A study of Cognitive Disengagement Syndrome, sleep and everyday functioning in adults.

Literature Review

and

Empirical Paper

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Pam Boullin, Trainee Clinical Psychologist

C0075091

P.Boullin2@ncl.ac.uk

Supervised by Professor Mark Freeston, Newcastle University

Mark.freeston@newcastle.ac.uk

I declare that this thesis is my own work, and I have appropriately acknowledged and referenced others' work. The assignment is in accordance with University and School guidance on academic conduct (avoiding plagiarism and other assessment wrong doing). Consult ncl.ac.uk/right-cite for university guidance.

Abstract

Cognitive Disengagement Syndrome (CDS) symptoms manifest as sluggishness, mind wandering, withdrawal and brain fog. Previously studied as part of ADHD, CDS is now regarded as a separate construct, with both conditions still sharing around 30 % of variance. There are few meta-analyses in the CDS literature and limited studies on adult samples examining the relationship between CDS and psychopathologies such as sleep, daytime sleepiness and executive function. This thesis sought to explore these relationships to consolidate and expand the evidence base. A systematic review was conducted, 14 studies were included examining associations between CDS and poor sleep, daytime sleepiness and circadian preference. Overall, 13 studies were included for numerical synthesis, and one was reported narratively. Moderate significant associations were found between CDS and poor sleep (r = 0.42 CI [0.33,0.49], k = 13, *N* = 3,456), CDS and daytime sleepiness (r = 0.38, CI [0.31,0.44], k =3, *N* = 616) and CDS and evening preference (r = -0.31, CIs [-0.38, -0.24] k= 3, *N* =618). The review established that few adult studies have examined the relationship, as most were conducted in young student populations (k = 9), and many studies were conducted in the context of ADHD (k= 7). The significant moderate effects suggest that a relationship between CDS and sleep exists, however the meta-analytical findings could not ascertain whether this association was bidirectional. The empirical study aimed to examine this potential bidirectional relationship, and whether variables such as daytime sleepiness and executive function impacted the association. Using Hayes' PROCESS macro (models 14 and 15), we carried out conditional process analyses to test the hypotheses, predicting a bidirectional relationship between poor sleep and CDS, mediated by daytime sleepiness and moderated by executive function in a community adult sample (*N*= 453). Significant

direct effects between poor sleep on CDS, and CDS on poor sleep were found, significantly mediated by daytime sleepiness at the indirect path. There were non-significant findings for both the moderated sleep by executive function interaction and the concentration by executive function interaction. The mediating effects of sleepiness on the indirect pathway of poor sleep and CDS became non-significant when controlling for ADHD symptoms. The significant effects observed in the other pathways remained significant though weakened when controlling for depression and ADHD. These findings warrant further investigation. The results from this review and empirical study highlight the need for future longitudinal research to explore the CDS and sleep association across multiple timepoints to test the inferences drawn from cross-sectional studies such as the current study, to test possible causal pathways. Further exploration is required to examine the mechanisms underpinning the impact of evening preference on CDS and depression, and links with daily dysfunction. Given the impact of ADHD on the indirect relationship between sleep and CDS mediated by sleepiness, future research could examine the nuances of CDS sub-components and association with sleep. This could lead to potentially useful interventions targeting mood, ADHD and daytime sleepiness to address both poor sleep and symptoms of poor concentration

Acknowledgement of contributions

I would firstly like to thank my supervisor Professor Mark Freeston for his invaluable knowledge and guidance. I would also like to thank Georgia Mooney a fellow DClinPsy trainee. Although we researched separate questions related to CDS, we worked collaboratively to coordinate participant recruitment for both the pilot and main studies. Her wisdom and shared vision have enhanced this research process. I would also like to thank Caitlin Kittridge and Maeve Thompson, undergraduate students at Newcastle University School of Psychology for their contribution to the pilot study. Many thanks to Dr Rebecca Hirst at Open Science Tools for her expert assistance in designing the Stroop task. Thanks to Linda Errington, librarian at Newcastle University for her support in developing search strategies for the systematic review. I also thank all the participants for their time and invaluable contribution to this study.

Thank you to my amazing family for their unwavering support through the writing of this thesis. To my husband Lindsay, thank you for your consistent love and encouragement, your belief in me and for quietly ensuring that things have kept running smoothly in the background. To my three fabulous children, Jessica, Rosanna and Oliver. Thank you so much for your patience, encouragement, love and support. I hope that through my completion of this doctoral thesis, you appreciate you can take on new challenges, at any stage in life. Thank you to my sisters and friends for telling me to keep going and accepting my absence for so long. I look forward to sharing adventures in the future. I would also like to thank Michelle Mooney, fellow trainee and incredible friend for your constant support and encouragement throughout this process.

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Literature Review

Cognitive Disengagement Syndrome and sleep difficulties in adults: A systematic review and meta-analysis

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Doctorate in Clinical Psychology

C0075093

Pam Boullin

Supervisor : Professor Mark Freeston, Newcastle University

0.0 Abstract

The aim was to conduct meta-analyses examining the relationship between Cognitive Disengagement Syndrome (CDS), poor sleep, daytime sleepiness and circadian preference. Electronic databases were searched, identifying 14 studies for inclusion. A Restricted Maximum Likelihood Random Effects model (REML) was used to assess CDS and its association with poor sleep, and fixed effect models were used to evaluate CDS and associations with daytime sleepiness and circadian preference. One study examining CDS and circadian preference was reported narratively. In the main meta-analysis, a significant moderate association was found between CDS and poor sleep (r = 0.42 CI [33 -.49], k = 13, *N* = 3,456). In the smaller meta-analyses, a significant moderate association was found between CDS and daytime sleepiness (*r* = 0.38, [.314 -.442], k =3, *N* = 616) and a small negative association was found between CDS and morning preference tendency (*r* = -0.31, Cis [-0.377, -0.236] k= 3, *N* =618). Narrative report identified a negative association between CDS and morning preference (*r* = –.26, N = 65 ,k = 1, *p* =.04). This review suggests there is a moderate association between CDS and poor sleep. Future research should examine the reciprocal nature of this relationship and explore the associations between CDS and effects of sleep parameters we did not examine, such as sleep onset latency and efficiency. Further studies using objective sleep measurement and collateral CDS report would be helpful. Longitudinal data could measure changes in associations of sleep, sleepiness and circadian preference and CDS across the adult lifespan to inform and develop sleep interventions that potentially reduce concentration problems.

1. Introduction

Cognitive Disengagement Syndrome (CDS), previously Sluggish Cognitive Tempo (SCT), typifies symptoms such as poor and limited concentration, excessive daydreaming, brain fog, slow movement and mental disengagement (Barkley et al. 2022). Initially, interest in CDS arose through studies examining attention deficit hyperactivity disorder (ADHD), and research focussed on CDS as a subtype of ADHD-inattention, IN (Becker et al., 2016); a strong significant association was found with CDS and the ADHD-inattention (IN) criteria.

However, research moved direction towards the concept of CDS sharing intersecting features with ADHD-IN, but the two were considered as separate constructs (Becker et al., 2016). A strong association has been identified between ADHD-IN and CDS, evidenced in Becker's meta-analysis (k= 20, *N*=19 000), finding a strong association (r = 0.63) with more overlapping features than those found in impulsivity or hyperactivity ADHD subtypes (Becker et al., 2016). Sixteen items examining CDS symptomology found that 13 CDS items loaded reliably on a CDS factor as opposed to an ADHD factor, meta-analysed from 20 studies comprising varied factor analytic methodologies, sampling methods and ages (Becker et al., 2016). Findings supported the test-retest and interrater reliability of CDS as well as internal consistency (Becker et al., 2016). Subsequently, two more of the 16 items have been validated and deemed distinct from ADHD-IN, excluding only poor motivation from CDS symptomology (Becker, 2025).

Despite an initial call from some academics to include CDS as a distinct disorder in the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-V), acknowledging its overlap with a Restrictive Inattentive ADHD type to address the heterogeneity in ADHD symptoms (see Tannock 2013), neither were included (Mahone &

Denckla,2017). CDS is not recognised as a separate, diagnosable condition with clearly classified diagnostic criteria (Becker et al., 2023), but is however endorsed as a significant syndrome, aiding understanding of numerous different internalised and externalised presentations (Frederick et al; 2024), and holding its own as a clinically valid construct separate from other DSM-5 syndromes (Creque & Willicut, 2021).

The CDS construct appears to be invariant over time (Becker et al., 2023), but evidence indicates marginal increase in CDS with age. Becker's meta-analysis reports a significant correlation between increased age and CDS albeit small (r = .11) (Becker et al., 2016). A longitudinal study across ten time points in early and mid-childhood (N=1173, 3rd to 5th grade), found modest increases in mean levels of CDS with age, using both parent and teacher ratings (Dvorsky et al., 2021). Findings have also distinguished between ADHD-IN and CDS in children as young as 3, although only four CDS items were measured (Dvorsky et al., 2021). A recent longitudinal two time point population-based youth study (N = 376, 8 to 16-year-olds), suggests that CDS status at baseline is the greatest predictor of CDS at follow up (Mayes et al., 2023). Most early studies have focussed on CDS in children, but an emerging evidence base is exploring young adults' self-reports of CDS symptoms and the impact on everyday functioning. Reported CDS symptoms in adults are significantly related to depression (k= 6, N = 2,737) r = 0.50, 95% CI [0.43,0.57] (Becker et al.,2016), suicidal ideation, social withdrawal, sleep difficulties and to a smaller degree executive function problems, over and above ADHD (Becker, 2023). Comorbidity of CDS and ADHD-IN is around 30-50% (Becker, 2025),

Assessing CDS

Specific rating scales have been developed demonstrating robust structural validity, reliability and independence from ADHD in both clinical and community

populations (Becker, 2021). A recent meta-analysis (k=76) detected nine adult / child CDS assessment measures comprising teacher/parent/child report or self/collateral report in adults, signifying moderate to excellent reliability and highlighting the utility of the measures in assessing external correlates of CDS across all age groups (Becker, 2021). Adult studies may still lack incorporation of multiple informants to accurately measure CDS, as demonstrated in an adult clinical ADHD study (*N*=124, *M*= 31.13, *sd* = 11.47), in which self and collateral reports of three CDS factors daydreaming, sluggishness and low initiation, yielded discrepant results (Lunsford-Avery et al., 2021).

Sleep

Optimal daily performance and functioning are dependent on good sleep (Gul et al., 2025), and sleep disorders manifest when sleep behaviours or patterns are disturbed (Bukhari et al., 2021). The International Classification of Sleep Disorders, Third Edition (ICSD-3), classifies six main criteria across the lifespan: insomnia, sleep-related breathing disorders, circadian rhythm disorders, hypersomnolence, excessive sleep-related movement disorder and parasomnia (American Academy of Sleep Medicine, 2014). The most reported sleep disorder is insomnia, and sleep quality or quantity comprise the most prevalent complaint related to the condition (American Psychiatric Association, 2013). Research promotes strong associations between good sleep, optimal daily functioning and positive mental health outcomes, evidenced in a meta-analysis investigating sleep quality measurement (k=37). concluding that sleep disruptions are associated with neurocognitive disturbances, attention and concentration problems, reduced cognitive functioning, anxiety, depression and increased impulsivity (Mollayeva et al., 2016). Assessment of people's sleep is therefore an important consideration in clinical and epidemiological studies (Fabbri et al., 2021).

Chronotype relates to the time of the day where someone is most cognitively and physically functional, with three classifications: “morningness,” “eveningness,” and “neither” (Roenneberg et al., 2003). Morningness is correlated with better mental and physical well-being, functionality, and academic achievement, and protects against sleep-related conditions as opposed to eveningness, which is linked to the opposite outcomes including augmented susceptibility to sleep-related conditions (Zou et al., 2022). Morningness and eveningness relate to circadian preference (Bauducco et al., 2020). A recent meta-analysis across adolescent studies found a small significant positive association between preference for evenings rather than mornings and general mental health problems (r = 0.20), anxiety (r = 0.13) and mood-related disorders (r = 0.17) (Cheung et al., 2023). Exploration of circadian predilection, particularly the tendency towards being a “night owl “is an important consideration in sleep research (Bauducco et al., 2020).

Assessing Sleep

Sleep studies still currently fail to provide a consistent definition of sleep quality (Cudney et al., 2022). A recent literature review across 49 studies reflects the need to consider both diurnal impairments and nighttime sleep parameters to effectuate robust evaluation of sleep quality (Fabbri et al., 2021). The extent to which someone feels well slept and alert the next day appear to bias their perception of their sleep quality (Ramlee et al., 2017). This is demonstrated in a study examining self-reported good and poor sleepers (N=100) where there was no direct positive correlation between self-reported sleep maintenance and latency, and feeling refreshed the next day; feeling refreshed and able to function ostensibly led to positive subjective judgements about the previous night’s sleep quality (Ramlee et al., 2017).

Consideration of the full range of sleep measures used in sleep studies is essential, as the chosen measure can impact the findings. Objective tools such as the polysomnography (PSG) and actigraphy are deemed reliable instruments for accurate measurement of sleep variables (Fabbri et al., 2021). Heterogeneity in sleep questionnaires results in measurement across various timespans, and measures range from a single question to questionnaires with numerous subscales, meaning there is no one established method to measure people's sleep (Fabbri et al., 2021).

CDS and sleep

Several cross-sectional child and recently emerging student / young adult studies have evaluated the relationship between sleep problems and CDS amongst other variables, often in the context of ADHD research. Significant overlap in CDS symptoms and disturbed sleep correlates such as poor concentration, inability to remain alert and delayed processing ability, have been clinically observed, especially in child studies (Lunsford-Avery et al., 2021). The lethargy, cognitive slowness, fogginess and excessive sleepiness that typify CDS can also typify symptoms of sleep problems, evidenced in diurnal sleepiness (Wood et al., 2020). Early studies investigating daytime sleepiness and CDS focussed on the distinction between CDS symptomology and the manifestations of daytime sleepiness. An early student study exemplifies this (N=768), finding an overlap with CDS /sleepy symptomology especially between lethargic and tired CDS items, and daytime sleepiness, but the two remained empirically separate (r =0.51), (Langberg et al., 2014).

Irrespective of ADHD status, young people with CDS are reporting excessive daytime sleepiness and decreased sleep efficiency, singularly linked to CDS (Becker et al., 2023), and the only two community adult studies examining these two variables

suggest a more consistent association between CDS and sleep problems than ADHD (Knouse & Becker, 2025; Frederick et al., 2022). Limited research suggests that CDS may be related to evening preference but the internal circadian mechanisms behind this diurnal preference in people with CDS are poorly understood (Lunsford-Avery et al., 2021; Voinescu et al., 2012).

Objectives

The literature lacks comprehensive systematic reviews exploring studies on CDS in adult populations (Becker, 2023). Currently, there is no systematic synthesis of studies exploring the relationship between sleep issues and CDS in adults. Becker et al. (2023), briefly examine this relationship in their "Report of a Work Group on Sluggish Cognitive Tempo" which provides an overview of all current research and gaps in the CDS literature. They report the findings of only 13 lifespan studies conducted between 2012 to 2022 on CDS and sleep in children and student adults. Their narrative synopsis concludes that in young student adults, overall sleep issues, shorter sleep duration, and increased diurnal sleepiness are uniquely associated with CDS (Becker et al., 2023). There is also growing evidence to suggest an association between evening preference and CDS in children and adolescents (Becker et al., 2023). This report does not capture all available adult studies (k=6), is not a systematic review, nor does it numerically synthesise the overall associations between these variables.

Researching the evidence base on CDS, sleep problems, daytime sleepiness and circadian preference may be beneficial for those reporting CDS symptoms. Firstly, by incorporating poor sleep characteristics as an intrinsic element in CDS assessment (Gloger & Suhr, 2020). Secondly, by understanding the associations, future research may move towards development of specific interventions targeting the poor sleep and thus

improving symptoms of daytime tiredness for people with CDS reporting poor concentration, and moderating difficulties in daily functioning (Smith & Suhr, 2020).

A systematic review that promotes critical investigation and systematic understanding of the evidence base and current gaps in research may promote greater understanding of CDS and its association with sleep. A systematic review and meta-analysis were conducted to answer the following research question:

An investigation of the relationship between sleep problems, including daytime sleepiness, circadian preference and Cognitive Disengagement Syndrome in adults. Within this question we sought to answer the following sub questions:

1. What are the principal features of studies that investigate CDS and sleep in adults?
2. What CDS and sleep measurement tools are used across the studies?
3. What do we know about the strength of the associations between CDS and sleep problems, daytime sleepiness and circadian preference?
4. Which methodological factors moderate the relationship?

2. Method

2.1. Pilot and Scoping

Prior to conducting the review, the researcher performed a brief scoping exercise to ascertain the amount and types of published literature available to examine CDS and sleep difficulties across the lifespan and gaps in this research area. A scoping review ascertained that there were no existing systematic reviews in the topic area by searching

Google Scholar, PROSPERO and the Cochrane Database of Systematic Reviews, in February 2024. A pilot review was carried out in February 2024, complying with Systematic Reviews' Preferred Reporting Items and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR 2020) checklist (Page et al., 2021). The pilot review evidenced proof of concept, through identification of an adequate number of sources for the review.

2.2 Protocol pre-registration

The researcher first registered the systematic review's protocol on PROSPERO (CRD42024550640) on 3rd September 2024. Prior to registration, a further check was made to establish that there were no registered reviews in this CDS topic area. The meta-analysis conformed with PRISMA standards (Page et al., 2021).

2.3 Literature Search

A systematic search of the literature was employed to identify relevant studies examining exploration of the relationship between CDS and sleep.

2.3.1 Eligibility of sources

The following inclusion and exclusion criteria were followed:

Inclusion Criteria

(1) There were no restrictions on sample characteristics e.g. ADHD, Autism, community or clinical, or medical conditions. Initially adult and child studies were extracted, but subsequently child studies were excluded (see results and discussion for further details); (2) any study exploring sleep parameters related to CDS was included whether the main focus of the study or a small part of more extensive study aims; (3) all studies written in English or in another language with English translations; (4) studies with one

or several CDS or sleep measures; (5) peer reviewed and grey literature such as dissertations and studies awaiting peer review; (6) no restriction on publication dates; (7) Empirical studies

Exclusion Criteria

Sources were excluded if they were: (1) non-English journals without available translations; (2) non empirical studies including commentaries, reviews, case studies or conference abstracts; (3) empirical studies comprising case study or intervention; (4) studies without a CDS or sleep measure.

2.3.2. Search strategy and database searches

The following bibliographic computer databases were searched: MEDLINE (PubMed), EMBASE, PsycINFO, Scopus, Web of Science and Proquest from inception until 4 November 2024. An advanced Google search was also carried out to find dissertations or studies awaiting peer review and publication. A library information specialist helped develop the searches. A Boolean search approach was used containing the main items sluggish cognitive tempo *or* cognitive disengagement syndrome *and* sleep. As the most recent terminology was changed from Sluggish Cognitive Tempo to Cognitive Disengagement Syndrome (CDS) in Becker's working group review (2023), it was deemed that most searches would bring up Sluggish Cognitive Tempo in studies precluding 2023, so both terms were used. Abbreviations SCT and CDS were omitted due to overlap with many other conditions and words unrelated to the search. Given the emergent and relatively novel field of CDS and its association with key variables, search terms were broad to ensure that all relevant

studies were captured. The term “sleep” used truncations, mainly through use of the wildcard asterix* at the end of the term sleep to cover its variety of endings.

There were no constraints placed on publication dates. Grey literature was included, to capture new unpublished studies or dissertations. References of the included studies were examined to find any studies missed in the initial search. A final search was re-run on 16th May 2025. (See Appendix A for search example).

2.3.5 Selection of studies

Relevant studies from the data bases were imported into Endnote 21. Endnote was then used to identify and remove duplicates. After duplicate removal, studies were reviewed manually to screen titles and abstracts for the inclusion criteria.

When sources appeared eligible but either the study was published in a language other than English, or access to full text or necessary data was restricted the researcher contacted authors for the missing translations or the full paper.

2.3.6 Data extraction and charting

One researcher screened titles, abstracts, then full texts appropriate to answer the review question. A data-charting template was developed on Microsoft Excel, to extract the relevant study information from the articles meeting the inclusion/exclusion criteria and based on the research questions. Extracted information:

1. Characteristics of sources of evidence (Table 2)

- Study
- Publication year
- Country of origin

- Title
- Sample size
- Age range
- Mean age and standard deviation
- Sample characteristics
- Percentage female
- Ethnicity – percentage majority
- Design

2. Individual sources of evidence (Table 3)

- Study
- Method of analysis
- Study type
- Sample type
- CDS Measure
- Correlate measures (sleep measures)
- Sleep parameter selected for analysis
- Pearson's correlation *r* statistical data

One researcher extracted data twice to mitigate extraction errors

2.4 Critical appraisal

A Quality Assessment Tool was utilised based on the tool employed by Frederick and colleagues' review examining CDS and medical conditions (Frederick et al.,2024). This tool was developed by the authors using the Johns Hopkins Nursing Evidence Based Practice Evidence Level and Quality Guide (Dang et al., 2022), along with the Methods

Guide for Effectiveness and Comparative Effective Reviews (Agency for Healthcare Research and Quality, 2014). Minor adaptations were made to align with the current review questions pertaining to CDS and sleep, and not all criteria were completed if not relevant to the current review (see Appendix B for table of criteria and ratings).

2.5 Analysis using meta-analytic method

2.5.1. Coding of Effect Sizes

This meta-analysis included 13 studies. The main summary measure chosen was Pearson's correlation coefficient (*r*) between CDS and sleep. Twelve of the included studies reported bivariate correlations, so Pearson's *r* was deemed to provide the most consistent measure of the relationship between CDS and sleep parameters across the studies, and provided essential interpretability (Bornstein et al., 2021). Effect sizes were interpreted using Cohen's conventions (1988) small, $r = 0.10$, moderate, $r = 0.30$ and large $r = 0.50$, using 95 % confidence intervals (Rosenthal et al., 1994).

Seven of the studies reported only one sleep outcome. One study (Gloger & Suhr, 2020) reported two different groups with mean differences between good sleepers and poor sleepers and reported the Cohen's *d* effect size. The Cohen's *d* effect size was therefore converted to Pearson's *r*. The author coded each effect size to a sleep parameter. To maintain the assumption of independent effect sizes, studies were excluded from the meta-analysis if their sample data were shared with other studies using the same sample data from larger study samples. One sample (Voinescu et al., 2012) reported independent effect sizes in two studies, with a clinical and community sample, so both groups were included as separate studies with independent effects. One study (Gul et al., 2025) initially included as a non-peer reviewed paper, was peer reviewed in 2025. A table reporting Pearson's correlations included in the non-peer reviewed paper

was excluded in the update, despite the study and sample being identical. The author confirmed via email that the original correlations table was accurate, so the effects were extracted for meta-analysis. One paper (Lunsford-Avery et al., 2021) reported partial correlations as they controlled for ADHD, sex and age before analysis. They carried out subgroup analysis but did not report the beta in either group which excluded the study from meta-analysis.

In all studies total CDS scores were reported. One study, (Gul et al.,2025) reported effects for the total CDS score as well as subscales daydreaming and sluggishness. Lunsford-Avery et al., 2020 reported partial effects for the total CDS score as well as three dimensions daydreamy/sluggish/low initiation. All effects were extracted.

2.5.2 Sleep Variables

Across the studies eleven different sleep parameters were identified. Seven of the studies reported only one effect related to sleep and CDS. Where studies reported multiple effects, only one effect was analysed per study to maintain statistical independence. To ensure conceptual consistency, the proxy effect size chosen for the main meta-analysis was based on a hierarchy of 1, total sleep scores, 2. sleep quality or insomnia 3. the sleep parameter most conceptually associated with the DSM-V criteria for insomnia:(i. sleep efficiency, ii. Sleep disturbance iii. difficulty initiating or iv. maintaining sleep) (APA, 2013). One study reported only the association of daytime sleepiness and CDS (Langberg et al., 2014). This was included in the meta-analysis but as it presents a somewhat different construct to poor sleep “sleep type” (poor sleep versus daytime sleepiness) sleepiness was tested as a moderator in a subgroup analysis.

2.5.3 Meta analysis

JASP software was used to carry out the meta-analyses (version 19.1, JASP, 2024). A Restricted Maximum Likelihood Random Effects model (REML) was chosen to estimate the effect sizes of the association between CDS and sleep in the main meta-analysis. The REML is recommended for meta-analysis where there are small to moderate amounts of studies (Brockwell & Gordon, 2001). Two separate fixed effect meta-analyses were utilised to analyse the association between CDS and daytime sleepiness, and CDS and circadian preference. A fixed effect model is useful when studies are limited, (k =3) decreasing the standard error of the weighted standard effect size, increasing statistical power (Cohn & Becker, 2003).

To integrate the statistics, we converted Pearsons's r to Fisher's Z (Zr). Fisher's Z was used to integrate data due to *r* not obeying the normal distribution (Hedges & Olkin, 2014). Fisher's Z value effect sizes were converted back to Pearson's *r* to remain consistent. Statistical heterogeneity was examined between the studies employing the I^2 statistic (Higgins & Thompson, 2002). Between-study heterogeneity was evaluated using the Q statistical significance test; the amount of actual heterogeneity between studies was quantified using the τ^2 statistic (Bornstein et al., 2021). Sensitivity analyses were planned if any study was deemed to be an outlier. All confidence intervals were calculated at the 95% level.

2.5.4 Moderator analyses

Six Categorical and four continuous moderators were statistically tested to assess possible variability across studies (Hedges & Olkin, 2014). Subgroup analysis was used to test pre specified categorical moderators (study population, sample, country, sleep type, sleep and CDS measure and examine heterogeneity sources (Higgins et al.,

2019). Meta regression was used to test continuous moderators (age, percentage white, gender, sample size).

2.5.5 Publication bias

Egger's test of funnel plot asymmetry (Egger et al., 1997), and Kendall's rank correlation test (Kendall, 1976) were processed to determine publication bias. Forest Plots were generated for each meta-analysis to present each effect size from the individual studies with their 95% confidence intervals with the overall combined effect (Cherry et al., 2023). To examine whether outliers or unpublished studies had influenced the overall estimate of effects, a Trim and Fill method was utilised, developed by Duval and Tweedie (2000).

2.5.6 Narrative Report

As one study reported only a partial effect for the CDS circadian preference correlation (Lunsford-Avery et al., 2021), it was excluded from meta-analysis and the association of circadian preference and CDS was reported narratively.

