

To What Extent Do ADHD Symptoms Predict the Adaptive Deployment of Attentional Shielding as A Form of Proactive Control in A Dual-Task Paradigm Manipulating Interference Probability (50% vs 100% T2 Presence)?

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Abstract

The present study investigated whether symptoms of Attention-Deficit/Hyperactivity Disorder (ADHD) predict the adaptive deployment of attentional shielding as a form of proactive control in a dual-task paradigm. Attentional shielding refers to the strategic protection of working-memory consolidation when interference from a secondary task is expected. To examine this, a dual-task paradigm was used in which participants encoded a visual target (T1) for later recall while responding to a secondary task (T2) that appeared either with 50% or 100% probability. Interference was further manipulated by varying the stimulus onset asynchrony (SOA) between T1 and T2. ADHD symptom severity was assessed using the Adult ADHD Self-Report Scale (ASRS), and both extreme-groups and dimensional analyses were conducted. Results revealed robust dual-task interference effects, with reduced T1 accuracy and slower T2 response times at short SOAs. Importantly, interactions between SOA and T2 probability provided evidence for adaptive attentional shielding, indicating that participants adjusted their attentional strategy based on the predictability of interference. However, ADHD symptom severity did not significantly predict the magnitude of adaptive shielding, neither in extreme-group comparisons nor in regression analyses. These findings suggest that adaptive attentional shielding operates reliably in response to interference expectancy but is not strongly modulated by differences in ADHD symptom severity within a non-clinical student sample. The results support accounts of flexible, proactive attentional control and highlight the robustness of adaptive shielding mechanisms across individuals.

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Everyday cognition often requires us to maintain information in mind while other stimuli compete for our attention. For instance, we might try to memorise a phone number while someone begins speaking to us. A major challenge for the cognitive system is therefore to protect the information currently being processed so that it can be encoded successfully and retrieved later. This protective function is closely related to working-memory consolidation, which strengthens initially fragile representations so they become more stable and less vulnerable to interference (Cotton & Ricker, 2022). Since interference can interrupt or delay consolidation, it becomes important to understand how the system prepares for potential distraction or instead reacts once distraction has already occurred.

The Dual-Task Paradigm

A widely used method to study interference is the dual-task paradigm. In this approach, participants first encode a target stimulus (T1) for later recall and shortly after must make a speeded response to a second target (T2). When the interval between the two stimuli (the stimulus onset asynchrony, SOA) is very short, both tasks rely on overlapping attentional processes. Classical findings show that T1 accuracy is usually preserved, whereas T2 responses become markedly slower at short SOAs when T2 needs to be processed while the consolidation of T1 is still ongoing (Jolicoeur & Dell'Acqua, 1998, 1999). This pattern reflects the well-known Psychological Refractory Period (PRP), which is typically explained by the presence of a central attentional bottleneck that prevents parallel processing of T1 consolidation and T2 response selection (Tombu et al., 2011). According to this account, central stages of processing are serial and capacity-limited, meaning that T2 must wait until T1 has been consolidated (Otermans et al., 2022). However, other studies have reported the

opposite outcome, in which T2 is processed quickly while T1 accuracy is reduced, suggesting retroactive interference (Bayliss et al., 2015; De Schrijver & Barouillet, 2017; Nieuwenstein & Wyble, 2014).

Adaptive Attentional Shielding

To reconcile these findings, Nieuwenstein et al. (2025) proposed that attentional processing is governed by an adaptive shielding mechanism. Rather than assuming a fixed structural bottleneck, they suggest that the cognitive system flexibly regulates the degree of protection given to T1 depending on expectations about upcoming interference. This mechanism involves both target selection and target shielding, and importantly, the amount of shielding varies with the probability of interference. When T2 is presented on every trial, participants appear to proactively shield T1, resulting in preserved T1 performance and slowed T2 responses. When T2 appears only on half of the trials, shielding is weaker, and T1 becomes more susceptible to disruption while T2 benefits from faster processing. This indicates that interference probability shapes how the system allocates attentional resources.

