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Metamemory in narcolepsy

BERNADETTE HOOD and DOROTHY BRUCK
Victoria University of Technology, Victoria, Australia

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SUMMARY People with narcolepsy consistently report diminished memory function attributable to the disorder, however, objective evaluations of memory performance in this clinical group remain inconclusive. Previous evaluations of these subjective experiences have been primarily anecdotal with subjects required to provide global assessments of their memory function. The present study aimed to evaluate subjective assessments of memory dysfunction more extensively comparing responses by narcoleptics, subjects experiencing excessive daytime sleepiness, and controls, on the Metamemory in Adulthood (MIA) questionnaire. The results of the study indicate that subjects with narcolepsy have lower self efficacy for memory performance than either of the comparison groups, despite there being no significant difference between groups in relation to knowledge based aspects of memory functioning. This lowered self efficacy in narcolepsy is expressed through increased anxiety about memory function, decreased evaluations of memory capacity and increased perceptions of memory decline in relation to the comparison groups. It is argued that the negative cognitive self evaluations of narcoleptics potentially arise as a consequence of global psychosocial adjustment difficulties.

KEYWORDS memory, metamemory, narcolepsy, performance, sleep

INTRODUCTION

One recurring theme in the literature relating to cognitive function in narcolepsy is the discrepancy between subjective and objective reports of memory performance. Despite the subjective experience of many narcoleptic subjects of diminished memory function, objective evaluations remain inconclusive in relation to the existence of memory deficits for this clinical group.

Research into the life effects of narcolepsy consistently report that subjective memory problems are of significant concern to this clinical population. Broughton and Ghanem (1976) and Broughton *et al.* (1981) investigated the psychosocial implications of narcolepsy and reported that $\approx$50% of respondents stated that their memory had deteriorated since the onset of the disorder. In both studies subjects reported memory for recent events being most significantly affected. Smith *et al.* (1992) in a more recent survey of 700 narcoleptics found that 38% reported moderate or severe memory problems, 39% had problems with forgetfulness, 40% with concentration and 26% with general learning. Whilst these self reports of cognitive dysfunction in narcolepsy were not compared with matched controls, Smith *et al.* (1992) summarize the data stating that 'the evidence for self-perceived cognitive impairment in narcoleptic persons is consistent and compelling' (p. 103).

Several studies have attempted an objective evaluation of this subjective experience of narcoleptics of diminished memory function. Aguirre *et al.* (1985) compared narcoleptic and control subjects on a series of both short and long-term memory tasks. No significant differences were noted between groups. Rogers and Rosenberg (1990) were also unable to identify performance deficits for subjects with narcolepsy across a diverse range of memory tasks. Smith *et al.* (1992) tested 24 narcoleptic subjects using a range of neuropsychological tests aimed at assessing global cognitive functioning in addition to memory processes. Despite self rated difficulties in memory and concentration being higher for the subjects with narcolepsy these differences did not transfer to performance differences in memory and concentration.

There are several possible explanations for this lack of consistency between subjective impressions of memory dysfunction and objective memory performance for narcoleptic subjects:

Correspondence: Dr B. Hood, Department of Psychology, Victoria University (St Albans), PO Box 14428 MCMC, Melbourne, Victoria, Australia 8001. Tel.: +61 0393652334; fax: +61 03 93652218.

(i) Narcoleptics are typically reported to maintain wakefulness throughout testing periods (e.g. 'there was no behavioural drowsiness in continuous observation', Aguirre *et al.* (1985) p. 22) and therefore whilst the memory studies of Aguirre *et al.* (1985), Rogers and Rosenberg (1990) and Smith *et al.* (1992) may provide support for the argument that no organic impairment in memory function exists, memory deficits for narcoleptics may well be secondary to the effects of sleepiness and as testing protocols generally fail to allow for the expression of this sleepiness, sleepiness related deficits have not been observed. To evaluate the potential impact of sleepiness on memory function Hood and Bruck (1996) manipulated arousal conditions for narcoleptic subjects but even under 'sleepy' conditions narcoleptics demonstrated no performance deficits on standardized memory tasks. Henry *et al.* (1993) tested memory function in narcoleptic subjects utilizing the Sternberg memory scanning task. Performance deficits were noted for response latency, word recall and frequency estimation and it was argued that these could be explained as deficits in the perceptual encoding of stimulus material. Whilst these deficits did not appear as secondary to sleepiness effects 'physiological arousal appeared to be consistent with a state of sustained full wakefulness' (Henry *et al.* 1993, p. 126), they may reflect performance decrements or lapses secondary to the high lability of narcoleptic vigilance states (Valley and Broughton, 1983; Pollak *et al.* 1992; Schulz and Wilde-Frenz, 1995). The failure of laboratory based, generalized memory tasks to demonstrate performance deficits may occur as a consequence of the attentional demands of the memory task masking the expression of fluctuating vigilance, and therefore potentially masking narcoleptics' everyday memory performance lability.

