Abstract

University students have poor sleep hygiene, leading to poorer health. Facets of self-regulation such as planning, behavioural inhibition, cognitive flexibility and working memory were explored in relation to three sleep hygiene behaviours: avoiding stress or anxiety before bed, avoiding going to bed hungry or thirsty, and making the bedroom restful. One hundred and thirty-seven participants took part in an internet-based survey over two time points separated by a period of 2 weeks. Only cognitive flexibility and behavioural inhibition correlated with sleep hygiene. Cognitive flexibility significantly predicted an aspect of sleep hygiene after controlling for past behaviour. However, when past behaviour was controlled for, behavioural inhibition no longer predicted sleep hygiene. Thus cognitive flexibility may play a role in explaining sleep hygiene, however behavioural inhibition does not appear as important as previously assumed. Further research could build on this study to determine whether cognitive flexibility can be experimentally improved.

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Introduction

Satisfactory sleep is comprised of numerous factors such as sleep quality and quantity (Pilcher, Ginter, & Sadowsky, 1997). However, many sleep factors are not directly modifiable or controllable, and therefore difficult to target through interventions. One component of sleep that is modifiable is sleep hygiene. Sleep hygiene covers a range of behaviours that are conducive to sleep. These include, but are not limited to making the bedroom as restful as possible, going to bed at the same time each day, and using the bed for sleep and sex only (Sleep Disorders Australia, 2006). In a previous study investigating sleep hygiene in university students, three sleep hygiene behaviours were found to be the most relevant: avoiding going to bed hungry and thirsty, avoiding anxiety and stress provoking activity before bed, and making the bedroom and sleep environment restful (Kor & Mullan, 2011). These behaviours form the focus of the current study.

Although sleep hygiene does not necessarily guarantee satisfactory sleep, research to date suggests that sleep hygiene may affect other less directly controllable aspects of sleep quality. Studies have found associations between sleep hygiene and disrupted sleep-wake cycles (Kohyama, 2011; Zee & Vitiello, 2009), as well as overall sleep quality in university students (Brown, Buboltz, & Soper, 2002), adolescents (Billows, et al., 2009) and children (Mindell, Meltzer, Carskadon, & Chervin, 2009). Although sleep hygiene research to date has been extremely limited, Brown et al. (2002) found that University students tend to have poor sleep hygiene, which puts them at risk of a range of mental, cognitive and behavioural problems (Pilcher, et al., 1997).

To date most of the sleep research has focussed on the impact of poor sleep on a range of mental processes and behaviours (e.g. Lim & Dinges, 2010; Pilcher & Huffcutt, 1996), and maintaining sleep quality and quantity has been suggested as a strategy to improve the mental health of university students (Tosevski, Milovancevic, & Gajic, 2010). However, there has been very little research into sleep hygiene and factors that may influence these behaviours, and the research that exists has predominantly focussed on sleep hygiene knowledge. For example, Wang, Wang, and Tsai (2005) reviewed studies using cognitive behavioural therapy to treat insomnia, and whilst sleep hygiene education was a component of some of these studies, sleep hygiene behaviours were not included as a treatment outcome. In addition, abbreviated cognitive behavioural therapy was generally more effective at improving insomnia symptoms than sleep hygiene education . Lacks and Rotert (1986) compared sleep hygiene knowledge and practices in insomniacs and healthy sleepers, however, they did not report the relationship between sleep hygiene knowledge and sleep hygiene practices in healthy individuals. Hicks, Lucero-Gorman, Bautista, and Hicks (1999) observed sleep hygiene knowledge and practices over several ethnic groups, and found that sleep hygiene knowledge was generally lower than sleep hygiene practices. In addition, Holbrook, White, and Hutt (1994) found that an increase in sleep hygiene knowledge and awareness did not correspond to an increase in sleep hygiene practices, further suggesting that factors other than knowledge play a role in determining sleep hygiene behaviour.

Self-regulation has only been explored in health psychology relatively recently. Self-regulation can be understood as the striving towards long-term or higher order goals that often requires thoughts, feelings and behaviours to be modified or controlled (de Ridder & de Wit, 2006). Models of behaviour that have incorporated self-regulation include the social cognitive theory (SCT), strength model of self-regulation (hereafter „strength model"), and the temporal self-regulation theory (TST), which attempt to explain how self-regulation and other constructs interact to predict and explain health behaviour.