Proactive and Reactive Control

The idea of adaptive shielding aligns with the Dual Mechanisms of Control framework (Braver, 2012), which distinguishes between proactive and reactive control. Proactive control reflects sustained, anticipatory maintenance of task goals, aiding in the prevention of interference before it arises, whereas reactive control is a more transient process that is activated only after interference occurs. Individuals differ in the extent to which they rely on proactive versus reactive control. For example, proactive control is associated with higher working-memory capacity (Wang & Yao, 2021), whereas greater impulsivity tends to relate to increased reliance on reactive control (Huang et al., 2017). Because adaptive shielding primarily reflects anticipatory preparation for interference, it can be interpreted as a behavioural manifestation of proactive control.

This distinction is directly reflected in the probability manipulation used in the present study. In the 100% T2 probability condition, interference is fully predictable, as the second task is present on every trial, creating a context in which proactive control and sustained shielding of T1 are advantageous. In contrast, in the 50% probability condition, interference is uncertain, as the second task is presented on only half of the trials in a random order, reducing the efficiency of sustained proactive preparation and increasing reliance on more flexible, reactive control processes. As such, the dual-task shielding paradigm provides a useful way to assess how individuals adaptively deploy proactive attentional control in response to predictable versus unpredictable interference.

ADHD and Proactive Control

Attention-Deficit/Hyperactivity Disorder (ADHD) is a highly prevalent neurodevelopmental condition characterised by persistent patterns of inattention and/or hyperactivity–impulsivity that interfere with daily functioning. Although there is no cure for ADHD, symptoms can often be managed effectively through evidence-based treatment approaches, including behavioural therapy and pharmacological interventions such as stimulant medications (e.g., methylphenidate or amphetamines; Mayo Clinic, 2023; CDC, 2024). Global prevalence estimates indicate that approximately 5–8% of children and adolescents are affected, with symptoms persisting into adulthood for a substantial proportion of individuals, resulting in an estimated adult prevalence of 2.5–3.4% (Popit et al., 2024). ADHD is associated with significant functional impairments in educational and vocational settings and has been linked to considerable societal and economic costs. For example, increased healthcare utilisation and reduced quality of life have been reported not only for individuals with ADHD but also for their families, highlighting the broader impact of the disorder (van Roijen et al., 2007). Together, these pervasive difficulties underscore the

importance of understanding the cognitive mechanisms that contribute to attentional and control-related impairments in ADHD.

Longitudinal evidence further indicates that ADHD frequently persists into adulthood, with the majority of individuals diagnosed in childhood continuing to experience clinically significant symptoms into emerging adulthood and only a small minority achieving sustained full remission (Henning et al., 2024). This persistence is associated with adverse outcomes across multiple life domains, including interpersonal relationships, employment, and mental health, reinforcing the view of ADHD as a condition with substantial long-term consequences for individual functioning and well-being. Importantly, these difficulties also extend beyond affected individuals, contributing to broader societal and economic costs (van Roijen et al., 2007).

From a cognitive perspective, ADHD has been linked to broad impairments in cognitive control rather than a single, isolated deficit. In adults, these impairments include difficulties with sustained attention, executive functioning, and the regulation of goal-directed behaviour, as well as increased response variability (Mostert et al., 2015). Importantly, Mostert et al. (2015) emphasise that cognitive control deficits in ADHD are heterogeneous and context-dependent, suggesting that impairments may emerge particularly under conditions requiring sustained or adaptive regulation of attention. This perspective highlights the relevance of examining how individuals with varying levels of ADHD symptoms adjust attentional control in response to predictable versus unpredictable interference.

Assuming that proactive and retroactive dual-task interference reflect different degrees of proactive attentional control, an important question is how individuals with symptoms of Attention-Deficit/Hyperactivity Disorder (ADHD) respond to manipulations of T2 probability in a dual-task experiment. A substantial body of research has shown that individuals with ADHD experience difficulties with sustained attention, goal maintenance, and other

components of top-down control (Tucha et al., 2017). Consistent with this, Cai et al. (2023) reported that children with ADHD engage proactive control less effectively and tend to rely more on reactive responses. However, despite these findings, no research has examined whether ADHD symptoms influence adaptive attentional shielding in fast-paced dual-task settings. In particular, it remains unclear whether ADHD affects how individuals balance T1 consolidation against rapid responding to T2 at short stimulus onset asynchronies.

