Carmen Ng BSc Hons MSc

PSYCHOLOGICAL WELLBEING AND COGNITION IN NARCOLEPSY

Section A: Psychosocial Functioning in Type 2 Narcolepsy: A Narrative Review.

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Section B: An Investigation into the Impact of Mood on the Relationship between Sustained Attention and Working Memory in People with Narcolepsy.

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Summary of MRP Portfolio

Section A presents a narrative literature review investigating the psychosocial outcomes of type 2 narcolepsy in adults (NT2) in comparison to type 1 narcolepsy (NT1). The review includes the summary and evaluation of 16 studies that were subjected to quality appraisal. Due to the current limited literature, studies examining type 1 narcolepsy and other sleep conditions were included in the review provided if data on NT2 was reported. Findings were synthesized and grouped under psychological, social, or occupational outcomes, and quality of life and revealed considerable difficulties in all areas identified, and were particularly influenced by severity of symptoms, social support, stigma, and gender. Clinical recommendations include increasing awareness of narcolepsy in education and mental health services and improving accessibility for social support. Recommendations for future research include emphasis on expanding the limited literature on NT2, and investigation of individual and historical factors that may increase susceptibility of psychosocial difficulties in people with narcolepsy.

Section B presents an empirical investigation of mood as a mediator between narcolepsy and cognitive areas such as memory and sustained attention. It utilises a cross-sectional design involving data from 36 people diagnosed with type 1 narcolepsy (NT1), 34 diagnosed with type 2 narcolepsy (NT2) and 70 controls matched on age, gender, and education. Several hypotheses concerning mood and cognitive outcomes in people with narcolepsy were created based on psychological theory and previous research and tested using quantitative methods. Results identified that people with narcolepsy were more depressed and had poorer working memory performance compared to controls. NT2 were more anxious than controls, whilst NT1 displayed poorer sustained attention performance than controls. There was no difference in short-term memory between all groups. There were no significant differences in mood or cognitive outcomes between NT1 and NT2. Depression was found to mediate the effects of narcolepsy on sustained attention. Lastly, depression and sustained attention were found to serially mediate the effects of narcolepsy on working memory. Limitations of the study are discussed, alongside clinical and research implications.

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Abstract

Background: Research has highlighted that people with narcolepsy experience diminished quality of life and psychosocial difficulties. Despite this, research has generally focused on type 1 narcolepsy, with minimal research investigating type 2 narcolepsy being available.

Method: A narrative literature review was carried out to investigate the current research literature investigating the social, psychological, occupational/academic functioning and quality of life in adults with type 2 narcolepsy and compared these difficulties to type 1 narcolepsy. A total of 16 studies were included in the review and were subjected to quality appraisal.

Results: Findings identified that people with type 2 narcolepsy experience significantly higher levels of depression compared to controls. It highlighted the influence of age of onset of symptoms and gender on the presence and severity of psychological difficulties. Significantly impaired social functioning and reduced opportunities for developing relationships was also found, with no differences found between narcolepsy types. Narcolepsy was not found to affect academic outcomes, however people with type 2 narcolepsy reported significantly more difficulties during school and attentional impairment compared to controls. Greater quality of life was found to be associated with better professional prognosis.

Conclusions: The review demonstrates that people with type 2 narcolepsy experience significant psychological and social difficulties which are comparable to those with type 1 narcolepsy. It highlighted that cataplexy did not influence the impact on these domains. Clinical implications from such findings include implementation of psychological intervention which focuses on improving self-efficacy, improving social support, and reducing stigma of the condition. Additionally, it further highlights the need for further research of the psychosocial impact of NT2.

Introduction

Narcolepsy is a neurological condition that affects the ability to regulate sleep-wake cycles. Classified by the International Classification of Sleep Disorders–Third Edition (American Academy of Sleep Medicine, 2014) as a central disorder of hypersomnolence as two different types: Type 1 Narcolepsy (NT1) and Type 2 Narcolepsy (NT2). Narcolepsy is characterized by a pentad of symptoms: excessive daytime sleepiness (EDS), sleep paralysis, hypnagogic hallucinations, disrupted nighttime sleep, and cataplexy. The difference in presentation between the two types is that NT2 do not experience cataplexy, which is described as the sudden loss of muscle tone often triggered by strong emotions. Narcolepsy is a lifelong condition, where treatment delivered in sleep clinics focusses on lifestyle changes (such as sleep schedules, exercise and naps) and medication.

Difference between narcolepsy types is attributed to hypocretin/orexin levels present in the cerebrospinal fluid; NT1 are evidenced to have a loss of 90% or more (Abad & Guiilleminault, 2017), whilst the aetiology of NT2 is less clear. For a diagnosis to be made, a Multiple Sleep Latency Test (MLST) and polysomnography (PSG) measuring number of sleep-onset rapid eye moments (SOREMPs) is required. Additionally, research has demonstrated poor test-retest reliability of the MSLT for NT2 in comparison to NT1 (Ruoff et al., 2018), further evidencing diagnostic uncertainty and increasing chances of under/misdiagnosis for NT2.

Table 1: Comparison between NT1, NT2 and IH on pentad of symptoms that characterises narcolepsy, and current classification of hypersomnia using criteria of sleep disorder, 3rd edition.

Feature	Narcolepsy Type 1 (NT1)	Narcolepsy Type 2 (NT2)	Idiopathic Hypersomnia (IH)
EDS	Present, often severe	Present, similar to NT1	Present, often intense
Sleep Attacks	Frequent and unpredictable	Frequent but generally less severe than NT1	Rare or absent
Sleep Paralysis / Hypnagogic Hallucinations	Common	May occur, but less frequent than in NT1	Rare or absent
Nighttime Sleep Disruption	Common, with fragmented sleep	May occur, but generally less pronounced/frequent than NT1	Associated with longer, nonrestorative sleep.
Cataplexy	Present	Absent	Absent
Hypocretin (Orexin) Deficiency	Low or undetectable (<110 pg/mL in cerebrospinal fluid)	90% of NT2 have normal levels. Partial loss of orexin possible but does not meet <110pg/ML threshold	Normal
Diagnostic Findings (including MLST/PSG)	Hypocretin deficiency **or** Mean latency of <8 mins on MLST **or** Short REM latency ≥2 SOREMPs **and** cataplexy for diagnosis	Mean latency of <8 mins on MLST **or** Short REM latency, ≥2 SOREMPs **and** normal hypocretin levels **and** absence of cataplexy for diagnosis	Mean latency of <8 mins on MLST. Less than 2 SOREMPs or shorter sleep latency. A total 24-hour sleep duration of at least 660 minutes for diagnosis
Prevalence	0.025 - 0.06% of the population	Less common than NT1, 0.02 – 0.05%	Less common than NT2, 0.008 – 0.01%

Some individuals diagnosed with NT2 eventually develop cataplexy leading to a diagnosis of NT1 (Lammers et al., 2020), with others observing a change towards idiopathic hypersomnia (IH) (Fronczek et al., 2020; Trotti, 2020). There is large contention in research to change/replace diagnostic criteria for NT2, as diagnostic challenges propose unanswered questions around if it is a subtype of narcolepsy or prodromal stage of NT1, a separate condition, or a form of IH (Baumann-Vogel et al., 2021); such indistinction of the condition may lead those diagnosed with NT2 to experience invalidation around the legitimacy of their experience. Despite such challenges, distinguishing between NT1, NT2, and IH is imperative to ensure effective clinical outcomes and advancements towards understanding NT2, please see table 2 below.

Table 2: *Key areas towards distinguishing between NT1, NT2, and IH for those diagnosed, clinicians, and researchers.*

Stakeholder	Reason for Distinction	Key factors per condition
Individuals diagnosed	- **Accurate diagnosis for treatment**: Properly distinguishing between NT1, NT2, and IH helps ensure the right treatment and management approach for each condition.	- NT1 requires hypocretin replacement strategies (e.g., sodium oxybate) due to low orexin levels, while NT2 does not. IH requires different pharmacological interventions because it lacks REM-related symptoms like cataplexy.
	- **Validation and understanding**: Accurate diagnosis provide individuals with an understanding of their condition, helping reduce the stigma and confusion surrounding symptoms.	- NT1 exhibit more objective and visible symptoms (such as cataplexy) which allows more understanding from others and facilitates validation. NT2 and IH, in contrast, might struggle without visible symptoms, leading to more misunderstanding of their fatigue.
	- **Prognosis and long-term management**: Identifying the correct condition is critical for managing long-term expectations regarding daytime sleepiness, job prospects, and quality of life.	- NT1 has a clearer prognosis with treatments targeting cataplexy, outcomes are more easily monitored through objective measurements of frequency of visible symptoms which cannot be as clear for NT2. IH involves long, unrefreshing sleep, which can complicate life in different ways from narcolepsy.
Clinicians (sleep clinics and professionals)	- **Tailored treatment plans**: Differentiating between NT1, NT2, and IH enables clinicians to tailor treatments based on the patient's specific condition, optimizing therapeutic outcomes.	- Central nervous system (CNS) depressants such as sodium oxybate is prescribed for NT1 only to address cataplexy and EDS. Lower levels CNS medication may be used in NT2. Stimulants and antidepressants are prescribed for EDS in all conditions; however, stimulants are less effective in IH. Lifestyle changes are recommended for all conditions, however, is less effective in managing NT1.
	- **Diagnostic accuracy**: Clinicians need to apply the correct diagnostic criteria to differentiate these disorders, which have overlapping symptoms but different underlying pathophysiology.	- Polysomnography and Multiple Sleep Latency Test (MSLT) results are key for distinguishing between conditions, with clear criteria defined in diagnostic manuals. Hypocretin levels in cerebrospinal fluid is also used to help diagnose between conditions.
	- **Management of comorbidities**: Differentiating these conditions is crucial for managing associated mental health issues, cardiovascular risks, and metabolic concerns.	- All conditions are at high risk of developing mental health difficulties, however narcolepsy is at higher risk of developing cardiovascular risk due to medications used. Metabolic concerns are higher in narcolepsy (albeit NT2 less severe than NT1) due to disrupted sleep-wake cycles, whilst IH can be linked to increased weigh gain due to chronic fatigue/sedentary behaviour. IH management focuses more on chronic fatigue.
Researchers	- **Understanding aetiology and pathophysiology**: Researchers need to distinguish these conditions to study their underlying causes and potential treatments.	- NT1 is associated with hypocretin deficiency, which provides a clear pathophysiological explanation. Whilst NT2 and IH lack hypocretin deficiency, suggesting a different or unknown neurobiological basis. Due to many overlapping symptoms and low distinguishing factors between NT2 and IH, research is still unclear and contentious and requires further investigation of these two conditions.
	- **Developmental of targeted treatments**: By differentiating NT1, NT2, and IH, researchers can focus on developing specific pharmacological treatments that address the unique symptoms of each condition.	- NT1 research focuses on orexin receptor agonists and REM sleep modulators. NT2 research also investigates REM modulators, however NT2 and IH research more frequently explore alternative stimulants and wake-promoting medication.
	- **Epidemiological studies**: Understanding prevalence and risk factors is key for prevention, diagnosis, and treatment strategies, making differentiation essential in research settings.	- Narcolepsy prevalence is often a combined statistic of NT1 and NT2, confounding accurate prevalence rates between both conditions. NT1 is reported to be the more prevalent condition however this may be due to easily distinguishable symptoms and clear diagnostic criteria. NT2 and IH have less established prevalence rates and more varied risk factors which may reflect under/misdiagnosis in these conditions.

The prevalence of narcolepsy is mixed dependant on population/country (Mațotă et al., 2023). Rates are often reported as a combined number of NT1 and NT2, however NT2 is recognised as less prevalent than NT1 (Longstreth et al., 2007; Kornum et al., 2017). Prevalence rates are speculated as an underrepresentation of those who suffer from NT2 due to diagnostic difficulties such as overlap of symptoms with other sleep disorders, lack of biomarkers and pathognomonic symptoms such as cataplexy; leading to underdiagnosis/misdiagnosis (Thorpy & Hiller, 2017; Acquavella et al., 2020). Higher rates have been reported in Japan compared to European countries or USA (Severin et el., 2023), evidencing the possible role of cultural, genetic and/or environmental factors on narcolepsy. Whilst the relationship between ethnicity and narcolepsy is unknown, research has demonstrated differences in age of onset and main symptoms between Eastern and Western populations (Wu et al., 2014; Dauvilliers et al., 2001). Additionally, research has found that African-Americans diagnosed with NT2 had a high prevalence of hypocretin deficiency and lower mean hypocretin levels, but less frequent cataplexy compared to White individuals (Kawai et al., 2015), suggesting a different NT2 presentation. The driver for these differences is unclear, as more research is needed investigating the cultural and environmental factors, and genetics in narcolepsy to increase the knowledge base in understanding how narcolepsy may present, which may lead to improvements in diagnosing NT2 in varying populations (Maski, 2015).

Given its neurobiological nature, literature is often focused on the medical aspects of narcolepsy, causing the psychosocial elements to often be overlooked in clinical practice. Narcolepsy causes significant impairments to psychosocial functioning attributed by impairments in cognition, reduced activity levels, and EDS (Bellebaum & Daum, 2016; Goswami & Pollak, 2015; Ettenger et al., 2018), resulting in difficulties within occupational and social settings (Schokman et al., 2023). One Danish study found 50% of people with

narcolepsy (PwN) were unemployed, compared to 39% of controls (Jennum et al, 2009), whilst another German study evidenced 59% of PwN were unemployed, compared to 9% of the general population (Dodel et al., 2004). A meta-analysis found that narcolepsy was associated with a significantly increased risk of depression (Li et al., 2021). It may be argued that there is large overlap in symptoms between depression and narcolepsy, however high levels of depression have been evidenced when excluding overlapping symptoms such as fatigue, disturbed sleep, impaired attention, and social withdrawal (Fortuyn et al., 2011). Researchers have linked high levels of depression in narcolepsy to hypocretin deficiency, as it is believed that hypocretin neurons are involved in the regulation of behaviours/processes often disrupted in depression i.e. motivated behaviour, arousal, appetite, cognition, and stress (Summers et al., 2020; Tyree et al., 2018). It has been theorised that PwN may experience higher levels of psychological distress due to low self-esteem/efficacy in managing their symptoms, feelings of being out of control in relation to sleep attacks or cataplexy attacks, or even due to altered perceptions of reality due to hallucinations (Fortuyn et al., 2009).

Given this profound impact, narcolepsy is still a largely misunderstood condition, with NT2 facing increased stigma than NT1. Media portrayals largely contribute towards society's understanding of narcolepsy, with it being depicted as a comedic condition where falling asleep in humorous environments is the primary problem. This belittles the significant impairments of the narcolepsy sequelae. Due to the lack of visible symptoms like cataplexy and differences in aetiology and prognosis; NT2 has been regarded as less severe/impairing than NT1 (Bassetti et al., 2019). Consequently, NT2 also face challenges similar to those living with invisible health conditions. Many cultures may stigmatise narcoleptic symptoms such as EDS, fatigue, and cognitive issues and conflate these with being lazy/unproductive/unmotivated. Productivity and discipline are highly valued in many cultures (Ly, 2020), PwNT2 may therefore experience discrimination in professional and

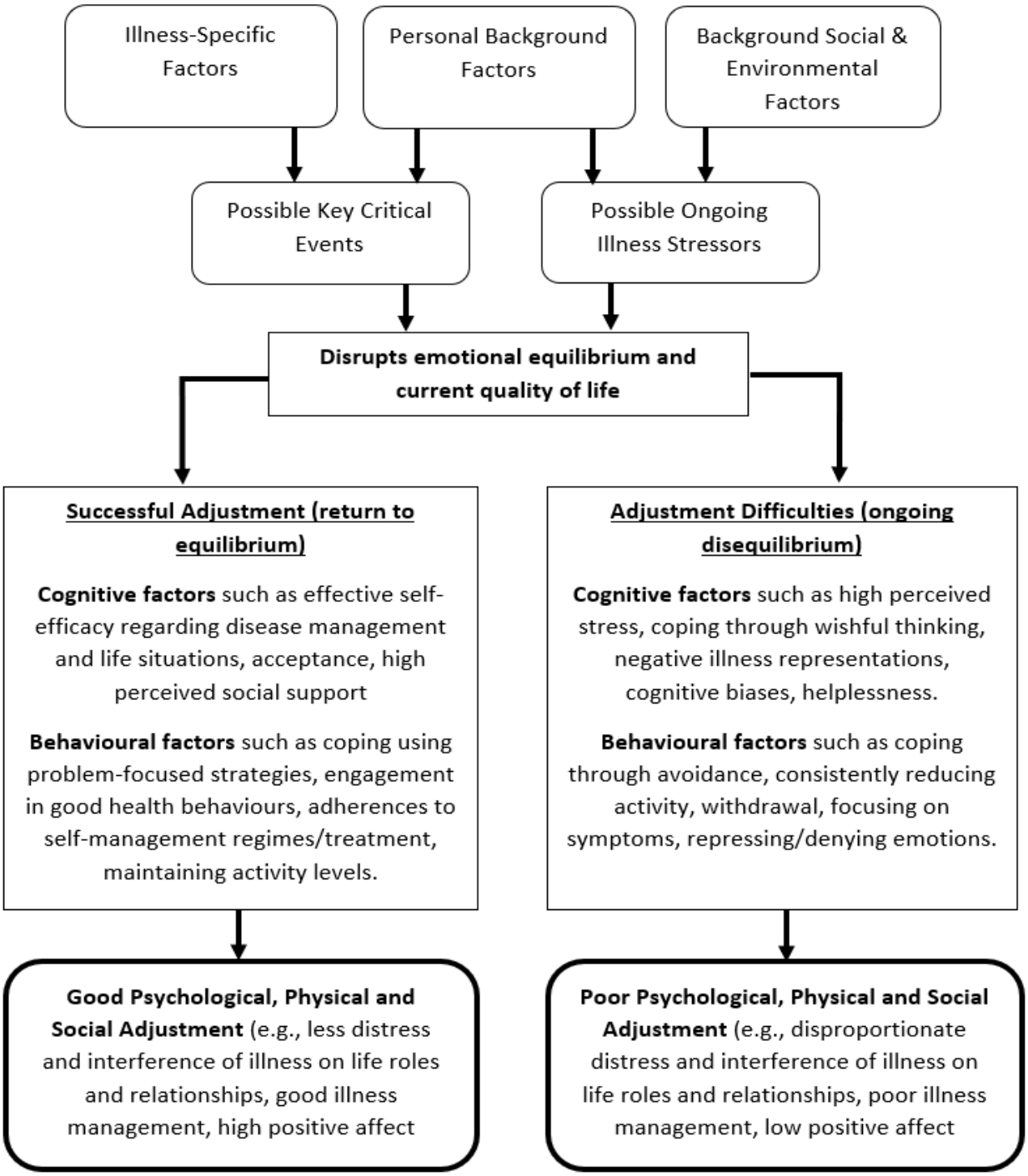
personal settings and be viewed as a failure or incompetent, causing PwNT2 to minimise/hide their condition due to fears of being unable to meet others'/society's expectations, appearing unreliable, and employment dismissal. Such judgements may cause PwNT2 to internalise criticism and feel shame when experiencing difficulties, leading to low self-esteem and psychological distress (Bruck, 2001). Furthermore, the unpredictable and fluctuating nature of narcoleptic symptoms can cause difficulties with predicting ones' capacity for daily activities, further amplifying disbelief from others about the validity of their condition. Consequently, the experience of NT2 symptoms, the constant need to justify impairments, and the management of others' scepticism and disbelief can have detrimental effects of psychosocial functioning and quality of life (QOL) (Kapella et al., 2015).

Research has evidenced diverse results in severity of multiple areas of QOL in narcolepsy (Ingravallo et al., 2012; Raggi et al., 2019). Such variations in research have elicited interest into what may account for such variation in outcomes in narcolepsy. Various theories/models have been developed to understand the mechanisms influencing this, recognising the role of adjustment and coping (Lazarus & Folkman, 1984; Lethanthal et al., 2020; Moos & Holohan, 2007). This is defined differently depending on the psychological/medical context but is broadly described as the processes in response to chronic disease that affects outcomes such as the preservation of functional status and absence of negative affect (Stanton et al., 2007; Dekker & de Groot, 2018).

Moss-Morris' adjustment model (2013) proposes a working model of adjustment to chronic conditions which draws upon empirical findings, patients' experiences of illness, incorporating other theories by Hoyt & Stanton (2012) and Moos & Schaefer (1984). It proposes personal background factors such as personality and early-life experiences can influence reactions to critical events; whilst background, social, and environmental factors

such as availability of social and healthcare and social support can influence response and adaptations towards ongoing illness stressors. Illness specific factors such as the degree of disability, uncertainty, nature of symptoms, prognosis and treatment can determine ongoing illness stressors such as engagement with health professionals, changes in autonomy, managing lifestyle changes/symptoms and critical events such as relapses/disease progression, changes in identity and life roles and the diagnosis of chronic condition; all of which have can potentially disrupt QOL and cause emotional disequilibrium.

Figure 1: *Moss-Morris (2013) Adjustment Model*



The model is consistent with self-regulation theory (Lethenthal et al., 1997), denoting the goal of adjustment is the return and maintenance of equilibrium following critical events and ongoing chronic stressors. Equilibrium is defined as the physical, social, and psychological adjustment one experiences following a reduction of distress, effective illness

management, minimal interference on relationships and life roles and the capacity to maintain positive affect. Successful adjustment is influenced by background factors, cognitive and behavioural strategies the individual utilises to manage the condition. Although the model provides factors that appear regularly related to poor/good adjustment, factors should be empirically determined for each illness group. One study found resilience as a strong factor in adapting to the psychological consequences of NT1 as it was associated with lower levels of depression and anxiety (D'Alterio et al., 2023); this was not investigated for NT2. The model has been applied to understand adjustment in various chronic conditions such as irritable bowel disease (Polak et al., 2020), diabetes (Winkley et al., 2020), multiple sclerosis (Calandri et al., 2019), eczema (Ghio et al., 2020), and arthritis (Arends et al., 2016). However, there is limited research exploring the application of this model to narcolepsy and understanding factors associated with successful adjustment. NT2 remains a poorly understood condition. Consequentially, it is important to recognise the influence of this condition as it is often under-represented in research; and identify possible factors into understanding its varying degree of psychosocial functioning on individuals.

Scope/Aim of Review

The current literature on sleep disorders largely focuses on NT1 and insomnia with various reviews focusing on epidemiology and aetiology, cognition, QOL and management/treatment in these conditions. However, there is limited literature highlighting the impact of NT2 solely, where reviews often combine NT2 with other conditions, thus interfering with the accurate depiction of NT2. There has been one review to date that separates the impact of NT2 on cognition (Filardi et al., 2021), and reviews investigating the psychosocial functioning in children/adolescents with narcolepsy (Blackwell et al., 2017; Burdass, 2023). With no reviews investigating the psychosocial functioning of NT2 in adults to date, there is a need to appraise the literature and synthesize the information related to the

psychosocial impact of the condition. Doing so may highlight gaps in knowledge to support the need for future research and identify important elements for intervention that may be helpful for those affected by the condition. Therefore, the aim of the current review focused on investigating the psychosocial functioning of NT2 in adults and elucidate differences in comparison to NT1.

Method

A search of the following databases was conducted in August 2023; PsychINFO, Medline, Web of Science, and PubMed. The search terms were identified based on the aim of the review which were as follows: (narcolepsy OR type 2 narcolepsy OR narcolepsy type 2 OR NT2 OR without cataplexy OR narcolepsy without cataplexy OR central hypersomnias OR narcolepsy type II) AND (mood OR emotion* OR psychological OR wellbeing OR coping OR adjustment OR mental health OR depression OR anxiety OR psych* OR social* OR relation* OR friend* OR occupation* OR academic OR work OR support* OR behavi* OR esteem OR qol OR quality of life). There were no date limits imposed onto the search.

Using the exclusion and inclusion criteria below, title screenings were first completed, followed by abstract screenings. Studies were excluded if titles/abstracts were not related to narcolepsy or did not include any NT2 data. Full text screenings were completed on the remaining studies. The review identified 16 eligible papers. References from these papers were also hand-searched to identify more eligible papers. A search was also conducted using Google Scholar, however there were no additional studies identified through this database.

Table 3: Eligibility criteria for current review.

Inclusion Criteria	Exclusion Criteria
1. Studies were to be written in the English language.	1. Studies that did not include research on type 2 narcolepsy.
2. Research utilising any methodological design were included i.e., quantitative, qualitative and mixed-methods.	2. Studies that did not report any data on type 1 and type 2 narcolepsy participants individually i.e., would combine both groups of data for the entirety of analysis
3. The study could either be published or unpublished.	3. Studies where all data on narcolepsy type 2 was combined with other sleep disorders.
4. Studies had to include participants of adult age (18 years and older)	4. Studies that included paediatric narcolepsy.
5. Studies that investigated any element of psychosocial impact or quality of life were included.	5. Studies that were not related to psychosocial factors or quality of life in narcolepsy.
6. Studies where narcolepsy type 2 was identified as its own entity.	

A PRISMA flow diagram can be observed below which illustrates the papers that were included/excluded at each stage of the screening process from the aforementioned databases.