The SCT was developed by Bandura (1986) as an extension of his earlier social learning theory of development (Bandura & Walters, 1963). The SCT allows for interactions between the individual, behaviour and the environment in a process called „reciprocal determinism" (McAlister, Perry, & Parcel, 2008). One of the main components of the SCT is self-regulation, which plays a role in forming and successfully carrying out goals (Bandura, 1991). The strength model, proposed by Baumeister and Colleagues (Baumeister, 2003; Baumeister, Bratslavsky, Muraven, & Tice, 1998) conceptualises self-regulation as a muscle. When used repeatedly, the „muscle" is weakened (Baumeister, 2003; Baumeister, et al., 1998; Hagger, Wood, Stiff, & Chatzisarantis, 2010), however with repeated use over long periods of time, the „muscle" can also build up strength (Oaten & Cheng, 2005, 2006, 2007). The TST, developed by Hall and Fong (2007), builds on the theory of planned behaviour (TPB; Ajzen, 1985) to also include behavioural prepotency and self-regulatory capacity as determinants of behaviour. Self-regulatory capacity is arguably the most important component of the TST (Hall & Fong, 2010).

Executive function (EF) has been linked to neurological brain activation of self-regulation processes (Hall & Fong, 2007). EF covers a broad range of higher order functions that are involved in goal-directed behaviour, to both plan and work towards goals as well as maintaining flexibility when unexpected situations arise (Pickens, Ostwald, Murphy-Pace, & Bergstrom, 2010). Aspects of executive function therefore include being able to plan and set goals, and also being able to maintain cognitive flexibility so that when barriers to goal achievement are encountered these barriers can be overcome (Pickens, et al., 2010). Being able to inhibit prepotent or immediately rewarding responses, and update and monitor progress towards goals through use of working memory are also important in overcoming barriers to goal achievement (Miyake, et al., 2000). For example, EF would be utilised when a plan is made to go to sleep at a certain time, to resist the temptation to watch TV instead of achieving this goal, and to problem solve (e.g. use earplugs) if noise prevents sleeping at the planned time.

EF has been objectively measured using a variety of psychological tests, such as the Go/No-Go (GNG), Stroop, Tower of London (TOL), Wisconsin Card Sort Task (WCST) and Iowa Gambling Task (IGT) (Hall & Fong, 2010). However, to date only one study has explored the relationship between sleep hygiene and EF. Kor and Mullan (2011) extended the theory of planned behaviour (TPB; Ajzen, 1985) to test whether behavioural inhibition, or the ability to inhibit a prepotent (or preferred) response was predictive of sleep hygiene. Kor and Mullan (2011) used the GNG, a common measure of behavioural inhibition (Cheung, Mitsis, & Halperin, 2004). The GNG predicted sleep hygiene behaviour, over and above past behaviour and the TPB variables of intention and perceived behavioural control (Kor & Mullan, 2011). Combined, these variables accounted for 27.1% of the variance in sleep hygiene behaviour, and behavioural inhibition accounted for 16.3% of this variance.

Whilst their study was promising in improving the prediction of sleep hygiene, Kor and Mullan (2011) concentrated only on behavioural inhibition. Thus, the aims of the current study were to 1) replicate the work of Kor and Mullan (2011) in using the GNG to predict sleep hygiene, 2) further test the role of behavioural inhibition in predicting sleep hygiene, by using the Stroop as an alternative measure of behavioural inhibition (Cheung, et al., 2004), and 3) extend their work to explore whether other aspects of EF such as planning, perseveration, and working memory can predict sleep hygiene behaviour, so that the processes leading to sleep hygiene can be better understood, and so that appropriate interventions can be developed to improve sleep hygiene.

It was hypothesised that behavioural inhibition, planning, perseveration and working memory would predict three sleep hygiene behaviours; avoiding going to bed hungry and thirsty, avoiding anxiety and stress provoking activity before bed, and making the bedroom and sleep environment restful, above the effects of past sleep hygiene behaviour. The EF components were expected to have a positive relationship with the sleep hygiene behaviours, such that better EF would be associated with increased sleep hygiene, irrespective of past sleep hygiene.

Materials and Methods

Participants

Participants were over 18 years old, and could not be currently undergoing treatment for sleep disorders. Due to the nature of the EF task software requirements (Inquisit, 2011), participants were also required to have access to a non-university, non-Mac computer, with internet access. One hundred and ninety participants who met the requirements volunteered for the study in return for course credit.

Design and Measures

The study was completed online and across two time points in accordance with theoretical models such as the TPB and TST. At baseline, participants completed demographic, sleep hygiene behaviour, and EF measures. At follow-up two weeks later, participants completed sleep hygiene behaviour and EF measures. Examination periods may inflate the stress and anxiety of participants, potentially acting as a confounder, and therefore data was collected during semester rather than around exam times.