3. Results

3.1 Search and identification of articles

A PRISMA flow diagram depicts the search results (Figure 1) The search identified 456 sources, and three non-peer reviewed studies found in a Google Scholar search. After removing duplicates,138 studies were screened at title and abstract, excluding 81 studies. Consequently, 57 sources remained for full-text screening

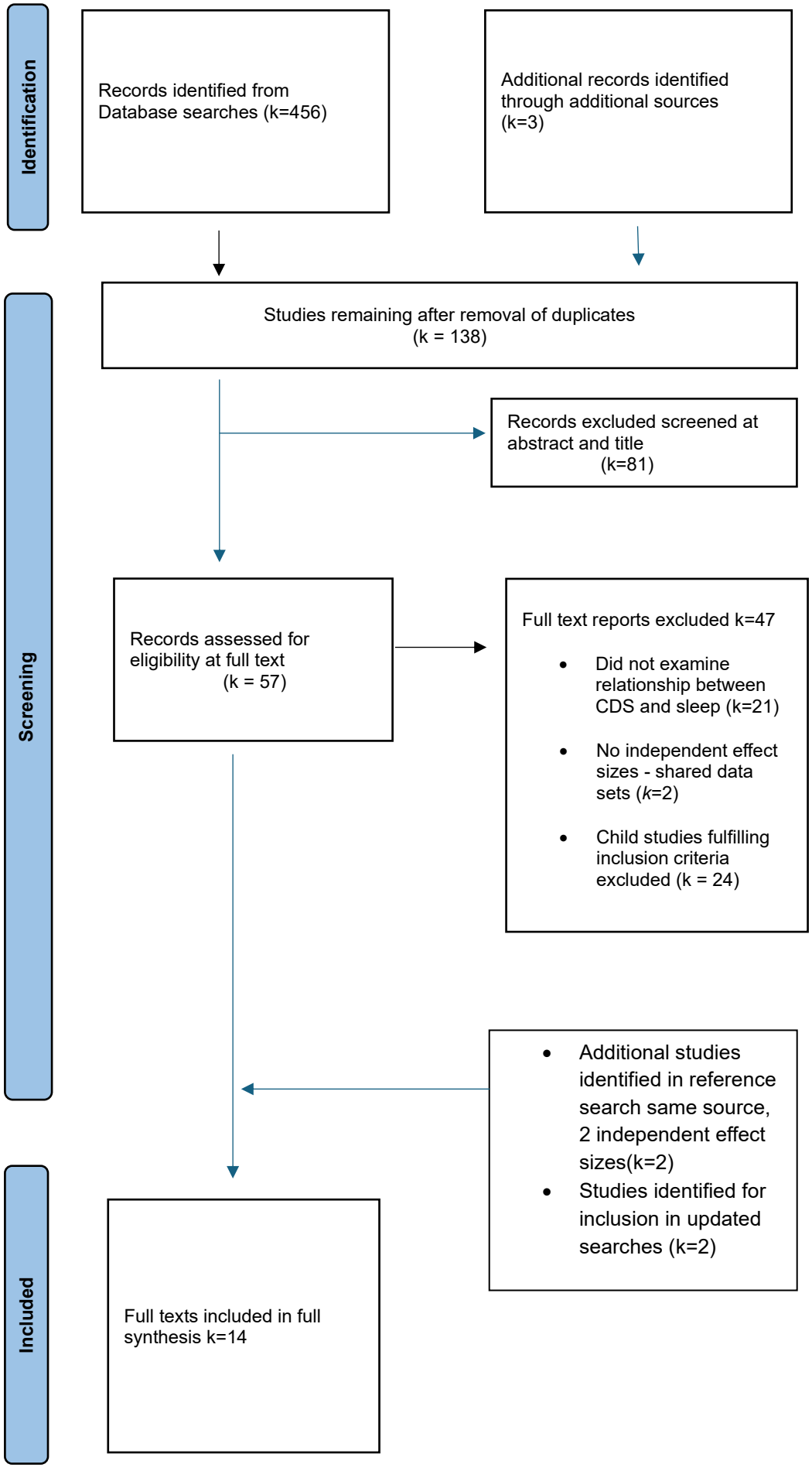
Rationales for exclusion at full text were: 1. No examination of the relationship between CDS and sleep, excluding 21 studies, 2. After careful quality assessment of all the included studies across the lifespan, it was decided that child studies should be

excluded from the meta-analysis due to the vast heterogeneity of measurement compared with adult studies. Therefore, all 24 child and adolescent studies were excluded. 3. To prevent violation of assumption of independent effects, two adult studies meeting inclusion criteria were excluded as they shared samples from larger epidemiological studies. In each case the two other studies were retained (Becker et al., 2014; Wood et al., 2020).

Ten studies were retained for data extraction. An additional two studies were found through a reference search (one source, two studies with two independent effects). These studies were missed in the initial search as no CDS related search terms were included in the abstract or title (Voinescu et al.,2012). Two new studies meeting inclusion criteria were found in the May 2025 search and were retained for the meta-analysis (Knouse & Becker, 2025; Sadeghi-Bahmani et al.,2025). At the final stage, in total 14 studies met inclusion criteria and were included for data extraction, 13 for meta-analysis, one for narrative report. Consistent with the aims of this systematic review, we present; 1. the principal features of studies that investigate CDS and the association with sleep problems, 2. CDS and sleep measurement tools used across the studies, 3. results for the bivariate correlations which examine the relationship of CDS with sleep, daytime sleepiness and CDS, 4. An examination of the methodological issues which may moderate the relationships.

Figure 1

Prisma Flowchart



3.2 Study Characteristics

The characteristics of the selected studies are summarised in Table 1. This systematic review includes 14 studies assessing 66 independent effects (19 of which were from subscales of CDS measures correlated with sleep). Studies were completed between 2014 and 2025, and all were cross-sectional in design. Sixty- four percent of studies (k = 9) were conducted in the United States, two in Turkey, two in Romania and one in Switzerland. Of these 14 studies, nine (64%) comprised student samples. The majority, 11 (79%) were community samples. Thirteen of the 14 studies were peer reviewed. Only three studies (21%) used clinical samples based on an ADHD diagnosis (and one of these, not included in meta-analysis was a mixed clinical with a predominantly ADHD sample). The total sample size across studies was 3,521. Eight studies (57%) did not report ethnicity. The five non-American studies reported nationality but not ethnicity. Among the reported demographic data, the total sample was k = 14, 64.6% female (n = 2,381) and pooled sample was k = 6, 75 % white (n=1181). Pooled sample mean age (k=11) was *M* =25.

3.3 Quality Assessment

Most studies were judged to use well validated measures for CDS assessment (79%), and most, excluding two, controlled for ADHD-IN or used a separate CDS group (86%). In general, the sleep measures were well validated (64%). Approximately two thirds of studies included a priori hypotheses or aims related to CDS and sleep that were at least implied (79%), and 50% presented aims or hypotheses explicitly related to this relationship. Studies were generally not judged to have good sample representativeness with 50 % being poor and 50 % being fair. The majority did not justify sample size (93 %),

and all studies were observational in their design (100%) (Quality of studies is summarised in Table 1).

Table 1

Table of Quality Assessment Results

Criterion	Author													
	Becker et al., (2014)	Frederick et al. (2022)	Gloger & Suhr (2020)	Gul et al. (2024)	Jarrett et al., 2014	Knouse & Becker 2025	Langberg et al (2014)	Lunsford-Avery (2020)	Podrasky (2024)	Sadeghi-Bahmani (2025)	Voinescu et al. (2012)	Voinescu et al. (2012)	Wood et al. (2020)	Yucens et al. (2023)
1a Priori 92&hypothesis *relating to CDS and sleep*														
2. Sample size justification for CDS related analysis														
3. Sample representativeness														
4. Quality of CDS measure														
5. Quality of correlates measures														
6. Control for ADHD-IN or separate CDS group														
7. Rates of missing CDS data														
8. Inferences and conclusions														

9. Type of study													
10. Level of control													

Note. Based on Frederick et al.,(2024)

Key

Not completed for this quality assessment	-	+	++

3.4 Results from individual studies

Effect sizes generally indicated positive correlations – higher CDS scores were associated with higher scores for poor sleep. In contrast, the effects related to circadian preference were negative, reflecting that higher CDS scores were associated with lower tendency to morningness. All 14 studies used only self-report measures to assess CDS and sleep in adults. In total, 66 effects were extracted (see Appendix C). To maintain independence of effects and avoid bias, one overall proxy effect for each study was analysed for the three meta-analyses (Bornstein et al., 2021). (See Table 2 for a synthesis of results).

Measures

The measures administered for CDS, and sleep measurement are shown in Table 2.

CDS

In total, three self-report CDS measures were administered. The majority of studies *k*=9 used the Barkley Adult ADHD Rating Scale-IV (BAARS-IV) with nine items related to CDS (Barkley, 2011), (Becker et al., 2014; Gloger & Suhr 2020; Gul et al.,2025; Lunsford-Avery et al., 2020; Knouse & Becker 2025; Podrasky, 2024; Voinescu et al., 2012; Voinescu et al., 2012; Wood et al., 2020).

Three studies administered The Adult Concentration Inventory (ACI), (Becker et al., 2018), 16 items (Frederick et al., 2022; Sadeghi-Bahmani et al., 2025; Yucens et al., 2023), One study (Gul et al., 2025) used the Barkley Adult Sluggish Cognitive Tempo Scale (BASCTS) (Barkley, 2012). a 9-item scale for measuring CDS in adults.

Sleep

For the purposes of quality assessment and to answer our review question concerning the types of sleep measurement administered in studies, all sleep measures are included in the results table and discussed below. However, in some studies, multiple sleep-related questionnaires were administered to measure different associations. A total of 11 self-report questionnaires were used to measure sleep.

Sleep measures

Seven of the studies used the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989), a 19-item measure of various sleep quality parameters from over the past month. (Becker et al., 2014; Frederick et al.,2022; Gloger & Suhr 2020; Gul et al.,2025; Knouse & Becker 2025; Wood et al., 2020; Yucens et al., 2023). Two studies (Voinescu et al., 2012; Voinescu et al., 2012) used the Sleep Condition Indicator (SCI) (Espie et al., 2011). Questions are aligned with the DSM-V criteria for insomnia (Fabbri, 2021) and is 8-items. One study used the Insomnia Severity Index (ISI) (Morin, 1993) a 7-item insomnia measure (Sadeghi-Bahmani et al., 2025). The Symptom Checklist-90-Revised (SCL-90-R) (Derogatis & Savitz, 1999), a broad-spectrum inventory for measuring psychological symptoms was used in one study (Jarrett et al., 2017). One study used The Sleep Disturbance Scale Checklist – 25 (SDS-CL-25) (Klingman et al., 2017), a brief non diagnostic screening tool to measure potential sleep disturbance, the study used question 9 only, directly related to sleep disturbance (Podrasky, 2024).

Daytime sleepiness measures

For the three studies examining daytime sleepiness, three different measures were administered. Two used The Epworth Sleepiness Scale, (ESS), (Johns, 1991) with 8-items (Langberg et al 2014; Becker et al., 2014), one The Paediatric Daytime Sleepiness

Scale, PDSS (Drake et al., 2003) an 8- item measure (Langberg et al.,2014) and one used The PSQI question related to daytime drowsiness (Gul et al., 2025).

Circadian Preference measures

For the four studies examining circadian preference, three studies administered the Composite Scale of Morningness (CSM) (Smith et al.,1989), a 13-item measure to ascertain evening or morning preference (Lunsford-Avery et al., 2020; Voinescu et al., 2012; Voinescu et al., 2012). One study used the Reduced Morning-Eveningness Questionnaire (r-EMQ) (Adan & Almirall, 1991), a 5-item measure for assessing circadian preference (Knouse & Becker 2025).

Table 2

Characteristics of Studies

Study	Country	Publication	Title	Sample size	Age range	Mean age (standard deviation)	Sample characteristics	% female	% Ethnic majority	Number of effect sizes	Design
Becker et al. (2014)	USA	Peer reviewed	Attention-Deficit/Hyperactivity Disorder Dimensions and Sluggish Cognitive Tempo Symptoms in Relation to College Students' Sleep Functioning	288	17-24	18.95(1.06)	Student University	65	90% non-Hispanic white	8	Cross sectional

Frederick et al. (2022)	USA	Peer reviewed	Examining the structural and external validity of the Adult Concentration Inventory for assessing sluggish cognitive tempo in adults	286	31-68	44.45(6.04)	Adult Caregivers	83.6	70% non-Hispanic white	8	Cross sectional
Gloger & Suhr (2020)	USA	Peer reviewed	Correlates of Poor Sleep and Subsequent Risk of Misdiagnosis in College Students Presenting with Cognitive Complaints	99	18-24	19.9(1.1)	Student University	60	Not reported	1	Cross sectional

Gul et al. (2024)	Turkey	Peer reviewed	Exploring the link between sleep and cognitive disengagement syndrome (CDS) in young adults: Integrating the role of ADHD	274	18-35	Not reported	Student University	70.4	100% Turkish	8	Cross sectional
Jarrett et al., (2017)	USA	Peer reviewed	ADHD Dimensions and Sluggish Cognitive Tempo Symptoms in Relation to Self-Report and Laboratory Measures of Neuropsychological Functioning in College Students	298	17-25	18.82 (1.08)	Student University	72	Not reported	1	Cross sectional

Knouse & Becker (2025)	USA	Peer reviewed	Unique associations of ADHD and cognitive disengagement syndrome symptoms with sleep problems and circadian preference in adults	106	18-75	38.69	Student Medics	73.6	71 % white	9	Cross sectional
Langberg et al., (2014)	USA	Peer reviewed	Are Sluggish Cognitive Tempo and Daytime Sleepiness Distinct Constructs?	58	17-30	19.9 (2.75)	Student Clinical ADHD	45	72% white	1	Cross sectional
Lunsford-Avery et al., (2020)	USA	Peer reviewed	Eveningness Diurnal Preference: Putting the “Sluggish” in Sluggish Cognitive Tempo	65	19-69	Not reported	Adult Clinical predominant ADHD	38	88% white	1	Cross sectional

Podrasky (2024)	USA	Non peer reviewed	The Relationship Between Attention-Deficit/Hyperactivity Disorder and Sluggish Cognitive Tempo	66	18-79	Not reported	Student clinical ADHD	45	Not reported	1	Cross sectional
Sadeghi-Bahmani et al. (2025)	Switzerland	Peer reviewed	Cognitive Disengagement Syndrome (CDS) and Psychological Ill-Being in Young Adults Using the Adult Concentration Inventory (ACI)	246	18-30	22.62(3.1)	Adult Community	56.3	Not reported	1	Cross sectional

Voinescu et al. (2012)	Romania	Peer reviewed	Sleep disturbance, circadian preference and symptoms of adult attention deficit hyperactivity disorder (ADHD)	301	Not reported	21.82(2.52)	Student University	84.7	Not reported	**2**	Cross sectional
Voinescu et al. (2012)	Romania	Peer reviewed	Sleep disturbance, circadian preference and symptoms of adult attention deficit hyperactivity disorder (ADHD)	250	Not reported	38.61(12.4)	Adult community	70.4	Not reported	**2**	Cross sectional

Wood et al. (2020)	USA	Peer reviewed	Sluggish cognitive tempo and impairment: The role of lifestyle factors	910	18-24	19.41	Student University	64.9	60.7% white	3	Cross sectional
Yucens et al. (2023)	Turkey	Peer reviewed	Examining cognitive disengagement syndrome in a psychiatric outpatient sample: Psychometric support and associations with internalizing symptoms and sleep problems	274	18-64	31.06(10.84)	Adult psychiatric community	75.9	Not reported	1	Cross sectional

Table 3

Results of Individual Studies

Study	Method of analysis	CDS measure	Sleep measure	Number of effect sizes extracted	Sleep domains extracted	Extracted sleep domain (proxy)	r
Becker et al. (2014)	Correlation	BAARS-1V	PSQI	8	Total Sleep Score, Sleep Quality, Sleep Efficiency, Daytime Dysfunction, Sleep Onset Latency, Sleep Disturbance, Sleep Duration, Sleep medication,	Total sleep score	.41
Frederick et al. (2022)	Correlation	ACI	PSQI ESS	8	Sleep Quality, Sleep Efficiency, Daytime Dysfunction, Sleep Onset Latency, Sleep Disturbance, Sleep Duration, Sleep medication Daytime sleepiness	Sleep quality	.29
Gloger & Suhr (2020)	Comparison of means	BAARS-1V	PSQI	1	Total Sleep Score	Total sleep score	.27

Gul et al. (2024)	Correlation	BASCTS - Turkish	PSQI Turkish	8	Total Sleep Score, Sleep Quality, Sleep Efficiency, Sleep Onset Latency, Sleep Disturbance, Sleep Duration, Sleep medication, daytime sleepiness	Total sleep score	.35
Jarrett et al., 2014	Correlation	BAARS-1V	SCL-90-R	1	Sleep Disturbance	Sleep disturbance	.43
Knouse & Becker (2025)	Correlation	BAARS-1V	PSQI r-EMQ	9	Total Sleep Score, Sleep Quality, Sleep Efficiency, Daytime Dysfunction, Sleep Onset Latency, Sleep Disturbance, Sleep Duration, Sleep medication, circadian preference	Total sleep score	.59
Langberg et al (2014)	Correlation	BAARS-1V	ESS PDSS	1	Daytime sleepiness	Daytime sleepiness	.51
Lunsford-Avery et al., 2020	Partial Correlation	BAARS-1V	CSM	1	Circadian preference	Circadian preference	-.26
Podrasky (2024)	Correlation	BAARS-1V	SDS-CL-25	1	Sleep disturbance	Sleep disturbance	.18

Sadeghi-Bahmani et al. (2025)	Correlation	ACI German	ISI German	1	Insomnia	Insomnia	.69
Voinescu et al. (2012)	Correlation	BAARS-1V Romanian	SCI CSM STQ Romanian	2	Total Sleep Score, circadian preference	Total Sleep Score,	.43
Voinescu et al. (2012)	Correlation	BAARS-1V Romanian	SCI CSM STQ Romanian	2	Total Sleep Score circadian preference	Total Sleep Score	.33
Wood et al. (2020)	Correlation	BAARS-1V	PSQI	3	Sleep quality, Daytime dysfunction, sleep disturbance,	Sleep quality	.29
Yucens et al. (2023)	Correlation	ACI Turkish		1	Sleep quality	Sleep quality	.48

Abbreviations ACI =Adult Concentration Inventory; BAARS-1V= Barkley Adult ADHD Rating Scale-IV Sluggish Cognitive Tempo subscale 4th Edition; BASCTS = Barkley Adult Sluggish Cognitive Tempo Scale; CSM = Composite Scale of Morningness; ESS = Epworth Sleepiness Scale; ISI= Insomnia Severity Index; PDSS = Paediatric Daytime Sleepiness Scale; PSQI = Pittsburgh Sleep Quality Index; r-EMQ = Evening morningness questionnaire; SCI = Sleep Condition Indicator;; SCL-90-R = Symptom Checklist-90-R ; SDS-CL-25 = Sleep Disturbance Scale- Check List -25; SR = Self-report STQ = Sleep Timing Questionnaire;

3.5 Synthesised Results

3.5.1 Meta analyses

CDS and sleep problems

In the first, main meta-analysis, 13 effect sizes were included with combined *r* as the effect statistic.

Heterogeneity

Heterogeneity was significant (Q (12) = 81.904, p <.001). The estimate for I^2 indicated that heterogeneity was relatively high. A large proportion of the variance was explained by heterogeneity between the effect sizes of studies (86.38 %, 95% CI: [72.28,95.34]

Our main analysis examined the combination of all the effect sizes for CDS and sleep for the 13 studies (reported in Table 2). The combined random effects point estimate of effect size was moderate approaching large and significant for the relationship between CDS and poor sleep (r = 0.42, 95% CI [33 -.49], z = 9.02, p = < .001, k =13). The forest plot below depicts the overall effect size and confidence interval as a diamond at the base of the plot (Figure 2). The squares depicted above the effect size represent each individual study, the size being relative to the sample size (Figure 5).

Sensitivity analysis

One study (Sadeghi-Bahmani et al., 2025), was found to be an outlier. This study reported a higher effect size 0.69, possibly due to use of a different sleep measure. A sensitivity analysis found that excluding the outlier study only slightly reduced the pooled effect size (r =.42 to r = 0.4). The outlier contributed to some variability across studies as

heterogeneity was reduced (I^2 0.86 to 0.66) and was deemed influential. The study was retained in the meta-analysis and sleep measure was tested as a categorical moderator.

Publication bias

A visual inspection of the funnel plot did not suggest an asymmetrical distribution. Neither Egger's test of funnel plot asymmetry (z = 0.08 and p = 0.93) nor Kendall's rank correlation test (τ =0.11 and p = 0.62) rendered significant p values ruling out possible publication bias (see figure 3 for funnel plot). The funnel plot did appear to have some asymmetry. However, the Trim and Fill procedure did not impute any studies to give an adjusted effect size estimate. This suggests that the estimated effect is not likely to be subject to publication bias.

CDS and daytime sleepiness

A separate meta-analysis examined the combined three effects for daytime sleepiness and CDS. The fixed effects point estimate summary of effect was moderate and significant for the relationship between CDS and daytime sleepiness (r =0.38, 95%CI [0.31,0.44], z =9.77, p < .001). The Q test for residual heterogeneity was not significant, (Q(2) = 2.358 p= 0.31).

CDS and circadian preference

A final separate meta-analysis examined the combined three effects for circadian preference and CDS again using a fixed effect model. The fixed effects point estimate summary of effect was moderate and significant for the relationship between CDS and circadian (eveningness) preference (r = - 0.31, 95%CI: [-0.377, -0.236] z = -8.08, p = < .001). The Q test for residual heterogeneity was not significant, (Q (2) = 2.02 p = 0.361). The forest plots below depict the overall effect sizes and confidence intervals (Figures 2-4).

Narrative report from the non-meta-analysed study (Lunsford-Avery et al., 2021), indicates a negative association between CDS and circadian preference after controlling for ADHD, age and sex (r = –0.26, p = 0.04). In group analysis between ADHD and internalising symptoms, more eveningness preference predicted greater CDS severity, but group differences were not significant (β = –0.225, p = 0.06). The interaction between higher CDS and eveningness was larger in the participants with internalising symptoms than those with ADHD, after controlling for sex, age, and comorbidity (β = 1.26, p = 0.009).

Figure 2

Forest Plots of Pooled Effect Sizes

For CDS and Sleep (Random effects)

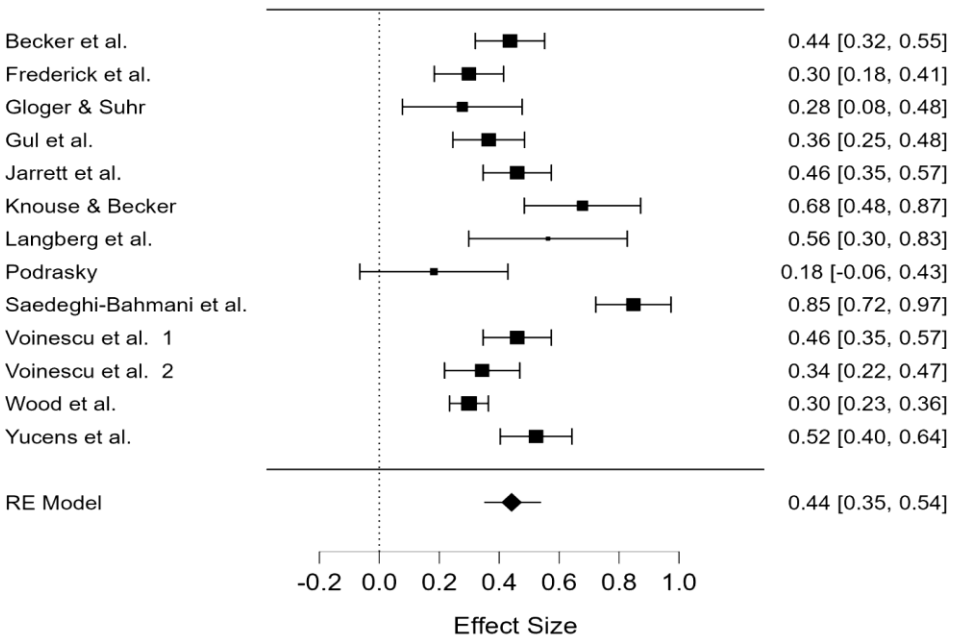


Figure 3

Forest Plots of Pooled Effect Sizes

CDS and Daytime Sleepiness (fixed effect)

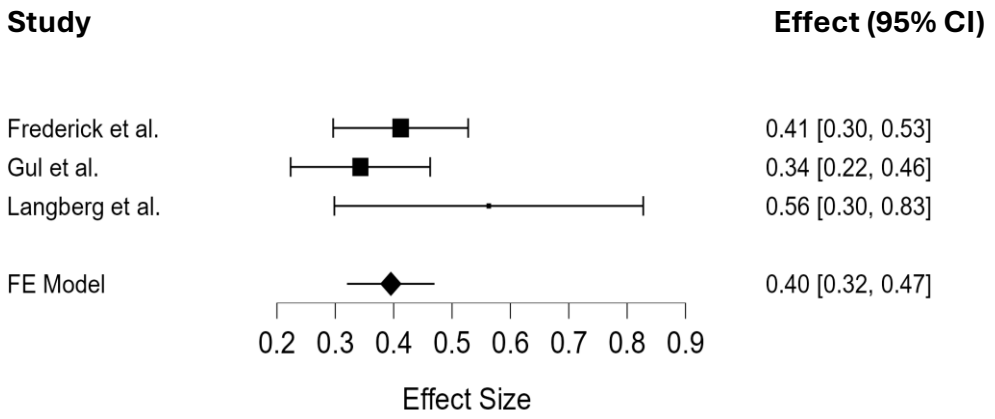


Figure 4

Forest Plots of Pooled Effect Sizes

For CDS and Circadian Preference (Fixed Effects)

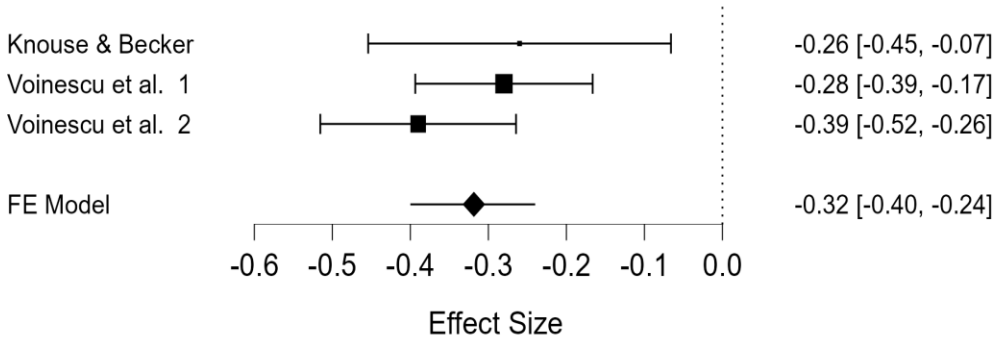
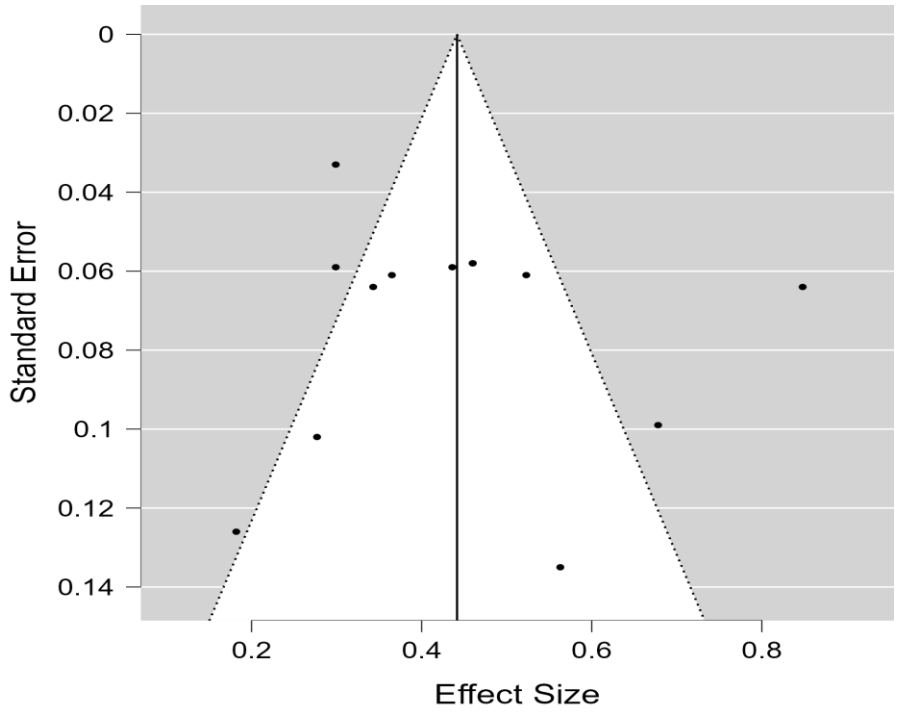


Figure 5

Funnel Plot for Main Meta- Analysis



3.4.2 Moderators

Moderators were examined to provide potential explanation for the heterogeneity between studies. No significant categorical or continuous moderators were found. (See Table 4 for pre-specified moderators and calculations of heterogeneity measures and effects for all moderators).