Figure 2: PRISMA flow diagram of search process for this review (Page et al., 2021)

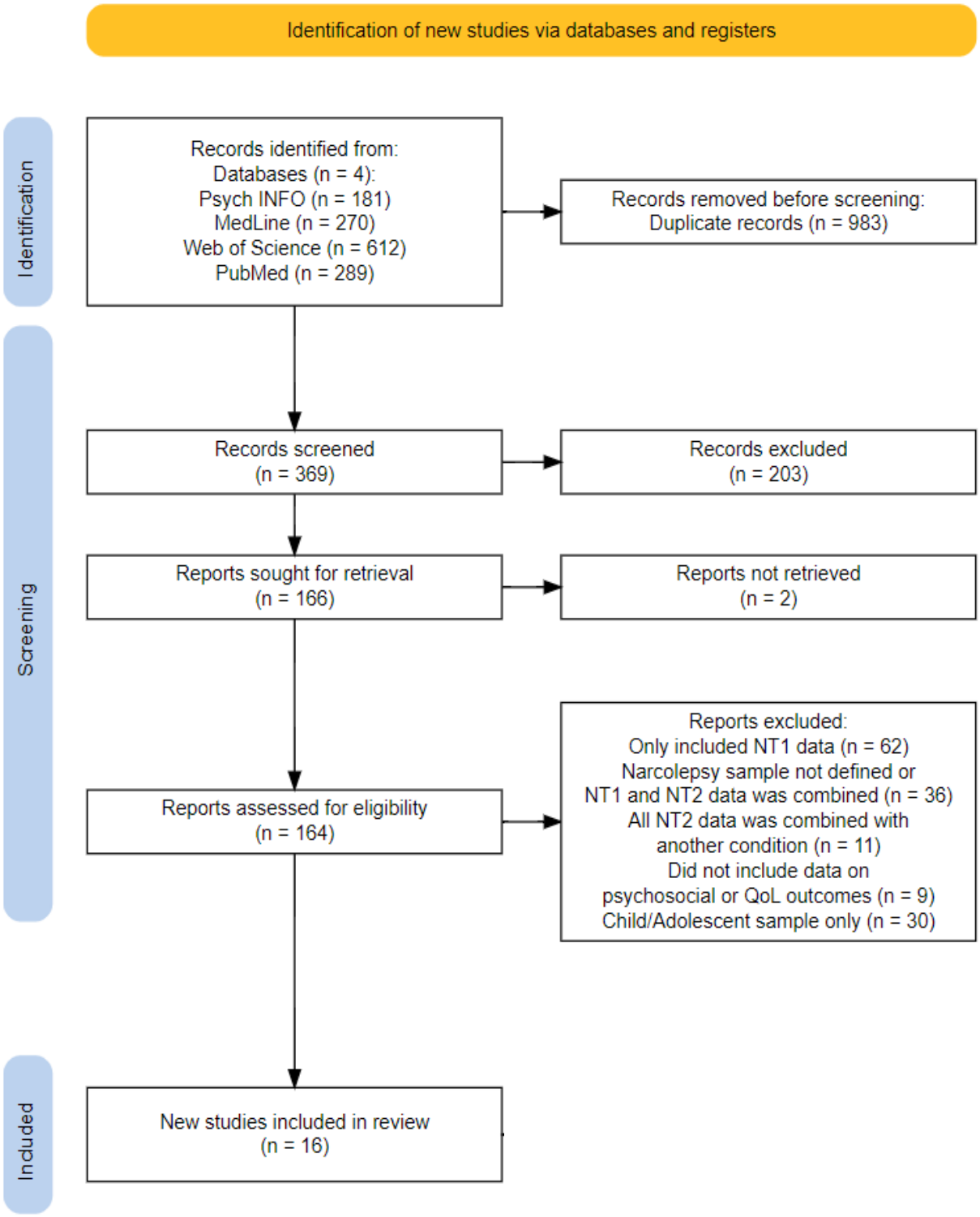


Table 4: *Summary of studies included in review.*

Study	Objectives	Location	Sample	Demographics	Design and Analysis	Outcome Measures	Key Findings related to review
1. Abenza-Abildua et al. (2022). Anxiety and depression in patients with narcolepsy	To analyse the co-existence of anxiety and depression in patients with narcolepsy who attended a sleep centre	Spain	27 NT1 and 24 NT2 Total of 51 PWN	23 males, 28 females Mean age: 42 (NT1), 39 (NT2)	Cross sectional design analysing retrospective data. Chi-squared test and t-tests	ESS, PSG, MSLT, Zung Depression scale, Zung Anxiety scale	- PwNT2 scored higher in measures of depression anxiety and exhibited more symptoms of GAD compared to controls. - No significant difference between NT1 and NT2 regarding the prevalence of anxiety and depression (55.55% in NT1 versus 44.44% in NT2). - The prevalence of anxiety and depression in PwN in this study was triple of the general population. - 18 participants out of the total sample were diagnosed with either anxiety or depression (10 NT1 and 8 NT2) - All 18 participants had received antidepressant treatment, almost all before the diagnosis of narcolepsy. - A statistically significant relationship was found between younger age and the presence of anxiety in PwN - There was no relationship found between the following variables: age, the type of narcolepsy, and the type of psychopathological disorder; degree of daytime sleepiness and the presence of anxiety or depression; type of narcolepsy and the presence of a psychopathological disorder (such as anxiety, depression, attempted suicide, manic outbreak, substance abuse) as defined by the authors. - For the majority of sample, psychopathology preceded the diagnosis of narcolepsy and was not found to be a reaction to the diagnosis
2. Alasim et al. (2019). Comorbid psychiatric disorders among patients	To assess the prevalence of psychiatric disorders in patients with	Saudi Arabia	44 NT1 and 30 NT2. Total of 74 PWN	Mean age: 29.4 (Narcolepsy group), 28 (control group).	Case-control study Multivariate logistic regression model.	A validated Arabic version of the MINI v6	- For NT2 group, the following numbers were diagnosed with: 50% (15) psychiatric disorder, 40% (12) major depressive disorder, 13% (4) with suicidality, 7% (2) panic disorder, 3% (1) mood disorder with psychotic features, 7% (2) with generalised anxiety disorder. - No significant difference was found between NT1 and NT2 in the prevalence of psychiatric disorders.

with narcolepsy.	narcolepsy using a structured clinical interview		265 controls age- and sex-matched	Males: 81% (Narcolepsy group), 79% (control group)	Firth logistic regression.		- Psychiatric disorders were diagnosed in 45% of narcolepsy group compared to 15% of control group. ($p < 0.001$). The prevalence of psychotic disorders, mood disorders with psychotic features, and other disorders (e.g., anxiety, bulimia nervosa) were higher in PwN. - PwN were more likely to have major depressive disorders and generalised anxiety disorder
3. Chin et al. (2022). Quality of life changes and their predictors in young adult narcolepsy patients after treatment: A real-world cohort study	To investigate the changes of the quality of life and the symptom severity of NT1 and NT2 patients and analyse the possible predictors of long-term quality of life	Portugal	111 NT1 and 46 NT2. Total of 157 PWN	89 males (60NT1, 29 NT2), 68 females (51 NT1, 17 NT2) Mean age: 23.90 (NT1: 23.89, NT2: 23.94)	Prospective follow-up cohort study Chi-squared test, t-tests, hierarchical linear modelling	SF-36, ESS, VAS, Conners' Continuous Performance Test	- NT2 group had significant improvements only in emotional role functioning (limitations in usual role activities because of personal or emotional problems) after treatment. - NT2 group had significantly better scores on measures of QOL than NT1 at baseline, but there was no significant difference between the two groups after treatment aside from physical role functioning (limitations in usual role activities due to physical health problems) and social functioning ($p = 0.03$). There was no significant difference in psychological domains aside from social functioning ($p = 0.014$). - PwNT1 responded better to medication and related narcoleptic symptoms than PwNT2. - Vitality and psychological health did not improve after treatment for both PwNT1 and PwNT2, despite EDS improvements after 5-year follow up. - ESS and VAS scores significantly improved during/after 5 years of treatment for both narcolepsy groups. - NT1 were significantly more overweight than NT2. - Gender, current age, and disease duration was not significantly correlated with any domains of the SF-36. - Age of onset was correlated with psychological health and vitality. - The different narcolepsy types (NT2) were correlated with physical function, physical role functioning, general health, psychological health, and vitality; indicating that PwNT2 could be predicted to have a better quality of life in these domains compared to PwNT1. - ESS (which measures EDS) was correlated with all domains of SF-36, except body pain.

4. Cremaschi et al. (2020). Health-related quality of life in patients with narcolepsy types 1 and 2 from a Sleep Center in Brazil	To describe the quality of life in a sample of patients with narcolepsy, and the influence of the nutritional status (as examined by categories of body mass index) in health domains	Brazil	33 NT1 and 33 NT2 Total of 66 PWN 33 controls matched by age and sex.	In each group: 27 females, 6 males Mean age: 36.2 (control group), 36.3 (NT1), 35.3 (NT2).	Cross sectional design Pearson's chi-square, parametric and non-parametric Analyses. Models of the Generalized Linear Model (Poisson log-linear regression). Bonferroni test	SF-36	- There was no significant difference in narcolepsy related symptoms between narcolepsy groups aside from cataplexy. - The NT2 group were found to have more history of depression compared to NT1 and control groups. - There were no significant differences between NT1 and NT2 according to the use of psychostimulant or antidepressant drugs. Both narcolepsy groups used more antidepressants than the control group. - Both narcolepsy groups scored lower on QOL measures compared to controls in all domains. Physical role functioning, emotional role functioning, and vitality were the most affected. - Physical role functioning was the only area where NT1 and NT2 significantly differed. NT1 had worse scores than NT2. - In overweight/obese participants, NT2 had the worse scores on physical health domains. In normal weight participants, NT1 had worse scores on physical role functioning than NT2. - In obese participants, NT2 group had worse vitality and emotional role functioning than NT1. In overweight participants, NT2 had worse vitality, social functioning, and mental health mean scores. - In the normal weight range, NT2 group had better vitality but worse emotional role functioning than NT1 group.
5. Dauvillers et al. (2009). Psychological health in central hypersomnias: the French Harmony study	To clarify the relationships between the severity of the condition, psychological health and treatment response	France	424 NT1, 68 NT2, 25 IH. NT2 and IH groups were later pooled into one	Gender M/F ratio: 48.3/51.7 (NT1), 48.5/51.5 (NT2), 36/64 (IH). Mean age: 42.8 (NT1), 34.4 (NT2), 41.4 (IH).	Observational case control study T-tests, Pearsons test.	ESS, Cataplexy Frequency Scale, S-BDI, PSQI. SF-36	- There was no difference between NT2 group and IH group on depression, QOL and sleep quality measures. - NT1 group was more often overweight compared to NT2/IH group. No obesity was reported in the NT2/IH group. - NT1 group had higher scores on depression measures and depression frequency compared to the NT2/IH group. - Similar curve profiles on QOL measure were observed in all separate groups, with NT1 demonstrating the worst scores, except on general health domain.

	in a large population of patients suffering from NT1, NT2 and IH.		group to be compared against NT1 group	Mean BMI: 27 (NT1), 23.7 (NT2, 24.6 (IH). Mean ESS score: 18.1 (NT1), 11.7 (NT2), 12.1 (IH)			
6. Davidson et al. (2022). The impact of narcolepsy on social relationships in young adults	The study investigated the impact of narcolepsy on friendships and romantic and sexual relationships.	USA	151 NT1 and 103 NT2 Total of 254 PWN	Mean age: 28.8 (NT1), 28.2 (NT2) Females: 127 (84.1%) (NT1), 95 (92.2%) (NT2) Race: White race: 140 (92.7%) (NT1), 94 (91.3%) (NT2). Black race: 5 (3.3%) (NT1), 5 (4.8%) (NT2). Other: 7 (4.6%) (NT1), 4 (3.9%) (NT2).	Cross sectional design Chi-square tests and unpaired two-sample Wilcoxon tests using Bonferroni corrections. Wilcoxon signed-rank test with continuity correction	MSPSS, a newly developed survey specific to the study including questions on narcolepsy and its impact on relationships and communication.	- In the total sample, excessive daytime sleepiness, depression, and brain fog were reported to have the greatest impact on social functioning. The impact of narcolepsy diagnosis and symptoms on social functioning was independent of the type of narcolepsy. - In the total narcolepsy sample, 98.4% reported that narcolepsy made friendships more challenging and their social life more difficult, 49.6% indicated they felt they had too few friends, and approximately 1 in 5 participants (19.7%) reported they had not spent any time with friends at all over the past week. - In the NT2 group, 96.1% reported that narcolepsy made friendships more challenging and their social life more difficult, 87.4% reported that narcolepsy made entering relationships more difficult, 84.2% reported being in a romantic relationship at the time of the study, 37.5% reported to be married and 32.5% were cohabiting, and 81.3% indicated that they were at least mostly satisfied in their relationship - In the NT2 group, the following reported how much narcolepsy impacted on their social life: 54.4% (56) reported narcolepsy makes it a lot harder, 41.7% (43) reported it makes it somewhat harder and 3.9% (4) said it had no impact. 31.1% (32) felt that narcolepsy made is a lot harder to enter a relationship, 56.3% (58) felt it makes it somewhat harder, and 12.6% (13) felt that it had no impact. 47.6% (49) felt they had too few friends, 51.5% (53) felt they had just right number of friends and 0.9% (1) felt they had too many friends. 78.7% (74) felt that narcolepsy impacted their sex life, 1% (1) experienced cataplexy during sex, 42.5% (40) said they had fallen asleep during sex whilst 5.3% (5) was not sure, 26% (13) felt that falling asleep currently impacted on their sex life whilst 14% (7) was not sure.

							- There was no significant difference between NT1 and NT2 groups in characteristics and quality of friendships and perceived social support. The only significant difference found between groups was NT1 experienced more cataplexy during sex compared to NT2. - PwN felt limited in how much energy they can commit to social relationships, therefore will often choose to prioritise single romantic relationships over friendships. Support from partners were perceived more highly by PWN than support from friends/family. - 82.6% of NT1 and 78.7% of NT2 reported that narcolepsy impacted on their sex life. - 53.1% of NT1 and 1% of NT2 reported experiencing cataplexy during sex. - Of the total narcolepsy sample, 53.2% reported falling asleep during sex. There was no significant difference between NT1 and NT2 in this area. - Out of the total narcolepsy sample, 69.3% was asked about their social life by their doctor, 72.8% said they wanted their doctor to ask about their social life, and 44.9% wanted their doctor to ask about their sex life.
7. Del Bianco et al. (2022). Alexithymia, impulsiveness, emotion, and eating dyscontrol: similarities and differences between narcolepsy type 1 and type 2	To evaluate mood, impulsiveness, emotion, alexithymia, and eating behaviour in patients with narcolepsy type 1 (NT1) and narcolepsy type 2 (NT2) compared	Italy	14 NT1 and 10 NT2 Total of 24 PWN 24 controls matched by age and sex	Females: 8 (NT1), 6 (NT2), 14 (controls) Mean age: 34.8 (NT1), 37.8 (NT2), 36 (controls) Mean ESS score: 12.3 (NT1), 13.3 (NT2), 5.2 (controls) Mean BMI: 26.8 (NT1), 26.3 (NT1),	Case control study Student's t test, Kruskal–Wallis test, Mann–Whitney U tests with Bonferroni correction. Spearman's Rho correlation coefficient	PHQ-9, GAD-7, BIS-11, DERS, TAS-20, EDE-Q	- PwN scored significantly higher in PHQ-9 than controls ($p = 0.001$). Ten out of 24 patients exhibited a PHQ-9 score > 10 (7 NT1 and 2 NT2) and one NT2 patient showed PHQ-9 score > 20 indicating moderate and severe degree of depression, respectively. - PwN scored slightly higher than controls without reaching statistical significance. GAD-7 score was > 10 (moderate anxiety) in one NT1 patient and > 15 (severe anxiety) in three out of 24 narcoleptic subjects (1 NT1 and 2 NT2). - No significant differences were found between NT1 and NT2 groups on depression (PHQ-9) and anxiety (GAD-7) measures. - There was no significant difference found between narcolepsy groups and control group on impulsivity and eating disorder features. Dietary restrain was higher in NT2 group than control group, whilst eating concern, shape concern and weight concern were higher in NT1 group than controls. Following Bonferri correction, these differences lost significance. - NT1 scored significantly higher on a measure of alexithymia compared to NT2 and controls.

	to healthy controls			23.6 (controls)			- There were no significant differences in drug-naïve and treated PwN on all measures.
8. Huang et al. (2023). Impact of Taiwan's 2021 COVID-19 lockdown on the symptom severity and quality of life of patients with narcolepsy	To investigate changes in the quality of life and symptom severity of patients with NT1 and NT2 during a period of lockdown	Taiwan	80 NT1 and 40 NT1 Total of 120 PWN	Mean age: 25.3 (NT1), 22.2 (NT2) Males: 48 (60%)(NT1), 21 (53%)(NT2) Mean BMI (pre-lockdown): 29.5 (NT1), 24.2 (NT2) Mean ESS score: 14.3 (NT1), 11.5 (NT2)	Cohort study T-tests	SF-36, ESS	- NT1 had significantly worse daytime sleepiness and were more overweight than NT2. - In the total sample, emotional role functioning was the only QOL domain that significantly improved during lockdown. Body mass index (BMI) significantly increased during lockdown. Subjective daytime sleepiness significantly improved during lockdown. - Subjective daytime sleepiness did not significantly change for NT2 during lockdown but did for NT1. - Male NT2 reported significantly worse physical role functioning and emotional role functioning, and significantly improved vitality during lockdown.
9. Jara et al. (2011). Determinants of Depressive Symptoms in Narcoleptic Patients with and Without Cataplexy	To assess depressive symptoms in PWN and controls and compare depression cores between NT1 and NT2	Germany	65 NT1 and 21 NT2 Total of 86 PWN 86 controls	Mean age: 45.4 (NT1), 51.7 (NT2), 45.2 (control group). Female to male number ratio: 35/30 (NT1), 11/10 (NT2), 46/40 (control group) Mean BMI: 29.5 (NT1), 28.5 (NT2),	Prospective cohort study Mann-Whitney U-test, Pearson chi-square test followed by Fisher exact test, ANOVA, Games-Howell test,	BDI, SDS, GSD, POMS, ESS	- No significant differences were found between NT1 and NT2 on all depression measures. There was no significant difference found in the distribution among the graded categories of depression severity between NT1 and NT2. Theres was no significant difference between NT1 and NT2 on subjective daytime sleepiness. - PwN scored significantly higher on all depression measures than controls (BDI, SDS, GSD) ($p < 0.0001$ for all scores). This difference remained significant when sleep items were excluded from analysis. - 40% of PwN were "at least mildly depressed". Four times more than controls. - The total narcolepsy sample, they scored significantly higher on total mood disturbance, all negative subscales (depression, anger, fatigue, confusion, tension) and significantly lower on positive subscale (vigour) than controls.

				23.8 (control group)	multiple linear regression, logistic regression		- Significantly more PWN scored within the clinical range on depression measures than controls. - In the total narcolepsy group, being female and taking a combination of medication explained 20% - 27% of the variance on depression measures. These two factors were also associated with higher probability for depressive symptoms independent of cataplexy (for NT1), BMI and age. There were no predictor variables associated with depression measures for the control group. - Cataplexy and interaction of drug did not have any influence on depressive symptoms. PWN that used a combination of stimulants and antidepressants presented with more depressive symptoms than those only using stimulants, or those only using anticataleptics, or unmedicated.
10. Kowalcyk (2017). Health related quality of life in narcolepsy and idiopathic hypersomnia	To understand more about symptoms, diagnosis and patient attitudes and behaviours in adults with narcolepsy or IH.	Online study based in USA.	338 NT1 and 210 NT2 and 285 IH Total sample of 833	Mean age: 42.2 (NT1, 39.2 (NT2), 37.7 (IH) Female: 279 (82.8%) (NT1), 178 (84.8%) (NT2), 249 (87.4%) (IH). Mean BMI: 28.5 (NT1), 26.4 (NT2), 27.9 (IH) Mean ESS score: 15.2 (NT1), 14.2 (NT2), 14.6 (IH)	Cross sectional study Chi-squared test, t-tests,	ESS, VR-36, PROMIS	- All study groups were found to have lower QOL compared to healthy US adults. - Physical composite and mental composite scores were between 35 and 42 between groups, with standard deviations of approximately 11, indicating that the sample was functioning approximately one standard deviation lower than the average population on mental and physical health - There was no significant difference between NT1 and NT2 on all health related QOL domains aside from mental health. - NT2 group reported significantly lower mental health functioning despite have better physical functioning compared to NT1 group. - Those who engaged more in regular activity reported better on all domains of health related QOL compared to those who engaged in rare/no activity.

11. Leu-Semenescu et al. (2011). Hallucinations in narcolepsy with and without cataplexy: Contrasts with Parkinson's disease	To compare the hallucinations associated with narcolepsy to those of Parkinsons disease	France	54 NT1 and 46 NT2 Total of 100 PWN 100 participants with Parkinsons	Mean age: 37.7 (PWN with hallucinations), 41.4 (PWN without hallucinations), 62.5 (Parkinsons with hallucinations), 63.9 Parkinsons without hallucinations) Mean ESS score: 19 (NT1), 17.5 (NT2), 9 (Parkinsons)	Cross sectional study Chi-square test, Mann–Whitney two tailed U-test, stepwise logistic regression	ESS, BDI, Interviews were also used to gather information related to study variables.	- PWN had significantly more auditory and kinetic hallucinations than those with Parkinsons. - There were twice as many PwN who experienced hallucinations than people with Parkinsons - PWN were significantly more likely to experience hallucinations at sleep onset/offset compared to those with Parkinsons - Higher levels of subjective daytime sleepiness were associated with hallucinations in PWN. - PWN who experienced more sleep paralysis experienced more hallucinations. - Presence/passage hallucinations are less common but involve more violence, blood and fear in PWN than in those with Parkinsons. (Presence hallucinations were defined as the perception that a living character or animal is behind or near to the individual, without the individual hearing or touching it. Passage hallucinations were the brief visions of a person or animal passing sideways) - 28% (13) of PwNT2 reported experiencing hallucinations, 100% of these were reported to be visual in nature.
12. Nevsimalova et al. (2022). Central Disorders of Hypersomnolence: Association with Fatigue, Depression and Sleep Inertia	To examine a group of patients with narcolepsy and idiopathic hypersomnia to find if fatigue, depression, and sleep inertia influence the course	Czech Republic	87 NT1 and 22 NT2 and 38 IH	Mean age: 33 (NT1), 35.5 (NT2), 41 (IH). 53 (63%) females (NT1), 13 (59%) females (NT2), 27 (69%) females (IH)	Cross sectional study Chi-square test, Fisher's exact test, Student's t-test, Mann–Whitney rank sum test, one way ANOVA,	ESS, NSS, IHSS, HADS, FSS, SIQ. An interview was also conducted to gain necessary information relating to family history of the disease and	- There was no significant difference between NT1 and NT2 on HADS anxiety and depression measures, nor on sleep inertia (sleep inertia is defined as the transitional state between sleep and wakefulness accompanied by compromised cognitive and physical performance, reduced vigilance, and the desire to return to sleep). - BMI was significantly higher in the NT1 group, BMI did not differ between NT2 and IH groups. - Women with NT2 had significantly worse scores on HADS anxiety measure compared to men with NT2. Women with NT2 were also found to have significantly higher levels of fatigue, sleep inertia and subjective daytime sleepiness than men. These findings were not found in women with NT1 or IH. - 36.4% (8) of NT2 group had mixed anxiety-depressive disorder and 9.1% (2) had attention deficit hyperactivity disorder (ADHD).

Prevailing in Women	of both illnesses.				two-way ANOVA, Newman–Keuls test	comorbidities, particularly of psychiatric origin	- In pooled data of all groups, mixed anxiety depressive disorder was found more frequently in women than men (36.6% versus 16.4 %; $p < 0.01$).
13. Ong et al. (2020). How does Narcolepsy Impact Health-Related Quality of Life? A Mixed-Methods Study	To identify patient-centred issues affecting Health-Related Quality of Life (HRQoL) in people with narcolepsy (PWN) and to evaluate patient-reported outcome measures using a mixed-methods approach	Online study based in USA	17 NT1 and 12 NT2 Total of 29 PWN	27 females, 2 males 26 white, 1 black, 2 more than one race Mean age: 31.1 Mean years of education: 16.9	Mixed methods study	PHQ-9, ESS, SF-36, PROMIS Thematic Analysis (guidelines described by Braun and Clarke (2006)) was used to code and derive themes from focus groups for qualitative data	- All PWN agreed that narcolepsy had a negative impact on HRQol. The symptoms reported to have the greatest impact were the constancy of daytime sleepiness and the unpredictability of cataplexy (for NT1). - Themes that were related to poor QOL in narcolepsy were negative perceptions of narcolepsy, impact on self-esteem and self-efficacy, impact from physical symptoms of narcolepsy, impact on social life, impact on family planning and relationships, and impact on occupational functioning. - PWN identified various challenges and barriers related to treatment, themes involved clinicians who did not have adequate knowledge of narcolepsy, insufficient time to discuss needs, and difficulties accessing care in the healthcare system. - PWN reported feeling mixed about whether intervention was to be delivered in a sleep or a mental health clinic. Intervention that was online/remotely was voted highly. There were mixed feelings about whether intervention should be individual or group based as some expressed desire for social connection. There were also mixed feelings about whether intervention should be delivered by a mental health specialist or a sleep specialist. PWN wanted intervention to be focused more on coping strategies, symptom self-management strategies, education about narcolepsy, and cognitive therapy. - There were no significant differences found on QOL measure domains between NT1 and NT2 aside from general health perceptions.
14. Ozaki et al. (2008). Health-Related Quality of Life Among	To evaluate the health-related quality life of drug naïve	Japan	28 NT1 and 27 NT2 and 82 IH without long sleep	Mean age: 33.2 (NT1), 28.6 (NT2), 31.4 (IH w/o LST) Male %: 35.7 (NT1),	Cross sectional study One way ANOVA, Chi-square test,	ESS, SF-36	- All study groups had significantly lower scores on all domains of QOL measure aside from physical functioning and body pain than age- and sex-matched population normative data - Between study groups, emotional role functioning was significantly lower in NT2s compared to NT1 and IH without LST.