The Present Study

The present study addresses this gap by applying the adaptive-shielding paradigm to a sample of young adults who were assumed to have varying levels of ADHD symptoms, as measured using the ASRS-18 questionnaire (Kessler et al., 2005). Proactive attentional control is operationalised using an adaptive-shielding index, which compares performance between the 100% and 50% T2 probability conditions. To derive an index of interference, performance at the short SOA, where interference between T1 and T2 is expected to occur, is subtracted from the performance at the long SOA, where interference is no longer expected because T1 has been processed completely by that time. Strong shielding should be reflected in higher T1 accuracy and slower T2 responses in the 100% condition, particularly at short SOAs. The main dependent variables are T1 recall (number of letters correctly reported) and T2 response times. Analyses will include both an extreme-groups comparison (lowest versus highest ADHD quartiles) and a continuous approach across the full range of symptom scores. This combination allows us to examine both categorical and dimensional aspects of ADHD-related variability.

H1: Participants with low ADHD scores will show stronger attentional shielding in the 100% T2 condition than in the 50% T2 condition, reflected in higher T1 accuracy and slower T2 response times when interference is certain. While high scoring ADHD participants will show

a weaker attentional shielding reflected in the reduced difference in performance between 50% and 100% probability conditions.

H2: In addition to these effects for the extreme-groups comparison, we hypothesized that a linear regression would predict ADHD symptom severity and its effect on the magnitude of adaptive shielding at the short SOA. Across the full sample, higher ADHD symptom scores will predict a smaller adaptive shielding effect, indicating reduced proactive attentional control.

Taken together, this study aims to clarify whether ADHD symptoms are associated with diminished proactive attentional control as expressed through adaptive shielding. The findings may contribute to current theoretical accounts of cognitive control differences in ADHD and help inform future investigations into attentional preparation and interference management in this population.

Method

Participants

The participants for this study were recruited using a convenience sample through the Sona system of the University of Groningen, social media, and family/friends. In total, 69 participants took part in the study. The inclusion criterion was a minimum age of eighteen years. Of the participants, 18.8% were male ($N_{\text{male}} = 13$) and 81.2% were female ($N_{\text{female}} = 56$). Participants were randomly assigned to one of the two experimental conditions. In the first condition, 33 participants completed trials with a 100% chance of T2 first, followed by trials with a 50% chance of T2. In the second condition, 36 participants completed trials with a 50% chance of T2 first, followed by trials with a 100% chance. Specifically, for the extreme-groups analysis, 47.8% ($N=11$) of participants belonged to the general population and 52.2% ($N=12$) to the ADHD group for the first condition. In the second condition, 64.3%

(N=9) of participants belonged to the general population and 35.7% (N=5) to the ADHD group.

Materials

The study was programmed and administered using OpenSesame (Mathôt et al., 2012). The experiment was conducted online using JATOS, a server-based platform compatible with OpenSesame's online export module (OSWeb), allowing the study to be completed remotely. The display resolution was set to 1980 x 1020 pixels, with a refresh rate of 60 Hz. Participants accessed the experiment in their web browser on a personal computer or laptop and responded using their keyboard. They were instructed to complete the experiment in a quiet environment and in one uninterrupted session.

Stimuli

The experimental stimuli consisted of two target stimuli, T1 and T2. Target 1 (T1) consisted of a string of four uppercase letters, presented for 100 milliseconds. Vowels and the letters "Q", "W", and "M" were excluded, leaving a set of 18 possible letters. The letters were randomly sampled without replacement from the alphabet. A mask of four characters, made up of three overlapping symbols (@, #, []), was used to obscure T1. The mask was also displayed for 100 milliseconds and was visually similar to target 1 in size and font, though the symbols were not within the target set. Target 2 (T2) consisted of a single digit, selected randomly from 2 to 9, and presented for 100 milliseconds. All stimuli were presented centrally in black 20-point Droid Sans Mono font on a white background.