Table 4

Results of Subgroup Analysis and Meta- Regression of Moderators

Categorical moderator	Qbetween	df	p	I^2	k	r	Lower CI	Upper CI
Sample type	0.283	1	0.595	87.740				
					Community k =11	0.451	0.347	0.556
					Clinical k =2	0.367	0.077	0.658
					β Contrast	-0.084	-0.392	0.225
Study population	0.247	1	0.619	87.094				
					Student k = 8	0.461	0.335	0.587
					Adult k = 5	0.409	0.246	0.572
					β Contrast	-0.052	-0.258	0.153
CDS measure	1.556	2	0.212	86.160				
					BAARS-IV k = 9	0.409	0.291	0.528
					ACI k =3	0.555	0.359	0.750
					β Contrast	0.145	-0.083	0.374
Sleep measure	0.648	1	0.421	86.117				
					PSQI k =7	0.406	0.277	0.536
					Other k =6	0.486	0.341	0.631
					β Contrast	0.080	-0.115	0.274
Sleep type	0.347	1	0.556	87.716				
					Poor sleep k =12	0.434	0.333	0.535
					Daytime sleepiness k =1	0.563	0.147	0.979
					β Contrast	0.129	-0.299	0.556

Country	1.302	1	0.254	85.352				
					USA k = 8	0.396	0.272	0.519
					Other k = 5	0.507	0.360	0.654
					β Contrast	0.112	-0.080	0.303

Continuous moderator	**Q**	**df**	**p**	**I^2**	**Estimate**	**Z**	**Lower CI**	**Upper CI**
Percent female k=13	.031	1	0.861	87.353	-7.774×10^{-4}	-0.175	-0.009	0.008
Sample size k=13	0.576	1	0.448	84.544	$-1{,}763 \times 10^{-4}$	-0.759	-6.314×10^{-4}	2.788×10^{-4}
Ethnicity (%white) k= 6	1.048	1	0.306	78.933	0.007	1.024	-0.006	0.020
Mean age k=11	.061	1	0.805	88.203	-0.002	-0.247	-0.013	0.010

4. Discussion

4.1 The relationship between CDS and sleep

To our knowledge, this is the first meta-analysis to investigate the relationship between sleep and CDS in adults. This review identified 13 sources reporting the association between poor sleep and CDS examined through meta-analyses, and one source was identified for narrative report. In total 66 effects were extracted across 14 sources published between 2012 and 2025, involving 3,521 adult participants.

The main aim of the review was to investigate the relationship between sleep problems and CDS in adults. The main meta-analysis found a significant moderate effect for this relationship (r =0.42, p = < .001). A separate smaller meta-analysis investigating the relationship between CDS and daytime sleepiness found a significant moderate effect, (r = 0.38, p = < .001). While not directly associated with sleep problems, circadian preference was nonetheless considered an important and relevant parameter related to sleep to include in the analysis and a moderate association was found (r = - 0.31, p = < .001). The narrative report on the partial effect found a near moderate association between CDS and eveningness preference, (r = – 0.26, p=0.04).

This review expands the evidence base by quantitatively supporting Becker and colleagues' report of an association between sleep problems and CDS in adults (2023). The moderate association found between CDS, and daytime sleepiness suggests these two variables are related but distinct constructs, which supports findings from several studies in children (Becker et al., 2023). We found a moderate association between eveningness preference and CDS in adults expanding the evidence focussing on children and adolescents (Becker et al., 2023). However, due to the limited number of studies

available for inclusion in this review, and the number of student and young adult samples, it is important that the findings are interpreted with some caution to avoid over generalisation.

4.2 Measures used in studies

The studies extracted indicate that tools used to measure CDS were generally well validated. It warrants attention that those studies using unvalidated measures utilised translated versions of well-established tools (ACI and BAARS-1V) that had not been formally psychometrically validated in German or Romanian (Sadeghi-Bahmani et al.,2025; Voinescu et al.,2012; Voinescu et al.,2012). This highlights the need for validation of measures that are already well validated in predominantly English, Spanish, Turkish and Iranian languages, allowing more transcultural understanding of adult CDS symptomology and the idiomatic nuances in various languages (Becker 2019).

CDS and sleep measurement

These 14 studies focussed on subjective assessment of sleep. Notably, sleep quality rating and quantity are not directly related and whilst the subjective appraisal of the experience of being awake and asleep can be more valuable than a simple analysis of the timings and variations in these two conditions (Krystal & Edinger, 2008), access to both objective report e.g. through actigraphy, and subjective report would have provided a more holistic assessment of sleep (Fabbri et al., 2021).

4.3 Methodological factors moderating the relationship

None of the subgroup analyses for categorical moderators nor meta regression for continuous moderators resulted in any significant findings. Cautious interpretation is warranted.

Categorical moderators

Subgroup analysis is an essential process in the examination of possible heterogenous sources in meta-analyses (Bornstein et al., 2021). However, due to the small number of studies, power was low thus inflating the possibility of the Type II error. The lack of evidence of a difference in all moderators does not necessarily mean a difference does not exist (Cuijpers et al., 2021). Furthermore, visual inspection of results suggests there were some notable differences across some of the other moderator intercepts i.e. CDS measure, sleep type and country, and despite non-significant findings, these results may suggest there may be some systematic variation between the chosen moderating categories accounting for some of the heterogeneity.

Continuous moderators

The continuous variables examined to predict the strength of effect sizes were non-significant. In the case of mean age, most studies were student studies examining associations in very young adults. In the 11 pooled reported samples, mean age was 25, suggesting limited variability in age across studies overall, restricting the ability to detect moderating effects of age on the association. Sample size did not result in a significant moderating effect, which could be explained by two factors. First, there was no evidence of publication bias in the meta-analysis, so the smaller studies were less likely to inflate the effect sizes (Sterne et al., 2000), and second, all studies apart from the outlier (Sadeghi-Bahmani et al.,2025), reported relatively consistent effect sizes, potentially limiting the required variability to detect sample size moderation. Only six of the 14 studies reported ethnicity which limited our understanding of the moderating effects of this demographic. The non-American studies reported nationality only but not race. This made generalisability across racial groups problematic and reduced statistical power.

4.4 Strengths and limitations

Strengths and limitations should be considered in the context of the results of this systematic review.

Strengths

This review represents one of only a few syntheses of the emerging literature in adult CDS. Thorough development of appropriate search terms, and systematic, varied database searches, inclusion of non-peer reviewed studies, thorough reference checks and an updated search before meta-analysis ensured that as far as we know, all the available studies were identified. Careful examination of samples for replicated participant groups ensured that all extracted effects were independent and only zero order correlations were included to avoid drawing misleading conclusions in our meta-analysis (Cheung 2019). The selection of the REML meta- analytical model was also a strength as it minimises the effect of heterogeneity among effect sizes when differences exist in study populations, measures, sample types and the model gives a conservative summary of effect (Brockwell & Gordon, 2001).

Limitations

Limitations are related more to the available studies included as opposed to problems with the conservative methodology used in the review itself. A salient limitation was the low number of studies available for subgroup analysis preventing a suitably powered consideration of moderation. Sample representativeness in many of the studies was poor, limiting the generalisability of the findings, compromising the external validity of the pooled effects. Half of the studies focussed on CDS in the context of ADHD (k = 7). Our search included physical illness or medical settings but studies evaluating CDS and sleep in this context were not identified. This reflects the paucity of research examining

CDS in adults in contexts beyond ADHD (Frederick et al., 2024). Furthermore, correlations were not reported separately for females and males precluding assessment of gender effects.

Only one researcher conducted this review, and the process may have benefitted from a research team to substantiate all decisions and reduce bias. However, extracted data were verified twice and any disagreements or decisions were discussed regularly and resolved with the supervisor, an experienced researcher.

Given the internal characteristics of CDS – such as "lost in thoughts" and the strong associations with internalising mental health conditions (Becker, 2023), self-report has been promoted as an optimal method to measure CDS in adults (Frederick et al., 2024). However, both the self and collateral versions of the BAARS-IV SCT subscale have demonstrated good internal consistency (Cronbach's $\alpha = 0.79$, Cronbach's $\alpha = 0.82$ respectively), in a study exploring the value of using both approaches to examine adult concentration difficulties (Lunsford-Avery et al., 2021). Notably, collateral reports, as are often used for children, may have offered a more accurate reflection of impairment related to CDS in adults' everyday functioning, highlighting the possible limitation of relying on self-report CDS measures (Lunsford-Avery et al., 2021). Furthermore, inclusion of multiple CDS measures within studies could possibly have generated different correlations (Becker, 2021) thus altering our overall effect.

Most studies in this review assessed CDS as a single construct ($k = 12$), and only two examined how separate CDS subsets relate to sleep (Gul et al., 2025; Lunsford-Avery, 2021). However emerging evidence supports use of a multidimensional CDS construct to examine associations with other variables in adult clinical settings (Becker, 2025). As there still lacks consensus on the set of symptoms defining CDS, subdimensions are

even less researched and less well defined (Becker, 2021). Multidimensional reporting is now more common in some child CDS studies, where for example, specific CDS factors such as CDS intermittent attentiveness has been associated with relational problems and CDS sluggishness has been associated with depression (see Cortes et al., 2017). Exploring the associations between distinct CDS subtypes such as sluggish/ low initiation/ daydreamy with sleep or daytime sleepiness may promote more understanding of the CDS factors that relate most to sleep problems. In their examination of CDS and circadian preference, Lunsford-Avery and colleagues (2021), found a much larger partial effect for the sleepy sluggishness CDS factor with evening preference (r = –0.41, p=0.001) and very small, non-significant partial effects for daydreamy (r = -0.07, p = 0.61) or low initiation CDS factors (r = –0.19, p = 0.13). By examining subfactors of CDS, researchers can generate more hypotheses (Lunsford-Avery, 2021). For example, does sluggishness throughout the day lead to reduced completion of daily tasks resulting in poor adherence to early bedtime routines due to a need to complete obligations. And does this late bedtime then reduce sleep efficiency and lead to daytime sleepiness (Lunsford-Avery, 2021).

4.5 Clinical implications of this review and future research

Some potential moderators are likely to have impacted the strength of the extracted effects in the main meta-analysis. However, due to inconsistent reporting across studies we can only speculate about which confounding variables may have impacted the results. A recent review (k=9 studies) postulates certain ADHD stimulants can lead to insomnia or a decline in sleep quality (Surman & Walsh, 2022). ADHD medication could therefore be a confounding factor, particularly given that many included studies involved participants either reporting elevated ADHD symptoms or

having an ADHD diagnosis. ADHD medication status information however was not available in most studies. There is also robust systematic evidence linking poverty to problematic sleep outcomes, often mediated by chronic health comorbidities as reported in a synthesis of 336 studies (Papadopoulos & Sosso, 2023). However, social economic status was rarely reported in our studies and ethnicity reporting was unavailable in studies conducted outside the USA. Inconsistent reporting of potential, important moderators, prevents useful meta-analytic modelling of their effects. Future research should therefore prioritise routine reporting of key variables that may be confounding the bivariate associations including for example medication status, SES, ethnicity and physical illness.

As there is currently no systematic synthesis of child and adolescent studies exploring the CDS/sleep association, a meta-analytical approach to examine this relationship across the lifespan rather than adults only would have provided a valuable contribution to the evidence base. Initially, a systematic review and meta-analysis were planned to synthesise the more established literature on CDS and sleep problems in child studies together with the emerging literature of the association in adults using age as a moderator. However, whilst there is merit in adopting a lifespan overview of this association, initial quality assessment highlighted the practical problems in combining both populations in one meta-analysis, even with age as a moderator. The main issue is the heterogeneity in the methods used to assess children's sleep and CDS compared with adult studies. Use of parent/teacher collateral and diverse CDS measures, and the diversity in the quality of the sleep measures, objective and subjective measurement tools used, and heterogeneity in sleep parameters extracted would make comparison with adult studies using fewer parameters, and more gold standard, validated

questionnaires more difficult. Therefore, the next logical step in expanding the knowledge base would be to meta analyse the independent effects for this association in children.

More sleep parameters were extracted than included in the final analyses due to their more tangential relevance to the central research question, giving clear rationale for exclusion. For example, eight sleep disturbance effects were extracted, six sleep duration and six sleep onset latency effects. As the field develops and more studies become available, this highlights a need for a future review, and research into how these parameters and CDS are related, particularly in terms of sleep timing and overall sleep efficiency.

Whilst cross-sectional studies are useful, they do not inform about cause or the direction of an association (Gul et al., 2025). Future research in this area could integrate more longitudinal observational studies allowing more inferences to be made about the possible direction of the relationship between CDS and sleep (Sadeghi-Bahmani & Brand, 2022). Further study could investigate the potential bidirectional nature of the relationship, around whether chronic poor sleep leads to more pronounced CDS symptoms or whether CDS interferes with sleep (Gul et al., 2025). Likewise, we cannot make inferences from cross sectional studies that CDS causes daytime sleepiness nor whether it can predict its increase over time (Langberg et al., 2017).

Now that a clearer understanding of the relationship between sleep and CDS has been established through this meta-analysis, sleep interventions could be trialled targeting the improvement of sluggishness and poor concentration. There is current paucity in intervention studies in CDS, but an open pilot of cognitive behavioural therapy for adolescents with ADHD (*N*=14), who reported circadian disruptions and insomnia found strong effects in decreased CDS symptomology from baseline to follow

association between evening chronotype and CDS, along with a potential link to internalising symptoms (Duraccio et al., 2023), further research could focus on understanding the mechanisms that link CDS and eveningness. Implementation of circadian treatments such as bright light therapy or melatonin could lead to improvement of CDS symptoms in adult outpatients (Lunsford-Avery et al., 2020).

Conducting qualitative studies can enrichen understanding of the meaning and subjective experience of patients in clinical contexts (Cypress, 2015). Future research could adopt a mixed method approach, to further explore the lived experience of people reporting concentration difficulties and how co-occurring sleep difficulties may affect daily functioning. Such insights may contribute to the development of a tailored sleep assessment that could be incorporated into a validated CDS measure as recommended by Gloger & Suhr (2020).

4.6 Conclusion

The findings of this meta-analysis offer a significant contribution to the emerging CDS evidence base in adult research and presents one of very few meta-analyses in this area. Synthesising the evidence on the association between CDS and sleep, has allowed key areas for further investigation to emerge which include more complete reporting of potential moderating and mediating factors. This review sets important foundations for future research to evolve from cross-sectional designs and produce more longitudinal data to measure changes in the association of sleep, daytime sleepiness and CDS over time throughout an adult's life. These results highlight the need to address factors related to sleep in the understanding, management and assessment of CDS.

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An asterix (*) indicates the studies used in the systematic review.

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Appendices

Appendix A Search Terms

Appendix search terms – Boolean search terms

1. "cognitive disengagement syndrome".ti,ab,kf.
2. Sluggish Cognitive Tempo/
3. "sluggish cognitive tempo".ti,ab,kf.
4. "concentration deficit disorder".ti,ab,kf.
5. 1 or 2 or 3 or 4
6. exp Sleep Disorder Wake Disorders/
7. insomn$.ti,ab,kf.
8. rest/
9. rest.ti,ab,kf.
10. exp Sleep/
11. sleep*.ti,ab,kf.
12. wake*.ti,ab,kf.
13. awake*.ti,ab,kf.
14. somnolen*.ti,ab,kf.
15. circadian*.ti,ab,kf.
16. chrono*.ti,ab,kf.
17. 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18. 5 and 17

Psychinfo

1.	cognitive disengagement syndrome.ti,ab,id.
2.	Sluggish Cognitive Tempo/
3.	sluggish cognitive tempo.ti,ab,id.
4.	concentration deficit disorder.ti,ab,id.
5.	1 or 2 or 3 or 4
6.	exp Sleep Wake Disorders/
7.	insomn$.ti,ab,id.
8.	rest/
9.	rest.ti,ab,id.
10.	exp Sleep/
11.	sleep*.ti,ab,id.
12.	wake*.ti,ab,id.
13.	awake*.ti,ab,id.
14.	somnolen*.ti,ab,id.
15.	circadian*.ti,ab,id.
16	chron*.ti,ab,id.
17.	6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18.	5 and 17

Appendix B Quality Assessment Tool Criteria

Quality Assessment Tool based on Frederick et al. review (2024) , adaptations made accordingly

Quality Assessment Tool and Explanation of Criteria and Rating Scales with minor Adaptations (Becker et al., 2024)

Criterion	-	+	++
1a priori aim/hypothesis	No aims or hypothesis related to CDS and sleep	Aims related to CDS and sleep are inferred but not explicit	Aims explicitly related to CDS and sleep
2. Sample size justification	Not justified	Sample size based on non-CDS outcomes	Sample size justified based on mainly CDS
3. Sample representativeness	Poor	Fair	Good sample representativeness for the study population being studied
4. Quality of CDS measure	-	Measure not developed for comprehensive CDS assessment	Specifically designed for CDS assessment
5. Quality of correlates measures (sleep)	-	Not well validated	Well validated
6. Control for ADHD-IN or independent CDS group	-	Specifies no recognised control for ADHD-IN symptoms or CDS group	Specifies study included a statistical control of ADHD-IN symptoms or a CDS group
7.Rates of missing CDS data	specifies >20%, and / not reported	specifies ≤20% and >10%,	Specifies ≤10%,
8. Inferences and conclusions	Poor	Fair	Good

9. Type of study	Non-experimental study	Quasi-experimental experimental study	Randomised controlled trial
10. Level of control	Specifies no control	Specifies some control	Specifies satisfactory control e.g. groups of clinical comparison

Appendix C Extracted Independent Effects

Table of all Extracted Independent Effects

Study	CDS/ SUBSCALE	Number of parameters		Total sleep score	Sleep Quality	Sleep Efficiency	Insomnia	Daytime Sleepiness	Daytime Dysfunction	Sleep Onset Latency	Sleep Disturbance	Sleep Duration	Sleep Medication	Circadian Preference
Becker et al. (2014)	Total	8	r	0.41	0.28	0.13			0.51	0.25	0.29	0.13	0.19	
Frederick et al. (2022)	Total	8	r		0.29	0.22		0.39	0.39	0.17	0.19	0.31	0.13	
Gloger & Suhr (2020)	Total	1	r	0.27										
Gul et al. (2024)	Total	8	r	0.35	0.31	0.08		0.33		0.24	0.34	-0.34	0.31	
	Daydreamy	8	r	0.37	0.31	0.08		0.33		0.3	0.33	-0.07	0.3	
	Sluggishness	8	r	0.24	0.21	0.07		0.26		0.12	0.24	-0.09	0.29	
Jarrett et al., 2014	Total	1	r	0.43										
Knouse & Becker (2025)	Total	9	r	0.59	0.42	0.21			0.64	0.36	0.31	0.23	0.21	-0.26
Langberg et al (2014)	Total	1	r					0.51						
Lunsford-Avery et al., 2020	Total	1	r											-0.26
	Daydreamy	1	r											0.07

	Sluggishness	1	r								-0.41
	Low initiation	1	r								-0.19
Podrasky (2024)	Total	1	r					0.18			
Sadeghi-Bahmani et al. (2025)	Total	1	r			0.69					
Voinescu et al. (2012)	Total	2	r	0.43							-0.28
Voinescu et al. (2012)	Total	2	r	0.33							-0.39
Wood et al. (2020)	Total	3	r		0.29		0.5	0.12			
Yucens et al. (2023)	Total	1	r	0.48							

Empirical Paper

A study examining Cognitive Disengagement Syndrome, poor sleep, daytime sleepiness and executive function in adults.

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Doctorate in Clinical Psychology

C0075093

Pam Boullin

Supervisor : Professor Mark Freeston, Newcastle University

0.0 Abstract

The association between sleep and Cognitive Disengagement Syndrome (CDS) is under researched in adults. This current study hypothesised a potential bidirectional relationship between poor sleep and CDS, partially mediated by daytime sleepiness and moderated by executive function (EF) in an adult community sample. Additionally, objective and subjective EF and CDS scores were compared. A pilot was conducted to assess measures (N = 452). In the main study (N= 453), participants completed measures on sleep, CDS, EF, sleepiness, ADHD and depression. A subsample completed an online Stroop task, and we compared self-reported EF and CDS scores with objective performance through subgroup correlational analyses (N= 55). Moderated mediation analysis found significant direct effects of poor sleep on CDS and CDS on poor sleep, significantly mediated by daytime sleepiness. There were non-significant findings for moderation by EF on the sleep to CDS effects and CDS to sleep effects. When controlling for ADHD, the direct effects remained significant but weakened, the indirect path of sleepiness mediating poor sleep and CDS became non-significant. Controlling for ADHD and depression weakened the direct and indirect effects warranting further investigation. Negative, small and non-significant associations were found between an objective test and subjective EF and CDS scores. Longitudinal designs could explore the bidirectional relationship and the potential mediating role of sleepiness, ADHD, mood and other psychopathologies in the pathways between CDS and sleep to develop appropriate interventions.

1. Introduction

Cognitive Disengagement Syndrome (CDS), previously called Sluggish Cognitive Tempo (SCT), characterises persistent developmentally incongruous symptoms, evident for at least six months, impairing one to several life activities (Barkley at al., 2022). Symptoms typically manifest in cognitive processes, such as daydreaming, somnolence, fogginess, mental disengagement from external stimuli and motor processes such as slow, reduced movement and inactivity (Barkley at al., 2022). Historically, research focussed on CDS in relation to attention deficit hyperactivity disorder (ADHD), specifically its subtype ADHD-inattention (ADHD-IN) (Becker, 2021).

CDS is considered a syndrome due to the intercorrelation of its symptom clusters, and external and internal validity (Becker et al., 2023), contributing unique variance to neurological and cognitive study results (Barkley et al., 2022). A meta-analysis examining eight studies, found that CDS is a latent variable, separate from ADHD-IN (Becker et al., 2016). A recent report by Becker examining the Adult Concentration Inventory (ACI) (Becker et al., 2018), concludes that 15 out of the 16 symptoms, excluding low motivation demonstrate strong structural validity, invariance across samples and time, and demonstrates convergent validity of CDS with ADHD-IN (Becker, 2025). CDS in student adults is more related to ADHD as a whole rather than just the inattention component (Smith & Suhr, 2020)

CDS is not acknowledged as a diagnosable condition with clearly defined diagnostic criteria (Becker et al., 2023). Little is known regarding differences in adults reporting CDS. Preliminary evidence suggests possible reduced sluggishness in men as age increases (β =-0.214), but the sample was predominantly female, (71%) (Gul et al.,

2025). CDS appears to strongly influence difficulties related to emotional regulation (Barkley et al., 2022), possibly linked to the strong relationship it has with depression (Becker & Barkley, 2022), and it appears to relate to internal distraction as opposed to the external distractions associated with ADHD (Becker & Barkley, 2021). More understanding is needed on how CDS relates to other psychopathologies, its functional difficulties, and causes (Becker et al., 2023).

CDS and sleep

Studies focussing predominantly on child, adolescent, and student populations link poor sleep and elevated CDS symptoms; the association between sleep and CDS has been insufficiently examined in adults (Gul et al., 2025). A recent novel meta-analysis conducted by this researcher synthesised findings from 13 studies and identified a moderate significant association between CDS and sleep problems (r = 0.42, 95% CI [0.33, 0.49], p < 0.001). While this provides robust evidence of a relationship between the two constructs, it remains unclear whether the relationship is reciprocal and bidirectional, and whether CDS manifests poor sleep or predicts it (Frederick et al., 2022; Gul et al., 2025). There is growing interest in the possibility that while sleep problems may develop or exacerbate concentration problems the reverse may be true (Sadeghi-Bahmani et al., 2022).

The fatigue and mental slowness that characterise CDS are also symptoms of poor sleep, manifested in daytime sleepiness (Wood et al., 2020). Both have been identified as separate constructs, despite overlapping symptoms (N=768, r = 0.51), (Langberg et al., 2014). A moderate association was found between CDS and daytime sleepiness across three studies in the researcher's smaller meta-analysis (r = 0.38, 95%CI [0.31, 0.44], p < 0.001). A study (2022), assessing CDS in adolescents reporting

poor sleep (N=302), concludes that regardless of an ADHD diagnosis, elevated CDS traits are associated with poor sleep parameters such as daytime sleepiness, poorer sleep efficiency, and sleep onset latency (Frederick et al., 2022). Two studies, student and adult, concluded that there is a unique association between CDS, poor sleep and daytime sleepiness even after controlling for ADHD (Becker et al., 2014, Frederick et al., 2022). Neither study examined whether sleepiness mediated the link between sleep and CDS. Adults with ADHD or insomnia report higher CDS symptoms than those without (Voinescu et al., 2012). A college study (*N*=910) found that when students experiencing depression and ADHD were removed from the analysis, CDS rates reduced significantly, as only 4.8% of the original high scoring CDS group remained (Lovett et al., 2021). The authors concluded that poor sleep and other psychopathologies may be augmenting CDS levels in students (Lovett et al., 2021).