Drug-Naïve Patients with Narcolepsy with Cataplexy, Narcolepsy Without Cataplexy, and Idiopathic Hypersomnia Without Long Sleep Time	patients with NT1, NT2, and IH without long sleep time (average sleep time is less than 11 hours) and to explore the factors influencing the HRQOL.		time (LST) Total sample of 137	37 (NT2), 56.1 (IH w/o LST). Mean ESS score: 16.9 (NT1), 15.5 (NT2), 14.1 (IH w/o LST)	Welch's test, multiple linear regression		-For NT2 group, scores on the mental health domain were positively associated with being male and disease duration. - ESS scores were significantly higher for NT1 than NT2 and IH - For the total sample, subjective daytime sleepiness (as measured by ESS) was significantly related to increased experiences of motor accidents/near misses. However, this was not associated with any domains on the QOL measure.
15. Ozaki et al. (2012). Quality of life in patients with narcolepsy with cataplexy, narcolepsy without cataplexy, and idiopathic hypersomnia without long sleep time: Comparison	To assess the quality of life of patients with NT1, nt2 and IH without LST who were taking psychostimulants, and to ascertain which factors influence quality of life in this population	Japan	83 NT1 and 48 NT2 and 54 IH without LST Total sample of 185	Mean age: 33.2 (NT1), 30.5 (NT2), 33.3 (IH w/o LST) Male %: 51.8% (NT1), 52.1 (NT2), 63% (IH w/o LST) Married %: 21.3% (NT1), 13.6% (NT2), 23.5% (IH w/o LST).	Cross sectional study T-tests, one way ANOVA, post-hoc analysis using Scheffe's test, chi-squared test, multiple logistic regression	SF-36, ESS	- The NT2 group was found to have a significantly lower age of onset in comparison to other groups. - Subjective daytime sleepiness was not significantly different between NT1 and NT2 groups; between NT2 and IH without LST group. But was significantly different between NT1 and IH without LST groups - Subjective daytime sleepiness significantly was significantly lower in treated participants than drug naïve participants for all groups. - There was no significant difference between treated NT1 and NT2 on subjective daytime sleepiness, nor between NT2 group and IH without LST group. - Between drug naïve and treated NT2 groups, emotional role functioning was significantly worse in the drug naïve group. - In treated NT2 group, physical functioning, physical role functioning, vitality, social functioning, emotional role functioning, and mental health were still significantly lower than national population normative data. - In the total sample of treated participants, a higher age and no experience of relocating or being dismissed due to symptoms was significantly associated with higher scores on the physical role functioning domain;

between patients on psychostimulants, drug-naïve patients and the general Japanese population							perceived support from others was significantly associated with general health perceptions domain; normal daytime sleepiness and having autonomy over job schedule was significantly associated with better vitality; normal daytime sleepiness and no experience of a relationship breakdown due to symptoms was significantly associated with better social functioning.
16. White et al. (2020). Academic and professional paths of narcoleptic patients: the Narcowork study	To study educational & professional pathways of PWN and examine factors associated with better academic & professional prognosis	France	51 NT1 and 18 NT2 Total of 69 PWN 80 Controls	Men: 34 (49.3%) (NT group), 31 (38.8%) (control group) Mean age: 42.5 (NT group), 41.9 (control group).	Cross sectional study	BDI, ESS, ERQ, NSS, EQ5D-3L	- PWN were less often married/in a relationship compared to controls. There was no significant difference between NT1 and NT2 in this area. - NT1 group was found to be significantly more overweight/obese than controls, with a strong trend observed within NT2 group. There was no difference between NT1 and NT2 on BMI. There was no difference between narcolepsy groups and controls on the use of wake-promoting substances (such as caffeine) and alcohol consumption. - There were no significant differences found between NT1 and NT2 groups regarding age at disease onset, age at diagnosis and clinical symptoms (such as sleep paralysis, sleep inertia, insomnia). - NT1 experienced more daytime sleepiness (ESS>10 in 91.8% NT1 vs 72.2% NT2 patients, p = 0.04), sleep attacks (more than 1/day in 86.4% NT1 vs 42.9% NT2 patients, p = 0.01, and hallucinations (66.7% NT1 versus 29.4% NT2 patients, p = 0.007) than NT2. - There were no significant differences between narcolepsy group and controls in the distribution of graduation levels, school absences/delays, school repetitions or interruptions. - 75% of the total narcolepsy groups reported attentional/concentration difficulties during school, compared to 22.1% of controls. This was particular worse for the NT2 group (77.78% vs 10%). - In the narcolepsy sample, 48.2% informed occupational health about their condition, 38.9% informed colleagues, 38.2% informed their line manager, and 37.5% informed their employer.

	- In the narcolepsy sample, 56.6% felt accepted/understood at work, 15.1% felt they were considered lazy and misunderstood at work. - In the narcolepsy sample, 55.8% pretended they were hyperactive, 46.2% avoided meetings, 36.5% hid to take naps, 11.5% avoided exams, and 5.8% avoided promotion to conceal their narcolepsy symptoms. - Despite a trend observed towards higher rates of unemployment, there was no significant differences found between narcolepsy groups and controls in the distribution of occupational status, socio-professional categories, Frequency of job changes, mean duration of current or previous position, and proportion of participants who had experienced at least one period of unemployment, work facilities and schedules, and lastly rate of absences. - The control group were significantly more satisfied about their work compared to the narcolepsy group ($p = 0.03$), particularly around areas of promotion and support for difficult situations. - No correlation was found between work satisfaction and quality of life after adjusting for age, sex, and narcolepsy type.

Note: BDI = Becks Depression Inventory, BIS-11 = The Barratt Impulsiveness Scale Version 11, DERS = Difficulties in Emotion Regulation Scale, EDE-Q = Eating Disorder Examination Questionnaire, EQ5D-3L = EuroQol 5D 3 level version, ERQ = Emotion Regulation Questionnaire, ESS = Epworth Sleepiness Scale, FSS = Fatigue Severity Scale, GAD-7 = Generalised Anxiety Disorder Questionnaire, GSD = Global Impression of Severity of Depression, HADS = Hospital Anxiety and Depression Scale, IHSS = Idiopathic Hypersomnia Severity Scale, , MINIv6 = The Mini-International Neuropsychiatric Interview version 6, MSLT = Multiple Sleep Latency Test, MSPSS = Multidimensional Scale of Perceived Social Support, NSS = Narcolepsy Severity Scale, PHQ-9 = Patient Health Questionnaire, POMS = the Profile of Mood States, PROMIS = Patient-Reported Outcomes Measurement Information System, PSG = Polysomnography, PSQI = Pittsburgh Sleep Quality Index, S-BDI = Short version Beck Depression Inventory, SDS = Zung Self-Rating Depression Scale, SF-36 = 36-Item Short Form Health Survey, SIQ = Sleep Inertia Questionnaire, TAS-20 = Toronto Alexithymia Scale, VAS = Visual Analogue Scale, VR-36 = The Veterans RAND 36 Item Health Survey

Methodology

Given the scarcity of literature in this area, information was gathered from multiple sources/modalities to complete a comprehensive appraisal. Given the variability in study design, outcome measures, lack of interventions employed, sample sizes and analyses used in the studies; considerable clinical and methodological diversity in the selected studies meant a meta-analysis was inappropriate. Therefore, a narrative review was conducted to identify the psychosocial outcomes of NT2. Findings from studies were synthesized using Mays et al (2005) and Consumers and Communication Review Group (2013) guidance on systematically reviewing literature. The psychosocial outcomes of narcolepsy were extracted from studies by reading through papers multiple times, synthesizing data through the identification and organisation of themes and outcomes. Please see figure 3 for more information on this process.

Quality Assessment

Quality of papers were assessed using the Quality Assessment with Diverse Studies (QuADS) (Harrison et al., 2021). It is an improved version of the Quality Assessment Tool for Studies with Diverse Designs (QATSDD), which was developed for the use of health research under the disciplines of sociology, nursing, and psychology. The QATSDD was created to be used for systematic reviews which include a range of methodologically diverse research, with the QuADS created to enhance its applicability to health-related research and multi/mixed method research. It is a 13-item, validated quality assessment tool used in systematic reviews that involve diverse study designs (appendix A). The use of quality assessment tools is often employed to support in assessing the quality of research. Subsequently, these assessments are often subjective, and some variation can be found between researchers. Most papers were appraised to have a minimum of good quality which

can be observed in table 4. Papers were not excluded based on their quality due to the limited body of research that has currently been completed on NT2.

Figure 3: *Narrative review process with consideration of Mays et al (2005) and Consumers and Communication Review Group (2013) guidance*

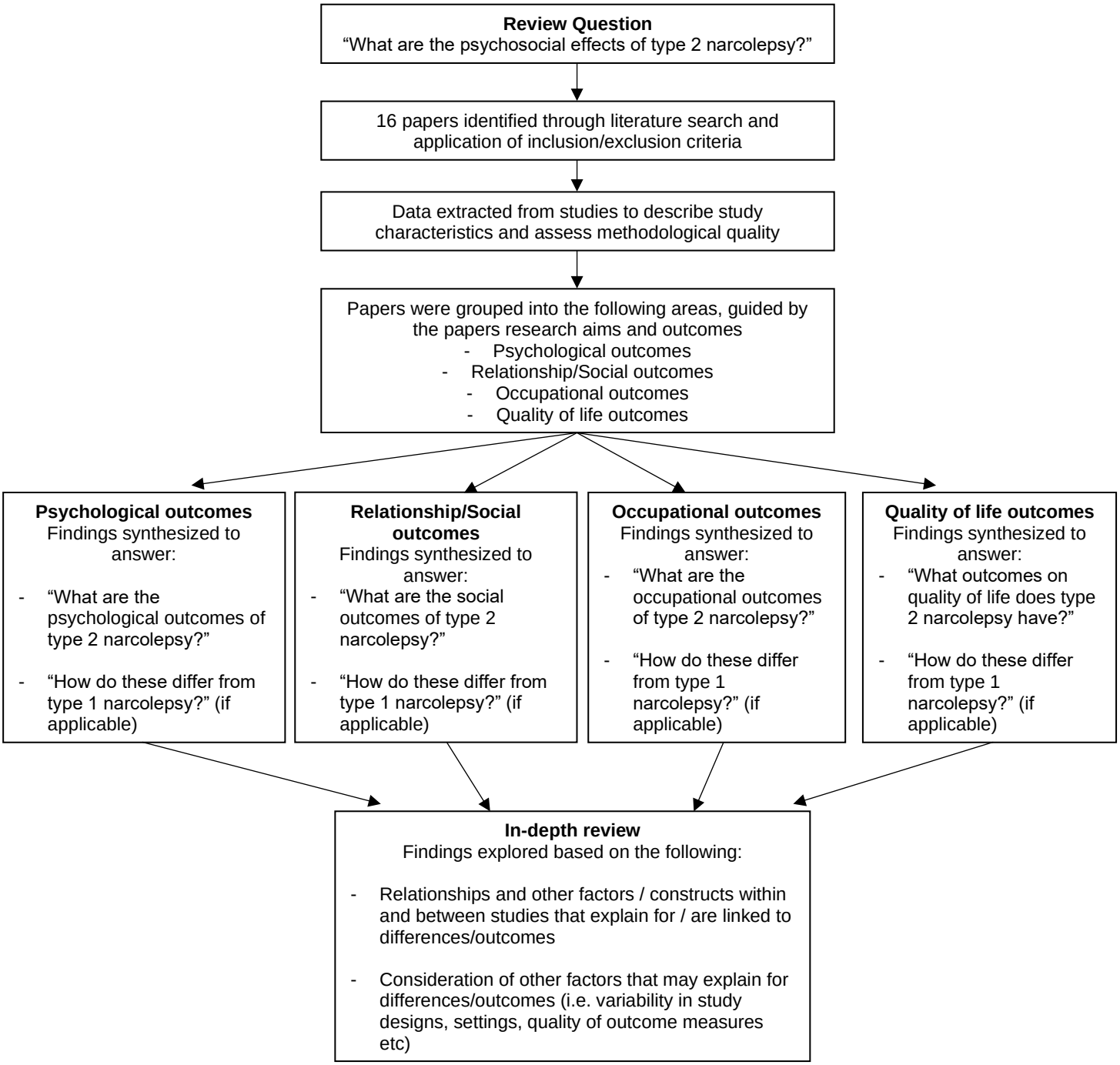


Table 5: *Quality Assessment of included studies*

Paper	Theoretical/ conceptual underpinning to the research	Aims clearly stated?	Clear description of research setting/ target population	Study design appropriate for research aims?	Appropriate sampling to address research aims?	Rationale for choice of data collection tools	Format/ content of data collection is appropriate	Description of data collection procedure	Recruitment data provided	Justification for analytic method	Analysis appropriate for research aims	Stakeholders considered in design/ conduct	Strengths and limitations critically discussed
1	2	1	3	2	2	0	2	1	2	0	2	0	1
2	2	2	2	2	2	1	1	1	2	0	2	1	1
3	3	3	3	3	3	3	2	1	3	2	3	0	3
4	2	3	3	3	2	1	2	0	2	1	2	1	2
5	1	2	2	3	3	1	2	2	3	0	2	0	1
6	3	3	3	2	3	2	3	2	3	2	2	2	3
7	3	3	3	3	3	2	3	1	2	2	3	0	2
8	3	3	3	3	3	2	3	2	2	1	3	0	2
9	2	2	2	2	3	0	3	1	2	0	3	0	1
10	2	3	3	3	3	0	2	2	3	0	2	0	2
11	2	3	3	3	2	3	3	2	2	1	3	2	1
12	3	3	3	3	3	2	2	2	2	1	2	2	2
13	3	3	3	3	3	2	3	3	2	2	2	0	2
14	2	3	2	3	2	1	2	1	2	0	2	0	1
15	1	2	3	3	2	1	2	1	3	1	3	0	2
16	2	3	2	3	2	2	3	2	2	1	3	0	2

Application of theory and aims

Six studies (3, 6, 7, 8, 12, 13) demonstrated awareness and consideration towards key theories and concepts within the introduction section of the study; with the application of these key concepts evident throughout other sections of the study. Seven studies (1, 2, 4, 9, 10, 11, 14, 16) identified specific and relevant theories/concepts and described how these helped inform their research aims, whilst two studies (5, 15) provided general reference to broad theories within the introduction section only. All studies provided a clear description of narcolepsy and its aetiology alongside examples and notions of psychosocial impact.

All studies aside from one (1) explicitly stated the aims of their research, with 11 studies providing further details within the main body of the report (3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 16). Study 1 gave an account of what they achieved but did not make an explicit statement of aims which may elicit some ambiguity for understanding the researcher's rationale in undertaking that study. Seven studies involved the investigation of psychological and/or psychiatric functioning in adults with narcolepsy (1, 2, 5, 7, 9, 11, 12), seven studies investigated health-related quality of life/quality of life in adults with narcolepsy (3, 4, 8, 10, 13, 14, 15), one (6) study investigated social functioning in adults with narcolepsy, and one study (16) investigated the occupational impact of narcolepsy.

Design

All but one study followed a quantitative research design. Study 13 was a mixed-methods study using a convergent parallel design. Three studies used a case-control design (2, 5, 7). Three studies (3, 8, 9) used a cohort design, ranging from a period of 3 months and 5 years. The remaining nine studies used a cross-sectional design (1,4, 6, 10, 11, 12, 14, 15, 16). Out of these nine cross-sectional studies, four included the use of a control group (4, 7, 9, 16). Two compared results to normative data available at that time (14, 15) and five

compared narcolepsy to other conditions or type (1, 6, 10, 11, 12). The lack of control groups makes it difficult to establish whether a relationship truly exists between narcolepsy and the psychological/social impact discovered and the severity of this (Kinser & Robins , 2013).

Population and Recruitment

All studies utilised convenience sampling. Participants were recruited through the researcher's sleep centre or outpatient clinics. Studies that took place online also recruited through local/own sleep centre alongside online forums such as social media and charitable organisations. This type of sampling has risks in creating bias within the results of studies as the sample may not be representative of the wider population (Andrade, 2021). All studies aside from 6, 10 and 16 confirmed a diagnosis of narcolepsy with a PSG and MLST at the minimum. Some studies also took additional measures to confirm diagnosis such as HLA typing, brain scans or a hypocretin test. Diagnosis was confirmed following ICSD-2 or ICSD-3 criteria. Study 16 requested from prospective participants documentation confirming diagnosis which could be in the form of a PSG/MLST report or letter from physician, and studies 6 and 10 excluded participants where symptoms did not match ICSD-3 criteria or reported NT2 and cataplexy together. Given the nature of narcolepsy, this method of sampling would appear most appropriate. However, doing so may lead to prevalence-incidence bias (Tripepi et al., 2010), which may cause implications when making conclusions about the impact of narcolepsy on variables of interest (i.e., unable to distinguish whether the severity or duration of the condition is what impacts certain psychosocial factors).

Sample sizes varied greatly between studies. Studies 2, 3, 6 and 11 grouped NT2 with other conditions such as NT1 or IH, whilst the rest kept NT2 as its own group in final analysis. The smallest sample size was 24 found in study 7 and the largest was 833 found in study 10. Out of the four studies that used control groups, three were matched by age and sex.

Study 9 ensured that controls did not have a clinical score on depression and sleepiness scales. Without control groups, it may be difficult to ascertain whether the psychosocial affect is due to narcolepsy or other confounding variables. This is particularly significant when understanding psychosocial functioning, as this can be impacted by many other factors aside from narcolepsy. For comparison studies, only four studies had equal sized groups (4, 7, 9, 11). The use of control groups can increase the finding's internal validity (Cahit, 2015). It is also important to note the impact of small and/or unequal sample sizes when completing inferential analyses, as doing so can have consequences on statistical power and increase the likelihood of type I and/or II errors (Rusticus & Lovato, 2014). Some studies made attempts to address this this by completing Bonferri corrections or running non-parametric tests however others made no reference to how they managed unequal samples or commented on variance.

Most studies included in this review were conducted with Western populations however, no studies took place in the UK. Study 9 specifically stated that they recruited White individuals only. Two studies reported ethnicity data (6, 13), both of which recruited via online means but limited to those who resided in the USA. Some studies were also conducted in Eastern populations such as Japan, Taiwan and Saudi Arabia who also did not report ethnicity data; however, this may be due to these areas being more ethnically homogeneous compared to Western countries (Lee et al., 2006; Dražanová 2020). Despite this, it would be valuable to report this demographic to ensure data is truly representative.

Outcome Measures

A variety of measures were used to measure narcolepsy/sleepiness, psychological wellbeing, QOL and social functioning. The Epworth Sleepiness Scale (ESS) was the most used scale to measure levels of sleepiness in participants. Other questionnaires that measured

sleepiness or symptoms associated with narcolepsy included the Narcolepsy Severity Scale (NSS) (1, 12, 16), Fatigue Severity Scale (FSS) (12), Pittsburgh Sleep Quality Index (PSQI) (5), Sleep Inertia Questionnaire (12) and the Visual Analog Scale (VAS) (3, 8). In term of measures of QOL, the Short-Form-36 Health Survey Questionnaire (SF-36) was most used, however other measures such as the EuroQol Quality of Life scale (EQ5D-3L) (1, 16) and the Veterans RAND 36 Item Health Survey (VR-36) (10) was used.

A variety of psychological wellbeing and mood measures were used across studies. The Beck Depression Inventory (BDI) (1, 5, 9, 11, 16) was the most used measure for low mood. The Patient Health Questionnaire-9 (PHQ-9) (7, 13), Hospital Anxiety and Depression Scale (HADS) (12), Generalised Anxiety Disorder scale-7 (7) were also used. Other psychological wellbeing measures used included the Emotion Regulation Questionnaire (ERQ) (1, 7), study 7 also incorporated the use of Barratt Impulsivity Scale-11, Toronto Alexithymia Scale, and Eating Disorder Evaluation Questionnaire, whilst study 9 used additional mood measures such as the Zung Self-Rating Depression Scale (SDS), the Global Impression of Severity of Depression (GSD), the Profile of Mood States (POMS).

Multidimensional Scale of Perceived Support (MSPSS) (6) and the Patient-Reported Outcomes Measurement Information System (PROMIS) (10, 13) were validated measures used to measure social functioning. Non-validated questionnaires that used a Likert-scale created by the researchers were often used to gather further information (6, 14, 15, 16).

The large use of validated measures across studies indicates assurance of accurate and reliable results of the construct investigated. However, it is important to discern whether such measures are reliable to be used with PwN. Many measures of low mood often incorporate questions relating to tiredness/excessive sleeping, naturally PwN will score higher than people without narcolepsy on these items leading to a higher average of scores on such

measures (BDI and PHQ-9) however this may not be an accurate depiction of low mood symptoms for PwN. Additionally, as measures are self-report, this can have implications on reliability and validity (Brenner & DeLamater, 2016). Self-report measures are subjective, meaning they can be susceptible to bias or distortions. Respondents may experience difficulties with accurately recalling/describing their experiences, have variation in the interpretation of questions or may not always accurately report their true feelings/behaviours/beliefs (particularly emphasized if respondents are experiencing EDS). Consequently, self-report measures will not be as precise or sensitive to identifying differences compared to objective measures of data collection.

Self-report measures may have difficulties capturing rich information related to the construct being investigated. As such, it can be useful to incorporate interviews to provide further detailed descriptions. Study 2 used a validated version of the Mini-International Neuropsychiatric Interview (MINI-6) to screen for psychological conditions, additionally studies 5, 11, 12, 13 also utilised either individual or group interviews alongside validated self-report measures to enhance the data collected.

Data Analyses and Limitations

All studies documented procedures of data analysis and provided a range of descriptive and inferential statistical methods to present data and achieve their aims. All studies acknowledged the limitations of their study, however there was great variation to the degree of which this was completed. Studies 2, 9, 10, 12, 14 and 15 limitations were not completed to detail or omitted glaring shortcomings of their study. Additionally, many studies did not comment on whether stakeholders were present in the creation/conduction of the study. It is unclear whether this was due to them excluding this information or whether no consultation with stakeholders had taken place.

Studies 3 and 8, and 14 and 15 were conducted by the same researchers where it is clear they have an interest and wealth of knowledge in narcolepsy. The researcher's previous studies were referred to when introducing concepts or explaining the rationale for the more recent study. This may indicate a potential bias with researchers pursuing their own opinions and ideas within this area or generating data to shape certain ideas or findings. There was no mention of researcher reflexivity or a conflict-of-interest statement in these studies, thus it is not possible to make any conclusions or links about the findings and researcher perspectives.

Synthesis of Findings

Psychological Outcomes

Overall, seven studies (1, 2, 5, 7, 9, 11, 12) investigated psychological conditions and mental wellbeing in PwN. Studies with control groups found that NT2 experienced significantly more psychological distress such as depression and anxiety (2, 7, 9). Study 2 found NT2 were twice as likely to present with psychiatric disorders such as major depressive disorder, suicidality and GAD compared to controls. Other studies also demonstrated that the prevalence of depression and anxiety in NT2 were triple or even quadruple that of the general population (1, 9). Study 9 demonstrated that NT2 still had significantly higher depressive symptoms compared to controls even when sleep items were excluded in analysis, supporting previous research (Fortuyn et al., 2011). Upon exploration of QOL studies (further explored later), all studies also illustrated that people with NT2 experienced higher levels of psychological distress compared to controls, particularly on mental health domains such as emotional health and reduction of activities due to emotional difficulties.

Two studies (1, 2) found NT2 scored higher in measures of anxiety or exhibited more symptoms of GAD compared to controls, whilst one study (7) did not find any significant differences in anxiety. Study 1 found a significant relationship between younger age and the

presence of anxiety in NT2. It may be theorised that this could be due to the individual not having had the necessary time to have adjusted to their symptoms compared to older PwN, however given the design of this study, further research is needed to elucidate such findings. It is noteworthy to consider the causes behind the significant and non-significant difference in findings between studies; it may be attributed to differences in sample sizes, as study 7 had the smallest sample size of all three studies, thus possibly not being sufficiently powered to detect any possible differences between groups (Button et al., 2013).