(ii) A second possible explanation for the general absence of objective memory deficits in narcolepsy is that routine memory tasks may have limited external validity in relation to everyday memory performance. The previously cited work of Hood and Bruck (1996) provides tentative support for this position. Despite the absence of performance decrements on routine memory tasks narcoleptic subjects, under conditions of low arousal, demonstrated significant decrements in performance on the PASAT task. This complex processing task incorporates a substantial memory component. Subjects are required to retain information in short-term storage whilst performing parallel cognitive tasks. This embedding of memory function amongst competing cognitive tasks perhaps reflects more accurately the everyday experience of memory function and it is this everyday perception of cognitive dysfunction that is reflected in the subjective experiences of narcoleptic subjects.

(iii) Whilst points (i) and (ii) argue that the lack of association between objective and subjective experiences of memory dysfunction in narcolepsy may occur as a consequence of the low external validity of objective memory testing it is also possible that narcoleptics may develop inaccurate subjective perceptions of their own memory function. For example Niederehe and Yoder (1989) argue that affective dysfunction, especially depression, may lead to individuals making subjective appraisals of memory dysfunction that are based on negative global perceptions of cognitive inadequacy. Niederehe and Yoder (1989) suggest that these subjective impressions are unrelated to subsequent memory performance. As up to 50% of subjects with narcolepsy report depressive symptomology (Broughton *et al.* 1981; Merritt *et al.* 1992) this may provide an explanation of the discrepancy between subjective and objective reports of memory performance in this clinical population.

Over the past decade there have been significant changes in the way that self monitoring of cognitive function has been understood and several instruments have been designed to explore this field of metacognition. The present paper focuses on a re-evaluation of the subjective impressions of memory dysfunction for narcoleptic subjects, extending the literature on memory performance in narcolepsy by exploring metamemory processes for subjects with narcolepsy.

The concept of metacognition was introduced by Flavell and Wellman (1977). At the simplest level metamemory relates to an understanding of how one's memory actually works (memory knowledge), coupled to an assessment of confidence to utilize memory effectively (memory beliefs) (Hertzog *et al.* 1990). Whilst memory knowledge is a necessary aspect of efficient memory processing it is not a sufficient condition and an understanding of the relationship between an individual's confidence in their memory ability and subsequent memory function has recently assumed a significant role in the memory research literature. Bandura (1989) writes that whilst much emphasis has been placed on an analysis of the knowledge and skills necessary for efficient cognitive functioning, the effective utilization of these skills requires a 'resilient sense of efficacy' (p. 733).

However, there is often a lack of association between subjective and objective memory performance measures with correlations between these indices being in the order of 0.2 to 0.3 (Hultsch *et al.* 1988). Hertzog *et al.* (1989) suggest that this poor association occurs as a consequence of individuals developing distorted belief systems. Individuals may construct a belief system about their memory function that is not based on factual incidents of memory functioning but reflects a more generalized, global perception of their capabilities and it is this general perception rather than actual memory performance that subjects use to estimate their memory performance. Factors that distort self belief systems therefore lead to inaccurate self estimates of performance.

As the excessive daytime sleepiness of narcolepsy is associated with substantial psychosocial disruption in a variety of areas (Broughton *et al.* 1981) it is reasonable to predict that some individuals with narcolepsy may also develop negative self evaluations of their capacity across a range of cognitive domains. From the paradigm of the role of belief systems in memory function, it is these negative evaluations that potentially form the basis for narcoleptics' subjective assessments of performance capability.

