p-value = 0.0068.

This suggests that MEWS alone does not have a significant direct relationship with conscientiousness, but it modulates change over time the effects of time depend on the initial MEWS level.

In other words, we can confirm a negative relationship between MEWS and the evolution of conscientiousness over six months: the higher the initial MEWS, the poorer the progression in conscientiousness.

Parameter	Estimate		Standard Error	t Value	Pr > |t|
MEWS*Tiempo 6mese	-1.56460410	B	0.56426031	-2.77	0.0068

Table 1

MEWS vs. openness to experience

Regarding the personality factor Openness to Experience, previous studies have reported a positive relationship with MEWS, particularly with intentional MEWS.

In our case, the model results table shows that the p-value for the MEWS variable is significant (p = 0.0408), indicating a positive relationship between these variables.

As MEWS increases, openness to experience also increases.

Parameter	Estimate		Standard Error	t Value	Pr > |t|
MEWS	0.67011100	B	0.32269057	2.08	0.0408

Table 2

DIVA vs. agreeableness

The model aims to identify a negative relationship between having a predominantly hyperactive ADHD diagnosis and lower levels of agreeableness.

Patients with a negative ADHD diagnosis tend to show higher levels of agreeableness.

Parameter	Estimate		Standard Error	t Value	Pr > |t|
DIVA_No	17.14285714	B	7.39946944	2.32	0.0230

Table 3

DIVA vs. extraversion

Patients with predominantly inattentive ADHD in the control group show lower levels of extraversion compared to those with the same diagnosis in the treatment group. Moreover, patients with the combined ADHD presentation in the treatment group exhibit the highest levels of extraversion among all subgroups.

However, being part of the pharmacological treatment group moderates the negative effect of having either an inattentive or combined ADHD presentation. Therefore, the treatment appears to be especially beneficial for individuals with these two diagnostic types.

The analysis also shows that patients with a hyperactive-impulsive diagnosis in the control group tend to exhibit higher levels of extraversion.

Parameter	Estimate		Standard Error	t Value	Pr > |t|
DIVA_ Predominant presentation with inattention *Treatment Group with pharmacological treatment	21.10565476	B	8.46237839	2.49	0.0147
DIVA_ Combined presentation*Treatment Group with pharmacological treatment	21.00586854	B	8.51923754	2.47	0.0158
DIVA_ Predominant presentation with lack of attention	-21.36607143	B	10.62101015	-2.01	0.0476

Table 4

Discussion

In a sample of adult outpatients with ADHD, those treated with psychostimulants were compared to a control group on treatment as usual (receiving psychodiagnostic assessment, cognitive-behavioral guidelines, and recommendations for exercise and mindfulness). Results showed significant differences favoring the treatment group in global MEWS scores and life productivity as measured by the quality of life scale.

The significant decrease in the post-treatment MEWS scores suggests that interventions targeting core ADHD symptoms can simultaneously alleviate MW related cognitive processes [164]. This finding is consistent with our study; Additionally, a decrease in the MEWS scale was observed in both groups; however, this decrease was statistically more significant in the treatment group, with a greater reduction observed. In other studies focusing on ADHD and rumination rather than MW, the effect of stimulant medication on the association between ADHD symptoms and rumination was observed-specifically for inattention symptoms, but not for hyperactivity [170].

The personality dimension openness to experience shows a positive relationship with MEWS scores. This suggests that patients with higher MEWS scores tend to show greater openness to experience.

We are in agreement with previous authors [38,117,119,121] regarding the positive association with MEWS, although these studies primarily observed the relationship with intentional MEWS. In our study, possibly because of the smaller sample size, the association was observed with the overall MEWS.

Additionally, we see a negative relationship between conscientiousness and MEWS: higher MEWS scores are associated with lower levels of conscientiousness. Prior work investigating ADHD's relation with the Five Factor Model has suggested that inattention may be negatively associated with emotional stability (conceptualized in studies as Neuroticism) and conscientiousness [115,165].

Other authors [115,166] observed a subgroup of college students with elevations in ADHD-related inattentive symptoms and emotional dysregulation, as well as emotional/instability and low conscientiousness. Those who scored higher in conscientiousness and emotional stability were less likely to experience unintentional MW. More conscientious individuals were less likely to let their minds wander compared to those who were less conscientious [122-124,157].