ADHD Questionnaire

Attention-Deficit/Hyperactivity Disorder (ADHD) symptoms were measured with the Adult ADHD Self-Report Scale (ASRS-v1.1) (Kessler et al., 2005). The ASRS consists of 18 items assessing inattention and hyperactivity/impulsivity symptoms according to DSM-5 criteria. Responses are made on a 5-point Likert scale (0 = never to 4 = very often). The scale

demonstrates good psychometric properties, with internal consistency ranging from $\alpha = .70$ – $.88$ and test–retest reliability of $r = .68$ – $.80$. The total ASRS score was calculated by summing all 18 items' scores. Based on the ASRS scores, participants were categorized into high and low ADHD symptom groups for the extreme groups analysis. Group assignment was determined using quartile cut-offs derived from the frequency distribution of ASRS scores: participants scoring above the 75th percentile (scores > 40.5) were classified as high scorers, while those scoring below the 25th percentile (scores < 23) were classified as low scorers.

Design

Participants underwent a within-subjects experiment where each participant experienced every level in the study. The order of the two T2-probability conditions (50% T2 first, followed by 100% T2 OR 100% T2 first, followed by 50% T2) was manipulated between-groups. The SOA had two levels (250ms and 1000ms), both used as a within-subject variable, where SOA was randomised in all trial blocks.

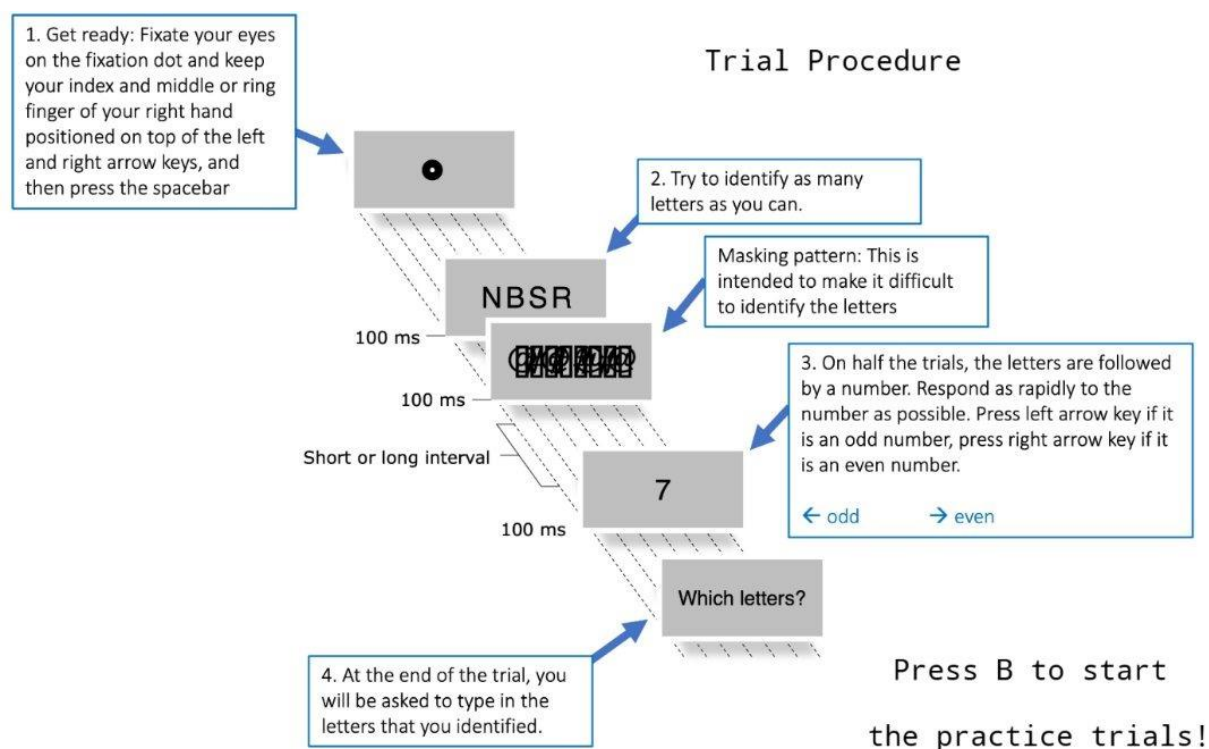
All participants completed 144 trials of which the first 16 trials served as practice trials in the 50% T2-Presence condition and 72 trials of which the 8 served as practice trials in the 100% T2-Presence condition. The trials with 50% T2 presence contained twice the number of trials of the 100% T2 presence condition to equate the number of T2-present trials across conditions. As T2 appeared on only half of the trials in the 50% T2 condition, increasing the total number of trials ensured that participants completed an equal number of T2-present trials in both the 50% and 100% T2 probability conditions. This resulted in 64 trials where T2 was present and 64 trials where T2 was not present in the 50% T2 condition, and 64 trials in the 100% T2 condition.