Executive Functioning (EF)

Executive functioning, vital for everyday tasks (Sen & Tai, 2023), is an umbrella term for top-down cognitive processes occurring in the prefrontal cortex brain region (Zink et al., 2021), required when automatic responses are insufficient (Miller & Cohen, 2001). Three core executive functions include *inhibition,* encompassing self-control and emotional regulation, *working memory,* a temporary storage and information processing system needed for decision making and problem-solving (Baddeley & Hitch,1994), and *cognitive flexibility,* the capacity to consider numerous conflicting perspectives concurrently (Dajani & Uddin, 2015). These support higher order EFs such as planning, problem solving and reasoning (Lunt et al., 2012). Efficient EF is crucial for mental and physical health (Diamond, 2013), but it can be impaired by low mood and poor sleep (Sen & Tai, 2023; Parra- Diaz et al., 2021).

CDS and Executive Functioning (EF)

Executive dysfunction and CDS research has focussed predominantly on children, with mixed findings. There is limited evidence of an association between slow processing speed and CDS in children (Khalid et al., 2024). A recent child study (*N*=263, aged 8-12), found consistent greater verbal inhibition, poorer divided attention capability and slower naming in those with CDS over and above ADHD symptom associations (Tamm et al., 2023). Few studies examine the cognitive problems associated with CDS in adults, and the central cognitive deficiencies underlying the syndrome are unknown (Barkley et al., 2022). Attention dysfunction plays a pivotal role in cognitive deficiencies impacting EF in several areas of everyday living for adults reporting CDS (Kim & Kim, 2021). Problems include disengagement and engagement and altering attention focus, resulting in a compromised orienting EF network, impacting the ability to easily shift and focus attention, and select and detect stimuli (Kim & Kim, 2021). Associations of CDS and EF problems are documented in student populations. CDS accounts for a large proportion of variance in EF domains such as time management and organisation (Jarrett et al., 2017), as well as problem solving skills (Godoy et al., 2023).

Objective assessment of interference control, planning or selective attention falls under the EF domain yet remains underutilised in CDS research (Becker, 2021), and to our knowledge only three student studies examining CDS have used objective tests to examine the association of self-report with objective testing of EF with small, non-significant effects (Jarrett et al.,2014, Gloger & Suhr, 2020, Smith & Suhr, 2021). The Stroop interference Test (Stroop 1935), administered in limited ADHD studies, objectively examines the relationship between response inhibition, interference control and attention. Jarrett's study (*N*=298, *M*=18.82), found non-significant negligible

associations with higher CDS symptomology and objective performance in their online Stroop interference scores (β=.07), reaction time scores (β=.05), and working memory scores (β= -0.02) (Jarrett et al., 2017). Strong correlations however have been found between CDS and Stroop interference scores in mothers with ADHD (*N*=223) (Yılmaz & Uzun Cicek, 2024), and children with obsessive compulsive disorder (Uzun Cicek et al. 2023).

CDS, sleep difficulties and EF

Several student studies link poor sleep, CDS and self-reported EF. A cross-sectional student study (*N*=99) found that poorer sleepers reported more CDS symptoms, inattention, and poorer EF than controls (Gloger & Suhr, 2020). Poor sleep may impair executive control, and sleep continuity has been deemed necessary for good EF throughout adulthood (Wilckens et al., 2014). A review found insomnia leads to impairments in several domains of EF, including working memory (k=24) (Fortier-Brochu et al., 2012). Problematic sleep may augment CDS symptoms mediated by daytime dysfunction, and long-term sleep problems could lead to exacerbation of CDS symptomology through EF impairment (Gul et al., 2025).

1.2 Rationale

One finding from our review, was the predominance of student study samples (k = 9), and the relatively low mean age across all studies (*M*=25), highlighting a need to explore associations of CDS and sleep in adults of all ages (Boullin, 2025). Currently, only one study examines the relationship between poor sleep, EF and CDS in non-student adults (Frederick et al., 2022). Furthermore, as observed in our meta-analysis there is a paucity in studies examining CDS beyond the context of ADHD research (Frederick et al; 2024). Frederick and colleagues' cross-sectional examination of poor sleep, daytime

sleepiness, EF and CDS (*N*=286), comprises part of an assessment of the validity of the ACI (Frederick et al., 2022). After controlling for ADHD, results indicate CDS is uniquely associated with reduced sleep quality, sleep efficiency, shorter sleep duration, more daytime sleepiness (ps < .05), and reduced self-reported performance in certain limited EF areas impacting daily function (Frederick et al., 2022).

The overarching aim of this project was to broadly replicate and expand part of Frederick and colleagues' study (2022), by examining not just the simple associations between CDS, poor sleep, daytime sleepiness and executive function but their interaction through moderated mediation analysis. Based on previous findings we hypothesised that poor sleep would predict higher levels of daytime sleepiness which would relate to higher reported CDS symptoms. We predicted that EF would moderate the direction and/or strength of the relationship between poor sleep and CDS. We also hypothesised that the direct path between sleep and CDS would be bidirectional with a direct relationship between CDS, and poor sleep partially mediated by sleepiness, moderated by EF. We also examined CDS in non-student adults through both report-based measures and objective assessment in the context of EF and CDS.

ADHD and CDS symptoms share around 25% of their variance (Barkley, 2022); it was thus important to control statistically for this correlation. Given that a recent meta-analysis (k = 25, *N*=8608), reports an association of depression with poor sleep (Scott et al., 2021), as well as evidence linking CDS to internalising symptoms, especially depression (Smith et al., 2020), it was important to control for depression.

1.3 Hypotheses

1. There will be a direct relationship between sleep difficulties and higher CDS symptoms partially mediated by daytime sleepiness. Further, this effect will be moderated by executive function; those with poorer executive function will show a stronger association between CDS symptoms and sleep difficulties.

2. There will be a direct relationship between CDS, and sleep difficulties partially mediated by daytime sleepiness. Further, this effect will be moderated by executive function; those with poorer executive function will show a stronger association between CDS symptoms and sleep difficulties.

To account for potential confounding effects, we also controlled for ADHD and depression to assess any potential influence on the moderated mediation outcomes.

A further aim was to objectively measure people's cognitive performance through administration of an online cognitive test and compare this with their self-reported scores for executive function and concentration.

2. Method

2.1 Phases

The pre-registered protocol for this study can be found at Open Science Framework https://osf.io/rj86z/. Ethical approval was granted through Newcastle University Ethics' Committee prior to conducting each study phase (see Appendix A).

This study was conducted in three phases:

Phase one - pilot

The aim of the pilot was threefold:

i. To evaluate the psychometric performance of the selected study measures by assessing reliability, normality, and convergent and divergent construct validity.

ii. To evaluate participant feedback regarding experience of completing the survey and understand patterns of survey attrition.

iii. To identify participants reporting concentration difficulties to invite to a focus group.

Pilot findings informed the main study measures and procedures.

Phase two – main study survey

This was designed to collect comprehensive demographic information and survey responses, and to identify potential participants for the online cognitive assessment in phase three. The gathered data from the main study was used to test the study hypotheses.

Phase three – objective cognitive testing

The administered online cognitive test was executed to provide objective participant data to compare with participants' subjective concentration and EF scores from the main survey.

2.2 Design

The study used a non-interventional cross-sectional design to capture data at a single time point at phases one and two, with an embedded online cognitive performance Stroop task at phase three, allowing within-subject comparisons between subjective report and objective performance.

2.3.1 Phase one – Pilot

Participants

Eligibility comprised being over 18 and proficiency in English. Participants were recruited between January and April 2024 through the Newcastle University network and social media platforms such as Instagram, Facebook and through closed WhatsApp groups. Snowballing sampling was employed to encourage a diverse participant pool. Newcastle University Students were recruited into the SONA survey and could collect course credits for participation. Other participants were directed to the main survey and informed that a contribution would be made to MIND on their behalf. They were directed to the online Qualtrics Research platform through a link or QR code and they clicked on the SONA/ survey link.

. Participants accessed an information sheet (Appendix B), consent form (Appendix C) and a debrief form on completion of the survey (Appendix D). Links to support information could be accessed throughout the survey (Appendix E). Once they consented, they were invited to complete social demographic information and measures and were advised that they could leave the survey at any point before completion. They were also asked to leave a 4-digit code comprising the last four digits of their mobile phone number linked to their data, to allow data removal from the study if they decided to withdraw consent within two weeks of completion. Participants were given the option to leave their email address stored separately to their data if they wanted to receive a copy of research findings and/or to consent to participate in a focus group to discuss concentration difficulties. The focus group did not take place. (See Appendix F). They were also asked to provide feedback on the experience of completing the survey. The survey was shared between the researcher, another DClinPsy student and two

undergraduate students to maximise recruitment. Due to the different hypotheses about CDS being examined, other measures were used in the survey and not included in this study. Only the measures relevant to this study are described.

Procedure

Measures

Existing measures were used, chosen for their psychometric components, appropriateness for self-administration, and using abridged versions when available to decrease participant burden.

CDS

The Adult Concentration Inventory (ACI) (Becker et al., 2018) is rated on a 4-point Likert scale from 0 to 3. It includes all 16 of the CDS symptoms, 15 of which are highly reliable (Becker, 2025), and have external and structural validity to support the investigation of CDS presentation in adults (Frederick et al., 2022).

ADHD

The Adult ADHD Self-Report Scale (ASRS) (Kessler et al., 2005) is an 18-item questionnaire, with good, reported reliability and validity in both clinical and community samples (Fuller-Killgore et al., 2013). High specificity (86%) and medium sensitivity (66%) have been reported (Lovett et al., 2021).

Sleep

The Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989), is a 19-item measure of the quality of sleep over the past month, giving a global score for non-clinical and clinical samples. A meta-analysis, (k = 37), reports good internal consistency by Cronbach's alpha, generally strong reliability, and validity with modest structural validity (Mollayeva et al., 2016).

Daytime Sleepiness

The Epworth Sleepiness Scale (Johns, 1991) is an 8-item questionnaire answered on a 0-3 Likert scale. A large-scale study (*N*=10 785) indicates uni dimensionality (Lapin et al., 2018), important in use with large clinical populations for comparison and interpretation of daytime sleepiness (Beaudreau et al., 2012), with internal reliability (Beaudreau et al., 2012). It has good internal consistency by Cronbach's alphas (0.73 – 0.86) (Kendzerska et al., 2014), and good test-retest reliability (Veqar & Hussain, 2018).

Executive Function

The Adult Executive Functioning Inventory (ADEXI) (Holst & Thorell, 2018), a brief 14-item measure, focussing on self-reported problems of inhibition and working memory. It has high specificity 0.91 and low sensitivity 0.76 when comparing between adults with and without ADHD (Holst & Thorell, 2018).

Measures for sensitivity analyses

Mood

Depressed mood

Patient Health Questionnaire-2 (PHQ-2) (Kroenke et al., 2003) consists of 2 items measuring depressed mood and anhedonia, on a 4-point scale 0 to 3. A meta-analysis examining 21 validation studies reported pooled sensitivity of 76% and specificity 87% (Manea et al.,2016).

Anxiety

Generalized Anxiety Disorder Scale-2 (GAD-2) (Kroenke et al., 2007) incorporates the first 2 questions of the GAD-7, on a 4-point Likert Scale 0 to 3, with specificity of 81% and good pooled sensitivity of 76% (Plummer et al., 2016).

Worry

Penn State Worry Questionnaire - 3 (PSWQ-3), (Berle et al., 2011). This ultra-brief 3- item questionnaire on a Likert scale 1-5, assesses pathological worry and has been reported to have high sensitivity (.90-.92) and high specificity (.88-.90) (Topper et al., 2014).

Data Analysis

Data preparation analyses were carried out in SPSS (version 29.0). Descriptive statistics were conducted to summarise demographic characteristics of participants (see Appendix G). Frequencies and percentages summarised categorical variables, and continuous variables was reported as means (*M*) and standard deviations (*sd*). A syntax file for data screening (Freeston et al., 2023), was used to screen for bots, duplicates or other fraudulent or unreliable data. Missing individual participant data of 70 % or above of items present was imputed at the scale level. This method was chosen to minimise data loss and maintain the individual participant's patterns of responses (Freeston, 2024)

Descriptive Statistics

To assess data, potential outliers were investigated through examination of standardised *Z* scores and skewed distributions. Any extreme Z scores beyond a threshold of ±3.29 indicated an outlier in the data set (Field, 2018). Skewness and kurtosis were calculated for each continuous variable to assess the distributions. As sample sizes were large (*N* = >200) and are more likely to have small standard errors (Field, 2018), skewness and kurtosis values were interpreted alongside visual inspection for symmetry using boxplots, histograms and Q-Q plots (Kline, 2023).

Reliability

Chronbach's Alpha was used to assess the reliability of the measures. Any value above $\alpha \geq 0.80$ was considered to have good internal consistency (Chronbach, 1951).

Validity

Examination of convergent and divergent validity of measures was carried out using Pearson's bivariate correlations. Pairwise deletion was utilised to keep the maximum number of cases that were valid for each variable pair (Field, 2018).

Pilot results

Pilot feedback and a visual inspection of measure responses indicated that participants found the PSQI measure too onerous, potentially impacting attrition rates in the main survey. The PSQI was replaced by The Sleep Condition Indicator (SCI) in the main survey. Due to the decision to replace the PSQI, it was not included in descriptive or correlation analysis.

The Sleep Condition Indicator (SCI) (Espie et al., 2014), consists of eight items, eliciting sleep pattern information from the past month, scored on a 5-point scale. It has been recommended in a recent review of sleep quality measures due to its brevity, ease of administration and scoring, and alignment with diagnostic criteria of DSM-V for insomnia disorder (Fabbri et al., 2021). It is reliable and valid and has demonstrated convergent validity with the PSQI and Insomnia Severity Index (ICI) (Epsie et al., 2014). Items were reverse coded to align with other survey measures ensuring that higher scores reflected poorer sleep quality. (See Appendix H for full pilot results).

2.3.2 Phase two - main study

The core procedure of the pilot was maintained for the main study, but included some modifications and methodological improvements:

Participants

Recruitment

i. To increase sample diversity and ensure representation of participants with neurodivergent conditions, recruitment was extended to include online ADHD, Autism and CDS charities and communities through Instagram, Facebook and online forums. Charities were approached through communications and research departments. The survey was shared with a DClinPsy trainee. (see appendices for the information form, consent form, debrief form and support information (Appendices I, J, K and E).

In total, 582 participants clicked on the survey between January and May 2025). Six were deemed fraudulent and one response was duplicated. Thirty clicked on the survey and did not proceed, *N*=32 consented only, one was underage. Overall, 512 participants were deemed eligible for analysis, *N*=17 left social demographic data but did not proceed to the questionnaires and eleven participants began the questionnaires but did not proceed past the first block. After imputation, the sample comprised 453 datasets available for analysis. Participants were aged between 18 and 83 (*M* = 32.42, *sd* = 17.79), 84% were female,13% were male and 2.8% identified as transgender, gender fluid, non-binary or preferred not to say, 89% identified as white British, 11 % non-white ethnicity (see Appendix L for demographic tables)

Power analysis

In accordance with Freeston (2024), a sample of 300 minimum and 500 or beyond was considered for less complex meditation and moderation analyses based on a range of credible scenarios (small to medium effect sizes) for the various models in relation to r/R^2 at power= .80, alpha =.05. A sample below 300 could result in underpowered analysis (Freeston, 2024).

Procedure

The survey was shared between the researcher and another DClinPsy trainee to maximise data collection.

Measures

ii. The SCI replaced the PSQI.

iii. The first 15 items of the CDS measure were used for analysis, 15 out of 16 have been validated in different studies (see Becker 2025). The only unvalidated item (11, - "*I am not motivated to do things"*) was excluded from analysis.

iii. The order of the questionnaire blocks was randomised to mitigate the risk of missing data occurring in the same measures towards the end of the survey.

iv. Participants were invited to leave their email address if they were interested in participating in the phase three online cognitive task.

Data analysis

Data were again analysed for fraud and replication. Participant data of 70 % or above of items present was imputed at the scale level using their own data. At sample level, there were <0.5% missing data with less than 4 % of cases with missing data. There was no missing data in social demographic variables. Missing data occurred in the PHQ-2, GAD-2, PSWQ-2 ASRS screening measures and ADEXI (7-9 for each variable). Data were imputed from relevant mental health screening data selected for conceptual and statistical relevance. Due to unavailability of multiple imputation and full information maximum likelihood, expectation maximisation was utilised. Pre-imputation, there were 453 potential datasets, after imputation, 469 cases remained with only 0.15% missing data. The 16 missing ADEXI cases were not imputed due to unavailability of conceptually relevant data, so 453 cases were ultimately available for analysis. Post-imputation,

descriptive descriptives were analysed to confirm reliability, validity and normality assumptions. To test our hypotheses, Hayes PROCESS macro (model 80) was used, recommended for examination of moderating and mediating effects in complex models (Hayes, 2018). To test these hypotheses and test the overall moderating effects on the mediation at both the *b* and *c* paths we used Hayes PROCESS models 14 and 15.

2.3.3 Phase three - Online cognitive task

Participants

Overall, 214 Participants who left email addresses in the main survey agreeing to be contacted to complete a cognitive task were sent an email invitation containing further information and instructions (between March and June 2025) . In total 73 participants who completed self-report data in phase two, performed the Stroop task in phase three. Fifty five tests were analysed, 99 participants consented, 23 tests were aborted (did not begin), , *n* = 12 participants used a different ID number on the ID information form or did not complete their ID, preventing their data from being matched to self-reported data, n= 2 abandoned the test before completion, n=3 duplicated the test (the first response was used for analysis) and n=1 made an error in every question.

Procedure

After receiving an email (Appendix M) and receiving instructions stipulating the use of a laptop (Passel et al., 2021), participants were directed to a link in Qualtrics to an information sheet, and consent form (Appendices N and O). Participants also received support information (Appendix E) and the Qualtrics information sheet in the email, and after consenting were directed to a link in Pavlovia Psychopy (Open Science Tools), to a dialogue box page where they entered the 4-digit code (last 4-mobile digits) used in the main survey to enable the researcher to link the cognitive task data to their online survey

data. They were then directed to the task page on the same platform, comprising a practice and main task. Participant age ranged from 18 to 75 years (*M*=43.22, *sd* = 17.61), 89% were white, 81% female, 19 % male and 21% were students (see Appendix P for full methodology).

Data analysis

Outliers were examined by plotting the distribution of accuracy for each congruency condition. The total scores, incongruent and congruent scores were calculated using Inverse Efficiency Scoring (IES) (Townsend & Ashby, 1978), a composite measure prioritising both speed and response accuracy (Stroop, 1935), where the mean reaction time (RT) is divided by the proportion of correct answers (PC). selected due to the augmentation of data sensitivity without increasing data variability (Ramon & Rossion, 2012).

$$IES = MRT / PC$$

As an objective measure of EF, a Stroop Interference score was calculated for each participant using the IES method. Interference scores were calculated by subtracting the mean congruent score from the mean incongruent score

As an objective measure of concentration, adjusted total scores for all 60 trials and mean scores were calculated using IES. Greater total mean scores suggested poorer concentration during the test.

Total mean scores and interference scores were correlated with the subjective concentration scores, and interference scores were correlated with the subjective EF scores using Spearman's Rho correlation.

3. Results

3.1 Main study

In total, 453 data sets were analysed.

3.2 Descriptive statistics

Table 1 presents the means, standard deviations, ranges, reliability coefficients and normality statistics for the study variables.

Normality

Skewness and kurtosis values all appeared within acceptable ranges (± 1), suggesting normality assumptions were met for parametric analyses (see Table 1). The PHQ-2 had the highest skew (0.943). Visual inspection of histograms, boxplots and QQ plots indicated no extreme outliers, and the data were considered suitable for analysis (Field, 2018).

Reliability

As seen in Table 1 all scales demonstrated good to excellent internal consistency (α = 0.815 to 0.942).

Structural validity

Correlations between the self-reported measures are presented in Table 2. Results indicate large significant associations between CDS and EF, CDS and ADHD and depression suggesting potential overlap between concentration difficulties, attention problems, EF and depression. A small significant association between sleep quality and daytime sleepiness was observed, a medium association with concentration and a large correlation with ADHD.

Table 1

Descriptive Statistics

Measure	*n*	Items	Alpha	Range	M	SD	Std. Error	Skewness	Std. Error	Kurtosis	Std. Error
ESS (sleepiness)	453	8	0.82	24	7.38	4.50	0.21	0.62	0.12	0.18	0.23
SCI (sleep)	453	8	0.88	32	14.41	8.14	0.38	-0.02	0.12	-1.03	0.23
ACI (CDS)	453	15	0.93	45	20.81	10.43	0.49	0.26	0.12	-0.74	0.23
ASRS (ADHD)	453	18	0.94	71	54.00	15.27	0.72	0.07	0.12	-0.62	0.23
ADEXI (EF)	453	14	0.92	55	39.82	11.74	0.55	0.13	0.12	-0.56	0.23
PSWQ-3 (Worry)	453	3	0.92	12	9.02	3.85	0.18	0.05	0.12	-1.19	0.23
PHQ-2 (Depression)	453	2	0.86	6	1.79	1.88	0.09	0.94	0.12	-0.21	0.23
GAD-2 (Anxiety)	453	2	0.90	6	2.15	0.91	0.89	0.64	0.12	-0.71	0.23

Table 2

Correlations of study measures

Table 2
Correlations Between Study Measures

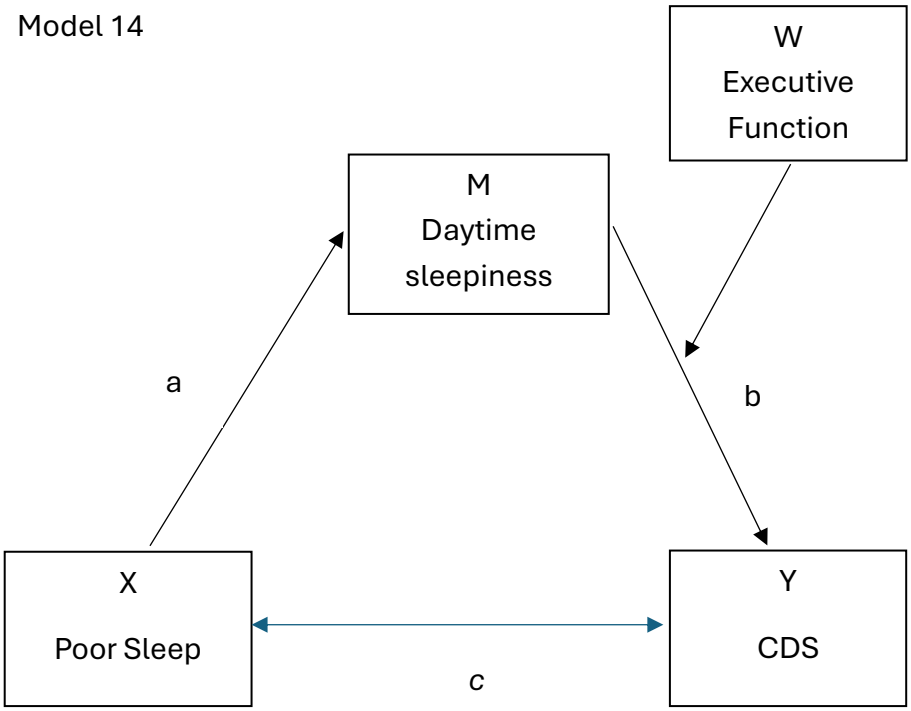
	1.	2.	3.	4.	5.	6.	7.	8.
1.ESS Daytime sleepiness	-	.						
2.SCI Sleep	0.31**	-						
3.ACI Concentration	0.35**	0.54**	_	.				
4.ASRS ADHD	0.32**	0.76**	0.76**	-				
5.ADEXI Executive function	0.31**	0.49**	0.77**	0.84**	-			
6.PSWQ-3 Worry	0.21**	0.45**	0.54**	0.49**	0.46**	-		
7.PHQ-2 Depression	0.20**	0.48**	0.60**	0.51**	0.50**	0.56**	-	
8.GAD-2 Anxiety	0.26**	0.42**	0.59**	0.49**	0.47**	0.76**	0.68**	-

*Note N=453 ** indicates significance at* 0.01 level

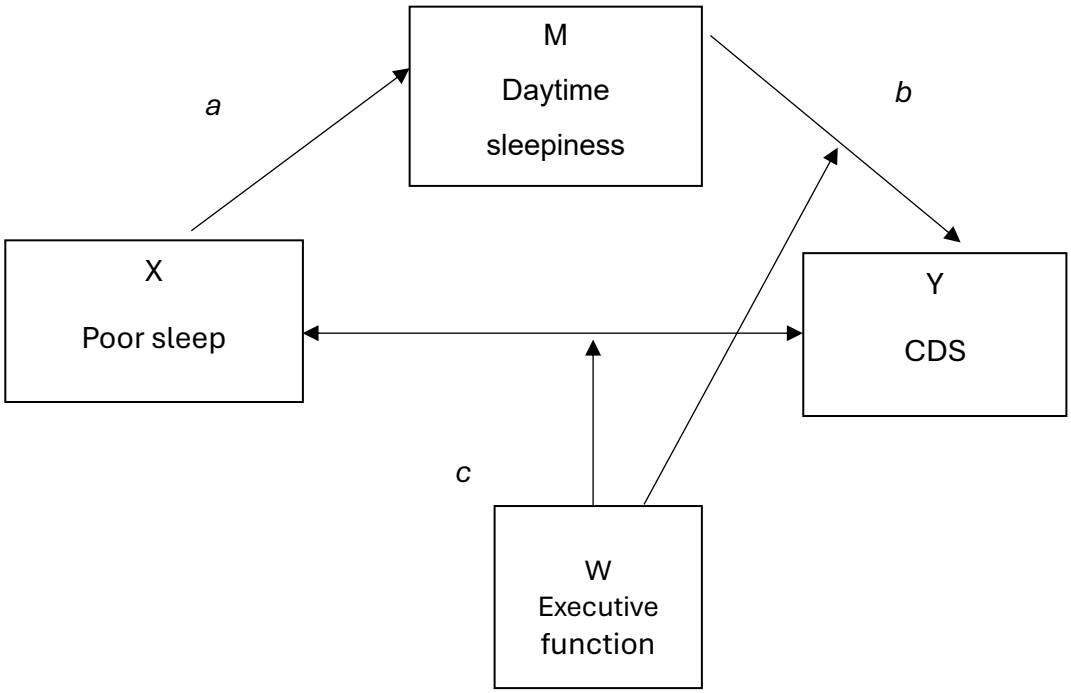
3.3 Hypotheses moderated mediation effects

Figure 1
Hayes Process Conditional Models 14 and 15

Model 14



Model 15



Hypothesis one

First, we tested the hypothesised moderated mediation using model 14 on PROCESS (figure 1), where the indirect (path *b)* is tested to assess whether executive function moderates the mediating role of daytime sleepiness between poor sleep and CDS, while entering covariates: number of sexual identities, heterosexuality, religion, residence, employment status, student status, gender, ethnicity.