Study 11 found that 28% of NT2 experienced hallucinations, all of which were but not limited to being visual in nature, whilst study 16 found that 29.4% of NT2 experienced hallucinations. Study 11 also found that these hallucinations were not predicted by levels of EDS and were more comparable to hallucinations experienced by people with Parkinson's disease. Consequently, people with NT2 may experience depression or anxiety if they have not yet found appropriate strategies to successfully adjust to their specific symptomatology.

Two studies investigated the influence of gender on the relationship between psychological wellbeing and narcolepsy and found an overwhelmingly strong relationship between mood and the female gender, which study 12 found was particularly significant in NT2 as their findings demonstrated anxiety and depression scores were significantly higher in women compared to men. Study 9 identified that being female was a strong predictor of experiencing depressive symptoms in PwN. Following logistical regression, this result was still significant when excluding the effect of medication and the presence of cataplexy (for NT1).

Study 1 found no relationship between: the presence of a psychological disorder and type of narcolepsy; age, the type of narcolepsy and the type of psychological disorder; and the degree of EDS and the presence of anxiety and/or depression. It is noteworthy that their

sample were all prescribed/taking anti-depressant medication before their diagnosis of narcolepsy due to being diagnosed with depression or anxiety beforehand, suggesting the onset of these mood-related difficulties preceded the medical diagnosis of narcolepsy and not due to the onset of the symptoms of narcolepsy such as EDS and/or cataplexy. However, this may be due to delayed diagnosis often seen in NT2, as there may be years of difference between when clinicians diagnose depression/anxiety before a definitive diagnosis of narcolepsy is made. Study 9 found PwN using both antidepressant medication and stimulants presented with more depressive symptoms than those only using stimulants or who were unmedicated. Following logistic regression, the researchers revealed that cataplexy did not affect the presence of depressive symptoms.

In comparison to NT1, study 5 reported increased depressive symptoms and frequency in NT1 than NT2, whilst five (1, 2, 7, 9, 12) studies did not find any significant differences in mood related difficulties between NT1 and NT2.

Relationships and Social Functioning

Study 6 investigated the impact of narcolepsy on friendships and romantic relationships. It identified that 96.1% of NT2 reported that narcolepsy made friendships more challenging and their social life more difficult. Forty-seven percent (47.6%) indicated they had too few friends and one in five reported that they had not socialised with friends at all over the past week because of their narcolepsy. In terms of romantic relationships, 87.4% of NT2 reported that narcolepsy made entering relationships more difficult. Despite this, 92.2% reported having previously been in a romantic relationship, with 84.2% being in a romantic relationship at the time of the study. Out of those reported being in a romantic relationship at the time, 37.5% reported to be married and 32.5% were cohabiting. Eighty-one percent (81.3%) indicated that they were at least mostly satisfied in their relationship. The marriage

rates reported in the study were not largely dissimilar to that of the general population rates (42%), however cohabitation rates were higher (19%). This may reflect the importance of the support provided by partners in the home for PwN, as it was identified that NT2 perceived social support from their partner significantly higher than perceived social support from friends/family.

Study 6 highlighted that PwN feel limited in how much energy/time they can dedicate towards social relationships due to their symptoms, therefore dedicating more towards their romantic relationships, as they were more likely to disclose their diagnosis to partners within the first six months of their relationship compared to disclosures with friends, which often occurred after six months to a year. Motivations identified for disclosing earlier on in relationships was due to safety, planning, and minimising judgement. Despite committing more towards romantic relationships, PwN often reported struggles with their sexual functioning because of their narcolepsy. The majority of PwN reported feeling exhausted in the evening, with over half reporting that had fallen asleep during sex. There was no difference found between NT1 and NT2 in this area.

Study 6 found 69.3% of PwN reported that their primary practitioner never asked about the impact of narcolepsy on their social life, with 72.8% of PwN stating they wanted their medical practitioner to review the impact of narcolepsy on their social life. In terms of romantic relationships, 44.8% of PwN wanted their medical practitioner to review how narcolepsy impacted their sex life, with only 9.8% of practitioners having asked. Although the subject may be viewed as a sensitive to review, it appears to be an important area to discuss for PwN as understanding more about the interactions of medications and behavioural interventions may support with their decisions and efforts to adjust to the condition and balance the need for connectedness with their partners and/or friends.

There were no significant differences found between the impact of NT1 and NT2 across all areas of social functioning and relationships characteristics/quality, apart from one area which was whether they had experienced cataplexy during sex or not (where all NT1 reported yes, whilst all NT2 reported no). The most impactful symptom on social functioning in narcolepsy was EDS, denoting that social functioning was independent from the type of narcolepsy. This highlights that the social impact of narcolepsy is not more severe in NT1 than NT2 and once again the consequence of NT2 should not be dismissed.

Occupational Outcomes

Study 16 investigated the occupational and educational pathways of PwN and explored the condition-related and environmental factors associated with better occupational and academic prognosis. In terms of academic outcomes, there were no significant differences found between PwN and controls in distribution of educational attainment, school absenteeism/attendance, repetition of school years, or study interruptions; this was regardless of age at disease onset or narcolepsy type. A higher frequency of difficulties encountered during school were reported by PwN and was associated with childhood disease onset. Seventy-seven percent (77.8%) of NT2 reported a higher level of attentional impairment compared to 10% of controls.

In terms of occupational outcomes, although there was a higher trend of unemployment found in PwN compared to controls, there was no significant difference found in the distribution of employment status between controls and NT2 or NT1, or between NT2 and NT1. There were also no significant differences found between PwN and controls on number of job changes, duration of unemployment periods, work absenteeism and accidents, and mean duration at current or previous role. PwN expressed significantly lower satisfaction about their work compared to controls, particularly with promotion perspectives and feeling

adequately supported in difficult situations. Further analysis revealed that there was no correlation between work satisfaction and narcolepsy type, age, or QOL. Fifty-six percent (56.6%) of PwN reported feeling understood/accepted at work, whilst 15.1% felt that they were perceived as lazy and 13.2% felt misunderstood. To conceal their symptoms, 55.8% of PWN pretended that were energetic, 46.2% avoided meetings and 36.5% hid themselves to take a nap. This highlights the perceived stigma PwN experience, how it transpires in work environments may be a strong factor that influences work satisfaction.

PwN were found to have significantly poorer professional prognosis compared to controls in relation to graduation level, number of changes in employment due to disease/dismissal, number of sick days, cumulative duration of unemployment and actual employment status. However, this difference was not significant for NT2 but was significant for NT1. Despite this, there was high heterogeneity found in the different narcolepsy groups which suggests great variability in these outcomes for PwN regardless of type. Gender, use of narcolepsy treatment/wake-promoting drugs, cognitive appraisal and age at diagnosis did not have any significant impact on professional prognosis. Narcolepsy type (NT2), lower EDS, less depressive symptoms, higher QOL and not being overweight was associated with better professional prognosis, however after multivariate analysis, only QOL remained significantly associated with professional prognosis. Lastly, the study found that a better professional prognosis was observed in PwN with early onset of the condition. The researchers theorized this may be explained by more appropriate choice in career path, education, and development of the ability to cope with symptoms.

QOL

Seven studies investigated QOL in PwN. Study 4 identified that all areas of QOL in NT2 was significantly worse compared to controls, whilst studies 10, 14, and 15 found QOL

was significantly lower compared to general population norms. Particularly, study 10 identified that PwN's mental and physical health functioning were approximately at least one standard deviation lower than the average population. The QOL areas that were found to be most impacted in NT2 were physical role functioning, emotional role functioning, vitality, general health perceptions, psychological health, and social functioning. Studies 4 and 15 also found that physical functioning was significantly worse compared to controls and population norms respectively.

Weight and physical activity were found to influence areas of QOL in PwN. Study 4 identified weight to significantly influence QOL in NT2. For overweight NT2: pain, physical functioning, vitality, social functioning, and psychological health was significantly worse compared to normal weight NT2; with obese NT2 showing a worse trend on all aforementioned domains in addition to general health perceptions. The influence of weight was found to impair QOL in these domains more for NT2 than NT1. Additionally, study 10 identified that PwN who reported higher physical activity had better scores on all physical and mental health domains.

Various studies revealed mixed findings on the role of EDS on QOL. Study 3 found EDS and cataplexy were correlated with many physical and mental health domains; particularly that EDS influenced most physical health domains aside from pain. Furthermore, study 13 identified the unrelenting nature of EDS as a key factor towards poor health-related QOL. However, study 14 investigated QOL in central disorders of hypersomnolence (NT1, NT2 and IH) and found that although all groups displayed varying degrees of EDS, this did not impact on the degree of poor QOL, demonstrating that the magnitude of subjective EDS is not a main factor for poor QOL. Study 15 revealed that reducing EDS did not normalise QOL, but instead identified the psychosocial consequences of EDS to be more associated

with QOL such as experiencing a divorce/break up due to symptoms, being dismissed or relocated from a job due to symptoms, and perceived social support from friends/family/manager/coworkers. Further to this, study 13 found that negative perceptions about narcolepsy from others such as mockery of symptoms due to misunderstandings/insensitivity, low self-esteem and self-efficacy were strongly related to QOL, and that role limitations and reduced functioning were due to low self-esteem and self-worth, which translated to poorer social functioning and reduced emotional role functioning. This appears to support findings from previous research on the impact of stigma and low mood (Kapella et al., 2015).

Medication use and QOL was investigated in two studies (3, 15). Study 15 found medication significantly improved EDS, however despite improvements, all domains aside from pain and general health perceptions were still significantly lower than general population norms, with only emotional role functioning significantly improving following the use of medication in NT2. QOL was significantly lower than general norms, even when the expression of depression was excluded. Study 3 found that medication significantly improved subjective sleepiness, however only emotional role functioning significantly improved following five years of medication use. Furthermore, study 3 found that medication did not improve psychological health or vitality despite EDS improvements.

In comparison to NT1, NT1 tended to demonstrate higher trends of diminished QOL compared to NT2. NT1 displayed significantly lower scores in general health perceptions (3, 15), physical functioning and physical role functioning (3, 4, 10), and social functioning and vitality (3). These findings may be anticipated due to the impact cataplexy. NT1 was also found to more overweight than NT2, which may explain for higher trends in poorer QOL. NT1 responded significantly better to medication compared to NT2 however this is likely due

to more apparent improvements with reduction in cataplexy. However, this once again highlights the presence of other components that affect QOL in NT2 and signifies importance to identify suitably tailored interventions for NT2 so that they may benefit from improved QOL since they are not afforded the same improvements from medication as NT1.

Discussion

The current review aimed to synthesize the literature on psychosocial functioning in NT2 and identify differences with NT1. In summary, NT2 was found to increase the prevalence of depressive symptoms, significantly affect social functioning and relationship development due to EDS, and diminished QOL with strong influence from weight and poor improvements from medication. There was no difference in the distribution of educational attainment and employment status between NT2 and healthy controls, however NT2 affected work satisfaction. NT1 and NT2 did not differ in psychological, social and occupational functioning, however NT1 was found to be more overweight and have poorer QOL than NT2.

The current review has demonstrated that the literature is still in its infancy, with research largely focusing on NT1 or combining both types. Although NT1 demonstrated greater QOL impairments, it has confirmed that NT2 experience considerable difficulties in psychological and social functioning. Findings suggest that cataplexy, NT1 and severity of EDS had little association on psychological distress. However, due to the cross-sectional designs and lack of control groups in studies, the causality of these relationships cannot be confirmed. Most studies were also cross-sectional, highlighting the lack of longitudinal studies, particular over a longer period. Subsequently, it can be difficult to make concrete conclusions around the progression of narcolepsy, evidence the long-term effects of the condition on psychosocial functioning or identify factors that may be helpful in managing the condition. This is particularly pertinent when researching a condition as rare as NT2, given

the knowledge on its prognosis is unclear. Combining the uncertain diagnostic pathway with the rare nature of the condition may have made it difficult for researchers to identify appropriate participants to conduct longitudinal studies possibly, thus leading to this gap.

Findings support previous research on the link between narcolepsy and depression, however the relationship between anxiety and narcolepsy is not as well established. Researchers often attribute hypocretin deficiency found in NT1 to depression and mood disorders in narcolepsy, however given these findings, this indicates that this theory is not supported and suggests the presence of other underlying factors which contribute to the psychological wellbeing of PwN that should not be disregarded in NT2.

Females were more likely to have poorer psychological outcomes than males. Females are more at risk of social and cultural stressors such as adverse child/adulthood experiences or power/status inequalities which have implications on societal evaluation of females in certain environments, possibly exacerbating psychological distress (Stegenga et al., 2012). Furthermore, biological factors may cause females to be more vulnerable to psychological distress than males (i.e. fluctuations in hormones, menopause, pregnancy) (Benedetto et al., 2024) Findings highlight the multiple disadvantages females with NT2 may experience and emphasizes the importance of psychological support for this specific population. It also proposes questions around gender and its influence on psychological wellbeing in NT2 and highlights the need for further research to understand the intersecting nature of these two factors to explicate whether it is sex-related differences or differences in how females are socialised, manage/cope with NT2 difficulties, or how they exhibit psychological distress compared to men.

Findings surrounding medication use and mood-related difficulties generate inquiry towards mental health status as a precursor for how NT2 experience psychological distress

following diagnosis. Considering Moss-Morris's adjustment model, it highlights the importance of factors such as personality, early-life experiences and significant events impacting psychological health prior to diagnosis, or personal opinions regarding medication use may contribute towards how NT2 may experience/manage psychological distress. Implications of such findings may include assessment of current and past psychological wellbeing, and previous significant events contributing to psychological wellbeing within sleep clinics to understand how PwNT2 may respond to diagnosis and management of symptoms and may help inform decisions on implementing appropriate psychological intervention for NT2. Furthermore, meaningful discussions with clinicians to assess beliefs and decisions regarding treatment/management to collaboratively formulate a plan which promotes self-efficacy would be clinically valuable.

The social impact of NT2 was evident, with findings demonstrating PwN must often sacrifice the development of certain relationships over others due to their symptoms. Motivations towards disclosing diagnosis in romantic relationships emphasize the notion of practical need as a driver for disclosure, further research would be valuable into understanding the mechanisms of this in relation to successful adjustment to the condition. The finding that PwN desired more review of social functioning by clinicians is particularly pertinent as many behavioural interventions for narcolepsy, such as regular naps, consistent sleep and wake times, and obtaining sufficient sleep can be viewed as an obstacle for attending evening and/or early morning social events, which may be central to developing and maintaining social relationships. Consequently, implications of this may include interventions involving sufficient review of social support and relationships in NT2 and recognition/review of current evidence-based interventions on socialisation to find methods of improving social functioning in NT2. Despite these findings, the research on social and

occupational impact of NT2 is extremely limited and further exploration in this area may reveal additional/different findings.

Findings propose that EDS only partially influences QOL in PwN, with variable influence from other psychological factors. Although QOL remained impacted irrespective of depression, findings suggest that the psychosocial consequences of EDS (such as loss of employment, relationship breakdowns, perceived stigma from others) and psychological factors such as low self-esteem, self-worth and health-related stigma were related to QOL. Consequently, interventions that target psychological wellbeing in these areas should be considered in sleep clinics to improve QOL in NT2. Findings also confirm that medication alone cannot improve QOL, and a holistic approach targeting psychosocial and environmental factors should be deliberated. Considering Moss-Morris' model, successful adjustment of psychological factors may focus on improving self-efficacy of disease management through means other than medication, such as behavioural interventions that support with maintaining activity levels or increasing perceived social support. Improving awareness/knowledge of narcolepsy in areas such as workplaces, school, and other healthcare settings such as mental health services and primary care; increasing accessibility to social support such as peer support groups; providing knowledge for families around how to support a PwN, and implementing mental health interventions with clinicians who have good understanding of narcolepsy would be valuable. Psychotherapy addressing negative beliefs and acceptance around identity and autonomy for people with NT2 would be beneficial to facilitate successful adjustment of the condition.

PwN's occupational/academic attainment were not found to significantly differ from healthy controls; however, QOL significantly affected occupational/career prognosis, and found to be significantly worse in NT1 than NT2. The above recommendations surrounding

QOL improvements may prove to have positive downstream consequences on professional prognosis, however future research would be worthwhile to explore such outcomes. Better professional prognosis was identified to be positively associated with early onset of the disease which highlights the importance of early identification and diagnosis, which is currently lacking for NT2. Thus, it would be beneficial for services to improve and streamline diagnostic pathways for NT2 given its current indistinctness.

Social support, stigma, and low self-esteem/efficacy were factors that were found to influence functioning in various areas for NT2 and contribute towards ongoing disequilibrium. Given society's poor understanding of narcolepsy, stigma and scepticism surrounding the legitimacy of PwNT2's difficulties from others will undoubtedly impair self-esteem and perceived social support. The invisible nature of NT2 may lead society to view NT2's difficulties as sleepiness with the belief that more sleep/rest or change in routine will address their issues, however this can further alienate PwNT2 given they suffer from a neurological condition with symptoms that are beyond their control. As such, findings have various implications for the individual, services that support PwN and at a societal level. On a societal level, changes may involve how narcolepsy is represented in the media and increasing education around the differences between NT1 and NT2 to improve stigma and negative representations of the condition. Sleep clinics should place more emphasis on providing psychological support (instead of medication) with interventions addressing issues relating to self-esteem/confidence, or aim to improve resilience, self-efficacy and coping. Considering therapeutic models, one study investigating the lived experience of narcolepsy in adolescence identified that accepting narcolepsy as part of one's identity may be helpful in coping with the condition (Chen et al., 2022). Consequently, implementing acceptance-based methods to help develop psychological flexibility and resilience in managing psychological and narcolepsy-related challenges may support successful adjustment of the condition.

Interestingly, there is no current research investigating the efficacy of such methods in narcolepsy whilst many have been completed for insomnia showing promising results (Schwartz & Margolies, 2019; Chapoutot et al., 2021).

Findings highlight the importance of PwN maintaining healthy weight/activity levels. Despite NT1 being more overweight than NT2, NT2 was found to have greater impairments in QOL when weight increased. This suggests that NT2 is more vulnerable to QOL changes when reducing activity levels, which may also have repercussions on social and occupational functioning, as findings highlighted the role of QOL in professional prognosis. NT2 symptoms may increase social withdrawal and engagement in activities due to worries around negative perceptions from others, therefore increasing weight/decreasing activity levels which may contribute to further impairments in social functioning, self-worth, and psychological wellbeing. This highlights the importance of maintaining weight/increasing activity particularly for NT2 and should be considered alongside intervention as this may have positive benefits on weight, initiating QOL improvements. PwNT2 should aim to monitor weight regularly, with support from reviewing clinicians assessing changes in weight, activity levels and social functioning (i.e. social withdrawal or isolation) regularly. Future correlational and explanatory research identifying how these factors uniquely effect coping and contribute towards successful adjustment in NT2 would be valuable, alongside identifying other disease-specific factors that may affect successful adjustment of NT2 such as historical responses towards distress and psychological wellbeing, events relating to diagnosis and the experience of treating/diagnosing clinicians and treatment.

Limitations

Several limitations were noted in the current review. There was a significant lack of qualitative research included in the review, thus, future research should focus on employing

this methodology or a mixed methods design to obtain comprehensive information relating to psychosocial functioning in NT2. It may be beneficial for a narcolepsy-wide measure that evaluates psychosocial and/or QOL outcomes for future research to employ to ensure uniformity across studies which can facilitate more thorough reviews so that synthesis of information is reported in a clinically meaningful approach. This would help facilitate meta-analyses on the impact of NT2, as it is acknowledged that narrative reviews rely on author interpretation, leading to bias and inconsistency (Grant & Booth, 2009) whereas meta-analyses can provide objective conclusions through synthesis of quantitative evidence. The review also only included studies written in English which were published; however, this was not implemented purposefully. Consequently, there may be more research on NT2 that may have been excluded.

Due to a lack of research in the area, data where NT2 was combined with other conditions to conduct additional analyses were included. Although efforts were exerted to separate both conditions, NT2 findings may be confounded with NT1, affecting validity of review findings. There was a significant lack of reporting/collecting data on ethnicity, given what we know about how the condition may present in other ethnicities, findings from this review may not be generalisable to PwNT2 from different ethnicities. Lastly, there appeared to be a large gap in research around NT2 and the role of mental health/community-based services. Given what we understand of this population, this review was unable investigate and explore accessibility and outcomes of such services to identify any improvements required to reduce the psychosocial impact of NT2.

Conclusion

This review has revealed an inadequate research base on NT2, however most of the included studies were to be at least good in quality. PwNT2 experience significant

psychosocial challenges, and their existence and wellbeing should not be minimised in clinical or academic practice. It highlights the need for increasing awareness of the condition to reduce stigma and improve social support to ensure good social outcomes. It emphasizes the importance for review and intervention of psychological wellbeing in NT2 within sleep clinics and the provision of high-quality mental health services specific to narcolepsy. Further research should focus on investigating the specific mechanisms that may produce such variability in individual outcomes of adjustment in the condition whilst applying methodological considerations as illustrated in the current review.

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Carmen Ng BSc Hons MSc

Section B: An Investigation into the Impact of Mood on the Relationship between Sustained Attention and Working Memory in People with Narcolepsy.

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Abstract

Study Objective: To investigate the role of mood on cognitive (memory and sustained attention) outcomes in people with narcolepsy (PwN).

Methods: This cross-sectional study included 70 PwN (36 with type 1 narcolepsy (NT1) and 34 with type 2 narcolepsy (NT2)) and 70 controls matched by age, gender, and education. Data on depression and anxiety symptoms were collected using the Hospital Anxiety and Depression Scale. A web-based digit span task and sustained attention to response task was employed to measure short-term memory, working memory and sustained attention. Group differences were identified using analysis of variance. Simple and serial mediation analyses were completed with a bias-corrected bootstrapping method.

Results: Descriptive statistics revealed that narcolepsy groups exhibited with more excessive daytime sleepiness than controls. PwN scored higher in measures of low mood and had lower working memory performance compared to matched controls. NT1 scored significantly lower on sustained attention than controls, whilst NT2 did not. NT2 were more anxious than their matched counterparts whilst no difference was found in NT1. There was no significant difference in all psychological or cognitive outcomes between NT1 and NT2. Mediation analyses revealed that the indirect effect of narcolepsy on working memory was serially mediated by low mood and sustained attention.

Conclusions: Our findings suggest that low mood and sustained attention significantly mediates the effects of narcolepsy on working memory. Although sustained attention is affected in narcolepsy, its effect on working memory is subject to its interaction with low mood symptoms. Future research and clinical implications with this population are considered.

Introduction

Narcolepsy is a chronic, neurological condition characterized by the inability to regulate sleep-wake cycles. Classified by the International Classification of Sleep Disorders – Third Edition (ICSD-3) into two types: Type 1 Narcolepsy (NT1) and Type 2 Narcolepsy (NT2). People with narcolepsy (PwN) suffer from excessive daytime sleepiness (EDS), the irrepressible need to sleep, and sleep disturbances (Barateau et al., 2022). People with narcolepsy type 1 (PwNT1) also experience cataplexy; the sudden loss of muscle tone, whereas PwNT2 do not.

Cognition in Narcolepsy

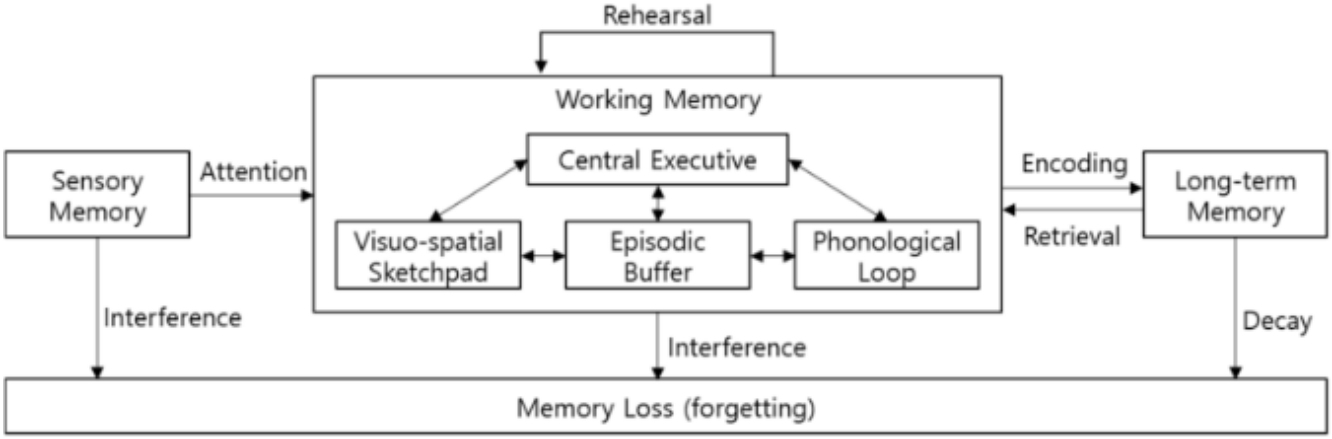
Narcolepsy demonstrated to impact cognition due to high levels of EDS, associated with poorer performances on tasks of memory, attention, and processing speeds due to reduced vigilance, concentration, and alertness (Lim & Dinges, 2010; Roth, 2015). Narcolepsy (particularly hypocretin deficiency) has been evidenced to lead to structural and functioning changes within the brain, specifically in the temporal and frontal cortex, and hippocampus (Joo et al., 2012; Scherfler et al., 2012). Previous findings on narcolepsy and cognition have been mixed, with some identifying no cognitive impairment, and others finding impairment within domains such as memory, executive functioning (EF), and attention (Mazzetti et al., 2006; Huang et al., 2018).