Procedure

The participants were asked to provide their informed consent in using personal data before taking part in the study, such as their age and gender. They were then asked to

complete the Adult Self-Report Scale (ASRS v1.1) reporting their symptomatology in their everyday life. The participants were asked to take the experiment in a quiet environment where distractions would be kept to a minimum, so as to ensure accurate responses and reaction times. The experiment was expected to take no more than 20 minutes to complete, while the entire study itself would not take more than 30 minutes, including completing the questionnaire.

Figure 1.0



After completing the ASRS, participants received instructions for the experiment. The participants were told to respond as fast as possible on the T2 reaction time task, indicating whether the number presented on screen was odd or even, using the left and right arrow keys respectively. They were then asked to respond as accurately as possible on the T1 response task, by typing in the letters they saw on the screen on their keyboard, for which there was no time limit. As illustrated in *Figure 1.0*, each trial in the experiment began with the presentation of a fixation dot, and a progress bar indicating how many trials had been

completed at that point. Participants were instructed to fixate on the fixation dot and to then press the spacebar to initiate the trial sequence.

Once the spacebar was pressed, the fixation dot remained on the screen together with a “get ready” instruction for 500 ms. Following this, T1 was presented for 100 ms, after which it was immediately replaced by a mask consisting of a combination of multiple symbols for 100 ms. This was followed by a blank interstimulus interval (ISI) of either 50 ms or 800 ms, after which T2 was presented for 100 ms. In trials in which T2 was absent, a blank interval of 100 ms was shown instead of the T2 stimulus.

In trials where T2 was present, a blank screen remained visible until the participant registered a response to T2. In trials where T2 was absent, a blank interval of 1000 ms was presented. Participants responded to T2 using the left arrow key for odd numbers and right arrow key for even numbers with the index and ring finger of their right hand.

Following the T2 phase, participants were prompted to report the letters presented in T1 by typing them on the keyboard, without a time limit. Participants then received written feedback after each response, prompting them to be faster or more accurate with their T2 responses, in case their performance was too slow or incorrect. The feedback display remained on screen until the participant pressed any key to continue.

A progress bar was shown below the fixation dot at the start of each trial, indicating how far along the respondent was in the sequence of trials. The participant had to press the spacebar to start the next trial.

Once the respondents finished the experiment, a debriefing was included to ensure they were fully informed about the intentions of the study. They were then able to exit the experiment once the data was uploaded, using the “esc” keyboard button.

Results

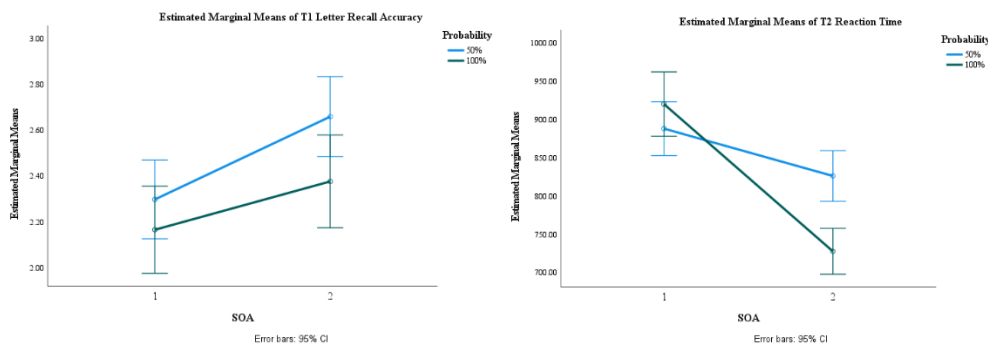
Descriptive Statistics

Table 1.0*Descriptive Statistics*

	Mean	Std. Deviation	N
T1_SumAcc_SOA250_T2Prob50	2.2967	.71589	69
T1_SumAcc_SOA250_T2Prob100	2.1642	.79241	69
T1_SumAcc_SOA1000_T2Prob50	2.6586	.72885	69
T1_SumAcc_SOA1000_T2Prob100	2.3754	.84439	69
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T2RT_SOA250_T2Prob50	887.8093	146.74609	69
T2RT_SOA250_T2Prob100	919.8718	174.73141	69
T2RT_SOA1000_T2Prob50	825.9414	137.65910	69
T2RT_SOA1000_T2Prob100	727.4172	124.83636	69