Additionally, to test whether the overall direct effect was significantly moderated by executive function, we tested model 15 (Figure 1) on Process to assess whether the strength of poor sleep on CDS was significantly moderated by EF at the direct effect (path *c*). As model 15 did not significantly alter the findings we report the results for model 14 below (see Appendix R1 for model 15 results).

As can be seen in table 1 there is a significant direct effect of poor sleep on CDS. There is a significant indirect effect of poor sleep on CDS through daytime sleepiness. The strength of the indirect effect was not conditional on the moderator, namely executive function. Nor was the direct effect. The SCI ADEXI interaction was not significant R2 =0.001, F (1,439) 0.875 *p*=.350

Table 1
Results of Moderated Mediation Hypothesis One

Effect		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	SCI→ACI	0.266	0.043	0.181	0.351	Significant
Indirect	SCI→ESS→ACI	0.265	0 .015	,0000	0.059	Significant
Moderation by ADEXI	*b* path	.00071	.00071	-.0006	.002	NS

Of the covariates, greater CDS was significantly associated with heterosexuality (see Appendix R2). Specificity analyses were run first by adding ADHD as a covariate. The direct effect remained significant, but not the indirect effect through sleepiness. When

we controlled for depression, the direct effect remained significant and the indirect effect through sleepiness remained significant but weakened (see Appendix R3). When controlling for ADHD nonwhite ethnicity became significant and religion became significant when controlling for depression (see Appendix R4).

Overall, partial support was found for the first hypothesis, with strongest support for the direct effect, as the indirect effect became non-significant when specificity analyses were conducted controlling for ADHD. Significance remained, but the effect weakened when controlling for depression. There was no support for moderation by executive function.

Hypothesis two

Next, to examine reciprocity, we tested the second hypothesis using a reversed directional model, (Figure 1) in the relationship between CDS and poor sleep. We tested the hypothesised moderated mediation using PROCESS Model 14, the indirect path *b* is tested to assess whether executive function moderates the mediating role of daytime sleepiness between CDS and poor sleep, while entering the same covariates. Again, we ran model 15 (see Appendix R5) with no difference to findings and report model 14 results below.

As can be seen in Table 2, there is a significant direct effect of CDS on poor sleep. There is a significant indirect effect of CDS on poor sleep through daytime sleepiness. The strength of the indirect effect was not conditional on the moderator, namely executive function. Nor was the direct effect. The ACI ADEXI interaction was not significant R2 =0.0029, F (1,439) 2.0169 *p* =.156

Table 2

Results of Moderated Mediation Hypothesis Two

Effect		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	ACI→ SCI	0.3	0.0486	0.204	0.395	Significant
Indirect	ACI→ESS→ SCI	0.410	0 .0132	0.0181	0.07	Significant
Moderation by ADEXI	*b* path	-0.0013	.00094	-.00327	.0004	NS

Of the covariates, poorer sleep was significantly associated with being a student (Appendix R6). This significant association remained when controlling for ADHD and depression (Appendix R8).

Specificity analyses were run first by adding ADHD as a covariate. The direct effect remained significant though weakened, and the indirect effect through sleepiness remained significant though weakened. When we controlled for depression, the direct effect remained significant but weakened and the indirect effect through sleepiness remained significant but weakened (Appendix R7).

Overall, partial support was found for the second hypothesis, with strongest support for the direct effect and the indirect effects which remained significant though effects were weakened when specificity analyses were conducted controlling for ADHD and depression. There was no support for moderation by executive function.

3.4 Cognitive Task Results

Descriptive statistics revealed one extreme outlier in the Interference scores dataset which was winsorised by replacing it with the closest non outlying score. After winsorising, the distribution remained non normal, with both interference scores and total mean scores being positively skewed (Appendix Q). Spearman's rank order correlations were selected using Bonett's method to calculate confidence intervals suitable for smaller sample sizes and non-normal distribution (Bonett & Wright, 2000).

There was little to no association between self-reported concentration scores and total mean Stroop scores r_s (55) =-0.03, CI [-0.29, 0.24] p = 0.834, indicating a negligible, non-significant negative association. There was a small, negative non-significant association between CDS scores and interference scores r_s (55) = -0.13, 95% CI [-0.39, 0.14], p = 0.35 and a small, negative association between self-reported EF scores and interference scores r_s (55) = -0.13 , 95% CI [-0.38, 0.4], p = 0.35 . Additionally, age was correlated with subjective CDS scores and performance-based scores. Pearson's correlation analysis found a significant negative association between age and CDS scores r = -0.31, , CI [-0.53, - 0.48], p = 0 .021. A significant positive association was found between age and total performance time r_s = 0.43, CI [0.174, 0.631], p = 0.001, and a non-significant positive effect between age and interference scores r_s = 0.21, , CI [-0.06, .46], p = 0.12.

4. Discussion

This study has extended the current literature examining CDS, sleep, daytime sleepiness, and executive function in adults by using moderated mediation analyses. We hypothesised that the bidirectional relationship between CDS and poor sleep is partially mediated by daytime sleepiness and moderated by executive function using Hayes conditional PROCESS macro. To test the overall moderating effects on the mediation at both the *b* and *c* paths we used Hayes PROCESS models 14 and 15, both rendering similar findings. Due to the association of depression with sleep and CDS (Smith et al., 2020), and shared variability between ADHD and CDS (Barkley, 2022), it was important to control for these two variables.

4.1 Is there a potential bidirectional relationship between CDS and poor sleep partially mediated by daytime sleepiness and moderated by EF?

When testing the first hypothesis we found strong support for the direct relationship between poor sleep and CDS partially mediated by daytime sleepiness. Our second hypothesis found strong support for the direct relationship of CDS and poor sleep, partially mediated by daytime sleepiness. The moderated mediation effect of EF was not statistically significant in either analysis, suggesting that the mediating role of sleepiness is independent of EF. Due to the need for moderated mediation models to be strongly powered (Freeston, 2024), a larger sample size may have led to significant results in the overall moderation pathway. Although the overall moderating effects on the mediation pathway between CDS and sleep were not significant, our findings are important as they support evidence of a bidirectional relationship between CDS and poor sleep, suggesting that they may mutually be reinforcing one another rather than one being a consequence of the other. Our sensitivity analysis highlights the importance of controlling for comorbidities (i.e. ADHD and depression) in CDS research to avoid making incorrect inferences of significant effects.

4.2 Sensitivity analyses

When evaluating the relationship between poor sleep and CDS, we controlled for ADHD and the indirect effect of poor sleep on CDS via daytime sleepiness became non-significant. The effect remained significant but weakened in the relationship between CDS and poor sleep. ADHD symptoms may therefore offer an alternative explanation for the association than daytime sleepiness. One interpretation is that ADHD may explain the association, and may influence poor sleep more than CDS, with daytime sleepiness no longer mediating the relationship. This is not consistent with previous studies where

CDS still remained uniquely associated with poor sleep quality even after controlling for ADHD (Becker et al., 2014, Frederick et al, 2022). However, they had smaller sample sizes and used alternative ADHD and sleep measures (BAARS-IV and PSQI). The findings imply that if sleepiness and poor sleep are targeted without addressing ADHD, CDS symptoms may not be alleviated.

An alternative explanation could be a potential symptomatic and conceptual overlap between ADHD and CDS, especially inattentive ADHD items, as reported in the literature (Barkley et al., 2022; Becker, 2016). Future studies could explore whether this is either due to salient distinct effects of ADHD and CDS or overlap between them. This could be addressed by first exploring ADHD inattention, impulsivity and hyperactivity and associations with sleep in the moderated mediation model, while controlling for CDS and depression through sensitivity analysis. Also, smaller components of CDS or individual CDS subscales such as lethargic and cognitive complaints (Khalid et al., 2025), could be assessed in future modelling to mitigate any potential overlap with ADHD.

When controlling for depression in both hypotheses the results remained significant, but the effect weakened. This implies that daytime sleepiness still partially mediated the direct relationship between sleep and CDS, independent of mood which is an important finding. Daytime sleepiness may contribute to the exacerbation of CDS symptomology regardless of mood indicating that CDS, sleepiness and mood are distinct but correlated constructs and should be assessed and treated separately. Further explorations could elucidate whether directly focussing on sleepiness through targeted interventions could alleviate CDS.

ADHD and depression may share a portion of the variance in this indirect pathway, implying the link between CDS and sleepiness may not be wholly unique. While a

previous student study found CDS remained a predictor of sleepiness after running sensitivity analysis, it did not examine sleepiness as a mediator (Langberg et al., 2014).

Findings imply that CDS and poor sleep may reinforce one another as suggested by Sadeghi-Bahmani et al., (2022). Interventions targeting daytime sleepiness could benefit poor sleepers reporting high CDS symptoms and similarly, those with high CDS may benefit from sleep-focussed support (Gloger & Suhr, 2020). Interventions for daytime sleepiness should target ADHD, depression, and other potential psychopathologies, not just CDS, as there are various underlying causes of sleepiness (Ghandi et al., 2021). Future models could incorporate ADHD and depression as mediators along with daytime sleepiness, to try and further understand the CDS sleep association and whether sleepiness, ADHD or depression interact as additional mechanisms in the pathway.

4.3 Covariates

Heterosexuality (versus sexual minority) was significantly associated with CDS even after sensitivity analysis. Since most of the sample reported heterosexuality (75%), the sample constitution may have led to this finding. However, a recent study (*N* =14,219), found that those who identified in sexual identity minority groups were more likely to identify as neurodivergent compared to heterosexual participants (Kroll et al., 2025). Our finding is unexpected given that neurodivergence has been associated with elevated CDS traits (Becker, 2025). This highlights an area for future exploration, to understand the interplay between sexual identity, neurodivergence and links with self-reported concentration difficulties.

When entered separately as covariates, ADHD and depression revealed associations between religion, nonwhite ethnicity and CDS. ADHD and depression may

have been obscuring the relationship between CDS and sociocultural factors. This highlights a need to explore CDS in culturally diverse or religious populations as research is scarce (Becker et al., 2025). Overall, 3.2 % of participants identifying as religious were Muslim, and a month of the data collection coincided with Ramadan which could have impacted concentration, EF, and sleep scores for these participants (Qasrawi et al., 2017).

Notably, being a student was significantly associated with greater sleep problems even when controlling for ADHD and depression. This is consistent with previous findings indicating that students report more sleep problems leading to poorer subjective reports of executive dysfunction ($p < .005$, $\eta p^2 = .19$) and concentration ($p < .001$ $\eta p^2 = .17$) (Gloger & Suhr, 2020). Student status may be a confounding factor in research examining poor sleep and CDS, as poor sleep and concentration issues can be influenced by contextual factors such as academic pressures, lifestyle habits or substance abuse (Gloger & Suhr, 2020; Wood et al., 2020).

4.4 Objective assessment

An additional study aim was to compare self-reported EF and CDS scores with objective results from an online Stroop task. There were no significant associations, aligning with previous student studies (Jarret et al., 2017; Smith & Suhr, 2021). This could be explained by participants' underestimation of cognitive problems in self-report due to report bias or limited self-awareness (Gloger & Suhr, 2021). The Stroop task may not have captured the cognitive processes that typify CDS such as mind wandering or sluggishness (Barkley et al., 2022). CDS potentially involves diverse and multi-faceted brain functioning configurations, and no specific cognitive test may fully capture its

essence (Becker, 2025). Furthermore, CDS may not be related to objective measurement of cognitive impairment (Smith & Suhr, 2021).

Within this subgroup, self-reported CDS scores decreased with age. However, total objective completion time mean scores significantly increased with age, potentially demonstrating disparity between subjective report and objective performance. Given the small sample size which could increase the chance of a Type I error (Field, 2018), and inclusion of only one cognitive test, these findings are tenuous, and there would be merit in exploring the associations between age, self-reported CDS and performance-based concentration abilities using more tests and larger samples.

While some studies have found small but significant associations between EF self-report and interference control tests (Holst & Thorell, 2018), others have found the discrepancy in findings between EF self-report and objective testing possibly due to self-report being more ecologically valid than cognitive assessment (Toplak et al., 2013). Subjective ratings can be more predictive of the type of dysfunction that people experience in everyday life than an unrelated assessment (Barkley & Murphy, 2011). Overall, our findings emphasise the importance of multisource assessment i.e. subjective, objective, and collateral assessment of EF (Holst & Thorell, 2018) and CDS (Lunsford- Avery et al., 2021).

4.5 Strengths and Limitations

Strengths

To our knowledge, this is the first study to use moderated mediation to examine the associations between CDS, sleep, sleepiness, and EF in adults. The current CDS evidence base mainly relies on self-report only. Inclusion of an objective performance

task alongside self-assessment measures enhanced the methodological rigour of the study (Frederick et al., 2022; Soto et al., 2020).

The execution of a pilot contributed to the robustness of the study (Cohen et al., 2002), enabling evaluation of measures, leading to the replacement of the PSQI with the less burdensome yet equally valid SCI to assess sleep quality. The recruitment strategy firstly generated a large sample size, a key factor given that moderated mediation analysis requires higher statistical power to detect small indirect and interaction effects (Hayes, 2018). Secondly, targeted outreach to neurodivergent forums and charities facilitated inclusion of a substantial proportion of neurodivergent participants. CDS research has yet to emphasise the importance of diversity and equity (Becker, 2025), and an important strength was the collection of detailed demographic data often lacking (Frederick et al. 2022), allowing us to examine demographic covariates and intersectionality in relation to CDS and sleep leading to more nuanced understanding of the association.

Limitations

There was a predominance of female participants in the main study sample compared with men, a prevailing issue in psychology research (Wu et al., 2022). Likewise, few people from ethnic minorities took part, rendering the sample predominantly white. Generalisability to men and nonwhite groups was thus limited which is salient given the poor understanding of gender and race differences in CDS symptomology (Becker, 2025). Furthermore, considering that 32% of the total sample were women over 40, we did not assess or control for peri / menopausal status (Troìa et al., 2025), nor did we account for medication, alcohol or drug use, all of which can impact sleep, mood, concentration, EF and daytime sleepiness (Gloger & Suhr, 2021).

As interference control has been under investigated in CDS research (Becker, 2025), we selected the Stroop task based on rationale. However, the lack of participants to attend a focus group to discuss concentration difficulties to inform the choice of the cognitive assessment task was a limitation. Inclusion of additional tasks i.e. variations of the Trail Making Test Part B (Reitan, 1958) to assess cognitive flexibility and the Symbol Search task (Wechsler, 2008), to assess processing speed and response inhibition could have developed assessment scope, strengthening the validity of our findings. Another limitation was the relatively small sample (*N*=55), potentially limiting statistical power, possibly increasing the Type II error (Field, 2018). The need to complete the task on a lap top could have impacted the sample size along with the loss of data that could not be linked to self-report data.

Our sleep and sleepiness measures (SCI and ESS) were self-report only; objective measurement may have given a more comprehensive assessment of sleep problems (Fabbri et al., 2021).

4.6 Future research

The main study was cross-sectional, and findings from moderators and mediators modelled in cross sectional design as per the MacArthur approach cannot infer causality (Kraemer et al., 2008). Through this study we are not claiming the mediator, or any moderator influences have been causally demonstrated. As per Hayes and Rockwood, our aim was to evaluate whether our results were consistent with, but not a direct assessment of our hypotheses and the implications of merit for further investigation in a longitudinal study with multi timepoints. In this way, more evidence could be accumulated to state the moderator and mediator (Hayes & Rockwood, 2020). A longitudinal study would assess the inferred causality and generalisability of our findings

concerning the bidirectional nature of CDS and poor sleep. Longitudinal research could also explore the mediating role of daytime sleepiness and other variables such as ADHD and depression impacting this relationship.

While executive function did not moderate the direct and indirect effects, the ADEXI was significantly and positively correlated with measures of CDS (strong), sleep and sleepiness (weak to moderate). Therefore, its potential influence on the inter-relationships cannot be discounted and future research with larger community samples to increase power and /or longitudinal design could potentially lead to stronger findings.

The question of whether CDS is a single or multi-dimensional construct remains unresolved (Smith & Langberg, 2017). Exploring the subdimensions of CDS such as daydreaming, sluggishness and hypoactivity may offer more subtle relational patterns (Smith & Suhr, 2021), offering potentially greater understanding of the bidirectional relationship with sleep, as well as discovering which subdimensions are most influenced by sleepiness. This could potentially lead to development of useful interventions to help those with CDS and sleep problems.

The researcher found emerging evidence linking evening preference to CDS in four studies in their review, and evidence suggests that eveningness preference leads to poorer mental health outcomes (Cheung et al., 2023). Researchers should consider investigating the role of circadian preference and how the tendency to be a night owl influences the relationship between CDS, poor sleep and depression (Knouse & Becker, 2025). A particular focus could be the mechanisms underpinning how circadian preference may influence the association between poor sleep and CDS by examining causality and the bidirectional nature of the associations (Knouse & Becker, 2025). Furthermore, there is little understanding of why there may be an association of sleep

problems and CDS, and future studies could examine measurements of EEG sleep and MRI imaging to explore neural mechanisms underpinning the relationship (Sadeghi-Bahmani et al., 2022).

4.7 Conclusion

This study has developed the CDS evidence base by using moderated mediation to explore the associations between CDS, sleep, sleepiness, and executive function. The findings support the existence of a bidirectional relationship between poor sleep and CDS partially mediated by sleepiness requiring further exploration though longitudinal research. Although EF did not significantly moderate the association in the model, the correlational results nonetheless suggest a potential interplay between EF, sleep difficulties and CDS. The comparison of self-reported and performance based cognitive ability strengthened the study and highlighted the importance of a multi modal approach in CDS research. Subjective report and task-based assessment both give valid, complementary insight into cognitive function (Snyder et al., 2020).

Reflections on ethical issues

Ethically the study was deemed low risk. It was important to be mindful however that as the project's main aim was to investigate people's potential concentration difficulties, certain responses to the Adult Concentration Inventory questions may have led participants to be concerned that they had poor concentration. After the launch of the main survey, a participant emailed me to thank me for doing the study, stating that the survey had made them consider that they may have CDS which was impacting them in everyday life. While this may have been positively viewed by the participant (and potentially others), it could also have caused stress and concern. Although the measures posed little risk to participants, there was still the potential to cause concern or alert a

participant to current functioning problems or mental health issues. This highlights the need to be mindful that although a study may be deemed low risk any measure or task has the potential to influence or impact a human participant.

These considerations made it very important to offer participants the opportunity to contact the researchers or access the comprehensive support organisation sheets attached to both the pilot and main survey and the cognitive task invite emails. Furthermore, it was also important that participants were given the opportunity to miss any questions that they did not wish to complete, as well as being able to leave the survey at any point or withdraw consent within two weeks of survey completion. The concern about concentration difficulties may have explained why some participants did not respond to the emails inviting them to participate in the focus group. They may have not wished to confront or discuss these issues which I initially did not consider.

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Appendices

Appendix A – Ethical Approval for the Three Study Phases

Phase one

thics Form Completed for Project: A study examining Concentration Difficulties in Everyday Life Pam Boullin, Georgia Mooney, Caitlin Kittridge, Maeve Thompson

Sent: 16 February 2024 15:34
To: Pam Boullin (PGR) <P.Boullin2@newcastle.ac.uk>
Subject: Ethics Form Completed for Project: A study examining Concentration Difficulties in Everyday Life Pam Boullin, Georgia Mooney, Caitlin Kittridge, Maeve Thompson

⚠ External sender. Take care when opening links or attachments. Do not provide your login details.

Ref: 39494/2023
Thank you for submitting the ethical approval form for the project 'A study examining Concentration Difficulties in Everyday Life' (Lead Investigator: Pam Boullin, Georgia Mooney, Caitlin Kittridge, Maeve Thompson). Expected to run from 01/03/2024 to 30/04/2025.
Based on your answers, the University Ethics Committee grants its approval for you to start working on your project. Please be aware that if you make any significant changes to your proposal then you should complete this form again, as further review may be required. This confirmation may be used within a research portfolio as evidence of ethical approval. Please note: this confirmation will be the only correspondence you should expect to receive as evidence of ethical approval. There will be no other confirmation provided. You may now proceed with research. If you have any queries, please review the internal and external ethics FAQ pages before contacting res.policy@ncl.ac.uk.
Best wishes
Research Policy Intelligence and Ethics Team,
Research Strategy & Development
res.policy@ncl.ac.uk

Phase two

Quick steps | Read / Unread

Ethics Form Completed for Project: A Study of Concentration Difficulties in Everyday Life Pam Boullin and Georgia Mooney

Policy & Information Team, Newcastle University<noreply@limesurvey.org>
To: Pam Boullin (PGR) Fri 24/01/2025 09:51

You forwarded this message on Fri 24/01/2025 09:52

⚠ External sender. Take care when opening links or attachments. Do not provide your login details.

Ref: 55393/2023

Thank you for submitting the ethical approval form for the project 'A Study of Concentration Difficulties in Everyday Life ' (Lead Investigator: Pam Boullin and Georgia Mooney). Expected to run from 03/01/2025 to 01/06/2025.
Based on your answers, the University Ethics Committee grants its approval for you to start working on your project. Please be aware that if you make any significant changes to your proposal then you should complete this form again, as further review may be required. This confirmation may be used within a research portfolio as evidence of ethical approval. Please note: this confirmation will be the only correspondence you should expect to receive as evidence of ethical approval. There will be no other confirmation provided. You may now proceed with research. If you have any queries, please review the internal and external ethics FAQ pages before contacting res.policy@ncl.ac.uk**.**

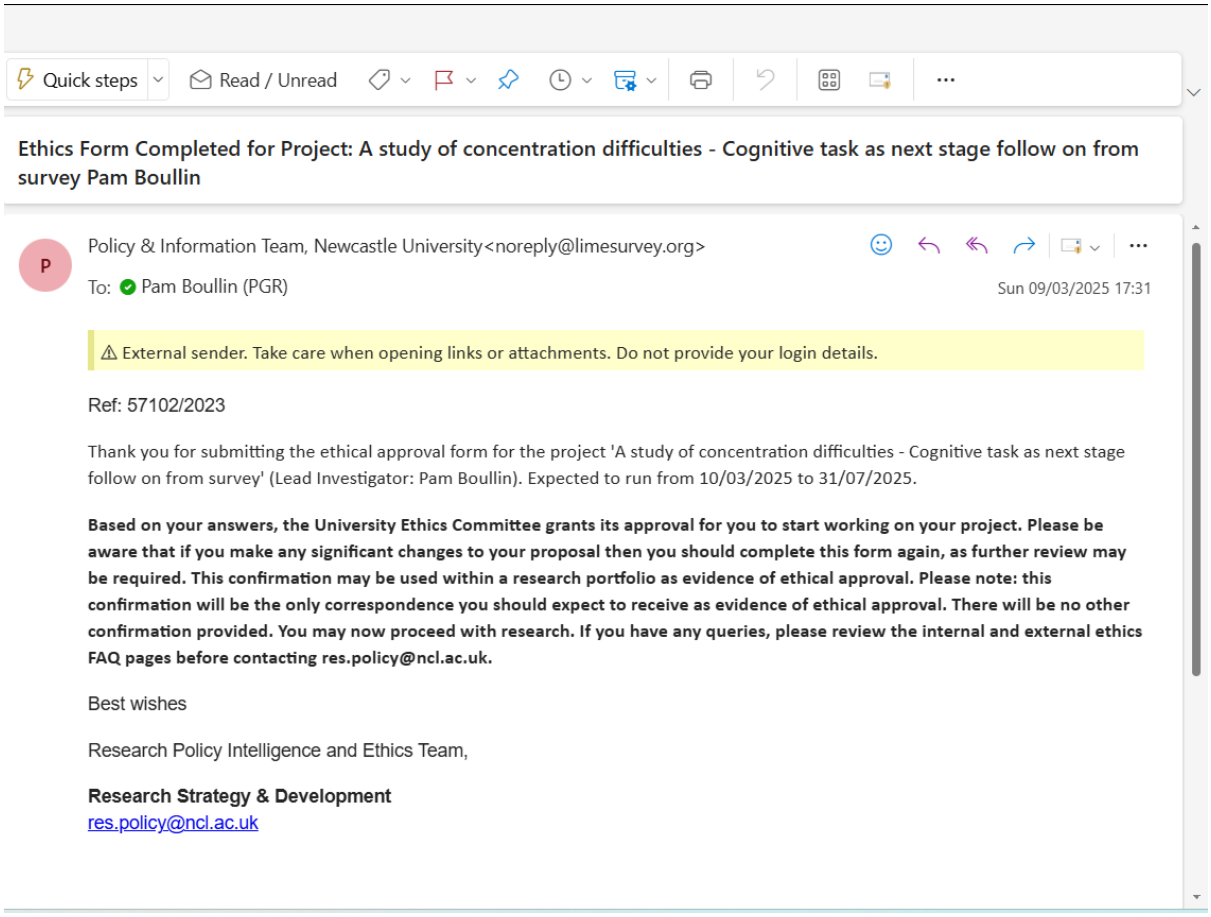
Best wishes

Research Policy Intelligence and Ethics Team,

Research Strategy & Development
res.policy@ncl.ac.uk

Ethics Form Completed for ... | paper | (No subject) | Fw: Ethics Form C...

Phase three



Quick steps | Read / Unread

Ethics Form Completed for Project: A study of concentration difficulties - Cognitive task as next stage follow on from survey Pam Boullin

P

Policy & Information Team, Newcastle University<noreply@limesurvey.org>

To: Pam Boullin (PGR)

Sun 09/03/2025 17:31

⚠ External sender. Take care when opening links or attachments. Do not provide your login details.

Ref: 57102/2023

Thank you for submitting the ethical approval form for the project 'A study of concentration difficulties - Cognitive task as next stage follow on from survey' (Lead Investigator: Pam Boullin). Expected to run from 10/03/2025 to 31/07/2025.