Psychological Models of Cognition

Baddeley & Hitch's (1974) multicomponent working memory model (MWMM) describes working memory (WM) as a multicomponent system that manipulates information stored within short-term memory (STM) for necessary action and more complex cognitive activity and was created using principles from Atkinson & Shiffrin's model (1968). It comprises of three components: the central executive, phonological loop, and the visuospatial

sketchpad. A later conception introduced the episodic buffer, which serves as a temporary and limited storage that integrates information from other components (Baddley, 2000a). The central executive is described as the attentional control system, responsible for integrating information from all other components (Baddeley, 2000b). Previous research unanimously agrees that the relationship between attention and WM is multifaceted and interconnected, with several theories theorising the relationship's conceptualisation (Angelopoulou & Drigas, 2021).

Figure 1: *Kang & Bae (2021) adaptation of Baddeley & Hitch's MWMM with Atkinson & Shiffrin's multi-store memory model.*

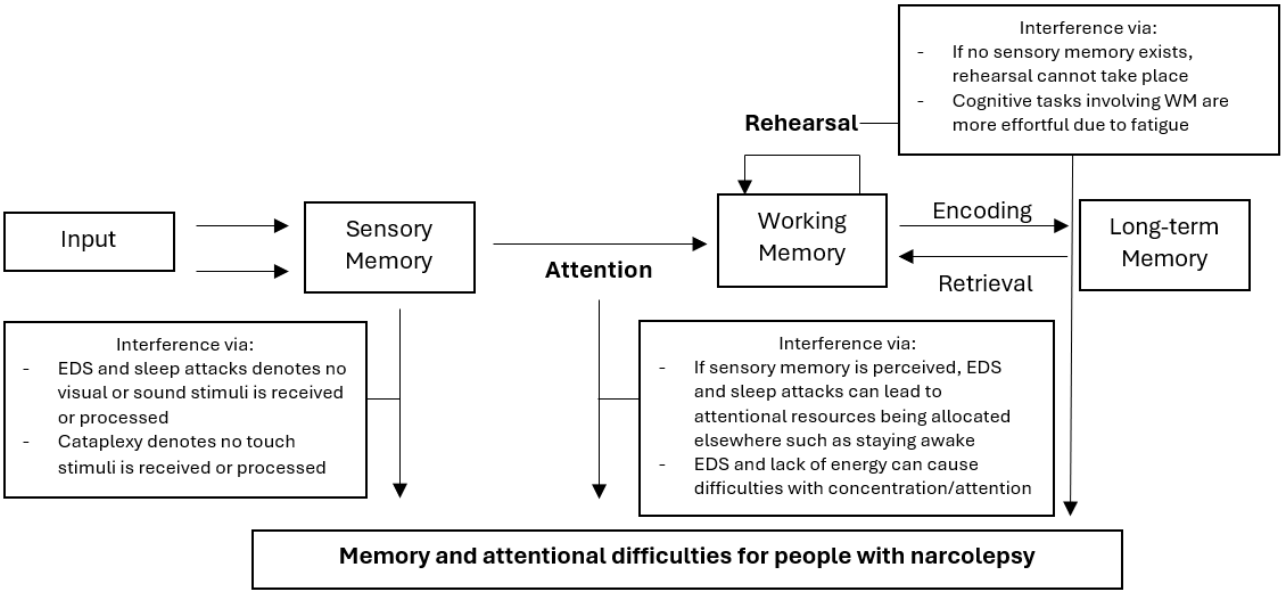


Attention is a mechanism that processes information related towards an individual's goals (Thiele & Bellgrove, 2018; Zaksaite & Tyagi, 2020). Research has evidenced that attention is formed of multiple elements such as selective attention, divided attention, and sustained attention (SAttention) (Leclercq, 2004; Parasuraman, 2016). Attention has been identified to be a fluctuating construct. Various factors may contribute towards these fluctuations which affects how an individual allocates their cognitive resources (Adam & deBettencourt, 2019). The concept of declining cognitive resources in attention are frequently linked to SAttention, vigilance decrements are often associated with a declining limited resource leading to the reduced ability to attend and focus on a task over time and can vary

between populations due to individual differences, homeostatic factors, motivation, intelligence, and arousal levels (Eysenck, 2012; Valdez et al., 2010; Lang et al., 2013; Thomson et al., 2015). Consequently, such fluctuations in attention can negatively affect WM due to cognitive resource allocation, leaving less resources available for WM processes.

PwN frequently report poor attention, WM, and forgetfulness. Considering the MWMM, one can infer that PwN may overlook sensory processing of input due to sleep lapses, fatigue and EDS, for example falling asleep omits the opportunity for iconic (visual) and echoic (sound) memory to be processed. Previous research has evidenced PwN experience difficulties with balancing/sharing cognitive resources between attention monitoring and task performance in comparison to healthy controls, where allocation of their cognitive resources is focused on maintaining attention at the cost of cognitive performance (Witt et al., 2018). Consequently, performance on WM tasks is impacted for PwN as they are more focused on maintaining wakefulness as opposed to the cognitive processes required for day-to-day activities (figure 2). One literature review identified that PwN demonstrated reduced performance mostly in attention and WM tasks, particularly SAttention, with PwNT1 exhibiting increased error rates and performance that markedly declined over time (Filardi et al., 2021). Dimitrova and colleagues (2011) compared PwN and controls using a test of alertness and found that PwNT2 demonstrated slower response times than controls, and PwNT1 demonstrated slower response times than PwNT2. Huang and colleagues (2018) assessed vigilance and set-shifting in PwN and found PwNT1 displayed slower and more variable response times than PwNT2 and controls, and PwNT2 performed worse than controls. PwN had higher error rates than controls however there were no difference between NT1 and NT2.

Figure 2: *The MWMM used to explain for memory and attentional interference as experienced by people with narcolepsy*



Research has evidenced mixed findings on WM performance in NT1, with some demonstrating significant impairments with higher error rates, variability in response times, and fewer sequences remembered (Ha et al., 2007; Yoon et al., 2013; Moraes et al., 2012; Park et al., 2016), whilst other studies have found no differences between NT1 and controls with comparable quality of performance (Naumann et al., 2006; Kim et al., 2016) WM in PwNT2 has only been assessed by one study, finding significant WM impairments in NT2 compared to controls and no differences with NT1 (Bayard et al., 2012). Medrano-Martinez & Peraita-Adrados (2020) investigated attentional processes and EF in PwNT1 and found that they performed worse than controls in neuropsychological measures of information processing speed, sustained and divided attention, and WM. They concluded that information processing speeds and SAttention played a fundamental role in the manifestation of cognitive impairments in NT1 and highlighted the importance of assessing the influence of these two domains in future research of cognition in PwN.

Mood and Narcolepsy

The relationship between depression and cognition is well-established, resulting in the diagnostic criterion in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition as “diminished ability to think or concentrate or indecisiveness” (American Psychiatric Association, 2013, p. 161). One meta-analysis revealed significant cognitive deficits in EF, memory, and attention in individuals with depression relative to controls (Rock et al., 2014). Another review found that the first episode of depression significantly impairs attention, psychomotor speed, visual learning, EF, and memory, and although depressed individuals in remission displayed improvements in their attention; this was still not to the performance levels of healthy controls (Roca et al., 2015).

Beck’s cognitive theory of depression (1987) posits that existing memory representations lead individuals to filter stimuli from the environment, so attention is directed towards information that is congruent with their schemas. Beck theorized that the schemas of depressed individuals include themes of loss, failure, worthlessness, and rejection; consequently, they will exhibit bias in their processing of environmental stimuli/information relevant to these themes. Consequently, depressed individuals attend selectively to negative stimuli in their environment and interpret neutral and ambiguous stimuli in a schema-congruent way, adversely affecting cognitive processes. Other cognitive theories of depression include Bower’s network theory (1981) and Teasdale’s differential activation hypothesis (1988), collectively denoting that depression is characterised by biased attention based on affect which influences cognitive ability.

Narcolepsy research have consistently confirmed higher levels of depression relative to controls. Studies have identified prevalence rates between 30% to 62% (Mosko et al., 1989; Li et al., 2021) and can be four times higher compared to the general population (Ruoff

et al., 2017). Despite the available literature, there is limited research investigating the role of depression on cognition in PwN. Previous studies investigating cognitive impairment in PwN have found significant differences of depression between controls and PwN (Ramm et al., 2019; Medrano-Martinez & Peraita-Adrados, 2020), however these findings have not yet been further investigated. Studies have also evidenced subjective memory complaints in PwN (Zamarian et al., 2015), however this has not been replicated objectively through neuropsychological testing (Medrano-Martinez et al., 2022). This disparity between PwN's self-reports and test findings are unclear. Given that not all PwN may experience high levels of depression, one may speculate that levels of depression may explain for this disparity and clarify mixed pattern of findings across research.

Cognitive interference theories explain the role of anxiety on cognition. The processing efficiency theory (PET) (Eysenck & Calvo, 1992) posits that task-irrelevant thoughts/worries can impair processing efficiency by expending attentional resources, resulting in less resources for task processing. It suggests that anxiety affects the central executive system in the MWMM by reducing available capacity, causing impaired performance in dual-tasking, but has minimal effects on the visuospatial sketchpad and phonological loop (Derakshan & Eysenck, 2009). The attentional control theory (ANT) (Eysenck et al., 2007) was created as an extension of the PET and denotes the existence of two attentional systems: a top-down goal driven system associated with high-level cognitive processes and a bottom-up stimulus-driven system that is automatic and reactive to threatening stimulus (Pashler et al., 2001). The ANT suggests that anxiety interferes with the inhibition function of the central executive leaving it exposed disruption/interference from task-irrelevant stimulus and disrupts the balance of systems by increasing the influence of stimulus-driven processes over the goal-driven processes, leading to difficulties in attention

(Derakshan et al., 2009). Findings from numerous research have demonstrated the support for these theories (Eysenk et al., 2005; Maloney et al., 2014; Angelidis et al., 2019).

There is increasing interest around anxiety as a comorbidity in narcolepsy, however current research is limited. Studies have evidenced higher levels of anxiety in PwN compared to controls, particularly in NT1 (Fortuyn et al., 2010; Alasim et al., 2019), with one study revealing high anxiety prevalence rates being associated with younger age in PwN (Rouff et al., 2017). It has been theorised that PwN experience increased anxiety due to a perceived loss of personal control related to cataplexy (Morse & Sanjeev, 2018). To date, research has not investigated the role of anxiety on cognition in PwN.

The Impact of Narcolepsy

The impact of narcolepsy on an individual's life is profound, with significant impairments in social, occupational/academic, and psychological outcomes (Chin et al., 2022; Davidson et al., 2022). Cognitive impairments experienced by PwN can lead to significant consequences on their academic/vocational achievements and quality of life (Inocente et al., 2014; Goswami & Pollak, 2015). It is a life-long medical condition with real-world consequences, however its presentation/symptoms are often confounded with negative/unwanted personality traits, conflated by sensationalistic and comedic representations in the media (Varallo et al., 2022). A common trope often portrayed is the dramatic depiction of one falling asleep at inappropriate times to exaggerate comedy value (Flygare & Parthasarathy, 2015), which trivialises the condition by perpetuating the idea that PwN are tired/lazy, rather than recognising the profound psychosocial impact. Such misrepresentations contribute towards stigma attached to the condition which negatively affect the healthy psychosocial/identity development in PwN, whereby individuals often report feeling excluded, rejected and devalued through social judgement of their symptoms

(Kapella et al., 2015). The validity of narcoleptic symptoms is undermined due to such misunderstandings, leading to dismissal of symptoms by both PwN and their networks, ultimately leading to experiences of guilt and delays in diagnosis and intervention, further deteriorating quality of life (Culbertson & Bruck, 2005; Kilmartin & Day, 2024). Currently, there is no cure for narcolepsy, with treatment focusing on medication and lifestyle changes (Barker et al., 2020; Bassetti et al., 2021). Therefore, PwN are faced to make significant accommodations in their life that sacrifices opportunity for social and personal development. If such accommodations are made inadequately, PwN face increased vulnerability in public spaces, such as increased risk of vehicular and work-related accidents (Smolensky et al., 2011), and worries surrounding theft/assault if unaccompanied in public (particularly females) (Schokman, 2023). These factors intersecting with the indisputable cognitive and biological deficits in narcolepsy misunderstood by society, alongside the threat of securing stable protective factors (such as maintaining employment, having a supportive network, personal autonomy) require PwN to navigate a life with multiple disadvantages which predisposes them to a higher risk of psychological distress compared to the general population.

Rationale

Findings from various research investigating cognition in NT1 have been mixed. Studies have identified significant impact on attention in PwN, and the impact on WM has been varied. Thus, the exact mechanisms behind these impairments still require exploration. Additionally, research on cognition in NT2 is extremely scarce. Previous research has evidenced increased prevalence of mood disturbance in PwN, however to the author's knowledge, there has not been any research investigating the role of mood on cognition in PwN. There is a need for more research on cognition in PwN, especially in NT2, in conjunction with discovering explanations for contrasting findings in previous literature. This

study aimed to clarify the relationship between SAttention and WM in PwN with attempts to discover what role depression and anxiety may have in this relationship to clarify previous mixed findings. The study demonstrates clinical relevance as findings aim to aid clinicians in treatment decisions towards whether compensatory strategies to improve attention or interventions aimed at managing mood should first be utilised with PwN.

Hypotheses

- H1: PwN will score lower in measures of memory and SAttention than controls.
- H2: PwN will score worse in measures of mood than controls.
- H3: Attention will, at least partly, mediate the difference in memory performance between controls and PwN i.e. Group > Attention Impairment > Memory Impairment.
- H4: Mood will, at least partly, mediate the difference in attention performance between controls and PwN i.e. Group > Anxiety/Depression > Attention Impairment.
- H5: Mood and Attention will at least partly, mediate the difference in memory performance between controls and PwN i.e. Group > Higher depression/anxiety > Attention impairment > Memory impairment.

Figure 3: *Mediation Model for Hypothesis 3*

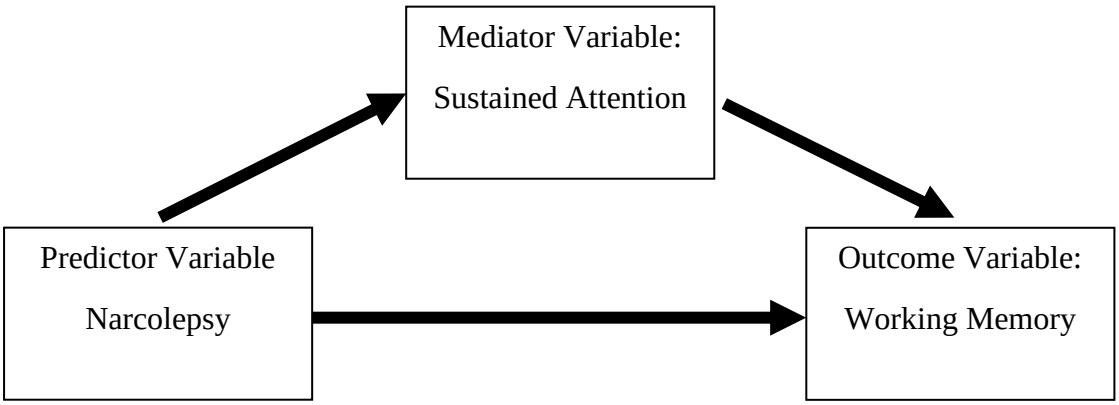


Figure 4: *Mediation Model for Hypothesis 4*

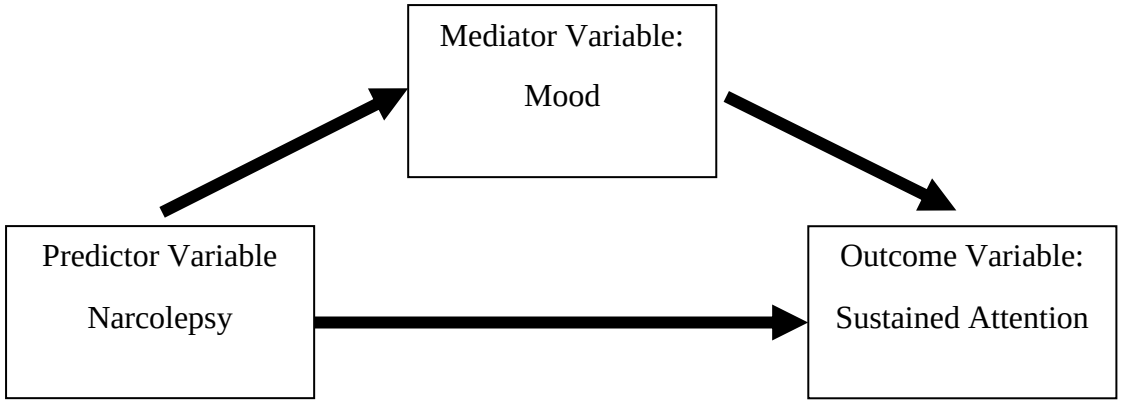
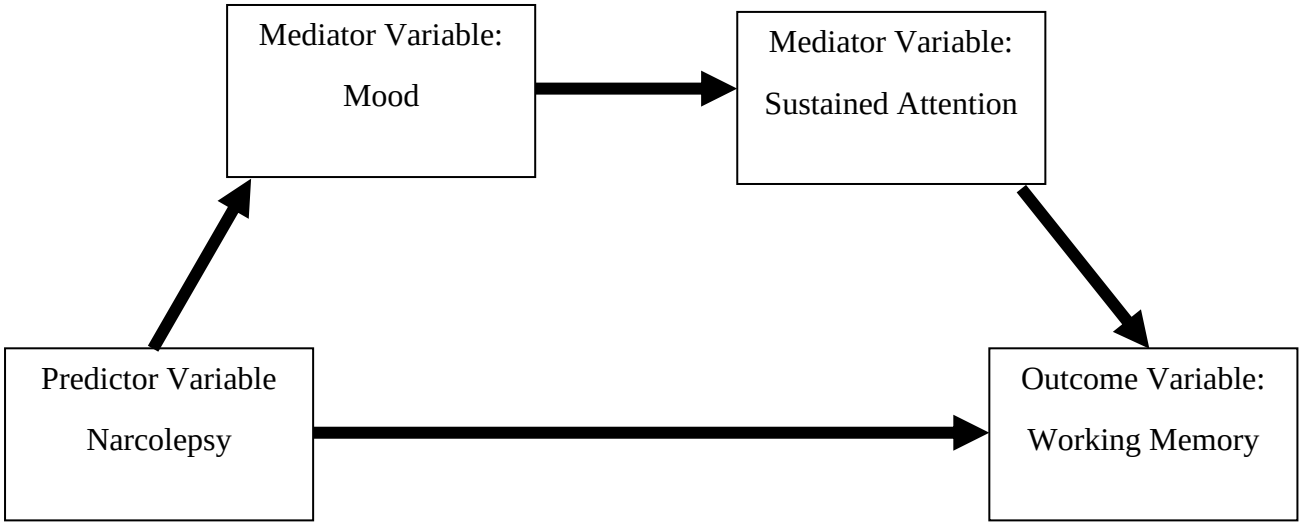


Figure 5: *Serial Mediation model for Hypothesis 5*



Method

Design

This study used a cross-sectional, between-participants design. Participants completed the study online by completing self-report measures assessing EDS and mood, alongside the completion of two interactive tasks measuring STM, WM, and SAttention. The online study was created and conducted via the Gorilla platform.

Participants were separated into four groups: NT1, NT2, NT1 controls (NT1C) and NT2 controls (NT2C), forming the predictor variable. Three mediator variables included depression, anxiety, and SAttention and outcome variables included STM, WM and SAttention impairment. Covariates within the study included education and age. Due to the cross-sectional nature of the study, analyses of variance and regression analyses were used to investigate differences and the level of association between variables, there was no intention of investigating causality.

The study utilised opportunity sampling advertised via social networking sites, online forums, word of mouth to family and friends, and the university. Participants required to be 18 years or over, have capacity to consent to partaking and not be diagnosed with any health condition that could impact on their cognition. The narcolepsy groups were recruited first, following which the Gorilla platform rejected any control participants if they did not match demographic information (within five years of age, sex, and education).

Expert by experience involvement

The study was created through consultation with a PwN and considered the suitability for PwN in the design of the study in relation to length, appropriateness of tasks, and wording of documentation provided to the participants.

Participants

Advertisement of the study stated that participants were required to have had a clinical diagnosis of narcolepsy made by a clinician. Participants in the control group were then recruited to match existing narcolepsy participants. Participants were given the opportunity to be included into a prize draw to win one of two Amazon vouchers worth £50 each. One hundred and nighty-eight individuals consented to partake in the study. Data from 54 participants were removed as they did not complete the study. Descriptive analysis

revealed four significant outliers, upon examining the data it was clear they had not adhered to instructions of tasks and therefore removed. A total of 140 participants were included in the study and can be viewed in table 1.

Table 1: *Participant demographics*

	Total (n=140)	NT1 (n=36)	NT2 (n=34)	NT1C (n=36)	NT2C (n=34)
Age					
Mean (SD)	33.24 (11.35)	34.39 (11.16)	33.00 (12.18)	32.86 (10.59)	32.68 (11.89)
Range	46 (18 – 64)	45 (18 – 63)	46 (18 – 64)	41 (20 – 61)	43 (20 – 63)
Gender					
Female	128 (91.4%)	32 (88.9%)	32 (94.2%)	32 (88.9%)	32 (94.2%)
Male	10 (7.1%)	4 (11.1%)	1 (2.9%)	4 (11.1%)	1 (2.9%)
Non-binary	2 (1.4%)	0	1 (2.9%)	0 (0%)	1 (2.9%)
Highest education achievement					
No formal qualifications	2 (1.4%)	1 (2.8%)	0 (0%)	1 (2.8%)	0 (0%)
High school/Secondary school equivalent (GCSE, GED, IB)	26 (18.6%)	6 (16.7%)	7 (20.6%)	6 (16.7%)	7 (20.6%)
Technical/Community college or equivalent (Certificates, A-Levels, O-Levels)	34 (24.3%)	9 (25%)	8 (23.5%)	9 (25%)	8 (23.5%)
Undergraduate degree or equivalent (BSc, BA)	40 (28.6%)	11 (30.6%)	9 (26.5%)	11 (30.6%)	9 (26.5%)
Postgraduate degree or equivalent (MSc, MA, MEd)	34 (24.3%)	8 (22.2%)	9 (26.5%)	8 (22.2%)	9 (26.5%)
Doctorate (PhD, EdE)	4 (2.9%)	1 (2.7%)	1 (2.9%)	1 (2.7%)	1 (2.9%)
Epworth Sleepiness Scale mean (SD)	10.21 (6.29)	15.92 (3.77)	13.94 (5.27)	6.08 (4.16)	4.77 (2.56)
Medication (n = 70)					
Yes	64 (91.4%)	31 (86.1%)	33 (97.1%)	N/A	N/A
No	6 (8.6%)	5 (13.9%)	1 (2.9%)	N/A	N/A

Measures

Hospital Anxiety and Depression Scale (HADS)

The HADS is a brief 14-item self-report questionnaire, comprising of two 7-item subscales that measure symptoms of anxiety (HADSA) and depression (HADSD) (Zigmond & Snaith 1983). Items are scored on a scale of zero to three, with higher scores indicating elevated levels of depression and/or anxiety and each total subscale scores ranging from zero to 21 (appendix A).

The HADS omits items linked to physiological symptoms to minimize biases related to co-existing medical conditions (Snaith, 1987). It has generated an array of studies validating its psychometric attributes, highlighting its high internal consistency (a = .90), and strong test-retest reliability (r = .80) (Zigmond & Snaith, 1983). It has also demonstrated consistent reliability and validity across varying cultural contexts (Michopoulos et al., 2008; Hinz & Brahler, 2011; Bocéréan & Dupret, 2014) and has been previously used in research with PwN (Kapella et al., 2015). Internal reliability with the current sample was consistent with previous findings ($\alpha = .78$).

Epworth Sleepiness Scale (ESS)

The ESS is an eight-item self-report measure of EDS which assess how likely an individual will fall asleep in various daytime activities (Johns, 1991). The measure uses a four-point Likert scale ranging from zero to three with total possible scores ranging from zero to 24 (appendix B). It specifically distinguishes dozing behaviour from feelings of fatigue and drowsiness, as these descriptions can often be confused with other conditions or states such as stress (Mairesse & Neu, 2016). Research has evidenced that PwN have exhibited moderate or severe EDS as measured by the ESS (Johns, 2000; van der Heide et al, 2015).