The aim of the present study is to compare dimensions of metamemory across the three subject groups of (a) subjects with narcolepsy (b) non narcoleptic subjects experiencing excessive daytime sleepiness and (c) a control group of normal sleepers with no reported excessive daytime sleepiness, to determine whether subjects with narcolepsy differ from the comparison groups in relation to their metamemory profile.

METHOD

Subjects

Sixty-one subjects with narcolepsy were contacted by mail through the Australian Narcolepsy Support Group (NODSS). In addition to the metamemory questionnaire subjects were required to complete a form providing demographic details and aspects of the diagnosis, symptomology and management of narcolepsy. Of the 42 subjects who returned questionnaires 33 were selected for inclusion in the study. All subjects selected had specialist, and/or, sleep laboratory, diagnoses of narcolepsy and met the International Classification of Sleep Disorders criteria of excessive daytime sleepiness and unequivocal cataplexy (American Sleep Disorders Association, 1990). Cataplexy was assessed using the Postural Atonia Rating Scale (Parkes *et al.* 1994).

Included in the mail out package was a second questionnaire that narcolepsy participants were asked to give to a partner or friend, without narcolepsy, who considered themselves to be a normal sleeper. Thirty-three questionnaires were returned by these control subjects. Four of these 33 were excluded from the analysis as they failed to complete all of the questionnaire or responded 'yes' to the screening question 'do you suffer from daytime sleepiness?'.

The third subject group comprised of subjects with excessive daytime sleepiness (EDS) not associated with narcolepsy. Subjects were recruited from a sleep disorders centre and had presented to the centre with the complaint of excessive daytime sleepiness. All subjects utilized in the EDS group had subsequent, confirmatory sleep laboratory diagnoses of sleep apnoea.

The final sample comprised of 33 subjects with narcolepsy, 29 control subjects and 23 subjects with EDS not associated with narcolepsy. The mean ages of the three subject groups were 55.18 (SD = 14.37), 49.64 (SD = 12.73) and 48.52 (SD = 11.81), respectively. One-way analysis of mean age differences between groups indicated no significant differences $F(2,81) = 2.155$ ($P>0.05$). Similarly there was no significant relationship between the variables of category and gender (Phi coefficient = 0.18, $P>0.05$).

Apparatus

Metamemory was examined using the Metamemory in Adulthood (MIA) scale developed by Dixon and Hultsch (1983) and full details of the scale are available in Dixon *et al.* (1988). The MIA consists of 108 Likert rating scales and identifies the following seven subscales. Sample items from each subscale are provided.

Achievement: (16 items, score range = 16–80). Higher scores represent increased perceptions of the importance of a good memory, e.g. 'It is important to me to have a good memory.'

Anxiety: (14 items, score range = 14–70). Higher scores indicate increased stress related to memory performance, e.g. 'I get upset when I cannot remember something.'

Capacity: (17 items, score range = 17–85). Higher scores measure increased perceptions of performance capabilities on memory tasks, e.g. 'I am good at remembering names.'

Change: (19 items, score range = 19–90). For this dimension higher scores measure increased memory stability whilst lower scores indicate memory decline across time, e.g. 'I can remember things as well as always.'

Locus: (9 items, score range = 9–45). Low scores represent an external locus of control with higher scores moving towards internality, e.g. 'I have little control over my memory ability.'

Strategy: (18 items, score range = 18–90). The scale evaluates the use of memory aids to enhance performance. Higher scores represent increased usage of memory strategies, e.g. 'When you try to remember people you have met, do you associate names and faces?'

Task: (16 items, score range = 16–80). This dimension measures knowledge of basic memory processes and an awareness of the memory capabilities of others. A higher score indicating increased knowledge, e.g. 'Most people find it easier to remember concrete things than abstract things.'

Analysis of the MIA identifies two higher order factors of knowledge and self efficacy. The knowledge factor comprises the strategy, task, achievement and anxiety dimensions and reflects an understanding of the way that memory processes work and how to utilize memory strategies to enhance memory function. The self efficacy factor defined by the capacity, change, anxiety and locus subscales, provides a measure of confidence related to memory performance. For the self efficacy factor the subscales of change and locus appear age dependent with higher factor loadings for older subjects (Hultsch *et al.* 1988).