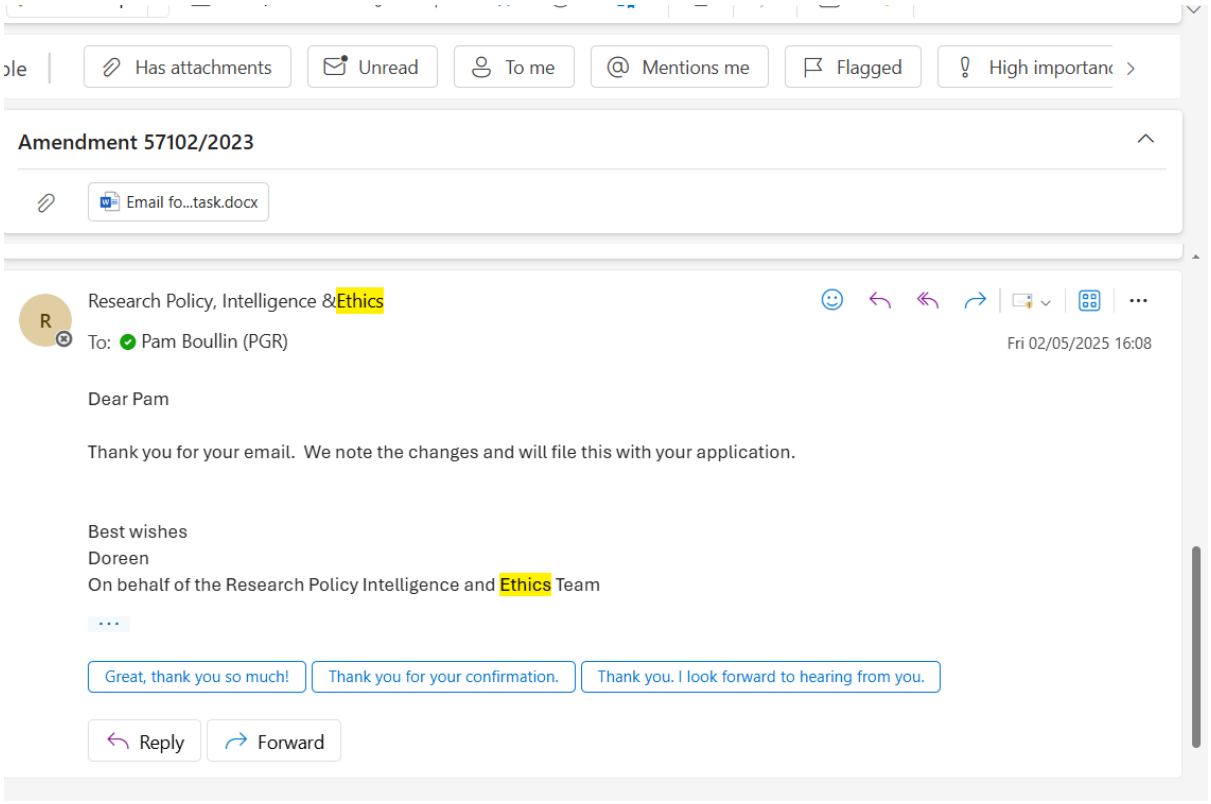
Based on your answers, the University Ethics Committee grants its approval for you to start working on your project. Please be aware that if you make any significant changes to your proposal then you should complete this form again, as further review may be required. This confirmation may be used within a research portfolio as evidence of ethical approval. Please note: this confirmation will be the only correspondence you should expect to receive as evidence of ethical approval. There will be no other confirmation provided. You may now proceed with research. If you have any queries, please review the internal and external ethics FAQ pages before contacting res.policy@ncl.ac.uk.

Best wishes

Research Policy Intelligence and Ethics Team,

Research Strategy & Development
res.policy@ncl.ac.uk

Amendment to cognitive task email



Appendix B Phase One Pilot Study Information Sheet

A Study of Concentration Difficulties in Everyday Life

Thank you for your interest in taking part in this study. Please take time to read this information sheet carefully and consider whether you would like to take part.

What is the purpose of this study?
The purpose of this study is to improve our understanding of concentration difficulties and how they affect people in their everyday lives.

What is the study about?
This study is examining the relationship between concentration difficulties, sleep difficulties, and daily functioning, including socializing, in adults. You are being invited to take part and before you decide, it is important for you to understand why the research is being done and what it involves. Please take time to read the following information and feel free to discuss it with other people. If anything is unclear and /or you require further information, please do not hesitate to contact the research team.

We are interested in finding out more about the relationship between concentration difficulties, poor sleep, and daily functioning in adults. Some people experience concentration difficulties with brain fog, daydreaming, mental disengagement, and slow movement. Previously, these were considered part of attention deficit hyperactivity disorder (ADHD), specifically ADHD-inattention. However, recent research suggests that these concentration difficulties are now separate to ADHD with their own group of related signs.

Adults with concentration difficulties may have more problems in day-to-day activities than children with concentration difficulties. We are interested in learning more about the relationship between poor concentration and daily functioning among adults. To do this we wish to investigate memory, ability to solve problems and plan ahead, organizational skills, and socializing.

Recent studies suggest that poor sleep can make concentration difficulties worse. Currently, research suggests that concentration difficulties lead to poor sleep, but it is also possible that poor sleep may cause concentration difficulties. We wish to examine the relationship between concentration difficulties and both poor sleep and daily functioning among adults. Socializing with others can be demanding, so concentration may affect how much people seek out contact with others or socialize.

Additionally, we aim to further our understanding of concentration difficulties and anxiety or worry and the way that uncertainty may contribute.

What are the benefits of this study?
This area of research may benefit people reporting concentration difficulties in the longer-term. Firstly, increasing the availability of helpful sleep interventions can improve daytime tiredness for people reporting poor concentration and problems with

daily functioning. Secondly, it may lead to adapted strategies to help people meet their social goals. Finally, it may provide further insight into how concentration difficulties may influence the way people react to uncertainty and anxiety/worry.

Can anyone take part?
Provided you are over 18, you can take part in this study. You do not have to have a mental health problem or have noticed any sleep or concentration difficulties.

Who is carrying out this research?
Pam Boullin and Georgia Mooney (Trainee Clinical Psychologists at Newcastle University, employed by Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust), and Caitlin Kittridge and Maeve Thompson (Undergraduate Psychology Students at Newcastle University) are carrying out this research.
Professor Mark Freeston, Newcastle University, is supervising this project.

What does taking part involve?
Taking part in this research is voluntary. After reading this information sheet, you will be asked to complete a consent form to confirm you are eligible to participate in this research and to confirm that you consent to taking part. Before signing up it is important that you understand what participation involves. Participation in this research involves the completion of an online survey. This questionnaire may take up to 20 to 30 minutes to complete. The information collected will be anonymized and only the research team will be able to see your individual responses.

What if I feel I need to access further support after completing the survey?
We will provide a list of support organisations throughout the survey at the bottom of each page; in case you feel you need to seek further support. You can download this page.

What information will be collected and who will have access to the information collected?
You will be asked to answer questions about difficulties with concentration and attention, your sleep habits, potential sleepiness during the day, experiences of daily life including socializing, your mood, worry and anxiety. You will be asked to provide some information about your sociodemographic factors, for example your age and gender. The questionnaires do not ask you to give your name. If you wish to receive a report on the study on its completion, you will be asked to provide an email.

All information will be stored securely and anonymously. You have the right to withdraw from the research, and we will ask you to create a 4-digit code at the start of the questionnaire (instructions are provided) to allow the researchers to withdraw your data. Data collected during the online survey will be stored by Qualtrics, a secure online survey software platform, and the researchers will export it and store it securely in password protected files on Newcastle University's servers. The information will only be accessible to the research team.

Will my information be private and what will happen to it?
We will need to use information about you for this research project. All the data we collect will be kept strictly confidential and in accordance with the General Data Protection Regulation (GDPR). The research team will only have access to information which you choose to provide for research purposes. We will store your information with a unique identifier code.

Newcastle University are leading and managing this study and acting as the data processor and sponsor and are responsible for looking after your information and using it properly. Newcastle University will keep any identifiable data you provide for 6 months after completion of the study. All precautions will be taken by all those involved to ensure your confidentiality. After this time, all identifiable information relating to your data will be securely erased (in this case your e-mail should you choose to provide it). We will ask for your consent to use your completely anonymised data within a larger data set which may be accessed by other researchers at Newcastle University and in other organisations, such as other universities, or NHS organisations. Your anonymised data will only be used by organisations and researchers to conduct research.

You will be asked if you would like to provide your email address only if you choose to receive a report on the study findings. This will be around September 2025, the anticipated time of project completion. We will also ask separately for your consent to be approached by email about possible research studies carried out as a direct follow-up to this study in the next six months. If you agree to be contacted, you will be asked for your e-mail address.

How will my information be used?
Newcastle University will be using information from you in order to undertake the study and will act as the data controller for this study. This means that Newcastle University is responsible for looking after your information and using it properly. When we use personally identifiable information from people who have agreed to take part in research, we ensure that it is in the public interest. After the two-week period, your rights to access, change or move your information are limited, as Newcastle University needs to manage your information in specific ways in order for the research to be reliable and accurate.

To safeguard your rights, the minimum personally identifiable information will be used (your email, if you choose to provide it). You can find out more about how Newcastle University uses your information
at: https://www.ncl.ac.uk/data.protection/dataprotectionpolicy/privacynotice/ or by contacting Newcastle University's Data Protection Officer (Maureen Wilkinson, rec-man@ncl.ac.uk).

What happens if I want to leave the study?
You are not obliged to take part in this study. Your involvement is voluntary, and you can withdraw from the study at any time. If you decide to withdraw, the questionnaire data up until the point of withdrawal will still be included unless you contact the researcher

and request for your data to be removed from the report. You are requested to contact the researcher within two weeks of completion or partial completion of the survey and inform the researcher of your unique code created at the beginning of the survey.

What happens to the study results?
The researchers will write up the results in a report and submit it to Newcastle University. The report will be finalised approximately six months after the end of the study and will be available from September 2025. To receive a copy, please tick the box declaring interest in receiving the report when you complete the questionnaires. We aim to submit the research findings to academic journals for publication and share with varied audiences.

Has this study received ethical approval?
Yes, the study has been reviewed and approved by Newcastle University's Faculty of Medical Science Research Ethics Committee.

Who is the contact for questions about this research study?
Pam Boullin, Trainee Clinical Psychologist. Email: p.boullin2@newcastle.ac.uk
Georgia Mooney, Trainee Clinical Psychologist. Email: g.mooney2@newcastle.ac.uk
Caitlin Kittridge, Undergraduate Psychology Student.
Email: c.r.kittridge1@newcastle.ac.uk Maeve Thompson, Undergraduate Psychology Student. Email: m.c.e.thompson2@newcastle.ac.uk

Who should I contact to lodge a complaint?
Professor Mark Freeston, Newcastle University.
Email: mark.freeston@newcastle.ac.uk The Chair of the Faculty of Medical Sciences Ethics Committee is a final point of contact for any unresolved issues relating to this project: fmsethics@newcastle.ac.uk To lodge a complaint on the handling of your personal data, contact the Data Protection Officer who will investigate the matter: Newcastle University's Data Protection Officer Maureen Wilkinson (rec-man@ncl.ac.uk) If their response is unsatisfactory, you can lodge a complaint with the Information Commissioner's Office (ICO): https://cc.org.uk/

Thank you for your interest in taking part in this study.

Appendix C Phase One Pilot Study Consent Form

Before you take part in the study please complete this short Consent Form. Please complete this Consent Form after you have read the Participant Information Sheet on the previous page. You can download a copy of this Consent Form here.

Please read the following statements and select the relevant response at the bottom of this page.

Consent Form for the Online Survey
Title of Study: A Study of Concentration Difficulties in Everyday Life

Please read the following statements and select the relevant response at the bottom of this page.

1. I confirm that I have read the online Participant Information Sheet for the above Study. I have had the opportunity to consider the information provided and have received the researcher contact details to ask further questions if needed prior to taking part in the Study.
2. I understand that my participation in the Study is voluntary, and I can withdraw my completed survey data from the Study anytime up until the two weeks after completing the survey without providing any reason. I understand that if I decide to withdraw my data after the two-week period, it will not be possible for my completed survey data to be omitted from the Study's data analysis and reported study findings.
3. I understand I will be asked to provide a four-digit code (e.g. the last four digits of my telephone number) to enable the identification of my completed survey if I decide to withdraw my completed survey from the Study within the two-week period.
4. If I choose to provide my email address, I understand that Newcastle University will retain the email address I provide in line with the University's information governance polices and GDPR (General Data Protection Regulation) and that this will be stored separately from my completed survey data.

5. I understand that at the end of the survey I will be asked if I wish to be contacted about future studies. This places me under no obligation.

6. I give consent for my data to be used for the purposes of this research study, as described in the Participant Information Sheet.

7. I give permission for my data from this study to be shared with other researchers provided that my anonymity (I cannot be identified) is completely protected.

8. I understand that my anonymized research data will be reported as part of the researchers' dissertations and theses and may be published in peer reviewed journals.

Appendix D Phase One Pilot Study Debrief Form

Thank you for taking part in this survey
Please take some time to read through the participant debrief information

Who are we?

Pam Boullin and Georgia Mooney are Trainee Clinical Psychology Doctorate Students at Newcastle University School of Psychology.

Caitlin Kittridge and Maeve Thompson are Undergraduate Students at Newcastle University School of Psychology.

Professor Mark Freeston is the research supervisor for this research study.

Thank you for taking part in this study. We are very interested in talking to people who experience concentration difficulties. If you would be interested in us contacting you to discuss your experiences of concentration in everyday life, please submit your email address so that we can invite you to an online focus group.

What was the purpose of this study?

Concentration difficulties have been associated with brain fog, daydreaming, slow behaviour, and problems in thinking, a group of difficulties that have been labelled Cognitive Disengagement Syndrome (CDS). Historically, research focussed on CDS in relation to Attention Deficit Hyperactivity Disorder (ADHD), specifically ADHD-inattention. However, recent research suggests that these concentration difficulties are now separate to ADHD with their own group of related difficulties, but they sometimes occur together.

Adults with CDS seem to have more memory, attention, and planning problems in daily life than children with CDS symptoms (Barkley et al., 2022). A recent study by (Wood 2017) found an association between CDS and difficulties managing emotions, organising and problem-solving, as opposed to difficulties with time management and motivation which were associated with ADHD-IN. We are interested in learning more about the relationship between CDS and daily functioning in adult populations.

Recent studies link poor sleep and increased CDS symptoms, but they focus predominantly on children, young people, and students (Frederick et al., 2022) hence

our interest in adults in this study. The fatigue and mental slowness that characterise CDS may also be symptoms of poor sleep, leading to daytime sleepiness (Wood et al., 2020). Currently, research suggests that CDS leads to poor sleep, but it is also possible that CDS is due to poor sleep which we wish to investigate further.

CDS also appears to be linked to people withdrawing socially or avoiding social contact. Social withdrawal and associated lack of social support are also related to low socio-emotional wellbeing. It could be that the organisational demands and uncertainty in social situations are difficult for people with more CDS difficulties, but there is little research in this area. We want to understand more about why those with CDS are more likely to be socially withdrawn.

Finally, some research, again mainly among children, has found a relationship between CDS and anxiety. When considering what may underpin this relationship, the way people manage uncertainty has been suggested: people who process the world differently because of concentration difficulties may also experience it as a less certain place. Relatively little is known about the differences and overlaps of CDS with other forms of neurodiversity, meaning more research is needed to establish the unique characteristics of CDS, and how they relate to how people manage uncertainty and anxiety.

This area of research may benefit people reporting concentration difficulties in the longer-term. Firstly, increasing the of availability of improved sleep interventions may improve daytime tiredness for people reporting poor concentration and problems with daily function. Secondly, it may contribute to helpful strategies to help people meet their social goals. Finally, it may provide further insight into how concentration difficulties may influence the way people react to uncertainty and lead to better coping strategies.

Right to withdraw

You can withdraw your data from the study any time until two weeks from when you have completed the questionnaire. The survey will ask for the last four digits of your telephone number, to determine which survey is yours if you change your mind and wish to withdraw your data from the study. If you decide to withdraw your data from the study within the above-mentioned two-week timeframe, please email outlined researchers. Your data will be kept anonymous, to protect your safety and privacy. This information will not allow anyone to identify you personally but will enable the researchers to ensure your survey information is not included in the data analysis and

any written reports. If you choose to withdraw your data from the study, all your data will be destroyed and not included in the analysis or publication for this study. If you request to withdraw your data after the cut-off date outlined above, your data may have already been used for analysis and publication, but all your data will be destroyed and will not be included in any data analysed for publication.

Research conduct & ethics

This study was approved by the Faculty of Medical Sciences Research Ethics Committee, part of Newcastle University's Research Ethics Committee. This committee contains members who are internal to the faculty. This study was reviewed by members of the committee, who must provide impartial advice and avoid significant conflicts of interests.
If you wish to ask a question, withdraw your data, or if you have any other concern, please contact the researchers via email below.
The Chair of the Faculty of Medical Sciences Ethics Committee is a final point of contact for any unresolved issues relating to this project: fmsethics@newcastle.ac.uk

Contact details

If you have any other questions about this research, please contact the researchers at emails provided below:

Pam Boullin, Trainee Clinical Psychologist: p.boullin2@newcastle.ac.uk
Georgia Mooney, Trainee Clinical Psychologist: g.mooney2@newcastle.ac.uk
Caitlin Kittridge, Undergraduate Psychology Student: c.r.kittridge1@newcastle.ac.uk
Maeve Thompson, Undergraduate Psychology Student: m.c.e.thompson2@newcastle.ac.uk

If you wish to directly contact the research supervisor, please contact Mark Freeston by email: mark.freeston@newcastle.ac.uk

Who can I talk to for support?

I need urgent help and support for my mental health right now.

Mental health emergencies are serious, and it is important to seek support immediately.

You can contact emergency services, including the Police and Ambulance Service, who can be reached by dialling 999 (UK-only). You can also attend your local A&E department in hospital.

If you are a student at Newcastle University and require urgent support on a university campus, you can contact university security on 0191 208 6817, 24 hours a day, 7 days a week.

Local mental health crisis team. If you do not have their number and live in England, you can find it using this NHS website https://www.nhs.uk/service-search/mental-health/find-an-urgent-mental-health-helpline

If you feel distressed and need to talk to someone right now you can contact Samaritans on 116 123. Samaritans is open 24-hours a day 365 days a year and provides a free, confidential service where you can talk to someone about how you are feeling.

Text SHOUT to 85258 (UK-wide) is open 24-hours a day and is a text service that provides support if you need immediate help.

Contact your nearest medical facility to make an appointment with a doctor. You can ask for an emergency appointment (only available during working hours, if you contact them on evenings or weekends, they may not be available).

More extensive list of downloadable resources are available here: Support organisations sheet

Appendix E Support Information Sheet

A Study of Concentration Difficulties in Everyday Life

School of Psychology
Newcastle University
mark.freeston@newcastle.ac.uk

Support Organisations Sheet
If you would like to receive support for mental health and well-being
Make an appointment with your doctor to discuss your concerns. You can ask for an emergency appointment (which is available only during working hours, if you contact them on evenings or weekends, they may not be available).
The Mind website contains information about different mental health problems and information about different types of support for mental health.
https://www.mind.org.uk/
Rethink Mental Illness website contains information about different mental health problems and information about local support groups you may be able to access.
https://www.rethink.org/
The NHS website provides information regarding self-help guides, tools and activities that can improve one's mental health and well-being:
https://www.nhs.uk/mentalhealth/self-help/guides-tools-and-activities/
The World Health Organisation (WHO) provides information regarding several mental health conditions and well-being: https://www.who.int/news-room/factsheets/detail/mental-disorders
If you are a student at Newcastle University and have concerns about your wellbeing that are non-urgent you can contact the Student Health and Wellbeing Service on 0191 208 3333. Newcastle University offers a variety of support services to students. To find out about what support is available you can visit this website:
https://www.ncl.ac.uk/wellbeing/
If you would like more information about anxiety, then you may find the following websites helpful:
https://www.nhs.uk/mental-health/conditions/generalised-anxiety-disorder/overview/
https://www.mind.org.uk/information-support/types-of-mental-health-problems/anxietyand-panic-attacks/about-anxiety/
Anxiety UK is a charity that offers advice and information about anxiety and coping with anxiety https://www.anxietyuk.org.uk/
If you think that you are struggling to cope with anxiety, worry and/or panic attacks, then you can make an appointment with your doctor to discuss your concerns further.
If you live in England, you can also self-refer to an NHS psychological therapies service. This website will help you find your local service. Find an NHS talking therapies services -
NHS (www.nhs.uk)
If you would like support for sleep quality and sleep behaviour, you may find these websites helpful:
https://www.nhs.uk/every-mind-matters/mental-health-issues/sleep/
Fall asleep faster and sleep better - Every Mind Matters - NHS (www.nhs.uk)

If you would like to have more information regarding worry and generalized anxiety disorder or related problems, you may find these websites helpful:
Overview - Generalised anxiety disorder in adults - NHS (www.nhs.uk)
Generalised Anxiety Disorder - Anxiety UK
What are anxiety disorders? - Mind
If you think that you are struggling to cope with anxiety, worry and/or panic attacks, then you can make an appointment with your doctor to discuss your concerns further.
If you live in England, you can also self-refer to an NHS psychological therapies service. This website will help you find your local service. Find an NHS talking therapies services - NHS (www.nhs.uk)
If you would like to have more information regarding social anxiety, you may find these websites helpful:
Social anxiety (social phobia) - NHS (www.nhs.uk)
Social Phobia/Social Anxiety - Anxiety UK
Social Anxiety Alliance UK
If you think that you are struggling to cope with social anxiety, then you can make an appointment with your doctor to discuss your concerns further.
If you live in England, you can also self-refer to an NHS psychological therapies service. This website will help you find your local service. Find an NHS talking therapies services - NHS (www.nhs.uk)
If you would like to have more information regarding stress or related health issues, you may find these websites helpful:
Get help with stress - NHS (www.nhs.uk)
Stress | Mental Health Foundation
What is stress? - Mind
https://www.who.int/publications/i/item/9789240003927
If you think that you are struggling to cope with stress, then you can make an appointment with your doctor to discuss your concerns further.
If you live in England, you can also self-refer to an NHS psychological therapies service. This website will help you find your local service. Find an NHS talking therapies services - NHS (www.nhs.uk)
If you would like to have more information regarding depression and mood related symptoms, you may find these websites helpful:
Depressive disorder (depression) (who.int)
Overview - Depression in adults - NHS (www.nhs.uk)
Depression | NHS inform
Mood Disorders - Oxford Health NHS Foundation Trust
If you think that you are struggling to cope with mood difficulties, then you can make an appointment with your doctor to discuss your concerns further.
If you live in England, you can also self-refer to an NHS psychological therapies service. This website will help you find your local service. Find an NHS talking therapies services - NHS (www.nhs.uk)
If you would like to have more information regarding visual processing difficulties like Meares-Irlen Syndrome, you may find these web page helpful:

Visual_stress_SLD.pdf (ruh.nhs.uk)
https://irlen.com/what-is-irlen-syndrome/
https://irlen.com/the-irlen-method/
If you would like to locate a Irlen Testing Center, the following web page would be helpful:
https://irlen.com/find-an-irlen-test-center/
If you would like support for ADHD,
The following websites contain more information about what ADHD is and where you can find support.
https://aadduk.org/help-support/support-groups/
https://www.nhs.uk/conditions/attention-deficit-hyperactivity-disorder-adhd/living-with/
https://www.mind.org.uk/information-support/tips-for-everyday-living/adhd-and-mentalhealth/
WHO Resources: WHO - ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD)

Appendix F Phase One Pilot Invitation to Participate in a Focus Group

At the end of the pilot survey, participants were asked to leave an email address if they were interested in participating in a focus group to discuss everyday functioning and concentration difficulties. The aim of the focus group was to interview participants about experience of daily function and concentration issues. The themes generated from this focus group were intended to inform selection of the cognitive task for phase three. The scores for the ACI 1-16 from the pilot study were totalled and in accordance with S. Becker (personal communication to M Freeston, October 5, 2018), a score of ≥ 24 signified a cut off for concentration difficulties (based on nine to ten of the 16 symptoms reaching a T score of >70) Thirteen participants who scored highly in the ACI (≥ 24) and who had left an email address to say they were happy to be contacted about a focus group were contacted by email in early September 2024. Initially two people responded and said they would like to take part but after the initial interest, one did not respond to the follow up email. The other interested participant was recovering from illness and decided that the time was not appropriate to participate. The other 11 were contacted again at the end of September but no potential attendees responded. Some of the potential participants could have been final year students who potentially may no longer have accessed University email addresses.

Appendix G Pilot demographic data

Table G1
Participants' Demographics

		N=452	%
Gender			
	Female	351	77.7
	Male	93	20.6
	Gender fluid	1	.2
	Genderqueer	1	.2
	Nonbinary	4	0.9
	Self-describe	1	0.4
	Female at birth	356	78.8
	Male at birth	95	21
	Prefer not to say	1	0.2
Ethnicity			
	Asian British	23	5.1
	Black British African/Caribbean/ British	3	0.7
	Mixed (multiple ethnic)	9	2.1
	White British	395	87.4
	Other ethnic group	22	4.9
Sexual Orientation			
	Asexual	8	1.8
	Bisexual	51	11.3
	Fluid	1	0.2
	Gay man	7	1.5
	Gay woman	12	2.7
	Heterosexual	358	79.2
	Pansexual	7	1.5
	Unsure	4	0.9
	Prefer not to say	7	1.5
	Self-describe	3	0.7
Religion	Christian	153	33.8
	Hindu	6	1.3
	Jewish	3	0.7
	Muslim	9	2
	Sikh	2	0.4
	No religion	256	56.6
	Prefer not to say	12	2.7
	Self-describe	10	2.2
	No response	1	0.2
Highest education level	Secondary School	16	3.5
	College A-levels/BTEC	252	55.8
	Undergraduate degree	115	25.4
	Postgraduate degree	49	10.8
	PhD	11	2.4
	Prefer not to say	2	0.4
	Other	1	1.5

Employment status			
	Employed	181	40
	Self -employed	17	3.8
	Unemployed	12	2.7
	Student	220	48.7
	Full time parent/carer	3	0.7
	Retired	14	3.1
	Prefer not to say	2	0.4
	Self-Describe	3	0.7
Place of residence			
	Asia	5	1.1
	Australia	3	0.7
	Caribbean	1	0.2
	North/Central America	4	0.9
	UK	376	83.2
	Other	14	3.1
	Europe	49	10.8
English first language			
	Yes	427	94.5
	No	24	5.3
	Prefer not to say	1	0.2
	Educated in English		
	Yes	20	4.4
	No	4	0.9
	English proficiency test		
	Yes	5	0.11
	No		

Table G2

Participants' Disability Demographics

	N=452	
Disability or access needs	n	%
Disability access needs	53	11.7
ADHD diagnosed	15	3.3
ADHD awaiting diagnosis	5	1.1
ADHD undiagnosed	5	1.1
Autism diagnosed	7	1.5
Autism awaiting diagnosis	4	0.9
Autism undiagnosed	2	0.5
Cerebral Palsy undiagnosed	1	0.2
Dyscalculia diagnosed	1	0.2
Dysgraphia diagnosed	1	0.2
Dyslexia diagnosed	16	3.5
Dyslexia awaiting diagnosis	2	0.4
Dyspraxia diagnosed	1	0.2
Dyspraxia awaiting diagnosis	1	0.2
Dyspraxia undiagnosed	1	0.2
Epilepsy diagnosed	1	0.2
Hearing impairment diagnosed	3	0.7
Learning disability/difficulty diagnosed	8	1.8
Learning disability awaiting diagnosis	1	0.2
Physical disability diagnosed	10	2.2
Physical disability awaiting diagnosis	1	0.2
Sensory processing disorder diagnosed	2	0.4
Sensory processing disorder awaiting diagnosis	1	0.2
Sensory processing disorder undiagnosed	2	0.4
Visual Impairment disorder diagnosed	2	0.4
Other disability or access needs	10	2.1

Table G3

Participants' Mental Health Demographics

	N=452	
	n	**%**
Mental Health Disorder		
Anxiety	82	18
Bipolar	9	2
Depression	69	15.3
Eating disorder	20	4.4
Hoarding	5	1.1
OCD	20	4.4
Panic disorder	10	2.2
Personality disorder	10	2.2
Phobia	11	2.4
PTSD	17	4

Appendix H Pilot results

In total, 490 participants clicked on the survey link in Qualtrics. Two possible fraudulent cases were detected, *N* = 21 did not consent to the study, *N*= 14 consented but did not proceed, one participant began the first measure but only completed one item. Overall, 452 participants left social demographic data. Thirteen consented and completed demographic information but did not proceed to questionnaires. Overall, 439 participants' data were available for analysis. Age ranged between 18 and 79 (*M* = 30.68, *sd* = 15.25) and 78.1 % identified as female.

