The Relationship Between Sleep, Mood, Alertness and Cognitive Function

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Abstract Impairments to daytime function are common complaints of those with poor sleep although measuring daytime performance has proven problematic. Subjective aspects of sleep and performance were much more strongly related than objective measurements, with how refreshed a participant feels upon awakening being most predictive of self reported sleep quality.

Introduction and Purpose

Previous research has demonstrated that poor sleep is associated with poor next day mood, alertness and cognitive function. This has been shown using healthy individuals in sleep restriction studies (Belenky et al., 2003; Van Dongen et al., 2003; Dinges et al., 1997) and in insomniac patients using constant routine protocols (Varkevissor & Kerkhof, 2005). Poor daytime functioning is also one of the major complaints of those who suffer with poor sleep, and mood disorders such as depression are common co-occurrences with sleep complaints.

However, there is a comparative lack of evidence to show that improving sleep quality leads to improvements in next day mood and cognitive function. This could be confounded by pharmacological interventions for poor sleep that commonly had detrimental effects on next day functioning. Newer pharmacological interventions may have fewer side effects but only recently have secondary outcome measures been included in clinical trials. The time course of recovery sleep and mismatch of subjective and objective complaints also complicate this picture.

For future intervention studies it would be useful to know which factors are most predictive of sleep quality, daytime mood and performance so that these can be targeted for improvement and minimize demand on participants by specifying appropriate outcome variables to be included.

Methods

• Randomised, placebo-controlled, double-blind 3 week intervention study with first week as baseline
• 33 poor sleepers identified by a sleep questionnaire, otherwise healthy, taking no medication, with a regular weekday routine
•Sleep measures: Bristol Sleep Questionnaire (BSQ), Actiwatch, Sleep Diary
•Cognitive performance measures: Arrow Flankers test (reaction time, attention in the presence of distracting information, response inhibition).
•Subjective performance: "How well did you perform today?" contained in the sleep diary on a daily basis.
•Mood measures: DASS, Quality of Life (HD-16), VAS scales 3 times/day (fatigued/ drained, sleepy/half-awake, mentally alert, stressed/tense).

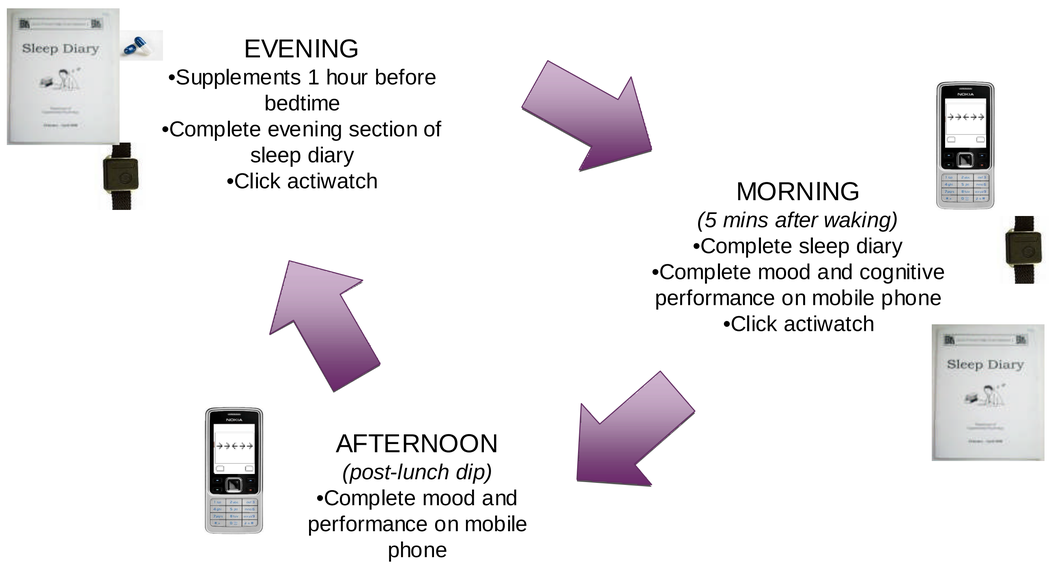
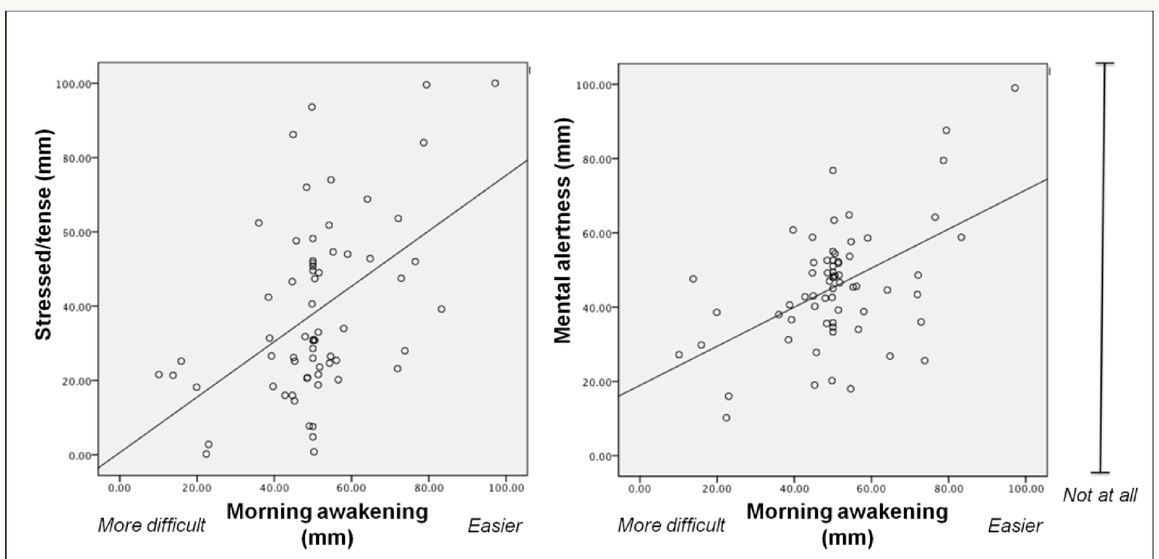