Conscientiousness is evaluated due to its frequent association with age-related differences in the frequency of MW. Conscientiousness levels tend to increase slightly in older adults [167], which has been associated with changes in MW frequency. Findings indicate that with increasing age, agreeableness and conscientiousness tend to increase, whereas neuroticism decreases [129,130]. We see that evolution in our sample: With increasing age, agreeableness and conscientiousness tend to rise, whereas neuroticism tends to decrease (Although not statistically significant, this may be due to the limited sample size). This suggests that MEWS alone does not have a significant direct relationship with conscientiousness; however, it moderates the effect of time. In other words, the impact of time on conscientiousness depends on the initial MEWS level. Specifically, a negative relationship between MEWS and conscientiousness is confirmed at the six-month mark: the higher the MEWS score, the poorer the evolution of conscientiousness over time.

Besides, the predominance of hyperactivity is confirmed to be associated with higher levels of extraversion, while a negative ADHD diagnosis is linked to increased levels of agreeableness in the observed patients. It was also seen whereas hyperactivity/impulsivity may be associated with higher Extraversion and lower Agreeableness [115,165]. A negative correlation has been observed between agreeableness and intentional MW [38], as well as with conscientiousness [38,168,169].

In our study, as MEWS increases, openness to experience also increases. In contrast, the remaining factors-treatment duration and type-are not significant in the model, indicating that they do not have a substantial effect on the openness to experience variable.

Patients with a negative diagnosis of ADHD tend to exhibit higher levels of agreeableness.

Belonging to the predominantly inattentive group is associated with lower levels of extraversion. Additionally, receiving pharmacological treatment moderates the negative effect of having either the inattentive or combined presentation. Therefore, treatment appears to be particularly beneficial for individuals diagnosed with both presentations.

Limitations of the Study

The findings suggest the need for a methodology that includes clinical samples followed longitudinally to establish causality. The limited sample size makes it challenging to draw definitive conclusions. While MW is commonly assessed using questionnaires, it is crucial to consider the context in which thoughts emerge when evaluating thought processes in ADHD; For instance, using a think-aloud task in combination with ecological momentary assessment may provide a more context-sensitive approach to evaluating MW in individuals with ADHD.

Despite the small sample size, the longitudinal follow-up of the same patients and the reassessment of the same parameters provide data on MW treatment, functionality, and personality dimensions-areas that have been scarcely studied in the literature to date.

Conclusion

We observed associations between personality dimensions, MEWS Scores, and ADHD diagnosis.

Openness to experience shows a positive correlation with MEWS scores, indicating that individuals with higher openness tend to exhibit more MW tendencies.

Conscientiousness is negatively associated with MEWS, suggesting that higher levels of conscientiousness are linked to lower levels of excessive MW. Furthermore, higher MEWS scores are associated with a poorer progression in conscientiousness.

Individuals with a predominantly hyperactive presentation tend to score higher in extraversion.

Patients with a negative ADHD diagnosis (i.e., not diagnosed with ADHD) tend to exhibit higher levels of agreeableness.

Conversely, individuals with a predominantly inattentive presentation show lower levels of extraversion.

These findings contribute to a more nuanced understanding of how personality traits relate to cognitive profiles and clinical presentations such as ADHD and MW tendencies. Several differences have shown between stimulants treatment of ADHD patients after 6 months. Future research should examine how the progression of MW and personality traits is affected by ADHD treatment, Besides, we see how quality of life is better after pharmacological therapy.

It is possible that the challenges faced in daily life by individuals with ADHD may stem from an inability to focus their thoughts, due to their increased thought activity.

It appears that reduced mental hyperactivity enhances the ability to listen attentively and to discriminate environmental stimuli more effectively.

Also, it is necessary to refine theoretical models that explain how ADHD symptoms and MW interact; for example, exploring how executive functioning deficits, a core feature of ADHD, mediate or moderate the association between ADHD symptoms and MW.

It would be beneficial to enhance the positive aspects of MW, such as creativity, while reducing its negative effects, such as diminished executive task performance.

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Conflict of Interest

I have worked as speaker in conferences with Jansen, Lundbeck, Takeda and Rovi.

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