Pilot data were screened for outliers through boxplots and stem and leaf plots generated to observe each pilot variable (Field, 2018). No extreme outliers were detected and inspection of Q-Q plots and histograms suggested that the few fringeliers detected were approximately normally distributed. The fringeliers were therefore not winsorised. Skewness ranged from 0.31 to.90 and kurtosis ranged from -.97 to .20. These distributions confirmed there were no considerable deviations from normality (Kline, 2023) (see Table H1 for table of descriptives) Note, due to changing the PSQI for the main study, this measure was not included in pilot analyses.

Pearson correlation coefficients were calculated using pairwise deletion to retain maximum data. According to Cohen's (1988) conventions, a correlation between *r* = 0.00 and 0.19 suggests a very weak or no correlation. *r* = 0.20 to 0.39 suggests a small to moderate correlation. and *r* = 0 .4 to 0.59 suggests a moderate correlation and *r* = 0.60 to 0.79 suggests a strong correlation, 0.80 to 1 suggesting a very strong correlation (Field, 2018). The aim was to establish the relationships between the variables in the measures, and to detect any unanticipated patterns. Significant strong positive correlations were found between concentration difficulties and ADHD severity *r* = 0.69, p < .001, EF

difficulties $r = 0.73$, $p < .001$, executive function and ADHD $r = 0.79$, $p < 0.001$, anxiety and worry 0.78, $p < .001$ Mainly significant but small to moderate correlations were found between daytime sleepiness and other variables between $r = 0.26$ and $r = 0.42$, $p < .001$ Overall, the results suggest a pattern of small to strong associations, supporting good convergent validity among the measures.

References

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). Sage Publications.

Pilot Results Tables

Table H1

Descriptive Statistics for Pilot Measures

Measure	*N*	Items	Alpha	Range	M	SD	Skewness	Std. Error	Kurtosis	Std. Error
ACI	437	16	0.93	48	19.05	9.88	0.52	0.117	-0.14	0.23
ASRS	421	18	0.92	72	50.35	13.05	0.38	0.119	0.03	0.24
ADEXI	419	14	0.91	55	37.13	10.63	0.31	0.119	-0.01	0.24
ESS	437	8	0.82	22	6.97	4.39	0.60	0.117	0.08	0.23
PHQ-2	422	2	0.84	6	1.70	1.61	0.90	0.119	0.20	0.24
GAD-2	421	2	0.89	6	2.08	1.83	0.69	0.119	-0.44	0.24
PSWQ-3	422	3	0.93	12	8.24	3.68	0.33	0.119	-0.97	0.24

Table H2

Correlations Between Measures (ACI, ASRS, ADEXI, ESS, PHQ-2 GAD-2, PSQW-3)

	1.	2.	3.	4.	5.	6.	7.
1. Concentration	-						
2. ADHD	0.69**	-					
3. Executive function	0.73**	0.79**	-				
4. Daytime sleepiness	0.42**	0.40**	0.39**	-			
5. Depression	0.59*	.043**	0.44**	0.34**	-		
6. Anxiety	0.59**	0.47**	0.45**	0.33**	0.67	-	
7. Worry	0.54**	0.45**	0.44**	0.26**	0.51**	0.78**	-

*Note All correlations are significant at **p < .001** (2-tailed).*
n ranged from 414 to 437 due to missing data

Appendix I Phase two main study information sheet

Participant Information Sheet
Title of the study: A Study of Concentration Difficulties in Everyday Life

Thank you for your interest in taking part in this study. Participation is open to anyone aged 18 or over, regardless of whether you experience concentration difficulties. We invite you to read this Participation Information Sheet before making an informed decision about participating in this research. If anything is unclear and/or you require further information, please do not hesitate to contact the research team.

Who are we?
Pam Boullin and Georgia Mooney (Trainee Clinical Psychologists at Newcastle University, employed by Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust) are carrying out this research.
Professor Mark Freeston, Newcastle University, is supervising this project.

What is the purpose of this study?
The purpose of this study is to improve our understanding of concentration difficulties and how they affect people in their everyday lives. More specifically, the study is examining the relationship between concentration difficulties, sleep difficulties and aspects of daily functioning, including socializing and loneliness in adults. Some people experience concentration difficulties accompanied by brain fog, daydreaming, mental disengagement, and slow movement. It is possible that people experiencing these difficulties may find the world more difficult to process, and experience more uncertainty, which can be unpleasant and attention demanding. We therefore aim to further our understanding of concentration difficulties, uncertainty and anxiety. Since socializing can be demanding, concentration may also affect how much people seek out contact with others or socialize. This may impact their experiences of loneliness. Furthermore, research suggests that poor sleep can worsen concentration difficulties worse and that concentration difficulties can lead to poor sleep, so we aim to better understand the relationship between concentration difficulties and poor sleep.

What does taking part involve?
After reading this information sheet, you will be asked to complete a consent form to confirm you are eligible to participate in this research and to confirm that you consent to taking part. Participation involves the completion of an online survey. This survey may take up to 30 minutes to complete.

Do I have to take part?
You are not obliged to take part in this study. Your involvement is entirely voluntary. You have the right to refuse participation and to withdraw from the research at any point during completion and up to two weeks after completion. We will ask you to create a 4-digit code at the start of the questionnaire to allow the researchers to withdraw your data. The questionnaire data up until the point of withdrawal will still be included unless you contact the researchers and request for your data to be removed from the report. If you wish to withdraw, you are requested to contact the researcher within two

weeks of completion or partial completion of the survey and inform the researchers of your unique code created at the beginning of the survey.

Can anyone take part?
Provided you are aged 18 or over, you can take part in this study. You do not have to have a mental health problem or have noticed any concentration difficulties.

What are the benefits and risks of taking part in this study?
We hope that this research will benefit people experiencing concentration difficulties in the longer-term. Firstly, it may contribute towards increasing the availability of helpful sleep interventions which reduce daytime tiredness for people reporting poor concentration and problems with daily functioning. Secondly, it may lead to adapted strategies to help people meet their social goals. Finally, it may provide further insight into how concentration difficulties may influence the way people react to uncertainty and anxiety/worry.

If you are a student studying Psychology at Newcastle University, you can also receive university credits for taking part, as part of Newcastle University's Research Participation Scheme. If you are a psychology student, you will need to register for the Study on the system to receive University Credits for your participation.

We will make a donation to Mind, a charity supporting people with mental health difficulties, on behalf of all participants.

Some of the questions you will be asked may make you feel uncomfortable. If you feel you need to access further support after completing the survey, a list of support organisations throughout the survey can be found at the bottom of each page. You will be able to download this page.

What information will be collected and who will have access to the information collected?
You will be asked to answer questions about difficulties with concentration and attention, your sleep habits, potential sleepiness during the day, experiences of daily life including socializing, loneliness, your mood, worry and anxiety. You will be asked to provide some information about your sociodemographic factors, for example your age and gender. The questionnaires do not ask you to give your name. If you wish to receive a report on the study on its completion, you will be asked to provide an email.

The information collected will be anonymized and stored securely. Data collected during the online survey will be stored by Qualtrics, a secure online survey software platform, and the researchers will export it and store it securely in password protected files on Newcastle University's servers. Only the research team will be able to see your individual responses.

Will my information be private and what will happen to it?
All the data we collect will be kept strictly confidential and in accordance with the General Data Protection Regulation (GDPR). The research team will only have access to

information which you choose to provide for research purposes. We will store your information with a unique identifier code.

Newcastle University are leading and managing this study and acting as the data processor and sponsor and are responsible for looking after your information and using it properly. Newcastle University will keep any identifiable data you provide for 6 months after completion of the study. All precautions will be taken by all those involved to ensure your confidentiality. After this time, all identifiable information relating to your data will be securely erased (in this case your e-mail should you choose to provide it). We will ask for your consent to use your completely anonymised data within a larger data set which may be accessed by other researchers at Newcastle University and in other organisations, such as other universities, or NHS organisations. Your anonymised data will only be used by organisations and researchers to conduct research.

You will be asked if you would like to provide your email address only if you choose to receive a report on the study findings. This will be around September 2025, the anticipated time of project completion. Your email address will be stored separately from your research data to maintain anonymity.

How will my information be used?
Newcastle University will be using information from you to undertake the study and will act as the data controller for this study. This means that Newcastle University is responsible for looking after your information and using it properly. When we use personally identifiable information from people who have agreed to take part in research, we ensure that it is in the public interest. After the two-week period, your rights to access, change or move your information are limited, as Newcastle University needs to manage your information in specific ways in order for the research to be reliable and accurate.

To safeguard your rights, the minimum personally identifiable information will be used (your email, if you choose to provide it). You can find out more about how Newcastle University uses your information at: https: www.ncl.ac.uk/data-protection/data-protection-policy/ or by contacting Newcastle University's Data Protection Officer (Maureen Wilkinson, rec-man@ncl.ac.uk).

What happens to the study results?
The researchers will write up the results in a report and submit it to Newcastle University. The report will be finalised approximately six months after the end of the study. To receive a copy, please tick the box declaring interest in receiving the report when you complete the questionnaires. We aim to submit the research findings to academic journals for publication and share with varied audiences.

Has this study received ethical approval?
Yes, the study has been reviewed and approved by Newcastle University's Faculty of Medical Science Research Ethics Committee.

Who is the contact for questions about this research study?

Principal Investigator - Pam Boullin: p.boullin2@newcastle.ac.uk
Principal Investigator - Georgia Mooney: g.mooney2@newcastle.ac.uk
Research Supervisor - Mark Freeston: mark.freeston@newcastle.ac.uk

Who should I contact to lodge a complaint?
Professor Mark Freeston, Newcastle University: mark.freeston@newcastle.ac.uk
The Chair of the Faculty of Medical Sciences Ethics Committee is a final point of contact for any unresolved issues relating to this project: fmsethics@newcastle.ac.uk
To lodge a complaint on the handling of your personal data, contact the Data Protection Officer who will investigate the matter - Maureen Wilkinson: rec-man@ncl.ac.uk
If their response is unsatisfactory, you can lodge a complaint with the Information Commissioner's Office (ICO): https://ico.org.uk/

If you wish to download this information please click here

Appendix J Phase Two Main Study Consent Form

Consent Form: A Study of Concentration Difficulties in Everyday Life

Before you take part in the study, please read the following statements and select the relevant response at the bottom of this page.

1. I confirm that I have read the online Participant Information Sheet for the above Study. I have had the opportunity to consider the information provided and have received the researcher contact details to ask further questions if needed prior to taking part in the Study.
2. I understand that my participation in the Study is voluntary, and I can withdraw my completed survey data from the Study anytime up until two weeks after completing the survey without providing any reason. I understand that if I decide to withdraw my data after the two-week period, it will not be possible for my completed survey data to be omitted from the Study's data analysis and reported study findings.
3. I understand I will be asked to provide a four-digit code (e.g. the last four digits of my telephone number) to enable the identification of my completed survey if I decide to withdraw my completed survey from the Study within the two-week period.
4. If I choose to provide my email address, I understand that Newcastle University will retain the email address I provide in line with the University's information governance polices and GDPR (General Data Protection Regulation) and that this will be stored separately from my completed survey data.
5. I understand that at the end of the survey I will be asked if I wish to be contacted about future studies. This places me under no obligation.
6. I give consent for my data to be used for the purposes of this research study, as described in the Participant Information Sheet.
7. I give permission for my data from this study to be shared with other researchers provided that my anonymity (I cannot be identified) is completely protected.
8. I understand that my anonymized research data will be reported as part of the researchers' dissertations and theses and may be published in peer reviewed journals.

Appendix K Phase Two Main Study Debrief Form

Thank you for taking part in this survey
Please take some time to read through the participant debrief information

Who are we?
Pam Boullin and Georgia Mooney are Trainee Clinical Psychology Doctorate Students at Newcastle University School of Psychology.

Professor Mark Freeston is the research supervisor for this research study.

What was the purpose of this study?
Cognitive Disengagement Syndrome (CDS) is characterised by a group of symptoms including concentration difficulties, brain fog, daydreaming, slow behaviour, and problems in thinking. Historically, these symptoms were investigated in relation to attention deficit hyperactivity disorder (ADHD), specifically the inattentive subtype (ADHD-I). However, recent research suggests that these concentration difficulties are distinct from ADHD with their own group of related difficulties, but they sometimes occur together.

Adults with CDS seem to have more memory, attention, and planning problems in daily life than children with CDS symptoms (Barkley et al., 2022). We are interested in learning more about the relationship between CDS and daily functioning in adult populations.

Recent studies link poor sleep and increased CDS symptoms, but they focus predominantly on children, young people, and students (Frederick et al., 2022) hence our interest in adults in this study. The fatigue and mental slowness that characterise CDS may also be symptoms of poor sleep, leading to daytime sleepiness (Wood et al., 2020). Currently, research suggests that CDS leads to poor sleep, but it is also possible that CDS is due to poor sleep which we wish to investigate further.

CDS also appears to be linked to people withdrawing socially or avoiding social contact and experiencing increased levels of loneliness. It could be that the organisational demands and uncertainty in social situations are difficult for people with more CDS difficulties, but there is little research in this area. We want to understand more about why those with CDS are more likely to be socially withdrawn.

Finally, some research, again mainly among children, has found a relationship between CDS and anxiety. When considering what may underpin this relationship, the way people manage uncertainty has been suggested: people who process the world differently because of concentration difficulties may also experience it as a less certain place. Relatively little is known about the differences and overlaps of CDS with other forms of neurodiversity, meaning more research is needed to establish the unique

characteristics of CDS, and how they relate to how people manage uncertainty and anxiety.

This area of research may benefit people reporting concentration difficulties in the longer-term. Firstly, increasing the of availability of improved sleep interventions may improve daytime tiredness for people reporting poor concentration and problems with daily function. Secondly, it may contribute to helpful strategies to help people meet their social goals. Finally, it may provide further insight into how concentration difficulties may influence the way people react to uncertainty and lead to better coping strategies.

Right to withdraw
You can withdraw your data from the study any time until two weeks from when you have completed the questionnaire. The survey asked you to create a 4-digit code at the start of the questionnaire to allow the researchers to determine and withdraw your data. If you decide to withdraw your data from the study within the above-mentioned two-week timeframe, please email researchers. Your data will be kept anonymous, to protect your safety and privacy. This information will not allow anyone to identify you personally but will enable the researchers to ensure your survey information is not included in the data analysis and any written reports. If you choose to withdraw your data from the study, all your data will be destroyed and not included in the analysis or publication for this study. If you request to withdraw your data after the cut-off date outlined above, your data may have already been used for analysis and publication, but all your data will be destroyed and will not be included in any data analysed for publication.

Research conduct & ethics
This study was approved by the Faculty of Medical Sciences Research Ethics Committee, part of Newcastle University's Research Ethics Committee. This committee contains members who are internal to the faculty. This study was reviewed by members of the committee, who must provide impartial advice and avoid significant conflicts of interests.
If you wish to ask a question, withdraw your data, or if you have any other concern, please contact the researchers via email below.
The Chair of the Faculty of Medical Sciences Ethics Committee is a final point of contact for any unresolved issues relating to this project: fmsethics@newcastle.ac.uk

Contact details

Principal Investigator - Pam Boullin: p.boullin2@newcastle.ac.uk
Principal investigator - Georgia Mooney: g.mooney2@newcastle.ac.uk
Research Supervisor - Mark Freeston: mark.freeston@newcastle.ac.uk

Who can I talk to for support?
I need urgent help and support for my mental health right now.
Mental health emergencies are serious, and it is important to seek support immediately.

You can contact emergency services, including the Police and Ambulance Service, who can be reached by dialling 999 (UK-only). You can also attend your local A&E department in hospital.
If you are a student at Newcastle University and require urgent support on a university campus, you can contact university security on 0191 208 6817, 24 hours a day, 7 days a week.
Local mental health crisis team. If you do not have their number and live in England, you can find it using this NHS website https://www.nhs.uk/service-search/mental-health/find-an-urgent-mental-health-helpline
If you feel distressed and need to talk to someone right now you can contact Samaritans on 116 123. Samaritans is open 24-hours a day 365 days a year and provides a free, confidential service where you can talk to someone about how you are feeling.
Text SHOUT to 85258 (UK-wide) is open 24-hours a day and is a text service that provides support if you need immediate help.
Contact your nearest medical facility to make an appointment with a doctor. You can ask for an emergency appointment (only available during working hours, if you contact them on evenings or weekends, they may not be available).

A more extensive list of downloadable resources is available here

Appendix L Demographic Information for Main Study

Table L1

Participants' Demographic Information

		N= 512		N= 453	
Gender		n	%	n	%
	Female	419	81.8	379	83.7
	Male	74	14.5	61	13.5
	Gender fluid	3	0.6	2	.4
	Genderqueer	2	0.4	2	.4
	Unsure	1	0.2	1	.02
	Nonbinary	3	.7	3	.7
	Preferred not to say	2	0.4	1	.2
	Self-describe	2	0.4	1	.2
	Female at birth	433	84.6	389	85.9
	Male at birth	78	15.2	63	13.9
	Prefer not to say	1	0.2	1	.2
Ethnicity					
	Asian British	18	3.5	17	3.8
	Black British African/Caribbean/ British	4	0.8	3	.7
	Mixed (multiple ethnic)	10	2	8	1.8
	White British	451	88.1	402	88.7
	Other ethnic group	29	5.7	23	5.1
	Non white ethnic	61	12	51	11.3
Sexual Orientation					
	Asexual	16	3.1	15	3.3
	Bisexual	56	10.9	48	10.6
	Fluid	2	0.4	1	0.2
	Gay man	6	1.2	5	1.1
	Gay woman	18	3.5	15	3.3
	Heterosexual	382	74.6	340	75.1
	Pansexual	12	2.3	11	2.4
	Unsure	4	0.8	2	0.4
	Prefer not to say	19	3.7	17	3.8
	Self-describe	8	1.6	6	1.3
Religion	Buddhist	4	0.8	3	0.7
	Christian	171	33.4	149	32.9
	Hindu	4	0.8	3	0.7
	Jewish	3	0.6	3	0.7
	Muslim	7	1.4	6	1.3
	No religion	299	58.4	269	59.4
	Prefer not to say	13	2.5	12	2.6
	Self-describe	11	2.1	8	1.8
Highest education level	Secondary School	28	5.5	21	4.6

	College A-levels/BTEC	226	44.1	206	45.5
	Undergraduate degree	124	24.2	112	24.7
	Postgraduate degree	100	19.5	83	18.3
	PhD	17	3.3	16	3.5
	Prefer not to say	3	0.6	2	0.4
	Other	14	2.7	13	2.9
Employment status	Employed	216	42.2	181	40.0
	Self -employed	33	6.4	27	6.0
	Unemployed	19	3.7	16	3.5
	Student	165	32.2	157	34.7
	Full time parent/carer	3	0.6	3	0.7
	Retired	48	9.4	46	10.2
	Prefer not to say	3	0.6	2	0.4
	Self-Describe	25	4.9	21	4.6
Place of residence	Asia	3	0.6	3	.7
	Australia	1	0.2	1	.2
	Caribbean	1	0.2	1	.2
	North/Central America	7	1.4	4	.9
	UK	456	89.1	406	89.6
	Prefer not to say	1	0.2	1	.2
	Other	1	0.2	37	8.2
	Europe	42	8.2	3	0.7
English first language	Yes	482	94.1	429	94.7
	No	30	5.9	24	5.3
	Educated in English				
	Yes	21	4.1	18	4.0
	No	9	1.8	6	1.3
	English proficiency test				
	Yes	8	1.6	5	1.1
	No	1	0.2	1	0.2

Table L2 *Participants' Disability Demographics*

Disability or access needs	N=512 n	%	N=453 n	%	
Disability access needs	132	25.8	114	25.2	(9 not stated)
ADHD diagnosed	56	10.9	48	10.6	
ADHD awaiting diagnosis	17	3.3	15	3.3	
ADHD undiagnosed	16	3.1	14	3.1	
Autism diagnosed	45	8.8	39	8.6	
Autism awaiting diagnosis	12	2.3	9	2.0	
Autism undiagnosed	8	1.6	6	1.3	
Dyscalculia diagnosed	7	1.4	4	0.9	
Dyscalculia awaiting diagnosis	2	0.4	3	0.4	
Dyscalculia undiagnosed	3	0.6	3	0.7	
Dyslexia diagnosed	17	3.3	16	3.5	
Dyslexia awaiting diagnosis	1	0.2	1	0.2	
Dyslexia undiagnosed	7	1.4	5	1.1	
Dyspraxia diagnosed	6	1.2	5	1.1	
Dyspraxia awaiting diagnosis	2	0.4	2	0.4	
Dyspraxia undiagnosed	4	0.8	4	0.9	
Epilepsy diagnosed	2	0.4	2	0.4	
Epilepsy awaiting diagnosis	1	0.2	1	0.2	
Epilepsy undiagnosed	0	0	0	0	
Hearing impairment diagnosed	13	2.5	11	2.4	
Learning disability/difficulty diagnosed	8	1.6		1.5	
Learning disability undiagnosed	2	0.4	2	0.4	
Physical disability diagnosed	34	6.6	29	6.4	
Physical disability undiagnosed	2	0.4	0	0	
Sensory processing disorder diagnosed	5	1	4	0.9	
Sensory processing disorder awaiting diagnosis	4	0.8	4	0.9	
Sensory processing disorder undiagnosed	3	0.6	3	0.7	
Visual Impairment disorder diagnosed	4	0.8	3	0.7	
Visual Impairment disorder awaiting diagnosis	2	0.4	1	0.2	
Visual Impairment disorder undiagnosed	1	0.2	1	0.2	
Other disability or access needs	38	7.4	19	4.2	
CDS	1	0.2	1	0.2	

Table L3

Participants' Mental Health Demographics

	N=512		N=453	
Mental Health Disorder	n	%	n	%
Mental Health Disorder	171	33.4	147	32.5
Anxiety diagnosed	114	22.3	99	21.9
Anxiety awaiting diagnosis	3	0.6	3	0.7
Anxiety undiagnosed	20	3.9	17	3.8
Bipolar Disorder diagnosed	5	1	4	0.9
Bipolar Disorder awaiting diagnosis	2	0.4	2	0.4
Bipolar Disorder undiagnosed	1	0.2	0	0
Anorexia/Bulimia/ARFID diagnosed	22	4,3	19	4.2
Anorexia/Bulimia/ARFID awaiting diagnosis	1	0.2	1	0.2
Anorexia/Bulimia/ARFID undiagnosed	5	1	5	1.1
Hoarding disorder	3	0.6	3	0.7
Depression diagnosed	97	18.9	85	18.6
Depression awaiting diagnosis	1	0.2	1	0.2
Depression undiagnosed	11	2.1	8	1.8
OCD diagnosed	13	2.5	11	2.4
OCD awaiting diagnosis	4	0.8	3	0.7
OCD undiagnosed	13	2.5	12	2.6
Panic disorder diagnosed	8	1.6	8	1.8
Panic disorder awaiting diagnosis	1	0.2	1	0.2
Panic disorder undiagnosed	2	0.4	2	0.4
Personality disorder diagnosed	12	2.3	9	2
Phobia diagnosed	6	1.2	6	1.3
Phobia undiagnosed	4	0.8	4	0.9
PTSD diagnosed	21	4.1	21	4.6
PTSD awaiting diagnosis	3	0.6	2	0.4
PTSD undiagnosed	9	1.8	5	1.1
Other	26	3.5	17	3.3
(CDS)	1	0.2	1	0.2

Appendix M Phase Three Cognitive Task Email

Newcastle University Ethics Ref: 57102/2023
Dear Participant
Thank you for recently completing a survey answering various questionnaires on concentration and everyday functioning to provide data for the research of Pam Boullin and Georgia Mooney. At the end of the survey, you left your email address indicating that you would be interested in completing an online cognitive task as the final part of the study.