Figure 1. Daytime schedule (Monday – Friday)

Results

Data are averaged over each week due to large night-to-night and day-to-day variability in sleep, recovery sleep and associated effects. Similar results were found with day by day analyses.

1 Higher ratings of stress and mental alertness before bedtime related to greater ease of awakening



Stress and anxiety are common reasons given for not being able to 'switch off' and go to sleep at night although stress before bedtime was not associated with sleep quality in this study ($p > .1$). Higher ratings of stress and alertness before bedtime were associated with a greater ease of awakening and it may be that these anxieties surface quickly in the morning and paradoxically aid with awakening.

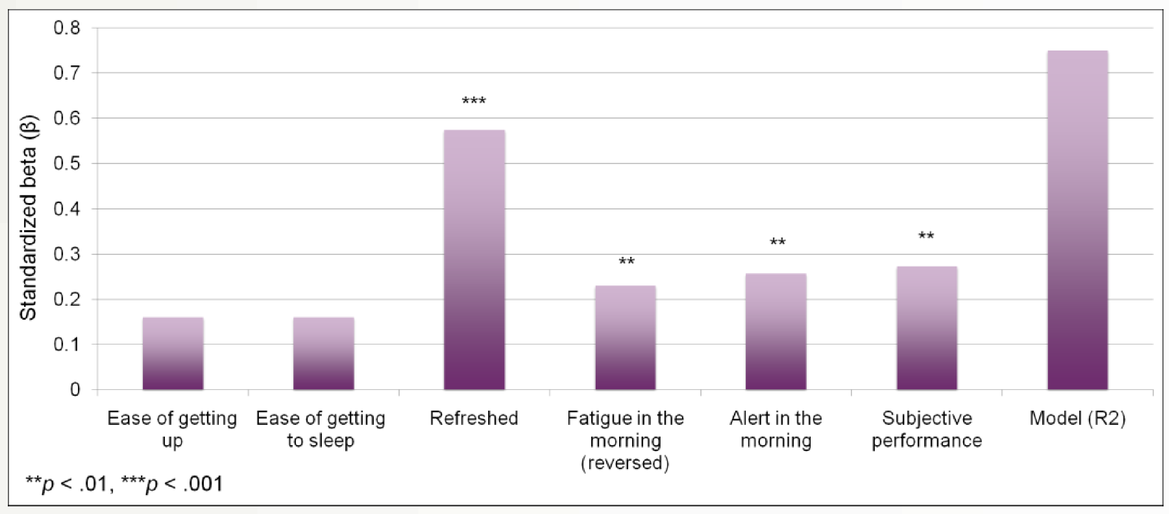
2 Results of multiple regression to predict daytime performance from sleep related factors. (N = 65)