Means and standard deviations for T1 accuracy and T2 reaction times as a function of stimulus onset asynchrony (SOA) and T2 probability are presented in Table 1. Overall, T1 accuracy was lower at the short SOA compared to the long SOA, indicating greater interference when T1 consolidation overlapped with T2 processing. Additionally, performance differed across probability conditions, with lower T1 accuracy when T2 was always present. For T2 reaction times, responses were substantially slower at the short SOA compared to the long SOA, reflecting dual-task interference, and were slower in the 100% T2 probability condition at the short ISI.

Effects of SOA and T2 Probability on Task Performance**Figure 2.0**



For T1 accuracy, a repeated-measures ANOVA revealed a significant main effect of SOA, $F(1, 68) = 47.92, p < .001, \eta^2p = .413$, indicating lower accuracy at the short SOA compared to the long SOA. A significant main effect of T2 probability was also observed, $F(1, 68) = 11.68, p = .001, \eta^2p = .147$, with lower accuracy in the 100% T2 probability condition. Importantly, the interaction between SOA and T2 probability was significant, $F(1, 68) = 6.76, p = .011, \eta^2p = .090$, indicating that the effect of probability on T1 accuracy differed depending on temporal overlap between tasks. To further examine this interaction, follow-up analyses were conducted to assess the effect of SOA separately for each T2 probability condition. In the 50% T2 probability condition, a significant main effect of SOA was observed, $F(1, 68) = 56.76, p < .001, \eta^2p = .455$, indicating substantially lower T1 accuracy at the short SOA compared to the long SOA. In the 100% T2 probability condition, the effect of SOA was also significant, $F(1, 68) = 15.94, p < .001, \eta^2p = .190$; however, the magnitude of this effect was notably smaller than in the 50% condition, indicating that the temporal overlap effect on T1 accuracy was more pronounced when T2 occurrence was uncertain.

For T2 reaction times, there was a significant main effect of SOA, $F(1, 68) = 189.54, p < .001, \eta^2p = .736$, with substantially slower responses at the short SOA. A significant main effect of T2 probability was also found, $F(1, 68) = 5.85, p = .018, \eta^2p = .079$, reflecting faster responses when T2 was always present. The SOA \times Probability interaction was significant, $F(1, 68) = 59.53, p < .001, \eta^2p = .467$, indicating that the magnitude of dual-task interference

on T2 reaction times varied as a function of interference probability. To further clarify this interaction, follow-up analyses were conducted to examine the effect of SOA separately for each T2 probability condition. In the 50% T2 probability condition, a significant effect of SOA was observed on T2 reaction times, $F(1, 68) = 37.18, p < .001, \eta^2p = .353$, indicating slower responses at the short SOA compared to the long SOA. In the 100% T2 probability condition, the effect of SOA was also significant, $F(1, 68) = 175.62, p < .001, \eta^2p = .721$, with a substantially larger effect size, indicating that dual-task interference on T2 reaction times was more pronounced when T2 was always present.

Extreme Groups Analysis

A mixed-design ANOVA with T1 accuracy as the dependent variable, including ADHD group as a between-subjects factor revealed that the three-way interaction between SOA, T2 probability, and ADHD group was not significant, $p = .172$, indicating that adaptive shielding effects did not reliably differ between participants with low and high ADHD symptom levels.

Dimensional ADHD Symptom Analyses

Table 2.0

Coefficients^a

Dependent Variables		R square	Sig.	Standardized Coefficients	
				Beta	t
1	T1 Shielding	.026	.190	.160	1.33

Linear regression analyses were conducted to examine whether ADHD symptom severity predicted shielding effects at the short SOA. Shielding effects were quantified using a

shielding index computed at the short SOA. For T1, the shielding index was calculated by subtracting T1 accuracy in the 50% T2 probability condition from T1 accuracy in the 100% T2 probability condition at the short SOA. ASRS total scores did not significantly predict T1 shielding, $\beta = .160$, $t = 1.33$, $p = .190$, $R^2 = .026$, indicating that ADHD symptoms were not reliably associated with the magnitude of adaptive shielding.