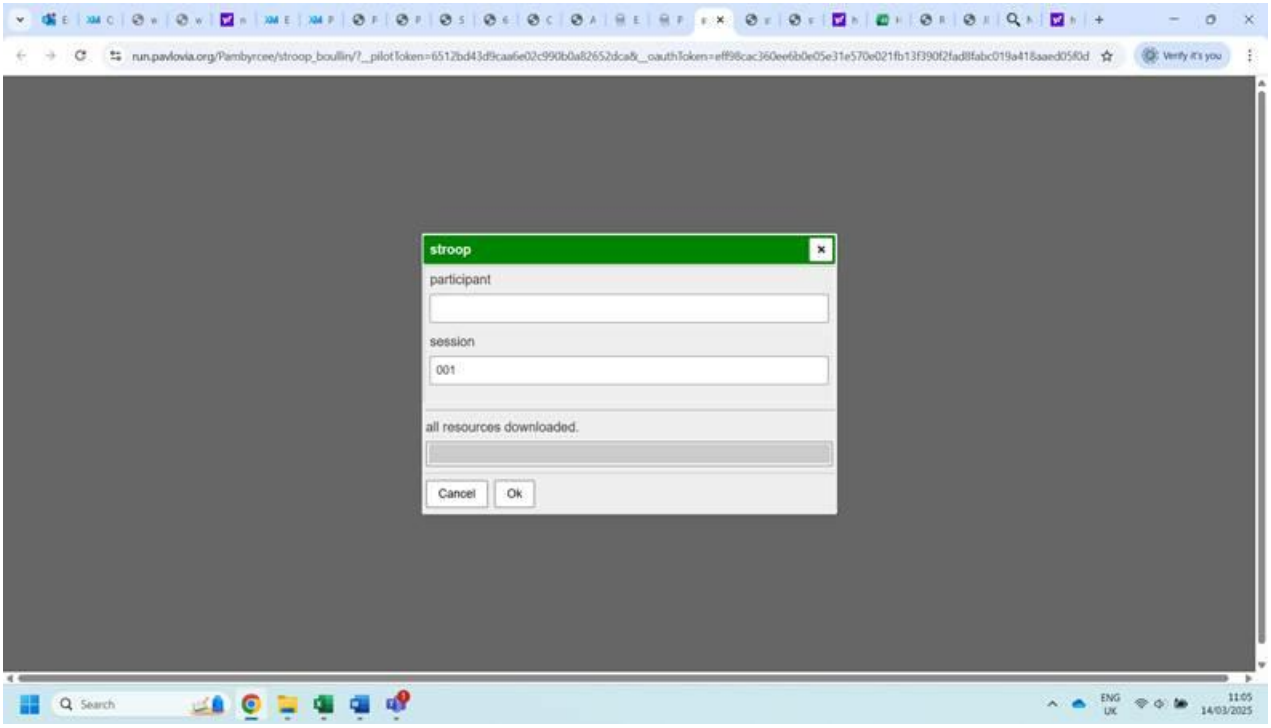
I am now inviting you to complete the short cognitive task for this research. After reading this email, please click on the link below to consent to the cognitive task. After reading the information sheet and consenting you be able to click onto a URL link at the end of the survey which will take you to the cognitive task. It shouldn't take longer than 5-10 minutes to complete**.**

Please read the following instructions carefully

You must first consent to the project by clicking on the link at the end of these instructions. The task must be done on a laptop so you may wish to click on the consent link on your laptop as you will be immediately directed to the cognitive task.

Make sure you are in a quiet space and have access to a computer/laptop as this test needs a full keyboard so CANNOT BE COMPLETED ON PHONE / TABLET

- Once you click on the link on your laptop /PC, you will see this dialogue box:



. Where you see *participant* please fill this box **with the four-digit pin number you used for the original survey** — you were asked to use the last four digits of your **mobile phone number** as an identification number when you completed the survey. Please

use this same number to allow us to link your original survey data with this cognitive task data. We cannot use your data without this number as we need to link it to the original survey data you kindly completed. WE CANNOT USE YOUR DATA UNLESS YOU USE THE SAME 4 DIGIT CODE IN THE PARTICIPANT BOX

- Once you input your unique identification number, click ok and you will begin a practice page where you will be given some instructions on how to complete the task. Please read the instructions carefully. You will then be given a practice test to complete before the main task. The instructions are repeated on the main task, so you don't have to remember which keys to press. Do not worry if you make a mistake, just continue until the end of the test. You are free to leave the task at any time by pressing the escape button. Please note that once you leave the task before it finishes, you will have to recommence.

. When the task is finished data will upload and you will see an “ok” sign

If you would like to participate, please click on the link below to consent. Once you have read the information sheet and consented you will be able to click on the link to the cognitive task at the end of the consent form
https://nclpsych.eu.qualtrics.com/jfe/form/SV_6VaqC03UdjM9DCe
Please find attached organisations for support and signposting and the information sheet regarding this project
Please contact me for any further information or queries
Thank you
Pam

Original email

Newcastle University Ethics Ref: 57102/2023

Dear Participant

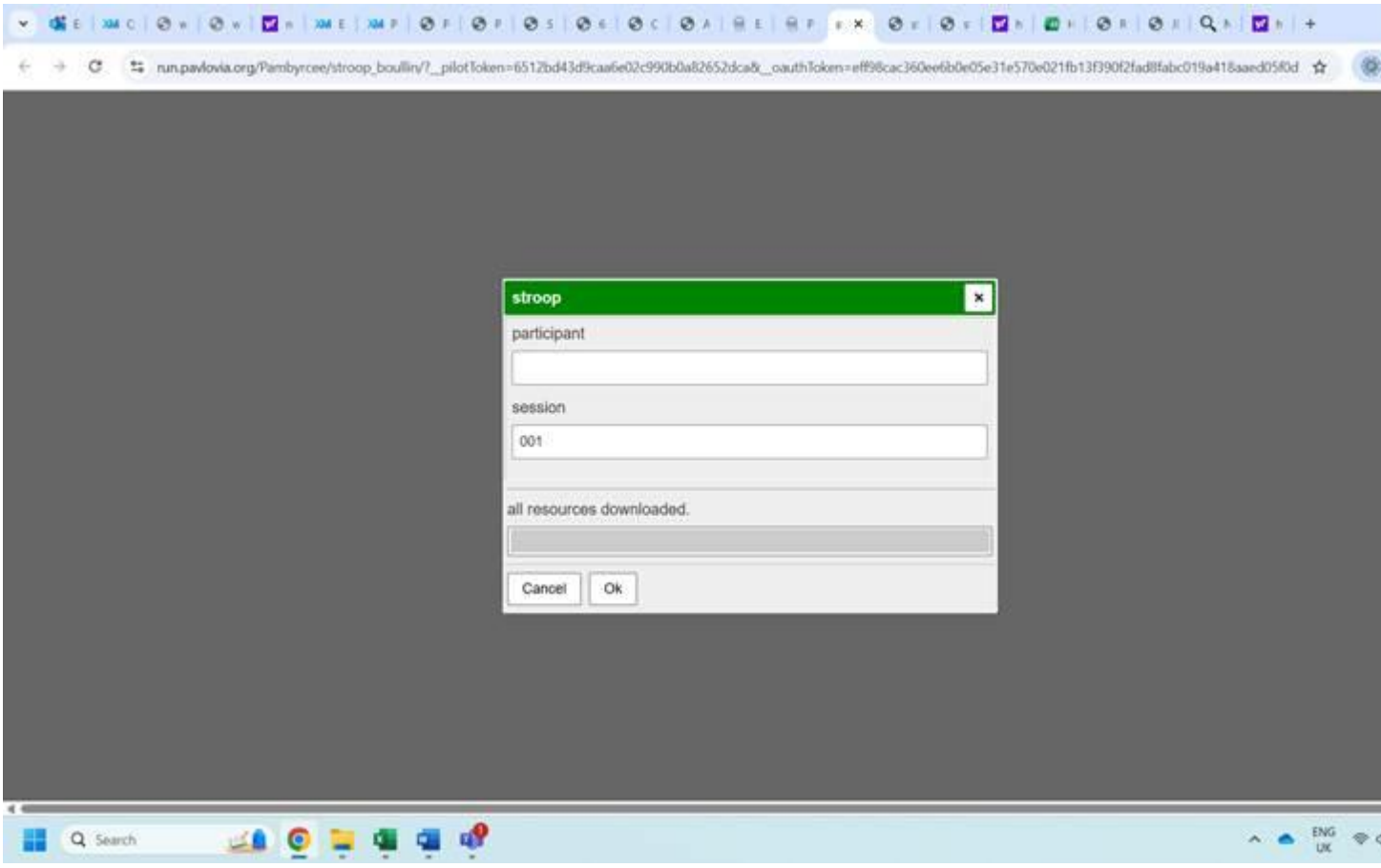
You recently completed a survey answering various questionnaires on concentration and everyday functioning to provide data for the research of Pam Boullin and Georgia Mooney. At the end of the survey, you kindly left your email address indicating that you would be interested in completing an online cognitive task as the final part of the study.

I am now inviting you to complete the short cognitive task for this research. After reading this email, please click on the link below to consent to the cognitive task in Qualtrics survey platform. After reading the information sheet and consenting you will be able to click onto a URL link at the end of the survey which will take you to the cognitive task. It shouldn't take longer than 5-10 minutes to complete**.**

Please read the following instructions carefully

Make sure you are in a quiet space and have access to a computer/laptop as this test needs a full keyboard so CANNOT BE COMPLETED ON PHONE / TABLET

· Once you click on the link on your laptop /PC, you will see this dialogue box:

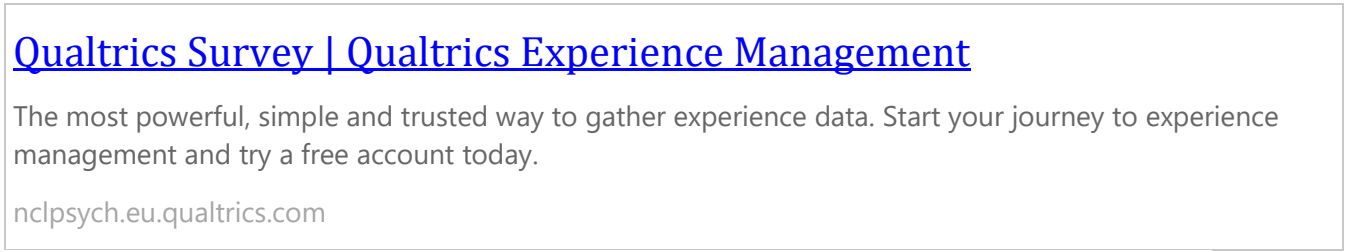


. Where you see *participant*, please fill this box **with the four-digit pin number you used for the original survey** — you were asked to use the last four digits of your mobile phone number as an identification number when you completed the survey. Please use this same number you used for the survey to allow us to link your original survey data

with this cognitive task data. You may have used a different number. It is important that you use the same 4 digits as you used in the survey. Any concerns about this do not hesitate to contact me.

- Once you input your 4-digit number, click ok and you will begin a practice page where you will be given some instructions on how to complete the task. Please read the instructions carefully. You will then be given a practice test to complete before the main task. The instructions are repeated on the main task, so you don't have to remember which keys to press. Do not worry if you make a mistake, just continue until the end of the test. You are free to leave the task at any time by pressing the escape button. You only ned to submit the task once
- When the task is finished data will upload and you will see an “ok” signal and a blank screen

If you would like to participate, please click on the link below to consent. Once you have consented you will be able to click on the link to the cognitive task at the end of the consent form
https://nclpsych.eu.qualtrics.com/jfe/form/SV_6VaqC03UdjM9DCe



Please find attached a PDF on organisations offering support and signposting and a PDF copy of the information sheet you will read in Qualtrics before consenting to do the online task
Please contact me for further information
Thank you
Pam

Appendix N Participant Information Sheet for Cognitive Task.

Title of the study: A Study of Concentration Difficulties in Everyday Life

Thank you for your interest in taking part in this study. Participation is open to anyone over 18, regardless of whether you experience concentration difficulties. We invite you to read this Participation Information Sheet before making an informed decision about participating in this research. If anything is unclear and / or you require further information, please do not hesitate to contact the research team. You can download this here

Who are we?
Pam Boullin and (Georgia Mooney), (Trainee Clinical Psychologists at Newcastle University, employed by Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust) are carrying out this research on concentration difficulties.
Professor Mark Freeston, Newcastle University, is supervising this project.

What is the purpose of this study?
The purpose of this study is to improve our understanding of concentration difficulties and how they affect people in their everyday lives. More specifically, the study is examining the relationship between concentration difficulties, sleep difficulties and aspects of daily functioning, including socializing and loneliness in adults. Some people experience concentration difficulties accompanied by brain fog, daydreaming, mental disengagement, and slow movement.

The aim of the cognitive task is to compare your objective performance in a task which demands concentration and attention, with the subjective reports of concentration and attention and functioning difficulties you answered in measures you completed in the online survey. We are interested in comparing whether people's objective performance in a task reflects their perceived concentration and attention capabilities.

What does taking part involve?
After reading this information sheet, you will be asked to consent to doing the cognitive task then click on a link in the email we sent to participate in the cognitive task. The task may take around 5-10 minutes to complete

Do I have to take part?
You are not obliged to take part in this task. Your involvement is entirely voluntary. You have the right to refuse participation and to withdraw from the research at any point during completion of the task and up to two weeks after completion. We will ask you to create a 4-digit code (the same code as you used in the online survey, usually the last 4 digits of your phone number) at the start of the task to allow the researchers to withdraw your data (if you request this) or to compare your objective task data with your original online survey data. The code should be the same code that you used in the online survey, to allow the researchers to link your cognitive task data to your survey questionnaire data. The task data up until the point of withdrawal will still be included

unless you contact the researchers and request for your data to be removed from the report. If you wish to withdraw, you are requested to contact the researcher within two weeks of completion or partial completion of the cognitive task and inform the researchers of your unique code created at the beginning of the task.

Can anyone take part?
Provided you are over 18 and you already completed the survey, and you received an invite to participate via the email address you left at the end of the survey, you can take part in this study task. You do not have to have a mental health problem or have noticed any concentration difficulties.

What are the benefits and risks of taking part in this study?
We hope that this research will benefit people experiencing concentration difficulties in the longer-term. Firstly, in future, it may contribute towards increasing the availability of helpful sleep interventions which reduce daytime tiredness for people reporting poor concentration and problems with daily functioning. Secondly, in future it may lead to adapted strategies to help people meet their social goals. Finally, it may provide further insight into how concentration difficulties may influence the way people react to uncertainty and anxiety/worry.

We will make a donation to Mind, a charity supporting people with mental health difficulties, on behalf of all participants.

What information will be collected and who will have access to the information collected?
You will be asked to complete a cognitive task if you consent to participate. You have already answered questions in our online survey about difficulties with concentration and attention, your sleep habits, potential sleepiness during the day, experiences of daily life including socializing, loneliness, your mood, worry and anxiety. You also provided some information about your sociodemographic factors, for example your age and gender.

The cognitive task data will be anonymized, linked to your online survey data through the unique four-digit code you created, and stored in a password protected file on Newcastle University's server. Data from the cognitive task will be stored securely in an excel spreadsheet and data collected from the online survey will be stored by Qualtrics, a secure online survey software platform, and the researchers will export all data and store it securely in password protected files on Newcastle University's servers. Only the research team will be able to see your individual responses.

Will my information be private and what will happen to it?
All the data we collect will be kept strictly confidential and in accordance with the General Data Protection Regulation (GDPR). The research team will only have access to information which you choose to provide for research purposes. We will store your information with a unique identifier code.

Newcastle University are leading and managing this study and acting as the data processor and sponsor and are responsible for looking after your information and using it properly. Newcastle University will keep any identifiable data you provide for 6 months after completion of the study. All precautions will be taken by all those involved to ensure your confidentiality. After this time, all identifiable information relating to your data will be securely erased (in this case your e-mail should you choose to provide it). We will ask for your consent to use your completely anonymised data within a larger data set which may be accessed by other researchers at Newcastle University and in other organisations, such as other universities, or NHS organisations. Your anonymised data will only be used by organisations and researchers to conduct research.

How will my information be used?
Newcastle University will be using information from you to undertake the study and will act as the data controller for this study. This means that Newcastle University is responsible for looking after your information and using it properly. When we use personally identifiable information from people who have agreed to take part in research, we ensure that it is in the public interest. After the two-week period, your rights to access, change or move your information are limited, as Newcastle University needs to manage your information in specific ways for the research to be reliable and accurate.

To safeguard your rights, the minimum personally identifiable information will be used (your email, if you choose to provide it). You can find out more about how Newcastle University uses your information at: https: www.ncl.ac.uk/data-protection/data-protection-policy/ or by contacting Newcastle University's Data Protection Officer (Maureen Wilkinson, rec-man@ncl.ac.uk).

What happens to the study results?
The researchers will write up the results in a report and submit it to Newcastle University. The report will be finalised approximately six months after the end of the study. To receive a copy, please tick the box declaring interest in receiving the report when you complete the questionnaires. We aim to submit the research findings to academic journals for publication and share with varied audiences.

Has this study received ethical approval?
Yes, the study has been reviewed and approved by Newcastle University's Faculty of Medical Science Research Ethics Committee.

Who is the contact for questions about this research study?
Principal Investigator - Pam Boullin: p.boullin2@newcastle.ac.uk
Principal Investigator - Georgia Mooney: g.mooney2@newcastle.ac.uk
Research Supervisor - Mark Freeston: mark.freeston@newcastle.ac.uk

Who should I contact to lodge a complaint?
Professor Mark Freeston, Newcastle University: mark.freeston@newcastle.ac.uk
The Chair of the Faculty of Medical Sciences Ethics Committee is a final point of contact for any unresolved issues relating to this project: fmsethics@newcastle.ac.uk

To lodge a complaint on the handling of your personal data, contact the Data Protection Officer who will investigate the matter - Maureen Wilkinson: rec-man@ncl.ac.uk
If their response is unsatisfactory, you can lodge a complaint with the Information Commissioner's Office (ICO): https://ico.org.uk/

Appendix O Consent Form for Cognitive Task

Thank you for your interest in taking part in this study.

Before you take part in the study, please complete this short Consent Form.

Please read the following statements and select the relevant response at the bottom of this page.

1. I confirm that I have read the Participant Information Sheet for the study. I have had the opportunity to consider the information provided and have received the researcher contact details to ask further questions if needed prior to taking part in the task.

2. I understand that my participation in the task is voluntary, and I can withdraw my completed data from the Study anytime up until the two weeks after completing the cognitive task without providing any reason. I understand that if I decide to withdraw my data after the two-week period, it will not be possible for my completed cognitive task data to be omitted from the Study's data analysis and reported study findings.

3. I understand I will be asked to provide the last four digits of my telephone number to enable the identification of my completed task data if I decide to withdraw my completed task data from the Study within the two-week period. I understand that by using this four-digit code, the researcher will be able to link my data from the cognitive task to the data from the online survey I competed earlier this year.

4. I understand that Newcastle University will retain the email address I previously provided in line with the University's information governance polices and GDPR (General Data Protection Regulation) and that this will be stored separately from my completed survey data.

5. I give consent for my data to be used for the purposes of this research study, as described in the Participant Information Sheet.

6. I give permission for my data from this study to be shared with other researchers provided that my anonymity (I cannot be identified) is completely protected.

7. I understand that my research data will be reported as part of the researchers' Doctorate in Clinical Psychology University Thesis and may be published as a report within peer reviewed journals.

8. I understand that this online cognitive task will be carried out on the Pavlovia Psychopsy platform (Open Science Tools). Once I click on the URL link sent in the email, I will be directed to this platform.

9. I understand that the data recorded from this online cognitive task will be automatically downloaded onto an individual excel spreadsheet, identified by the four-

digit code I input before completing the task. I understand that the researcher will store this data according to GDPR standards set out in the information sheet.

Appendix P Phase Three Stroop Task Methodology

As participants from phase one with high scoring concentration scores had not consented to participate in the focus group to discuss their concentration issues, the researcher selected the Stroop task. Rationale was based on previous theory advocating its use as a test of executive function and its sensitivity to disengagement and attentional lapses (Mikaye et al., 2000), making it a robust choice for objective measurement of concentration and EF in phase three of the study and had been used in two previous CDS student studies (see Gloger & Suhr, 2020; Jarrett et al., 2021).

The researcher consulted with an Open Science Tools Chief Science officer to design the task. Open Science Tools Limited run the Pavlovia.org online platform on which Psychopy experiments are run. The Stroop task was designed with two conditions 1. Congruent trials where colours displayed on the screen were congruous with the written colour labels and 2. Incongruent trials where colours displayed did not match the written colour labels. In accordance with Rouder and colleagues there was no control (2023). There were three colours used in the task – blue, red and green. Trials were prepared in Psychopy Pavlovia (Open Science Tools), on an excel spreadsheet comprising 12 trials, 6 congruent and 6 incongruent. The administration of unblocked mixed trials was chosen to prevent participants from adapting to the trial and to maximise the need for concentration and executive engagement (Flodden et al., 2011) Participants were instructed to respond to the colour of the word flashed on the screen as quickly as possible and disregard the word of the colour they read, responding by pressing a left arrow key for blue, down arrow key for green and right arrow key for red. For example, if a word was displayed in blue labelled red, participants needed to press the left arrow.

Participants were firstly introduced to a practice comprising 12 randomised trials, 6 congruent and 6 incongruent, randomly presented. After each response in the practice, “correct” or “incorrect” was displayed on the screen before moving onto the next trial. The main test comprised 60 repetitions, the same 12 trials from the practice round, randomised five times without feedback. There was thus an equal split of congruent and incongruent trials for balance. The arrow key instructions were visible on every trial acting as a response prompt. Each trial response was timed in milliseconds from the time it was displayed to the time the participant released the response arrow key.

Fewer than 20 trials have been reported to reduce sensitivity and reliability (McLeod, 1991) and excessive trials may lead to attrition (Rouder, 2023)

The Psychopy script measured reaction times in both conditions and totalled the incorrect responses. Individual participant results were downloaded onto individual excel sheets. These data sheets were uploaded to a data file stored on the University server. Each participant’s data set was then linked to their survey data through the same four-digit code used in each study for analysis. Some participants completed the participant ID cover sheet using email or name which were immediately identified, recoded and deleted for anonymity. Overall, eleven participants did not complete the participant id box or changed their id code which meant their data could not be linked to the data from the phase two main study. The information sheet explicitly informed participants to use the same id and complete the id section. They also had an opportunity to contact the researcher if any problems arose. The researcher endeavoured to contact the potential participants who had failed to complete the correct id. However, due to emails being sent out in large batches, and time elapsing between participants consenting in Qualtrics then completing the task on a different online platform it was not

possible to follow up for these individuals. Some participants clicked on the consent form several times as they were led straight to the task after consent and some may have forgotten that they needed to use a laptop, having completed consent form on their phone. This may have led to an aborted trial, to be later completed by the same participant.

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Appendix Q Results for Moderated Mediation Analyses

Hypothesis 1

Results from Model 15

Table Q1

Results From Model 15 at Direct Moderated Path

Effect		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	SCI→ACI	0.200	0.043	0.116	0.284	Significant
Indirect	SCI→ESS→ACI	0.022	0.020	-0.003	0.034	Significant
Moderation by ADEXI	*c* path	0.00071	0.0007	-0.0006	0.002	NS

Table Q2

Covariate Associations with CDS Model 14

Covariates	*b*	*se*	*LLCI*	*ULCI*	Conclusion
Number of sexual identities	2.212	2.433	-2.569	6.993	NS
Heterosexuality	-2.492	0.723	-3.913	-1.072	Significant
Religious affiliation	-0.992	0.622	-2.214	0.231	NS
UK Residence	1.348	0.975	-0.568	3.265	NS
Employed	0.322	0.804	-1.258	1.902	NS
Student	1.145	0.878	-0.581	2.870	NS
Female	-0.096	1.864	-3.760	3.568	NS
Male	-1.301	2.015	-5.261	2.659	NS
Ethnicity nonwhite	1.515	0.948	-0.349	3.378	NS
Specificity					
ADHD (ASRS)	.219	0.035	0.149	0.288	Significant
Depression (PHQ-2)	1.374	0.184	1.012	1.735	Significant

Table Q3

Model 14 results controls of ADHD and Depression on moderated mediation model

Effect ADHD		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	SCI→ACI	0.201	0.043	0.117	0.285	Significant
Indirect	SCI→ESS→ACI	-0.143	0 .240	-0.615	0.330	NS
Moderation by ADEXI	*b* path	0.007	0.005	-0.004	0.017	NS

Effect Depression		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	SCI→ACI	0.172	0.043	0.089	0.256	Significant
Indirect	SCI→ESS→ACI	0.025	0 .013	0.003	0.053	Significant
Moderation by ADEXI	*b* path	0.001	0.005	-0.009	0.012	NS

Table Q4

Significant Covariates of CDS After Controlling for ADHD and Depression Model 14

	Covariate	*b*	SE	LLCI	ULCI	Conclusion
Control for ADHD						
	Heterosexuality	-2.294	0.695	-3.658	-0.929	Significant
	Ethnicity non white	1.835	0.912	0.043	3.626	Significant
Control for Depression						
	Heterosexuality	-1.708	0.690	-3.063	-0.353	Significant
	Religion	-1.156	0.586	-2.310	-0.003	Significant

Hypothesis 2

Table Q5

Results From Model 15 Moderated Mediation c path

Effect		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	ACI→SCI	0.266	0.043	0.181	0.351	Significant
Indirect	ACI→ESS→SCI	0.027	0.015	-0.0004	0.061	Significant
Moderation by ADEXI	*c* path	0.0009	0.001	-0.001	0.003	NS

Table Q6

Covariate associations

Covariates	*b*	*se*	*LLCI*	*ULCI*	Conclusion
Number of sexual identities	-1.889	2.582	-6.963	3.185	NS
Heterosexuality	0.600	0.778	-0.927	2.126	NS
Religious affiliation	0.516	0.661	-0.784	1.816	NS
UK Residence	-0.303	1.037	-2.341	1.736	NS
Employed	-1.637	0.849	-3.306	0.329	NS
Student	-4.122	0.912	-5.915	-2.328	Significant
Female	-2.595	1.974	-6.475	1.285	NS
Male	-1.069	2.138	-5.271	3.133	NS
Ethnicity nonwhite	0.726	1.008	-1.255	2.707	NS
Specificity					
ADHD (ASRS)	0.143	0.04	0.065	0.221	Significant
Depression (PHQ-2)	0 .936	0.210	0.522	1.35	Significant

Table Q7

Results controls of ADHD and Depression on Moderated Mediation Model 14

ADHD

Effect		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	ACI→SCI	0.238	0.051	0.139	0.338	Significant
Indirect	ACI→ESS→SCI	.235	0 .012	0.005	0.051	Significant
Moderation by ADEXI	*b* path	-.001	0.001	-0.002	.000	NS

Depression

Effect		*b*	*se*	*LLCI*	*ULCI*	Conclusion
Direct*	ACI→SCI	0.210	0.052	0.108	0.311	Significant
Indirect	ACI→ESS→SCI	0.041	0 .135	0.18	0.071	Significant
Moderation by ADEXI	*b* path	0.001	.005	-0.009	0.012	NS

Table Q8

Significant Covariates of Poor Sleep After Controlling for ADHD and Depression

	Covariate	*b*	SE	LLCI	ULCI	Conclusion
Control for ADHD						
	Student	-3.914	0.902	-5.687	-2.142	Significant
	Employed	-1.835	0.84	-3.485	-0.184	Significant
Control for Depression						
	Student	-3.866	0.690	-5.626	-2.107	Significant

Appendix R Descriptive Statistics for Cognitive Task Subsample

Table R1

Descriptive Statistics for Stroop Task

	n	Range	M	SD	Std. Error	Skewness	Std. Error	Kurtosis	Std. Error
Mean total Stroop	55	2.888	1.227	0.551	0.212	1.676	0.322	4.076	0.634
Stroop interference	55	2.107	0.264	0.392	0.529	2.054	0.322	5.186	0.634