Three sleep hygiene behaviours were investigated: making the bedroom and sleep environment restful, avoiding going to bed hungry or thirsty, and avoiding stress and anxiety provoking activity before bed. These behaviours were previously found to be the most relevant sleep hygiene behaviours to a similar sample of students at the same Australian University as the current study (Kor & Mullan, 2011).

Sleep hygiene was assessed by asking individuals to record how many days in the previous week they had performed each of the three sleep hygiene behaviours, on a scale from 0 days to 7 days. Higher sleep hygiene scores meant greater engagement in sleep hygiene behaviour. The same measures were used at baseline and at follow-up. Past behaviour has been found to be one of the strongest predictors of behaviour (Ouellette & Wood, 1998), and can help to control for baseline differences in behaviour.

Five EF tasks were measured through *Inquisit* software, online version 3.0.5.0 (2011): the TOL, IGT, WCST, GNG task, and the Stroop task.

The GNG task measured prepotent response inhibition (Fillmore, Rush, & Hays, 2006). The task consisted of rectangles that were either red or green, and horizontal or vertical that flashed on the screen, The task required responding to “go” trials (red rectangles), whilst not responding to “no-go” trials (green rectangles). The primary variable of interest was *performance index*, as used previously by Wong and Mullan (2009). The performance index was calculated by task accuracy over average time taken to complete the problem, with a greater accuracy and greater time taken indicative of a greater ability to inhibit responses. Mean GNG performance index was similar to that reported elsewhere (Kor & Mullan, 2011). The secondary

GNG measure extracted was *no-go latency*. Higher latencies were indicative of needing longer to inhibit the prepotent response, and therefore smaller values were preferable. Mean no-go latency was 969.10ms (*SD=85.17*) at baseline.

The IGT (Bechara, Damasio, Tranel, & Damasio, 1997) was designed to test working memory, response selection and inhibition. This was achieved through "bets" with play money placed on four decks of cards where participants either win or lose money, across 100 trials. Two of these decks have a large winning amount, but with a consistent net loss, while the other decks have a smaller winning amount but with a net gain. Participants start with $2000 and are instructed to try to reach the most beneficial outcome possible, but are blind to the duration and final outcome. The variable of interest was *mean final total*; i.e. the amount of money left from the original $2000, as previously used as a measure of cognitive flexibility and inhibition (Allom & Mullan, 2012). The mean final total for the IGT was $1751.16 (SD=618.67), which is similar to the mean final total of $1666.7 reported by Allom and Mullan on a comparable sample.

The Stroop task used was a computer-based version of the standard Stroop colour-word test (MacLeod, 1991; Stroop, 1935). Individuals consistently take longer to name the colour of a colour word printed in an incongruent colour, than they do to name the colour when the stimulus is congruent or neutral (MacLeod, 1991). Participants responded to the colour of the stimuli via a keyboard press. Congruent (e.g. „red" printed in red), incongruent (e.g. „red" printed in green) and neutral (colour patch) conditions were presented randomly. Two variables were extracted from the Stroop task. *Interference score* (e.g. Wignall & de Wit, 2011) was calculated as the mean difference in accuracy between congruent and incongruent trials, where a greater score is indicative of a poorer ability to inhibit a prepotent or dominant response. Baseline interference score was 13.55 (*SD=16.63*). In addition, *interference length* was calculated as the difference in reaction time between incongruent and control trials, with a greater difference indicative of greater interference, and is the most common Stroop outcome (e.g. Cain, Silva, Chang, Ronda, & Duffy, 2011; Chen & Tsou, 2011; Pace-Schott, et al., 2009). Baseline interference length was 200.78 (*SD=450.2*).

The TOL (Shallice, 1982) was designed to test mental planning, and is similar to the Tower of Hanoi (Welsh & Huizinga, 2001). Vertical pegs and disks of graduated sizes are presented on the screen, and the task requires an initial configuration to be transformed into a specific goal state in the minimum number of moves according to a set of rules. The TOL problems are graded, increasing in the number of moves required to reach the goal state. The two variables extracted were previously used as planning measures (Pace-Schott, et al., 2009). *First move time* was calculated as an average time taken between receiving the problem and making the first move. Mean first move time was 8.77 seconds (*SD=5.21*), which is between the 5.55 seconds (*SD=1.18*) reported on a sample of healthy participants inexperienced at the task (Berg, Byrd, McNamara, & Case, 2010), and the 12.9 seconds (*SD=12.0*) reported on a sample of university students (2009). *Total score* was calculated as a measure of accuracy across trials, with higher scores indicative of more planning. At baseline, the mean total score was 31.77 (*SD=4.04*).