	Subjective performance			RT			*1/Accuracy*			*1/Response Inhibition*		
	B	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Sleep Quality	**0.43**	**0.10**	**.50****	-2.11	1.09	-.43	**-0.005**	**0.002**	**-.30***			
Awakening	0.24	0.12	.24							**-0.005**	**0.002**	**-.30***
Getting up												
Getting to sleep										-0.006	0.004	-.25
Refreshed				**1.93**	**0.91**	**.43***				**0.004**	**0.002**	**.31***
Fatigue morning				-1.70	0.98	-.30						
Sleepy morning				1.84	0.96	.33				**0.008**	**0.002**	**.47****
Alert morning				-1.65	0.89	-.28				**0.006**	**0.002**	**.35****
Constant	***24.83***	***6.15***		***901.01***	***92.03***		***0.85***	***0.12***		***0.35***	***0.25***	
R^2	***.42***			***.20***			***.09***			***.28***		
F	***18.55*****			***2.34***			***4.85****			***4.24*****		

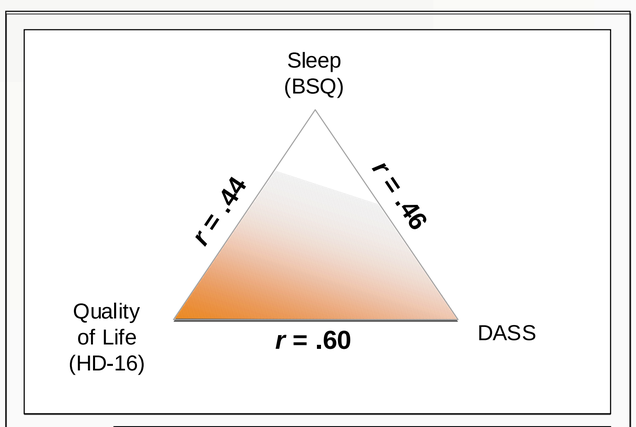
*$p < .05$, **$p < .01$.

Multiple linear regression (backward) was used to find the most predictive factors of daytime (afternoon) performance. Objective sleep measures of sleep efficiency and fragmentation index failed to meet criteria for inclusion in any model. Sleep quality was a significant predictive factor of daytime subjective performance and accounted for 42% of the variance in subjective performance ratings $F(2,52) = 18.55$, $p < .0001$. The remaining factors were highly related to the rating of 'sleep quality'. Models predictive of daytime cognitive performance were very weak in predictive value.

3 Relative importance of each factor contributing to a model to predict self-reported sleep quality



Multiple linear (backward) was used to find the most predictive factors of self-rated sleep quality. Objective sleep measures of sleep efficiency and fragmentation index again failed to meet criteria for inclusion in the model. Feeling refreshed upon awakening was the single most important predictor of sleep quality after all other predictors were held constant. The total model accounted for 75% of variation, $F(6,48) = 24.40$, $p < .0001$.



4

Positive associations between self-rated sleep quality, mood and quality of life. N = 86, $p < .001$.

5

A greater number of false responses (1/response inhibition) made in the morning was weakly associated with greater amounts of fatigue (r = .27, p = .007) and sleepiness (r = .26, p = .012) N = 95.

Conclusions

•Self-rated sleep quality was most predictive of subjectively rated daytime performance although other predictors were closely related to sleep quality.
•Feeling refreshed in the morning was the most important predictor of self-rated quality of sleep.
•Sleep, mood and quality of life all associated, as found in previous studies.
•Objective measurements of sleep and performance were much less useful as predictors. This may be because the tasks used are only weakly affected by fatigue and sleepiness ratings. On the other hand, it is a common finding for subjective and objective measures of sleep to not correlate.
•Subjective measures of performance need to be expanded to identify aspects of subjective performance most important to participants with poor sleep.

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