Discussion

Overview of the Present Study

The present study examined whether ADHD symptoms predict the adaptive deployment of attentional shielding as a form of proactive control within a dual-task paradigm manipulating interference probability. Building on adaptive shielding theory (Nieuwenstein et al., 2025) and the Dual Mechanisms of Control framework (Braver, 2012), the study aimed to determine whether individuals adjust attentional shielding based on interference expectancy and whether such adjustments differ as a function of ADHD symptom severity. By manipulating both stimulus onset asynchrony (SOA) and T2 probability, the design allowed for a direct assessment of dual-task interference and proactive modulation of attentional shielding.

Evidence for Dual-Task Interference and Adaptive Attentional Shielding

Robust dual-task interference effects were observed across both dependent variables. T1 accuracy was significantly reduced at short SOAs compared to long SOAs, and T2 reaction times were substantially slower when temporal overlap between tasks was greatest. These findings are consistent with classic dual-task research (Jolicoeur & Dell'Acqua, 1998, 1999) demonstrating that overlapping processing stages compete for limited attentional resources.

Significant interactions between SOA and T2 probability were found for both T1 accuracy and T2 reaction times, providing strong evidence for adaptive attentional shielding.

When interference was predictable, participants altered their performance patterns in a manner consistent with strategic modulation of attentional allocation. Specifically, at short SOAs, T1 accuracy was lower and T2 responses were slower in the 100% T2 probability condition compared to the 50% condition, suggesting that participants adopted a different attentional strategy when interference was predictable, prioritising management of the second task rather than maximising T1 accuracy. In contrast, at long SOAs, where T1 consolidation was largely complete, differences between probability conditions were substantially reduced for both T1 accuracy and T2 reaction times.

These results support the adaptive shielding account (Nieuwenstein et al., 2025), which proposes that attentional control is flexibly regulated in anticipation of interference rather than governed by a fixed structural bottleneck. The findings demonstrate that individuals proactively adjust attentional priorities based on task demands, even when such adjustments involve performance trade-offs.

Notably, T1 accuracy was significantly higher overall in the 50% T2 probability condition compared to the 100% condition, a pattern that deviates from the findings reported by Nieuwenstein et al. (2025). One plausible explanation is that uncertainty regarding T2 occurrence in the 50% condition led participants to prioritise the consistently relevant task (T1), which was present on every trial, resulting in more effective overall encoding. When interference was fully predictable, participants may have adopted a sustained anticipatory strategy to manage T2 on every trial, thereby reallocating attentional resources away from T1 and producing a global reduction in T1 accuracy. This interpretation suggests that under conditions of uncertainty, attentional resources may be preferentially devoted to stable task demands, whereas continuous anticipation of interference may carry a cost for primary-task consolidation

ADHD Symptoms and the Modulation of Adaptive Shielding

Contrary to the study's hypotheses, ADHD symptom severity did not reliably modulate adaptive shielding effects. Neither the mixed-design ANOVA using extreme symptom groups nor the dimensional regression analyses revealed significant associations between ADHD symptoms and the magnitude of shielding at short SOAs. These results suggest that, within the present sample, adaptive attentional shielding operates similarly across individuals with varying levels of ADHD symptomatology.

One possible explanation is that adaptive shielding reflects a relatively fundamental cognitive control mechanism that remains largely intact across non-clinical populations. Although previous research has linked ADHD symptoms to reduced proactive control (Cai et al., 2023), such deficits may not generalise to all forms of anticipatory attentional regulation or may require more demanding tasks or clinical samples to emerge. Additionally, ADHD-related differences may be more subtle than anticipated, particularly in young adult university samples where compensatory strategies may be present.

The absence of categorical group differences alongside non-significant dimensional effects suggests that ADHD related variability in this paradigm may be limited or require larger samples to detect. These findings highlight the importance of considering both experimental sensitivity and sample characteristics when examining individual differences in cognitive control.