The ESS's psychometric properties have been widely researched, with test-retest reliability scores ranging between .81 and .93 (Izci et al., 2007; Cho et al., 2011) and high internal consistency means of .82 in separate studies (Johns, 1992; Hagell & Broman, 2007). It has produced studies evidencing its validity and reliability with various cultural populations (Beiske et al., 2009; Ahmed et al., 2014), including PwN (van der Heide et al., 2015). It has also demonstrated good internal consistency in the current sample ($\alpha = .72$). Scores from this measure are used as a descriptor for participants and are not used in analyses.

Sustained Attention to Response Task (SART)

The SART is a novel continuous performance task designed to measure SAttention (Robertson et al., 1997). It consists of a series of digits from one to nine appearing one at a time in random order and requires participants to respond to all numbers, except for the number three. Digits are presented for 250ms, a mask then follows for 900ms and takes approximately five minutes to complete. The total score is calculated by totalling the number of commissions errors and omission errors.

The SART is frequently employed in research to explore associations between SAttention and other variables (Alloway & Alloway, 2012; Ralph et al., 2015). It has been evidenced to not be influenced by age, gender, or education (Chan, 2001). It has demonstrated good reliability and validity with non-clinical populations (Raz et al., 2014), and has been validated to be used with narcolepsy, demonstrating good reliability with this population ($\alpha = .82$) (van der Heide et al., 2015).

Digit Span Task (DST)

The DST is a widely used neuropsychological measure of STM and WM. It has validated normative data to provide a baseline of results to allow for comparison and support with identifying deviations in cognition. The current iteration featured in the Wechsler Adult

Intelligence Scale – Fourth Edition (Wechsler, 2008) comprises of three subtests: Digit Span Forward (DSF), Digit Span Backward (DSB), and the Digit Span Sequencing (DSS). DSF measures STM, whilst the DSB and DSS measure the ability to manipulate information in WM. A combined score of the DSB and DSS formed the Digit Span Working Memory (DSWM) in the current study. Previous research has evidenced the influence of age and education in performance of the DST (Lam et al., 2013; Zimmermann et al., 2015).

It is utilised in various clinical settings to monitor and differentiate from various neuropsychiatric/cognitive disorders (Leung et al., 2011; Kanser et al., 2022; Resch et al., 2023). It demonstrates high test re-test correlations and internal reliability (Sung, 2011; de Paula et al., 2016). It has also demonstrated good internal consistency in the current sample ($\alpha = .86$).

Procedure and Ethics

The study was approved by the Salomons Institute for Applied Psychology, Canterbury Christ Church University Ethics Panel (appendix C). Participants volunteered in the study through an anonymous link accompanied with a flyer (appendix D) detailing information about the study. Participants were directed to the Gorilla platform where the information sheet (appendix E) was presented. Following which, the consent form (appendix F) was displayed, and participants were unable to continue with the study unless informed consent was agreed.

Participants were asked to create a unique ID code (appendix G) and were informed this would be used to identify their data if they wished to withdraw. Participants were then presented with the demographic questionnaire (appendix H), ESS and HADS. After completion of these, participants were informed that the two interactive tasks of memory and attention would be commencing. Participants were requested to be in a quiet environment

where they would not be disturbed for the remainder of the study to ensure full concentration on the tasks.

Following completion of the tasks (appendix I), the debrief sheet (appendix J) was displayed. Participants were provided with contact information, relevant signposting and advised to seek further support if they felt distressed from completing the study. Participants were offered the option to enter a raffle draw and/or to receive a summary report of the study. For these additional opt-ins, participants were redirected to a separate survey so that this information was kept separately from their answers to the study (appendix K).

Data Analysis and Power

All descriptive and statistical analyses were conducted via the Statistical Package for the Social Sciences (SPSSv29). For mediation analyses, the Hayes PROCESS module for SPSS was used instead of the traditional causal steps method (Baron & Kenny, 1986), as it has been evidenced to be more robust and powerful via bootstrapping (Hayes, 2009). Bootstrapping is a method of repeated sampling of the data to control for distribution limitations, making the analysis robust against violations of assumptions. It also provides more reliable estimations of the indirect effect, particularly in research with small samples (Hayes, 2018). Bootstrapping was set to five thousand samples to estimate the indirect effect with confidence intervals set at 95%.

Priori power analyses using G*Power (Faul et al., 2007) suggested 72 participants were required to detect a medium effect size ($f2 = .15$) with a power level of .80 (set at $\alpha = .05$). Fritz & Mackinnon (2007) suggest a minimum of 71 participants to find a medium effect size for mediation analyses, whilst Sim, Kim & Suh (2022) suggest a minimum of 70 participants to find a large effect size for serial mediation analyses using the bootstrapping

method. The current study aimed to recruit a minimum of 72 paired samples. Due to significant recruitment difficulties, this was not possible.

A two-way ANOVA was used to address hypotheses 1 and 2 to identify any differences between all groups. Mediation analyses were conducted to address hypotheses 3 and 4 to identify whether SAttention mediated the relationship between groups and STM/WM, and whether anxiety and depression mediated the relationship between SAttention. Finally, serial mediation analyses were conducted to address hypothesis 5 to identify whether anxiety, depression and SAttention mediated the relationship between groups and STM/WM.

Results

Descriptive analyses were conducted on all groups. The Shapiro-Wilk test revealed that data were normally distributed amongst all groups for HADSD and DSWM, however it revealed that DSF for all groups, HADSA for controls, and SART for NT1C were not normally distributed. However, analysis identified that transformed skewness and kurtosis z-values fell within the acceptable range of -1.96 to 1.96 (Ghasemi & Zahediasl, 2012), indicating normal distribution of data. Furthermore, ANOVA's have been evidenced to be robust against violations of normality (Blanca et al., 2017). Four extreme outliers were identified and removed. A total of six mild outliers (more than 1.5 box-lengths but less than 3 box-lengths from the edge of the boxplot) were retained within HADSD (2) and DSF (4) in the NT1C group with the aim of retaining as much genuine data as possible.

Hypothesis 1: Differences in STM, WM and SAttention

A Quade's nonparametric ANCOVA was conducted to examine the effect of narcolepsy on STM, controlling for age and education, due to the assumptions of normality and linearity between age and STM being violated, alongside the presence of outliers. The

analysis revealed no significant effect of narcolepsy on STM, after controlling for age and education ($F(3, 138) = 1.42$, $p = .24$).

A two-way ANCOVA investigated the main differences between narcolepsy type and control groups, and their interaction effects on WM whilst controlling for age and education. The Levene's test showed that the variances of the groups were equal ($F(3, 136) = 2.05$, $p = .11$). A linear relationship was found between education and WM, but not for age and WM. A reciprocal transformation was completed which resulted in a linear relationship between age and WM. The assumption of homogeneity of regression slopes was also met. Education significantly affected WM scores ($p = <.001$), however age did not ($p = 0.13$). The main effect of narcolepsy on WM was statistically significant ($p < .001$). The interaction effect was not significant ($p = .08$). See table 2 for ANCOVA statistics. This suggested there was a significant effect of narcolepsy on WM performance, however this difference was not significant between narcolepsy types when controlling for education and age.

Table 2: *Two-way ANCOVA for WM.*

Source	*df*	MS	*F*	*p*	Effect Size
Age	1	25.66	2.32	.130	.017
Education	1	158.79	14.35	<.001	.097
Narcolepsy v Controls (A)	1	312.06	28.21	<.001	.174
Narcolepsy Type (B)	1	19.38	1.75	.188	.013
A x B	1	33.69	3.05	.083	.022
Error	134	11.06			

Note: MS = Mean squares, effect size = partial $\eta 2$

As the interaction effect was not significant, but revealed significant main effects, analyses investigating the difference in adjusted marginal means was completed (Howell, 2010). Pairwise comparisons (table 3) revealed a significant mean difference (MD) of -4.03 ($p <.001$) between NT1 and NT1C, and a significant MD of -2.18 ($p = .008$) between NT2 and NT2C. There was no significant mean difference found between NT1C and NT2C ($p = .68$), and NT1 and NT2 ($p = .07$).

Table 3: *Means, standard deviations, mean differences, and confidence intervals between groups for WM.*

Group	Type	Mean (SD)	Between groups	Between types
			Mean Difference and C.I.	
NT	1. NT1	15.53 (3.78)	- 4.03***	- 0.33
			[- 5.57, - 2.49]	[- 1.89, 1.24]
	2. NT2	15.91 (4.07)	- 2.18**	0.33
			[- 3.76, - 0.59]	[- 1.24, 1.89]
Control	3. NT1C	19.56 (2.88)	4.03***	1.52
			[2.49, 5.57]	[-0.04, 3.09]
	4. NT2C	18.09 (2.92)	2.18**	- 1.52
			[0.59, 3.76]	[-3.09, 0.04]

Note: SD is used to represent standard deviations. Values in square brackets indicate 95% confidence intervals for each comparison. * indicates p < .05, ** indicates p < .01, *** indicates p < .001.

A two-way ANOVA was conducted to compare the main differences between narcolepsy type and control groups, and their interaction effects on SAttention. The Levene's test showed that the variances of the groups were equal ($F(3, 136) = 1.39$, $p = .25$). The main effect of narcolepsy on SAttention was significant ($p < .001$) and yielded an effect size of 0.09, indicating that 9% of the variance in SAttention was explained by narcolepsy. The interaction effect was not significant ($p = .07$). See table 4 for ANOVA statistics. This suggested there was a significant effect of narcolepsy on SAttention, however this difference was not significant between narcolepsy types.

Table 4: *Two-way ANOVA for SAttention*

Source	*df*	MS	*F*	*p*	Effect Size
Narcolepsy v Controls (A)	1	1121.35	13.04	<.001	.087
Narcolepsy Type (B)	1	4.58	0.05	.818	.000
A x B	1	276.07	3.21	.075	.023
Error	136	85.99			

Note: MS = Mean squares, effect size = partial η2

Pairwise comparisons (table 5) to compare the simple main effects between groups revealed a significant mean difference of -8.47 (p <.001) between NT1 and NT1C. There was

no significant mean difference between NT1 and NT2 (p = .27), NT2 and NT2C (p = .09), and NT1C and NT2C (p = .32).

Table 5: *Means, standard deviations, mean differences, and confidence intervals between groups for SART.*

Group	Type	Mean (SD)	Between groups	Between types
			Mean Difference and C.I.	
NT	1. NT1	201.11 (10.44)	- 8.47***	- 2.45
			[- 12.79, - 4.15]	[-6.83, 1.93]
	2. NT2	203.56 (10.49)	- 3.82	2.45
			[- 8.27, 0.62]	[- 1.93, 6.83]
Control	3. NT1C	209.58 (7.99)	8.47***	2.20
			[4.15, 12.79]	[-2.18, 6.58]
	4. NT2C	207.38 (7.75)	3.82	- 2.20
			[- 0.62, 8.27]	[-6.58, 2.18]

Note: SD is used to represent standard deviations. Values in square brackets indicate 95% confidence intervals for each comparison. * indicates p < .05, ** indicates p < .01, *** indicates p < .001.

Hypothesis 2: Differences in Depression and Anxiety

A two-way ANOVA compared the main differences between narcolepsy type and control groups, and their interaction effects on depression. The Levene's test showed that the variances of the groups were not equal (F(3, 136) = 3.03, p = .03). However, research has evidenced the ANOVA to be robust against this violation so long as sample sizes are approximately equal and large (>50) (Jaccard, 1998; Larson, 2008). The main effect of narcolepsy on depression was statistically significant (p <.001) with an effect size of 0.22, indicating that 22% of the variance in depression scores was explained by narcolepsy. The interaction effect was not significant (p = .07). See table 6 for ANOVA statistics. This suggested there was a significant effect of narcolepsy on WM, however this difference was not significant between narcolepsy types.

Table 6: *Two-way ANOVA for Depression*

Source	*df*	MS	*F*	*p*	Effect Size
Narcolepsy v Controls (A)	1	578.44	41.85	<.001	.235
Narcolepsy Type (B)	1	10.05	0.73	.395	.005
A x B	1	46.67	3.38	.067	.024
Error	136	13.82			

Note: MS = Mean squares, effect size = partial η2

Given that there was no significant interaction effect, but a significant main effect, exploratory analyses was completed. Pairwise comparisons (table 7) revealed that there was a significant MD between NT1 and NT1C (p <.001), and between NT2 and NT2C (p = .002). There was no significant MD found between NT1C and NT2C (p = .06), and between NT1 and NT2 (p = .49). Due to the presence of two outliers within the NT1C group, analysis was also conducted with these removed and revealed that they did not influence results.

Table 7: *Means, standard deviations, mean differences, and confidence intervals between groups for depression.*

Group	Type	Mean (SD)	Between groups	Between types
			Mean Difference and C.I.	
NT	1. NT1	9.97 (3.92)	5.22***	- 0.62
			[3.49, 6.96]	[- 1.14, 2.38]
	2. NT2	9.35 (4.35)	2.91**	0.62
			[1.13, 4.70]	[- 2.38, 1.14]
Control	3. NT1C	4.75 (2.86)	- 5.22***	- 1.69
			[- 6.96, - 3.49]	[-3.45, 0.07]
	4. NT2C	6.44 (3.60)	- 2.91**	1.69
			[- 4.70, -1.13]	[- 0.07, 3.45]

Note: SD is used to represent standard deviations. Values in square brackets indicate 95% confidence intervals for each comparison. * indicates p < .05, ** indicates p < .01, *** indicates p < .001.

A two-way ANOVA compared the main differences between narcolepsy type and control groups, and their interaction effects on anxiety. The Levene's test showed that the variances of the groups were equal (F(3, 136) = 0.21, p = .89). The main effect of narcolepsy on anxiety was statistically significant (p = .02) and yielded an effect size of 0.04, indicating

that 4% of the variance in the anxiety was explained by narcolepsy. The interaction effect was not significant (p = .08). See table 8 for ANOVA statistics. This suggested that there was a significant effect of narcolepsy on anxiety scores, however this difference was not significant between narcolepsy types.

Table 8: *Two-way ANOVA for Anxiety.*

Source	*df*	MS	*F*	*p*	Effect Size
Narcolepsy v Controls (A)	1	88.58	5.44	.021	.038
Narcolepsy Type (B)	1	0.28	0.02	.895	.000
A x B	1	50.58	3.11	.080	.022
Error	136	16.27			

Note: MS = Mean squares, effect size = partial η2

Pairwise comparisons (table 9) to compare the simple main effects between groups revealed that there was a significant MD between NT2 and NT2C (p = .005). There was no significant MD found between NT1 and NT1C (p = .68), NT1 and NT2 (p = .25), and NT1C and NT2C (p = .18).

Table 9: *Means, standard deviations, mean differences, and confidence intervals between groups for anxiety.*

Group	Type	Mean (SD)	Between groups	Between types
			Mean Difference and C.I.	
NT	1. NT1	8.92 (4.05)	0.39	1.11
			[-1.49, 2.27]	[-3.02, 0.79]
	2. NT2	10.03 (4.37)	2.79**	- 1.11
			[0.86, 4.73]	[-0.79, 3.02]
Control	3. NT1C	8.53 (3.92)	- 0.39	1.29
			[-2.27, 1.49]	[-0.62, 3.20]
	4. NT2C	7.23 (3.78)	- 2.79**	- 1.29
			[- 4.73, - 0.86]	[- 3.20, 0.62]

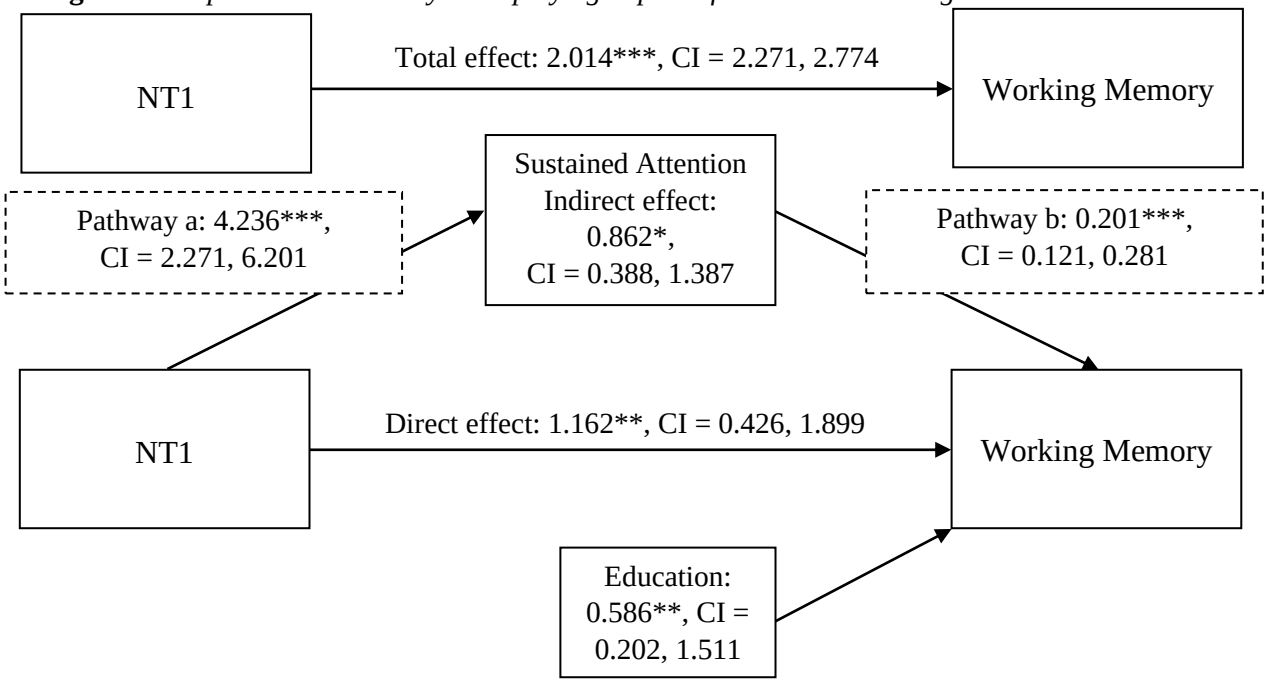
Note: SD is used to represent standard deviations. Values in square brackets indicate 95% confidence intervals for each comparison. * indicates p < .05, ** indicates p < .01, *** indicates p < .001.

Hypotheses 3: Mediation of SAttention on WM

As there were no significant differences found between narcolepsy and controls on STM, this was excluded from further analysis. Age was also excluded as previous analyses revealed it was not a significant covariate.

The first mediation analysis investigated the effect of NT1 on WM, and whether this was mediated by SAttention. There was a significant total effect between NT1 and WM (p <.001). The path from NT1 to SAttention was positive and significant (p <.001), suggesting the absence of NT1 was related to higher scores of SAttention. The path from SAttention to WM was positive and significant (p <.001), indicating that higher SAttention scores was related to higher WM scores. There was a significant indirect effect of NT1 on WM through SAttention. The direct effect from NT1 to WM remained significant despite the presence of SAttention (p = .003).

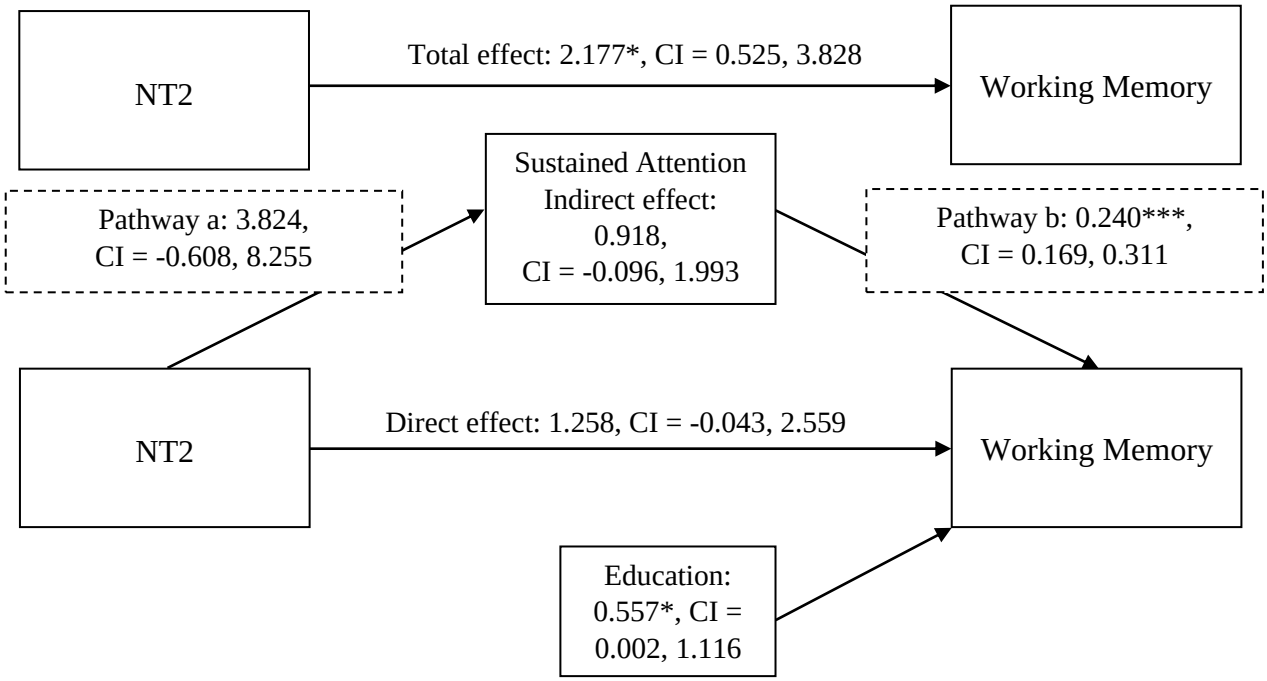
Figure 6: *Simple mediation analysis displaying impact of NT1 on WM through SAttention*



When investigating NT2, the analysis revealed a significant total effect between NT2 and WM (p = .02). Unsurprisingly, the path from NT2 to the SAttention was not significant

(p = .08). The path from SAttention to WM was positive and significant (p <.001), indicating that higher SAttention performance was related to higher WM performance. The indirect effect of NT2 on WM through SAttention was not significant. The direct effect of NT2 on WM was insignificant in the presence of SAttention (p = .53).

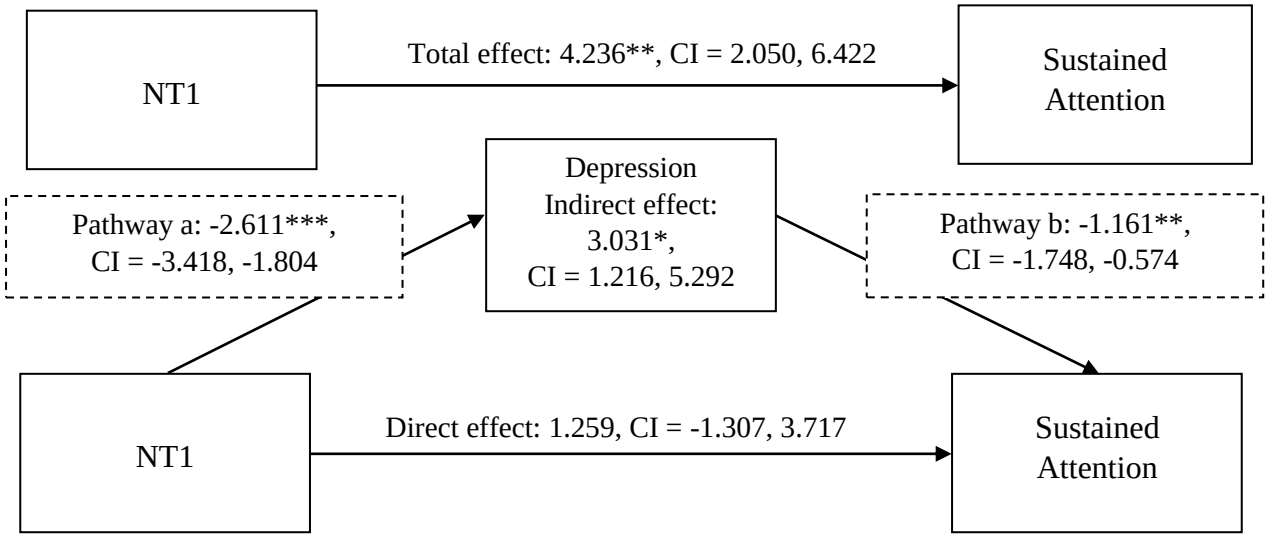
Figure 7: *Simple mediation analysis displaying impact of NT2 on WM through SAttention.*



Hypotheses 4: Mediation of Mood on SAttention

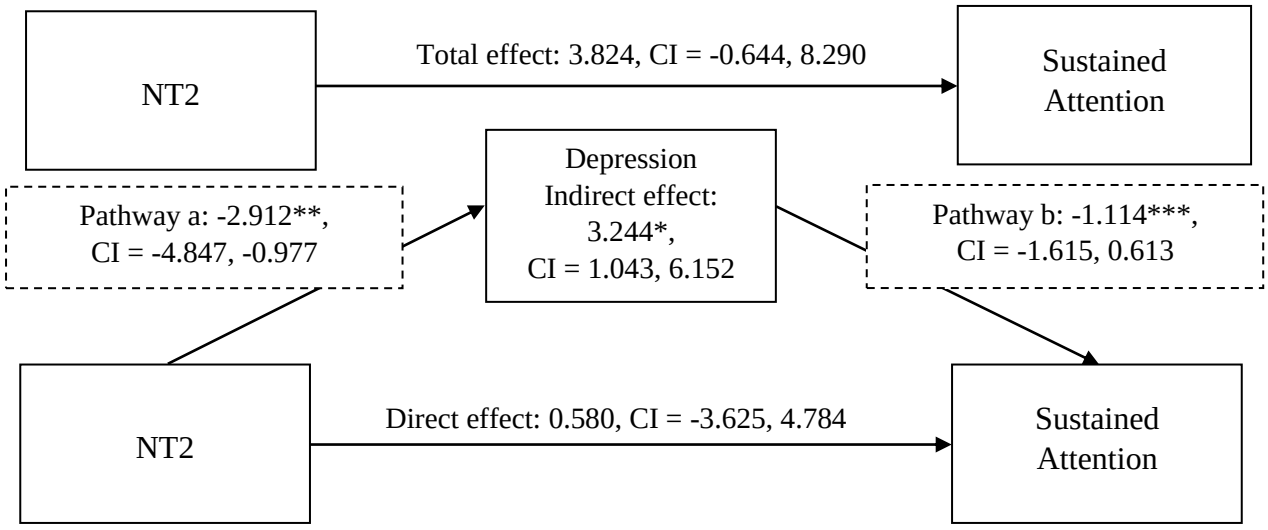
The second mediation analysis investigated the effect of NT1 on SAttention, and whether this was mediated by depression. There was a significant total effect between NT1 and SAttention (p <.001). The path from NT1 to depression was negative and significant (p <.001), indicating that NT1 was related to higher scores of depression. The path from depression to SAttention was negative and significant (p <.001), indicating that higher depression scores were related to lower SAttention performance. There was a significant indirect effect of NT1 on SAttention through depression. The direct effect from NT1 to SAttention was not significant with the presence of depression (p = 0.342).