Data analysis

To determine whether responses to the dimensions of the metamemory questionnaire varied as a function of the subject group a Multivariate Analysis of Variance (MANOVA) was used. The independent variables were the three subject groups of narcolepsy, EDS or control respondents and the dependent variables were the seven subscales of the MIA questionnaire. As there was no theoretical basis for ordering the dependent variables, univariate F statistics, rather than a stepdown analysis, were used to identify significant univariate relationships.

RESULTS

MANOVA analysis identified a significant difference between subject groups on the combined dimensions of the metamemory scale, $F(14,152) = 2.13$, $P = 0.013$. Table 1 provides an overview of the summary statistics of the MIA dimensions and the univariate analysis.

Table 1 Summary results of univariate analysis for MIA dimensions

			MIA subscales						*Factors*	
		Achievement	*Anxiety*	*Capacity*	*Change*	*Locus*	*Strategy*	*Task*	*Memory knowledge*	*Memory self efficacy*
Narcoleptics	$\bar{X}$	57.72	47.27	44.58	43.06	28.92	62.71	60.99	228.54	163.75
(N)	SEM	1.20	1.82	1.88	1.69	1.02	1.88	1.07	3.87	2.98
Controls	$\bar{X}$	55.70	40.79	52.72	55.34	30.52	60.24	61.34	218.06	180.9
(C)	SEM	1.41	1.88	2.01	2.35	1.05	2.24	1.59	4.03	3.93
EDS	$\bar{X}$	58.40	43.65	55.22	51	31.04	63.74	62.86	228.60	180
	SEM	1.60	1.95	2.15	2.55	1.16	2.57	1.25	4.99	4.14
Univariate ANOVA	F =	0.99	3.22	7.90	9.15	1.07	0.64	0.51	2.07	7.49
Result F (2,82)	P =	0.375	0.045	0.001	0.000	0.345	0.531	0.600	0.132	0.001
Tukey B Post Hoc test significant differences			N>C	C>N EDS>N	C>N EDS>N					N<EDS N<C

Table 1 identifies significant differences between subject groups on the univariate dimensions of anxiety, capacity and change. Tukey post hoc analyses of these differences indicate that subjects with narcolepsy showed significantly greater anxiety about memory performance (M = 47.27) than controls (M = 40.79). On the capacity dimension both the scores for controls (M = 52.72) and EDS subjects (M = 55.22) scored significantly higher perceptions of memory capacity than the narcolepsy group (M = 44.58). A similar pattern was observed for the change dimension where the mean scores for EDS (M = 51) and control subjects (M = 55.34) suggested significantly higher perceptions of stability than for the subjects with narcolepsy (M = 43.06).

Comparison was also made of the higher order factors of the MIA scale described by Hultsch *et al.* (1988). Scores for these higher order factors are incorporated in Table 1. Scores on the capacity, change, anxiety and locus dimensions were summed to define the memory 'self efficacy' factor. The strategy, task, achievement and anxiety scales were also summed to give a score representing 'memory knowledge'. Two, one-way ANOVA analyses were then performed with the independent variables representing subject group, i.e. subjects with narcolepsy, EDS and controls and the dependent variables of memory knowledge and memory self efficacy.

For the self efficacy factor a significant difference between subject groups was found $F(2,82) = 7.50$, $P = 0.001$. Post hoc analysis using the Tukey's test indicated that subjects with narcolepsy had a significantly lower mean self efficacy score (M = 163.75) than both the control subjects (M = 180.00) and the EDS (M = 180.9) group. For the knowledge factor no significant difference was found between subject groupings $F(2, 82) = 2.073$, $P = 0.132$.

DISCUSSION

The results of this study indicate that subjects with narcolepsy have lower self efficacy for memory performance than either of the comparison groups despite there being no significant difference between groups in relation to knowledge based aspects of memory functioning. This diminished self efficacy is expressed by a significant increase in memory performance anxiety for subjects with narcolepsy compared with controls, and significantly decreased scores for narcoleptics on the dimensions of capacity and change, compared with both EDS and control groups.