Theoretical Implications

The present findings add to theories of attention and cognitive control by providing behavioural evidence for adaptive attentional shielding. According to the adaptive shielding account, working-memory consolidation is a fragile process that can be disrupted by interference if attention is divided too early. The theory proposes that the cognitive system can protect consolidation by proactively allocating attention when interference is expected, rather than relying on a fixed processing limitation (Nieuwenstein et al., 2025).

The results of the present study support this idea. The interaction between SOA and T2 probability showed that interference effects depended on both the timing of the tasks and the likelihood of distraction. At short SOAs, when T1 consolidation overlapped with T2 processing, performance differed clearly between probability conditions, suggesting that participants adjusted their attentional strategy based on how predictable the interference was. In contrast, at long SOAs, where T1 consolidation was largely complete before T2 appeared, differences between probability conditions were much smaller. This pattern suggests that attentional shielding was mainly applied when consolidation was most vulnerable to disruption.

These findings are difficult to explain using strictly structural bottleneck models, which assume that interference occurs whenever tasks overlap in time, regardless of expectations (Tombu et al., 2011). Instead, the present results indicate that attentional limitations are flexible and can be adjusted depending on task demands. This supports accounts that emphasise adaptive control mechanisms rather than fixed capacity constraints.

The findings are also consistent with the Dual Mechanisms of Control framework, which distinguishes between proactive and reactive forms of control (Braver, 2012). Proactive control involves preparing for interference in advance by maintaining task goals and attentional priorities, whereas reactive control is engaged only after interference has occurred. Adaptive attentional shielding fits well within this framework, as it reflects anticipatory preparation for expected distraction. The present results therefore suggest that proactive control can operate in fast-paced dual-task situations to protect working-memory consolidation.

Although ADHD symptoms did not influence shielding effects in this study, this does not necessarily contradict theoretical accounts of control impairments in ADHD. Instead, it may indicate that the type of proactive control involved in adaptive shielding is relatively

preserved in non-clinical samples, or that ADHD-related differences emerge only under more demanding conditions. This interpretation is in line with previous research suggesting that cognitive control difficulties in ADHD are context-dependent rather than present across all tasks (Mostert et al., 2015).

Practical Implications

From an applied perspective, the findings underscore the importance of task structure and predictability in managing cognitive load. Environments that minimise unexpected interruptions or frequent task switching may facilitate more effective working-memory consolidation and attentional efficiency. This has potential relevance for educational contexts, where sustained attention is critical for learning, as well as occupational settings that involve multitasking demands.

Furthermore, the results suggest that decreased performance in memory tasks may reflect strategic attentional allocation rather than general cognitive limitations. This highlights the importance of considering attentional dynamics when interpreting cognitive performance, particularly in assessment contexts.

Limitations

Several limitations should be acknowledged. The sample consisted primarily of psychology students and exhibited a substantial gender imbalance, which may limit the generalisability of the findings to broader or clinical ADHD populations. The online nature of the experiment also introduced variability in testing environments that could have influenced attentional engagement and reaction times.

Additionally, preprocessing adjustments were required to correct scoring of T1 accuracy and T2 reaction times. Although these corrections were implemented prior to final analysis, some participants appeared to prioritise the T2 task at the expense of T1 recall,

potentially increasing variability in performance measures. Finally, the modest sample size may have limited statistical power for detecting individual difference effects.

Future Directions

Future research should aim to replicate these findings using larger and more diverse samples, including individuals with clinically diagnosed ADHD. Conducting laboratory-based experiments may help standardise testing conditions and reduce environmental variability.

Further studies may also explore how adaptive shielding operates across a wider range of task demands, interference probabilities, and temporal dynamics to better understand the flexibility of attentional control processes.

Conclusion

In summary, the present study provides strong evidence for adaptive attentional shielding within a dual-task paradigm, demonstrating that interference effects are flexibly modulated by expectancy and temporal overlap. While ADHD symptoms did not reliably influence the deployment of these proactive control mechanisms, the findings highlight the robustness of adaptive shielding across individuals. These results contribute to a growing body of research emphasising the dynamic nature of attentional control and underscore the importance of expectancy in managing cognitive interference.

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