Figure 8: *Simple mediation analysis displaying impact of NT1 on SAttention through depression.*



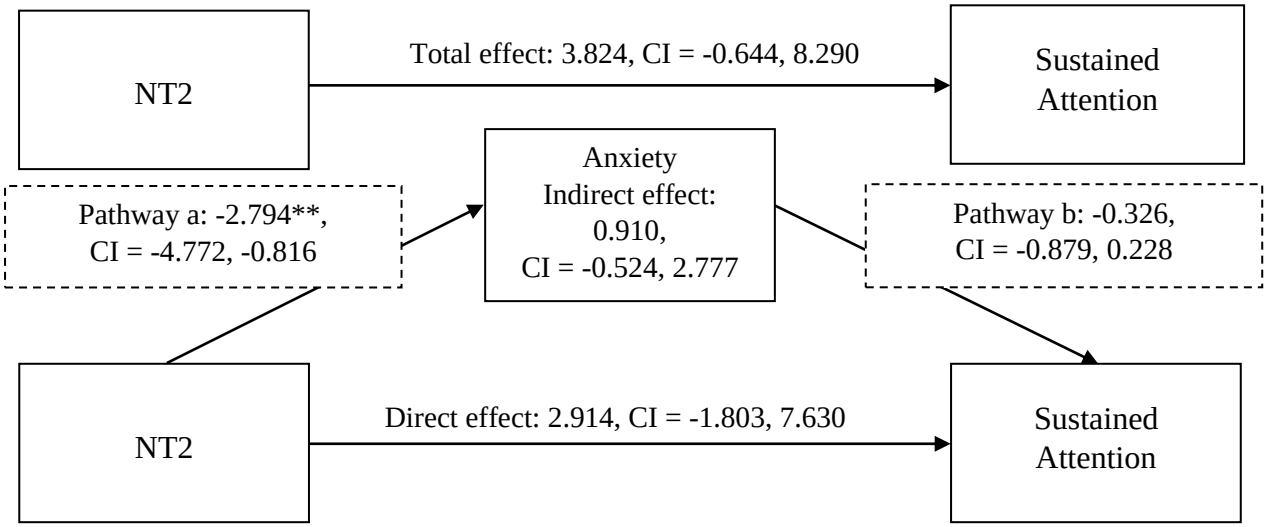
When investigating NT2, the analysis revealed a non-significant total effect between NT2 and SAttention ($p = 0.21$), corresponding with previous analyses. The path from NT2 to depression was negative and significant ($p = 0.003$), indicating that NT2 was related to higher scores of depression. The path from depression to SAttention was negative and significant ($p < .001$), indicating that higher depression scores were related to lower SAttention performance. There was a significant indirect effect of NT2 on SAttention through depression. The direct effect of NT2 on SAttention was not significant when accounting for depression ($p = 0.784$).

Figure 9: *Simple mediation analysis displaying impact of NT2 on SAttention through depression.*



Additional analyses were completed investigating anxiety as the mediator in this model. The path from NT2 to anxiety was negative and significant (p = 0.01), indicating that NT2 was related to higher scores of anxiety. Results revealed that higher scores of anxiety was associated with lower SAttention performance, however this path was non-significant (p = 0.23). The indirect effect of NT2 on SAttention through anxiety and the direct effect of NT2 on SAttention when accounting for anxiety was not significant (p = 0.42), suggesting that anxiety did not mediate the relationship between NT2 and SAttention.

Figure 10: *Simple mediation analysis displaying impact of NT2 on SAttention through anxiety.*



Hypotheses 5: Serial Mediation

Serial mediation analyses revealed similar results for both NT1 and NT2. It revealed a significant total effect of narcolepsy on WM (NT1: p < .001, NT2: p = .010). The path from narcolepsy to depression was negative and significant in the presence of SAttention (NT1: p < .001, NT2: p = .003), indicating that narcolepsy was associated with higher scores of depression. The path from narcolepsy to SAttention was positive and non-significant in the presence of depression (NT1: p = .342, NT2: p = .757). The path from depression to both SAttention (NT1: p = .003, NT2: p <.001) and WM (NT1: p = .022, NT2: p <.001) was negative and significant, indicating that higher scores of depression was associated with

lower scores of SAttention and WM. The path from SAttention to WM was positive and significant in the presence of depression (NT1: $p < .001$, NT2: $p < .001$), indicating that higher scores of SAttention was associated with higher scores of WM. The indirect path was significant from narcolepsy to WM through depression, but non-significant from narcolepsy to WM through SAttention. The indirect path from narcolepsy to WM through both depression then SAttention was significant. The direct effect of narcolepsy on WM was non-significant (NT1: $p = .105$, NT2: $p = .506$).

Figure 11: *Serial mediation analysis displaying impact of NT1 on WM through depression and SAttention.*

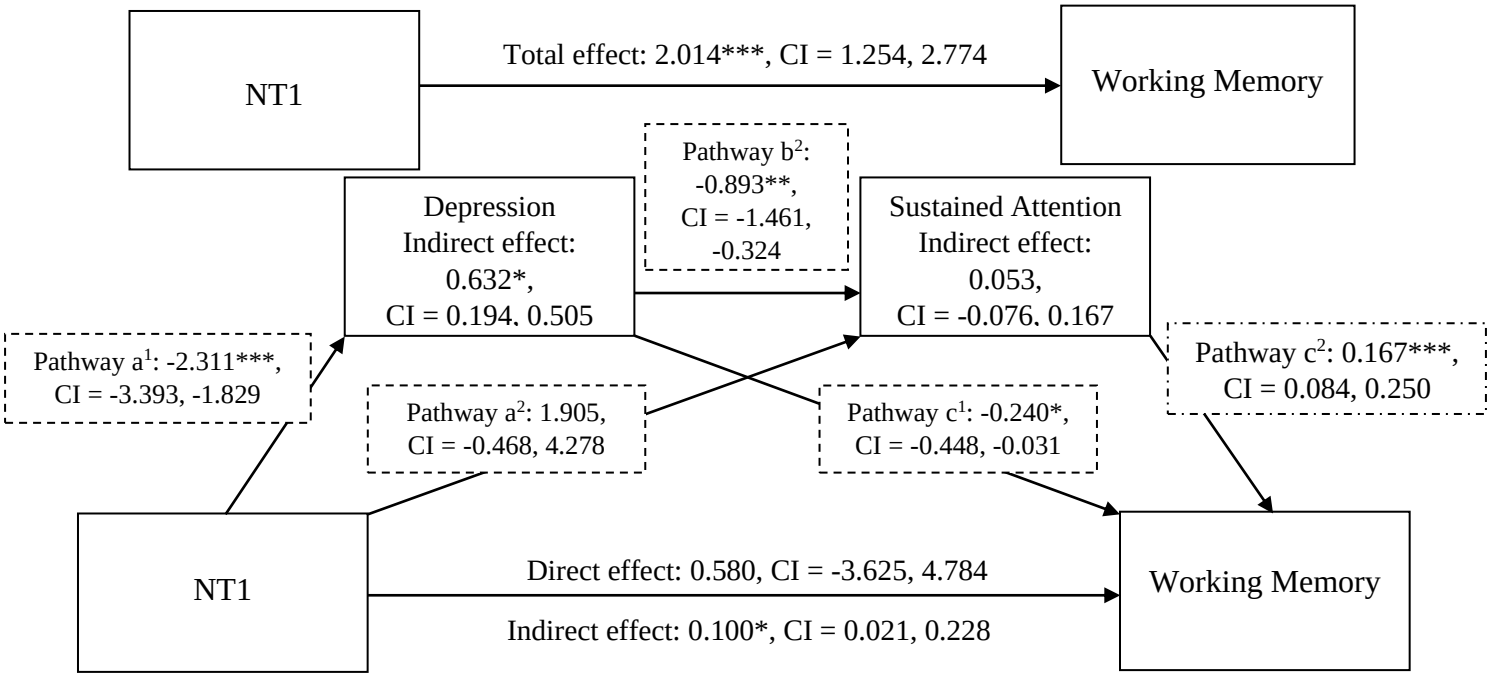
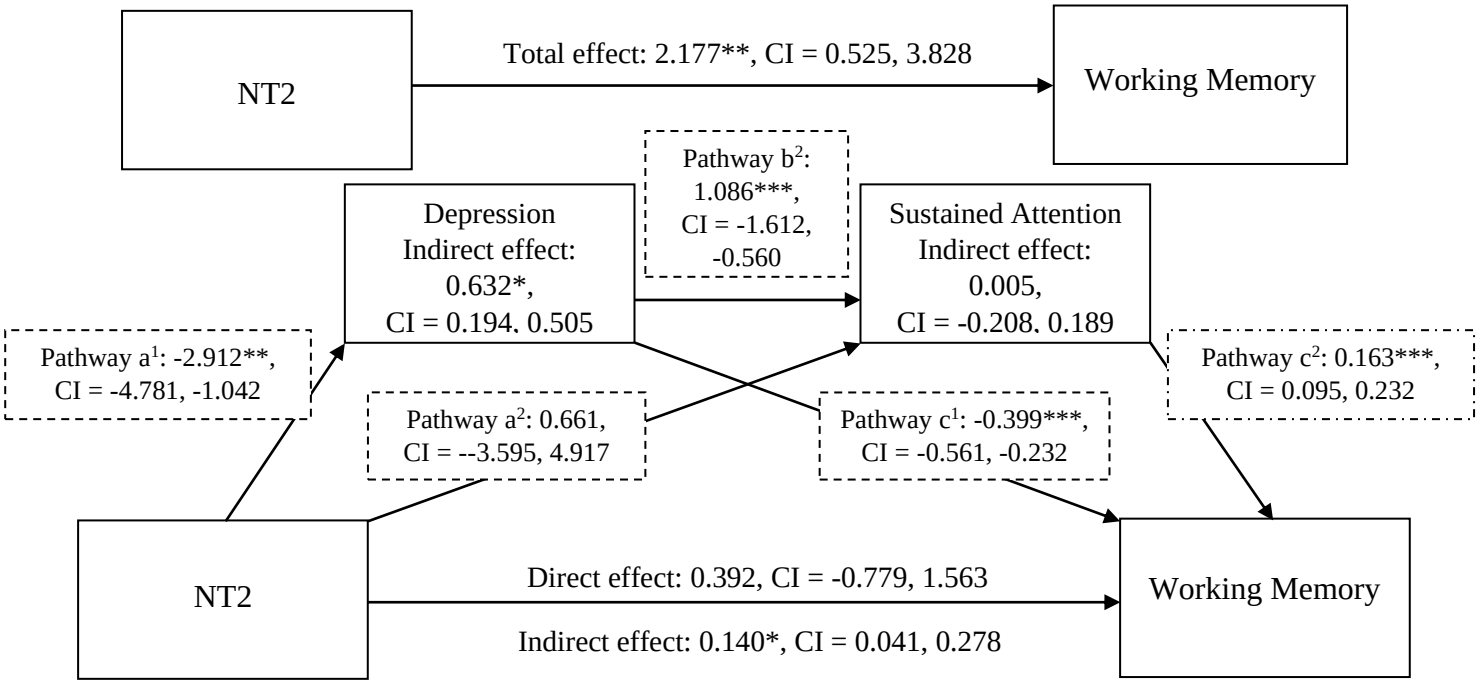


Figure 12: *Serial mediation analysis displaying impact of NT2 on WM through depression and SAttention.*



Discussion

This study aimed to investigate differences in STM, WM, SAttention and mood between PwN and controls, and identify whether mood mediated differences in performance of these cognitive areas. Findings partially supported hypothesis 1, as PwN performed significantly worse than matched controls in WM, whilst only NT1's performed significantly worse in SAttention than controls. Findings are consistent with previous studies (Yoon et al, 2013; Park et al., 2016) and provides evidence that WM is impaired in PwN. There was no significant difference between NT2 and controls on SAttention performance, nor between NT2 and NT1 on WM and SAttention performance. This is consistent with findings from Bayard and colleagues (2012) and Van Schie and colleagues (2012). There was no significant difference between PwN and controls in STM performance, in keeping with previous studies (Naumann et al., 2001; Delazer et al., 2011; Zamarian et al., 2015). These findings support Miller's (1956) theory of STM, who posited that limited items are held in STM and recalled

following a short duration (Atkinson & Shiffrin, 1968). As participants were asked to recall items immediately, indicates that PwN can attend briefly, store and recall information recently encoded within the MWMM with difficulty. Education was a significant covariate for WM whilst age was not, suggesting that PwN who attain a higher level of education may be more protected against WM impairments associated with narcolepsy.

Extreme outliers were removed from analyses of cognition; all found within the narcolepsy groups. These participants scored zero within the DSB and DSS conditions, instead recalling stimulus in line with the DSF condition, suggesting these participants did not adjust as instructed when the condition changed. Due to these outliers falling within the narcolepsy group, it was speculated whether these participants were affected by EDS or lack of motivation/effort leading to such results.

Results partially supported hypothesis 2. PwN were significantly more depressed than controls, supporting previous studies (Filardi et al., 2017; Ramm et al., 2019; Medrano-Martinez & Peraita-Adrados, 2020). However, only NT2 were significantly more anxious than controls, with no significant difference between NT2 and NT1. This is a curious finding as previous research has theorised that perceived loss of control related to cataplexy is a main factor for increased anxiety in PwN. However, given the lack of difference between narcolepsy types, this finding may be due to higher anxiety presenting within controls than normal. Additionally, previous research has identified anxiety being associated with younger PwN. Given that the mean age in NT1 was 34, this finding may be explained for by the sample being older thus having more time to adjust to their symptoms. However, this study did not collect data on onset of symptoms, therefore it is uncertain whether this can be concluded, and more research is needed to clarify this relationship between age, onset of symptoms and anxiety in PwN.

Although there was a general trend that NT1 performed worse than NT2, the current study did not find any significant differences between NT1 and NT2 on measures of mood and cognition which conflicts with previous findings (Dimitrova et al., 2011; Huang et al., 2018) and highlights the importance that NT2 should not be overlooked in future research.

Results revealed that SAttention mediated the effects of narcolepsy on WM, supporting hypothesis 3. However, this significant mediation was only found in NT1 and revealed a complementary mediation (Hair et al, 2021); suggesting that although SAttention mediated the effect of narcolepsy on WM when controlling for education, the results imply the existence of another omitted mediator. Considering theory around cognition and the symptoms of NT1, it may be theorised that cataplexy or processing speed may fulfil the role of the omitted mediator in this model. Findings for NT2 suggested that NT2 may directly influence WM beyond any mediated effect from SAttention, however given the pathway from NT2 to SAttention and direct effect was insignificant, findings from this analysis should be interpreted with caution.

Results supported that depression mediated the effects of narcolepsy on SAttention, supporting hypothesis 4. For NT1, depression was found to mediate on the effect of NT1 and SAttention revealing an indirect-only mediation (Hair et al., 2021). This suggests that the effect of NT1 on SAttention occurs only through depression, in that NT1 was associated with increased depression which was associated with poorer SAttention performance. This implies that NT1 alone was not directly linked to SAttention impairment, but instead the combination of NT1 and depression was associated with SAttention impairment. Similar findings were identified for NT2, revealing NT2 was associated with higher levels of depression, which was associated with poorer SAttention performance, however the total effect in this mediation analysis was not significant. However, when a significant mediation is found alongside an insignificant total effect, and suppression is not present, it is likely that one lacks power to

detect the total effect (Kenny & Judd, 2014). This emphasizes cautiously interpreting NT2 results from hypothesis 3 and highlights the importance of additional research to confirm findings for NT2. Additionally, despite the pathway from NT2 to anxiety being significant, indicating NT2 was related to higher anxiety, the pathway from anxiety to SAttention was not significant and anxiety was not found to mediate the relationship between NT2 and SAttention. Possible explanations for this finding are that ACT posits anxiety to disrupt functioning by impairing task-switching skills, performance on secondary tasks in dual-task conditions and increasing susceptibility to distraction. The current study did not include dual-tasking, set-shifting or distractions. Additionally, there was no inclusion of threatening stimulus to increase influence from stimulus-driven processes over goal-driven processes, thus possibly resulting in no adverse effects from anxiety on cognition in this study. Further research would be valuable to elucidate the impact of anxiety on cognition in PwN in dual-task conditions/set-shifting.

Results supported hypothesis 5, revealing depression and SAttention mediated the effect of both NT1 and NT2 on WM. The long-way mediation path (NT>Depression>SAttention>WM) and short-way indirect path through depression (NT>Depression>WM) was significant, however the short-way indirect path through SAttention (NT>SAttention>WM) was insignificant. This suggests that narcolepsy is associated with increased depression, leading to lower SAttention performance, ultimately leading to WM impairments. This also suggests that narcolepsy leads to WM impairment through high depression without influence from SAttention, but SAttention does not act as an independent mediator but rather is part of a longer chain that involves depression. This implies that while SAttention may be affected in narcolepsy, its impact on WM might be more through its interaction with depression rather than a direct effect and may explain for

the complementary mediation findings in hypothesis 3, with depression potentially performing as the omitted mediator.

Clinical and Research Implications

The current study provides insights towards the importance of managing depression in PwN, highlighting the importance of PwN evaluating and maintaining their mood to support with their cognitive functioning. These findings have various implications which should be considered in services that support PwN. Narcolepsy services should focus on offering more comprehensive screenings on mood and provide more holistic approaches to treatment addressing both medical and psychosocial difficulties, as opposed to solely focusing on EDS management through stimulants (Barateau et al., 2016). Psychotherapy can be utilised to address specific mental health needs such as feelings of guilt and depression related to living with narcolepsy by addressing concerns around identity/autonomy and use of fatigue management techniques through cognitive-behavioural therapy (CBT). Acceptance and commitment therapy (AaCT) may promote acceptance and resilience to managing the unpredictability of narcolepsy and create a more compassionate and balanced relationship with their condition. Systemic practices may also address social/relationship difficulties that PwN experience to foster greater support and understanding of the condition in families. Subsequently, future research should aim to evaluate the effectiveness of CBT/AaCT for addressing psychological distress in PwN. Randomised control trials would be valuable to measure the applicability/efficacy of these methods. Findings from such research could direct the creation of novel treatment for depression in PwN by understanding how depression develops and identify maintaining factors i.e. is depression linked to a neurological component, or manifests due to stressors associated with diagnosis, symptoms, and lifestyle changes. Previous research has identified negative themes such as incapability, stigma, and

societal devaluation in PwN (Schokman et al., 2024), however there is limited research investigating maladaptive thinking patterns, beliefs, and judgements in PwN.

Psychologists may support PwN to plan and set goals that align with their abilities by identifying meaningful activities/passions and adapting the pursuit of these in line with their condition to promote identity development and fulfilment. Sleep clinics may also facilitate peer support groups to allow PwN to connect with those who identify and share their experiences to reduce social isolation. Clinicians can also support PwN by addressing socioeconomic disadvantage resulting from their condition by assisting with disability applications to support with financial stability. As such, clinicians should also look to educate and empower PwN on their rights in line with the Equality Act (2010) to allow them to advocate for themselves and request appropriate adjustments and workplace accommodations, and how to seek legal advice if necessary.

Findings highlight implications on a wider level, such as destigmatising narcolepsy within society to allow for recognition of their experiences. This may be facilitated by improving public education/awareness of the condition and relationship between depression, narcolepsy and/or other comorbidities through public education campaigns, community workshops to family/friends/colleagues, and training delivered in workplaces and schools raising awareness on the profound impact and challenge misrepresentations of narcolepsy. Such destigmatisation may support PwN to live a more meaningful life through increased compassion for their difficulties and reduce shame experienced. Improved understanding of narcolepsy may lead to organic changes within work/academic environments to remove additional barriers that PwN face when pursuing education/employment. Such training should be extended to professionals in other settings (i.e. mental health, primary care, neurodevelopmental services) to ensure efficient and inclusive care is provided, given the

findings on SAttention in this study, it supports recent evidence of ADHD as a common comorbidity in narcolepsy (Ren et al., 2023).

Future research should explore the mechanisms through with depression affects cognition in narcolepsy and discover whether improving depression leads to cognitive improvements through experimental research or RCTs, comparing cognition following psychological treatment in PwN. The addition of neuroimaging would be valuable to understand how these difficulties manifest given the impact narcolepsy and depression have on brain activity (Joo et al., 2009; McKinnon et al., 2009).

More research is needed to fully understand how anxiety presents in narcolepsy and its impact on cognition. Despite insignificant findings in the current study, there is evidence that supports the study was underpowered. Additionally, research towards NT2 should be pursued as findings have highlighted that this condition is similarly affected as NT1. Given such scarcity in the literature on both topics, more research is needed to understand this further.

Limitations

Limitations of the study are largely methodological in nature. The study had a small sample size and was unable to recruit the desired number of participants, consequently increasing the risk of type II errors (Mascha, 2018), which have been reflected on and evidenced in the findings. Future research should aim to recruit larger samples; however, this has historically been difficult with previous research recruiting similar or smaller samples (Filardi et al., 2021). This may be due to complications in accessing the population given the rarity of the condition, and frequent misdiagnosis/underdiagnosis reducing the pool of potential participants (Dunne et al., 2016). Additionally, due to the online nature of the study

and risk of reducing recruited participants, there was no defined method of confirming whether PwN received their diagnosis from a clinician.

The sample was largely female and did not collect data on ethnicity. Ethnicity data was not collected largely due to how matching difficulties would produce further recruitment constraints. Nonetheless, previous research has evidenced the lack of consideration for this characteristic, and the influence it may exert on the expression of narcolepsy (Maski, 2015; Spruyt, 2020). Subsequently, this data would have been valuable to collect without its use in analysis as it would have added to the limited ethnicity data currently held in narcolepsy research, alongside provide further insight towards individuals partaking in the study. It is a curious finding that the sample was largely female. Although the reasons leading to this are unclear, factors relating to sampling (through social media), attitudes towards help-seeking, and online survey participation may have contributed to this. Significant determinants for females partaking in online studies were that they placed more importance on the implications of studies related to their personal health and are more influenced by general altruistic considerations than males (Hawke et al., 2024; Nuzzo & Deaner, 2023). Females were also more likely to seek health-related information online and disclose physical and mental health status compared to males (Jia et al., 2021; Doherty & Kartlova-O'Doherty, 2010), as previous research has evidenced males to repress mental health symptoms due to societal pressures/expectations and masculinity stigma (Shi et al., 2021). As the current study utilised sampling through social media sites, word of mouth through family/friends, and online forums relating to narcolepsy; and required the disclosure of depressive/anxiety symptoms, the aforementioned factors may have encouraged females to partake more than males. Considering these factors, there is less confidence in the generalisability of findings to the narcolepsy population, particularly males with narcolepsy. This highlights the importance of future research finding alternative ways to attract a larger sampling pool such as being

implemented in sleep clinics that can confirm diagnosis and may have a higher likelihood of accessing a broader sample to be able to provide more generalisable conclusions.

The study completed multiple statistical analyses and retained mild outliers. Although analysis was repeated without outliers and found no change in results, these factors have implications towards inflating type I errors (Ranganathan et al., 2016). The study also used self-report measures, which relies on participants accurately reporting their symptoms and can be subjected to social desirability bias (Paulhus, 2017), resulting in issues of reliability. The online nature of the study has implications on the use of neuropsychological tests employed. There was no regulation on environments where participants completed the study. It is likely that some participants were more distracted than others, leading to repercussions on effort exerted during testing. Such factors have significant effects on test performance and can lead to inaccurate results of the individual's abilities (An et al., 2012), leading to issues with validity. There is evidence to suggest that web-based and remote assessments provide comparable results to in-person testing, however it has demonstrated that distractions within the home environment produces significant variance in performance (Backx et al., 2020; Brown & Zakzanis, 2023). Consequently, these findings should be held cautiously and highlights the importance of replicated research using objective methods of measurement and consistent modes of administration to improve validity and reliability of future findings.