The dimension of anxiety loads into both the knowledge and self efficacy factors and represents an assessment of subjective feelings of stress associated with memory performance. Subjects with narcolepsy are significantly more anxious about their memory performance than control subjects. This finding is consistent with the elevations in global anxiety reported for subjects with narcolepsy by both Stepanski *et al.* (1990) and Kales *et al.* (1982) using the MMPI. Interestingly a study by Mosko *et al.* (1989) found that the Profile of Mood States (POMS) tension/anxiety rating was not significantly different for narcoleptics compared with several other categories of sleep disorder. Further both Mosko *et al.* (1989) and Zwicker *et al.* (1995) report that subjects with narcolepsy demonstrate no decrease on the tension/anxiety dimension of the POMS following treatment with stimulant medication. These findings may suggest that the elevated anxiety associated with narcolepsy, as found using the MMPI, is not contingent on sleepiness alone but reflects more global aspects of the disorder. Support for this position is evident in the current study where the observed mean metamemory anxiety rating for EDS subjects falls between the mean scores for subjects with narcolepsy and controls. Whilst the rating of the EDS group is not significantly different from either of these subject groups the trend appears to be that the general influence of having a disorder leading to daytime sleepiness may be to increase anxiety in relation to memory performance. This relationship may be heightened for subjects with narcolepsy either because of the increased sleepiness experienced by narcoleptics compared with EDS subjects or because, as suggested by

Mosko *et al.* (1989), other factors specific to the experience of narcolepsy may feed into this anxiety dimension.

The MIA dimension of capacity evaluates the subject's subjective assessment of their performance capacity for a range of memory tasks and narcoleptic subjects are less confident of their abilities than either EDS or control subjects. This diminished memory capacity assessment may be symptomatic of narcoleptics' global negative perceptions of performance capabilities across a range of educational and vocational settings (Kales *et al.* 1982) and may or may not also be associated with objective decrements in memory functioning.

For the change dimension subjects with narcolepsy scored significantly below both EDS and control subjects, indicating that subjects with narcolepsy appear to assess their memory as declining across time, in contrast to the more stable memory attributions of age matched EDS and control subjects. Thus the perceived decline for narcoleptics in memory function appears related to factors additional to age related changes. As noted previously, studies into the life effects of narcolepsy consistently report diminishing memory abilities which subjects attribute to the onset of the disorder (Broughton *et al.* 1981). Findings from the locus subscale provide tentative support for the attribution of memory dysfunction to the development of narcolepsy. Whilst the difference in locus of control mean scores between subjects with narcolepsy, EDS subjects and controls fails to reach statistical significance, they are consistent with a trend for narcoleptics to externalize the locus of control for their memory capabilities more than EDS and control subjects.

One potential confound of the current study is that the sample of subjects with narcolepsy had a mean age of approximately 55, and whilst the EDS and control groups were matched with this sample, the findings of diminished self efficacy for the subjects with narcolepsy may present a cohort effect. It is only relatively recently with the development of sleep disorder clinics in Australia that a diagnosis of narcolepsy has been more readily obtained and the sample of subjects with narcolepsy in the current study had a mean period of 13 y between the onset of symptoms and diagnosis of narcolepsy. This extensive period prior to diagnosis may have resulted in the development of diminished self esteem in this subject group and therefore the findings from the present study may not be able to be generalised to all narcoleptic subjects. The results of this study therefore require validation across more diverse narcoleptic populations.

In conclusion the factors of increased global anxiety (Stepanski *et al.* 1990), reduced global self-efficacy (Cohen *et al.* 1992) and the more pervasive negative psychosocial functioning in narcolepsy, including the high incidence of affective dysfunction (Broughton *et al.* 1981) and diminished vocational and educational opportunities (Kales *et al.* 1982) may account for the finding of diminished self efficacy in cognitive domains. Future correlational analyses between psychosocial adjustment to narcolepsy and subjective evaluations of cognitive dysfunction are necessary to confirm this potential relationship. Continued research is also necessary to decipher the potential association between sleepiness and objective cognitive dysfunction in this clinical population. The subjective impression of cognitive dysfunction in narcolepsy may well reflect an interplay between the psychosocial and psychophysiological factors associated with narcolepsy.

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ERRATUM

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