The study used a cross-sectional design, common for examining relationships between variables. Most narcolepsy participants were taking medication thus it was not possible to compare differences between medicated and unmediated PwN. Therefore, it is unclear what impact current medication has on psychological and cognitive outcomes. Additionally, despite mediation analyses demonstrating associations between narcolepsy, depression, and WM; causality cannot be confirmed. Consequently, future research should

aim to employ specific research designs that are able to determine causal inferences between variables, such as longitudinal or experimental designs (Farrington et al., 2010)

Conclusion

Previous research has demonstrated mood to be impacted in narcolepsy but was yet to be explored. To the authors knowledge, this is the first study to investigate the effect of mood on cognition in PwN. The study cannot state whether narcolepsy causes depression, however it suggests that narcolepsy is associated with higher levels of depression which in turn mediates WM and SAttention impairments. Clinicians should incorporate assessment, review, and evaluation of mood in PwN and include psychological intervention in their treatment. Furthermore, education on how depression and cognitive difficulties present in narcolepsy to wider services that PwN may access should be considered to improve care. The non-significant findings warrant further investigation as there is evidence to suggest that they reflect a lack of statistical power in the study rather than the connection of narcolepsy, mood, and cognition. The study supports previous findings in NT1 and has added to the limited literature of NT2, encouraging more research on NT2 as they do not significantly differ to NT1 in relation to depression and WM outcomes. Future research should utilise explanatory methods to investigate causal factors between narcolepsy and depression, alongside research into the efficacy and applicability of current and future interventions for depression in narcolepsy.

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Section C: Appendices of Supporting Materials

Section A: Appendix A - QuADS Assessment Criteria

QuADS Criteria	0	1	2	3
1. Theoretical or conceptual underpinning to the research	No mention at all.	General reference to broad theories or concepts that frame the study. e.g. key concepts were identified in the introduction section.	Identification of specific theories or concepts that frame the study and how these informed the work undertaken. e.g. key concepts were identified in the introduction section and applied to the study.	Explicit discussion of the theories or concepts that inform the study, with application of the theory or concept evident through the design, materials and outcomes explored. e.g. key concepts were identified in the introduction section and the application apparent in each element of the study design.
2. Statement of research aim/s	No mention at all.	Reference to what the sought to achieve embedded within the report but no explicit aims statement.	Aims statement made but may only appear in the abstract or be lacking detail.	Explicit and detailed statement of aim/s in the main body of report.
3. Clear description of research setting and target population	No mention at all.	General description of research area but not of the specific research environment e.g. 'in primary care.'	Description of research setting is made but is lacking detail e.g. 'in primary care practices in region [x]'.	Specific description of the research setting and target population of study e.g. 'nurses and doctors from GP practices in [x] part of [x] city in [x] country.'
4. The study design is appropriate to address the stated research aim/s	No research aim/s stated or the design is entirely unsuitable e.g. a Y/N item survey for a study seeking to undertake exploratory work of lived experiences. .	The study design can only address some aspects of the stated research aim/s e.g. use of focus groups to capture data regarding the frequency and experience of a disease.	The study design can address the stated research aim/s but there is a more suitable alternative that could have been used or used in addition e.g. addition of a qualitative or quantitative component could strengthen the design.	The study design selected appears to be the most suitable approach to attempt to answer the stated research aim/s.

5. Appropriate sampling to address the research aim/s	No mention of the sampling approach.	Evidence of consideration of the sample required e.g. the sample characteristics are described and appear appropriate to address the research aim/s.	Evidence of consideration of sample required to address the aim. e.g. the sample characteristics are described with reference to the aim/s.	Detailed evidence of consideration of the sample required to address the research aim/s. e.g. sample size calculation or discussion of an iterative sampling process with reference to the research aims or the case selected for study.
6. Rationale for choice of data collection tool/s	No mention of rationale for data collection tool used.	Very limited explanation for choice of data collection tool/s. e.g. based on availability of tool.	Basic explanation of rationale for choice of data collection tool/s. e.g. based on use in a prior similar study.	Detailed explanation of rationale for choice of data collection tool/s. e.g. relevance to the study aim/s, co-designed with the target population or assessments of tool quality.
7. The format and content of data collection tool is appropriate to address the stated research aim/s	No research aim/s stated and/or data collection tool not detailed.	Structure and/or content of tool/s suitable to address some aspects of the research aim/s or to address the aim/s superficially e.g. single item response that is very general or an open-response item to capture content which requires probing.	Structure and/or content of tool/s allow for data to be gathered broadly addressing the stated aim/s but could benefit from refinement. e.g. the framing of survey or interview questions are too broad or focused to one element of the research aim/s.	Structure and content of tool/s allow for detailed data to be gathered around all relevant issues required to address the stated research aim/s.
8. Description of data collection procedure	No mention of the data collection procedure.	Basic and brief outline of data collection procedure e.g. 'using a questionnaire distributed to staff'.	States each stage of data collection procedure but with limited detail or states some stages in detail but omits others e.g. the recruitment process is mentioned but lacks important details.	Detailed description of each stage of the data collection procedure, including when, where and how data was gathered such that the procedure could be replicated.

9. Recruitment data provided	No mention of recruitment data.	Minimal and basic recruitment data e.g. number of people invited who agreed to take part.	Some recruitment data but not a complete account e.g. number of people who were invited and agreed.	Complete data allowing for full picture of recruitment outcomes e.g. number of people approached, recruited, and who completed with attrition data explained where relevant.
10. Justification for analytic method selected	No mention of the rationale for the analytic method chosen.	Very limited justification for choice of analytic method selected. e.g. previous use by the research team.	Basic justification for choice of analytic method selected e.g. method used in prior similar research.	Detailed justification for choice of analytic method selected e.g. relevance to the study aim/s or comment around of the strengths of the method selected.
11. The method of analysis was appropriate to answer the research aim/s	No mention at all.	Method of analysis can only address the research aim/s basically or broadly.	Method of analysis can address the research aim/s but there is a more suitable alternative that could have been used or used in addition to offer a stronger analysis.	Method of analysis selected is the most suitable approach to attempt answer the research aim/s in detail e.g. for qualitative interpretative phenomenological analysis might be considered preferable for experiences vs. content analysis to elicit frequency of occurrence of events.
12. Evidence that the research stakeholders have been considered in research design or conduct.	No mention at all.	Consideration of some the research stakeholders e.g. use of pilot study with target sample but no stakeholder involvement in planning stages of study design.	Evidence of stakeholder input informing the research. e.g. use of pilot study with feedback influencing the study design/conduct or reference to a project reference group established to guide the research.	Substantial consultation with stakeholders identifiable in planning of study design and in preliminary work e.g. consultation in the conceptualisation of the research, a project advisory group or evidence of stakeholder input informing the work.
13. Strengths and limitations critically discussed	No mention at all.	Very limited mention of strengths and limitations with omissions of many key issues. e.g. one or two strengths/limitations mentioned with limited detail.	Discussion of some of the key strengths and weaknesses of the study but not complete. e.g. several strengths/limitations explored but with notable omissions or lack of depth of explanation.	Thorough discussion of strengths and limitations of all aspects of study including design, methods, data collection tools, sample & analytic approach.

Section B:

Appendix A: Hospital Anxiety and Depression Scale

This has been removed from the electronic copy

Appendix B: Epworth Sleepiness Scale

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Appendix C: Ethical Approval

This has been removed from the electronic copy

Appendix D: Study Advertisement Flyer

For matched controls:

For narcolepsy groups:

Appendix E: Information Sheet

Participant Information Sheet

You are invited to take part in the above research study. This research study is being conducted at Canterbury Christchurch University by Carmen Ng, Trainee Clinical Psychologist. It is supervised by Dr Holly Milling and Dr Shreena Unadkat, Clinical Psychologists.

Before you decide whether to take part, it is important that you understand why the research is being done and what it would involve for you.

Please do not participate if you are under 18 years of age AND/OR have been diagnosed with a condition (with the exception of narcolepsy) that can significantly impact on your memory or ability to think e.g. neurodegenerative diseases such as Parkinson's disease, Alzheimer's disease and multiple sclerosis, a brain injury, stroke, dementias etc.

What is the purpose of the study?

The current study aims to investigate any differences in thinking skills such as memory and attention, in those diagnosed with type 1 and type 2 narcolepsy compared and those who have not been diagnosed with narcolepsy. It is being completed as part of a Doctorate in Clinical Psychology

Do I have to take part?

Participation in the study is entirely voluntary. If you choose to partake in the study, you will be asked to sign a consent form. If you have any questions or concerns regarding the study, please do not hesitate to contact Carmen Ng (details below). Should you decide to participate, you will be free to (i) withdraw consent at any time without having to give reason, (ii) request that your data is erased and no longer used for processing.

What will happen if I take part?

You will be asked to complete a series of online questionnaires and interactive tasks. Overall, it should take approximately 20 minutes to complete the whole study.

We ask that you try to complete the tasks to the best of your ability and so recommend that you are undisturbed and in a quiet place whilst completing them so you can fully concentrate. If at any point you do not feel comfortable to continue with the study, you are free to close the application at any time during participation.

At the end of the study, you will be presented with more information detailing the rationale of the study and who to contact for further information/support.

What are the possible disadvantages and risks of taking part?

The tasks are designed to get progressively harder to test your thinking skills. Therefore, some people may find the tests challenging, however it is important to remember that the tests are designed to challenge people and getting answers wrong is part of the tasks. Nobody is meant to get a perfect score on any of the tasks.

What are the possible benefits of taking part?

There is no intended clinical benefit of taking part, however you would be contributing towards research that may help improve the treatment of people diagnosed with narcolepsy. Some people may also find the interactive tasks stimulating and fun!

There are two £50 Amazon e-vouchers to be won. You will have the opportunity to be entered into a prize draw for these once you have participated in the study (please note that this is only redeemable on Amazon.co.uk and not on any other Amazon website based in a different country).

What if I change my mind after partaking in the study?

You are free to withdraw consent at any time without having to give a reason. To do this, please email Carmen Ng (details below) with the study title, the unique participation code you will create after participating, and the subject email of "Withdrawing Consent". If you would like to withdraw your data, please request to do this prior to 1 month after your participation in the study (i.e. if you participated on 30th September, please request to withdraw before the 30th October).

What if there is a problem or I have a complaint?

If you have a concern about any aspect of this study, please email me your concerns and I will try my best to address these. Please email c.ng229@canterbury.ac.uk with the title of the study and “Concern/Complaint”. If you remain dissatisfied and wish to complain formally, you can do this by contacting Dr Fergal Jones, Clinical Psychology Programme Research Director, Salomons Institute for Applied Psychology – fergal.jones@canterbury.ac.uk

Will information from or about me from taking part in the study be kept confidential?

Yes. We will follow ethical and legal practice and all information about you will be handled in confidence, please see the next page for more information. There are some rare situations in which information would have to be shared with others, for example if there were concerns regarding your safety or the safety of someone else was at risk, however that is highly unlikely to be the case with the current study.

Confidentiality and Data Protection

On the legal basis of consent, all data and personal information will be stored securely in accordance with the General Data Protection Regulation (GDPR) and the University's own data protection policies. No unrelated or unnecessary personal data will be collected or stored. Data can only be accessed by Carmen Ng (researcher).

How will my data be collected?

Through the online platform Gorilla which is secure and GDPR compliant

How will my data be stored?

All answers are encrypted and stored on protected devices. Data will be uploaded anonymously into a data analysis software and all personal identifiers will be removed.

What will my data be used for?

Any data collected for this study will solely be used for this study alone. Data will not be used for any other future studies.

How will my data be used?

Data will be analysed in line with all other questionnaires collected from other participants within the study for the purposes of the Doctoral Major Research Project.

Who will have access to my data?

The researcher and responsible members of Canterbury Christchurch University to ensure compliance of research ethical guidelines.

How will my data be destroyed?

All data and electronic files will be deleted following completion of the study.

What will happen to the results of the research study?

It is hoped that the results of the study will be published. Should this happen, there is no possibility that you will be identified in any publications as all data is anonymised.

Regardless of whether the study is published, you will have the chance to opt in to receive a summary of findings report which will outline the results of the study.

Who has reviewed the study?

All research is looked at by an independent group of people, called a Research Ethics Committee, to protect your interests. This study has been reviewed and given favourable opinion by The Salomons Ethics Panel, Salomons Institute for Applied Psychology, Canterbury Christ Church University.

Please note that this project is based on UK ethics and therefore cannot cover information across the globe.

Any Questions?

If you have any further questions regarding the research study or specific information about this project, please contact Carmen Ng on c.ng229@canterbury.ac.uk or the supervisors Holly Milling (holly.milling@canterbury.ac.uk) and Shreena Unadkat (Shreena.unadkat@nhs.net).

If you wish to take part in this study, please proceed to the next page.

N.B: Please allow time for each page to load. If you have difficulty loading any page, you can refresh your browser - the website will save your progress as you complete the study.

Appendix F: Consent Form

Consent Form

Please read the below information carefully.

If you would like to participate in this study, please indicate your consent below:

- I confirm that I have read and understand the information page for this study and know who to contact to ask questions.
- I understand that the information provided for services are based only in the UK.
- I am aware of who to contact in my local area/local services/health specialists and agree to contact them for support should I need to.
- I understand that my participation is voluntary and that I am free to withdraw at any time before 30th January 2024 without giving a reason.
- I understand how my information will be used and that any personal information that I provide to the researchers will be kept strictly confidential and anonymised.
- I understand who will have access to my data and how my data will be used, how my data will be stored and what will happen to my data at the end of the research project.
- I have not been diagnosed with a health condition (with the exception of narcolepsy) that may affect my memory or ability to think (such as a brain injury, Parkinson's disease, psychosis etc.).
- I confirm that I have the capacity to make my own decision to consent to partake in this study.
- I confirm that I am over 18 years of age.
- I agree to take part in the study.

☐ **I have read and understood the above and consent to taking part as a participant.**

*If you **do not consent** to partaking in the study, you may close this page in your browser instead. We thank you for your interest and time.*

Please tick the box above and click Next if you would like to start the study.

Next

Appendix G: ID Code Creation Form

Participant ID code

Please create a unique ID code by using the following:

- The last letter of your first name
- The last two numbers of your birth year
- The number of siblings that you have
- Your favourite colour

For example; Andy who was born in the year 1995, who has 0 siblings and favourite colour is green. His unique code would be: Y950GREEN

--

This will be used to identify your data should you wish to withdraw this in the future.

Please create and enter your ID code below:

Please also make a note of this if you wish to opt in to the £50 Amazon prize draw at the end of the study.

Next

Appendix H: Demographic Questionnaire

Demographics

Please answer the following quesitons about yourself.

Are you ...

- ○ Female
- ○ Male
- ○ Non-binary
- ○ Prefer not to say

How old are you?

Highest education level completed

Do you have a diagnosis of Narcolepsy?

- ◉ Yes
- ○ No

If yes, what type?

- ○ Type 1 (with cataplexy)
- ○ Type 2 (without cataplexy)

Next

Appendix I: Instructions presented to participants for interactive tasks

Digit Span Task:

Memory Task

--

In this task, you will see a series of numbers. You need to remember the numbers in a certain order, then type the numbers you remembered on the keyboard.

--

This entire task should take no more than 10 minutes

--

Please continue to the next page for more instructions

Remember the numbers in the same order that they appear

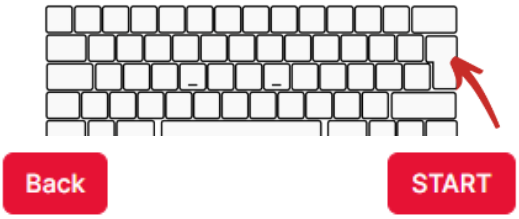
--

You will see a series of numbers. You need to remember **the order in which they appear** on the screen and **immediately** type the numbers you remembered **in the same order**.

For example, if you see numbers like **471**, then you should type **471** on your keyboard.

--

Press the **ENTER** key once you finish typing!



Back START

You will start with 3 numbers to remember, and then you will see more and more numbers.

--

Please remember as many numbers as you can, but if you can't remember all the numbers, don't worry - it is a difficult task. Please try to do your best.
If you are ready, please press "START" to begin the task.

If you have difficulty loading any page, you can refresh your browser - the website will save your progress.

Remember the numbers in the reversed order that they appear

--

You will see a series of numbers again. But this time you need to remember **the reversed order in which they appear** on the screen and **immediately** type the numbers you remembered **in the reversed order**.

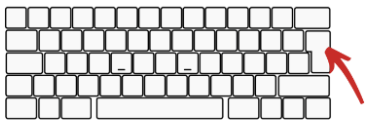
For example;

If you see numbers like **471**, then you should type **174** on your keyboard.

Or if you see numbers like **692**, then you should type **296** on your keyboard.

--

Press the **Enter** key once you finish typing!



"ENTER" key

✓

You will start with 2 numbers to remember, and then you will see more and more numbers.

--

Please remember as many numbers as you can, but if you can't remember all the numbers, don't worry - it is a difficult task. Please try to do your best.

--

If you are ready, please press "START" to begin the task.

If you have difficulty loading any page, you can refresh your browser - the website will save your progress.

Back START

Remember the numbers and put them in numerical order, from smallest to largest.

--

You will see a series of numbers again. But this time you need to remember the numbers on the screen and **immediately** type the numbers you remembered **in numerical order starting from the smallest number**.

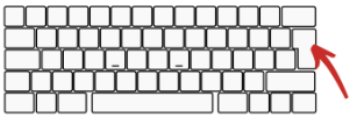
For example, if you see numbers like **471**, then you should type **147** on your keyboard
Or if you see numbers like **6927**, then you should type **2679** on your keyboard.

--

The aim is to put the numbers in numerical order, **from smallest to largest**.

--

Press the **Enter** key once you finish typing!



"ENTER" key

You will start with 2 numbers to remember, and then you will see more and more numbers.

--

Please remember as many numbers as you can, but if you can't remember all the numbers, don't worry - it is a difficult task. Please try to do your best.

--

If you are ready, please press "START" to begin the task.

If you have difficulty loading any page, you can refresh your browser - the website will save your progress.

Back START

Sustained Attention to Response Task:

Attention Task

--

This whole task should take approximately 5 minutes.

--

In this task, you will be presented with the digits 1 to 9 in the center of the screen. You need to press the SPACEBAR in response to each digit, **except for when the digit is '3'**.

--

If you are completing this on a phone or tablet, you can tap the "SPACEBAR" button that is provided. If you are completing this on a computer, you can either press the spacebar on your keyboard or use the "SPACEBAR" button that is provided.

--

Each digit is followed by a circle with a cross which you can ignore.

--

The numbers will come on screen in a random order

Next

Lets do a practice round! Here are the instructions for the practice round.

--

If you see the digit '1', press the spacebar.
If you see the digit '4', press the spacebar
If you see the digit '3', **DO NOT** press the spacebar.
If you see the digit '7', press the spacebar. And so on.

--

Please give equal importance to both the speed and accuracy of your responses.

Back Next

You will be shown feedback to your responses in the practice round.

--

If a green tick shows, this means that you have  answered correctly.

.

If a red cross shows, this means you have answered incorrectly 

--

The practice round will now start.

Back START

Well done!

You have completed the practice round!

--

Next will be the real part of the task, you will not get any feedback on your responses this time.

The same rules apply, you need to press the SPACEBAR in response to each digit, **except for when the digit is '3'**.

Please give equal importance to both the speed and accuracy of your responses.

--

Please do not click off the page during this time. If you do, the task will not continue and therefore will not finish. Please persevere with the whole duration.

Click START to start the real test.

START

Appendix J: Debrief Sheet

Debrief Sheet

Thank you for taking part in this study! Your time and participation are greatly appreciated.

--

The aim of the study was to investigate whether there was any difference in sustained attention and memory between people diagnosed with narcolepsy compared to those not diagnosed. We also wanted to investigate whether mood influenced the relationship between sustained attention and working memory.

It is expected that people with narcolepsy will score differently than those who have not been diagnosed with narcolepsy. This is because people diagnosed with narcolepsy are more likely to experience daytime sleepiness and disturbances in their sleep, which have been shown to impact on attention levels and the ability to remember things during the day.

--

If you were affected by anything in this study, please contact your local GP and/or specialist healthcare team. Please note that the following contacts are based in the UK, if you are based outside of the UK, please contact your local healthcare provider for further information or support.

--

Please see below 24-hour helplines for confidential emotional support and guidance, whom also have details of local and national support services:

Samaritans: 116 123

Mental Health Matters: 0800 107 0160

--

If you are a CCCU student, you can contact the CCCU Student Support and Wellbeing service on 01227 922675.

--

For more information or general support regarding narcolepsy, you can visit Narcolepsy UK:

https://www.narcolepsy.org.uk/

Helpline: 0345 450 0394

--

Contact Information

To find out more information regarding the study or if you have any questions or queries, you can contact any one of the researchers:

Researcher:

Carmen Ng (cn229@canterbury.ac.uk)

Researcher Supervisors:

Dr Holly Milling (Holly.milling@canterbury.ac.uk)

Dr Shreena Unadkat (Shreena.unadkat@nhs.net)

--

Please click the "Next" button below, where your responses will be saved, and you will be redirected to a page where you can opt-in to the Amazon e-voucher raffle and/or to receive a summary of the study's findings.

--

Once again, thank you for your participation. It is greatly appreciated!

Appendix K: Separate Opt-In Survey

Email *

Your email address

Please enter your unique participant ID that you created *
*Please note; unfortunately you will not be included into the additional opt-ins if you did not participate in the study

Your answer

I would like to receive a summary of results report when the study has been completed. *

- [ ] Yes
- [ ] No

I would like to be included in the chance to win £50 Amazon e-voucher raffle *
Please note that this is only redeemable on Amazon.co.uk, it is not redeemable on Amazon websites in other countries (such as Amazon.com) therefore orders made using the voucher must be sent to a UK address.

- [ ] Yes
- [ ] No

Submit Clear form

Never submit passwords through Google Forms.

Appendix L: Study Summary Letter to Ethics Panel

Dear Salomons Institute for Applied Psychology Ethics Panel,

This letter is to summarise the research competed for the Major Research Project approved by the Ethics Panel in April 2023 (application number: ETH2223-0166). Since approval, this project has now been successfully carried out and completed. Please see below a brief summary of the study.

Background: Narcolepsy is a rare, chronic neurological condition that affects one's ability to regulate sleep-wake cycles. Research has evidenced significant impairment in social, occupational/academic, and psychological outcomes due to the consequences of narcolepsy. Previous studies have consistently evidenced people with narcolepsy presenting with higher levels of depression but has yet to be further explored, alongside mixed findings in cognitive areas such as memory and attention. The aim of the current study was to explore the role of mood in cognitive functioning in people with narcolepsy.

Method: The study used a cross-sectional design to explore the impact of narcolepsy on memory (short-term and working memory) and sustained attention and investigated whether mood mediated this effect. There was a total of 140 participants, which included 36 people with type 1 narcolepsy, 34 people with type 2 narcolepsy and 70 matched controls. All participants completed a series of questionnaires assessing mood, sleepiness and completed two interactive tasks assessing memory and sustained attention.

Results: Analysis revealed that people with narcolepsy experienced higher levels of low mood and performed worse on tasks of working memory. People with type 1 narcolepsy performed worse on the task of sustained attention than their matched controls, whilst people with type 2 narcolepsy did not. People with type 2 narcolepsy were found to be more anxious than their matched counterparts, whilst people with type 1 narcolepsy were not. There were no differences found between type 1 and type 2 narcolepsy participants in measures of low mood, anxiety, working memory, and sustained attention. There was no difference in short term memory performance between all groups. Mediation analysis revealed that low mood and sustained attention mediated the relationship between narcolepsy and working memory in people with narcolepsy, whilst anxiety did not. Findings identified that although sustained attention is affected in people with narcolepsy and effects how working memory is impacted, this effect may be more through its interaction with low mood rather than a direct effect on working memory.

Future Implications: These findings have implications on how people with narcolepsy support are supported in services. Incorporation of assessment, review, and management of mood-related difficulties into current treatment plans with people with narcolepsy should be considered in services, alongside increasing education and public information in other services that people with narcolepsy may present to due to common comorbidities such as depression and ADHD. Future research exploring more effective interventions for depression in narcolepsy or more explanatory research investigating the impact of psychological treatment on cognition in people with narcolepsy would be valuable.

Conclusions: This study has made an important contribution to the limited literature on mood and cognition in people with narcolepsy, in particular type 2 narcolepsy. It highlights the importance of screening mood-related difficulties in narcolepsy services and emphasizes value towards future research in type 2 narcolepsy.

A summary of findings will be shared to all participants who opted into ongoing communication about the study via email. It is also hoped that the study will be published in the ‘Sleep’ journal.

Kind regards,

Carmen Ng

Trainee Clinical Psychologist