The WCST (Berg, 1948; Grant & Berg, 1948) is used to assess abstract thinking and perseveration. It involves four cards being presented to the participant, with one red triangle, two green stars, three yellow crosses, or four blue circles. These cards have to be placed on the correct pile of cards according to a particular rule (e.g. colour, shape, or number). After a certain number of card sorts, the rule changes without the participants‟ knowledge, and the participant must work out both that the rule has changed, and what the new rule is. The variable of interest was *perseverance*, i.e. how long participants continued with an old rule once it no longer applied.

Perseverance was measured as number of accurate trials as a percentage of total number of trials (*perseverance accuracy*), as previously used as a measure of perseveration (Mullan, Wong, Allom, & Pack, 2011). Perseverance accuracy was 50.50% (*SD=16.00*), and larger percentages were indicative of lower perseverance and greater flexibility.

Results

One hundred and ninety participants completed the baseline survey, and 137 completed the follow-up. Mean age was 19.7 (*SD=4.6*) years old. The sample was predominantly female (77.9%), Australian (49.5%), living with their parents (81.1%), and their head of household was most likely to be an intermediate to high level professional (60.5%). Similar demographics have been previously reported in a sample from the same Australian university (Collins & Mullan, 2011). Baseline rates of making the bedroom and sleep environment restful, avoiding going to bed hungry or thirsty, and avoiding anxiety and stress provoking activity were respectively 4.8, 5.5, and 4.5 times during the 7 day period.

The correlations between baseline EF tasks and follow-up behaviour measures are shown in Table 1. WCST perseverance was correlated with avoiding going to bed hungry or thirsty, and GNG latency was correlated with making the bedroom and sleep environment restful two weeks later. No other EF tasks were correlated with the follow-up sleep hygiene behaviours.

--- Insert Table 1 here ---

Past behaviour, EF and their interaction were then entered into hierarchical linear regressions. To avoid inflation of Type 1 error rate, only the EF variables that were significantly correlated with sleep hygiene were entered into a regression. These were WCST perseverance and GNG no-go latency.

As can be seen in Table 2, past behaviour was predictive of making the bedroom and sleep environment restful, and avoiding anxiety and stress provoking activity before bed, but was not significant for avoiding hunger and thirst. Controlling for past behaviour, WCST perseverance was predictive of avoiding going to bed hungry or thirsty, and independently accounted for 5.6% of the variance in behaviour. The interaction between past behaviour and perseverance was not significant.

--- Insert Table 2 here ---

As shown in Table 3, past behaviour was predictive of making the bedroom and sleep environment restful, marginally non-significant for avoiding going to bed hungry or thirsty, and significant for avoiding anxiety and stress provoking activity before bed. Controlling for past behaviour, GNG latency was not predictive of any of the three sleep hygiene behaviours. The interaction between past behaviour and GNG latency was also not significant for any of the behaviours.

--- Insert Table 3 here ---

Discussion

The ability of a variety of EFs to predict three sleep hygiene behaviours was investigated in the current study. This research extended the work of Kor and Mullan (2011), who found behavioural inhibition predicted the same three behaviours, to investigate other aspects of EF including planning, perseveration and flexibility, problem solving, and working memory.

Out of the EF measures used, only two were significantly correlated with sleep hygiene: WCST perseverance was correlated with avoiding going to bed hungry or thirsty, and GNG no-go latency was correlated with making the bedroom and sleep environment restful. That WCST perseverance was predictive of sleep hygiene suggests that flexible thinking and perseverance are important to some aspects of sleep hygiene. In particular, barriers to avoiding going to bed hungry and thirsty may need to be approached with flexibility in order to maintain this behaviour. Australians generally consume high levels of salt in food (Webster, et al., 2011) and eating these foods prior to sleep may increase thirst. Consuming alternative foods or drinking more water may overcome this barrier to sleep hygiene. Future research could extend the current findings and determine whether improving cognitive flexibility and perseverance bring about improvements in this sleep hygiene behaviour.

Although GNG no-go latency was correlated with making the bedroom and sleep environment restful, when controlling for past behaviour, this variable was no longer a significant predictor of sleep hygiene. No other measures of behavioural inhibition were significantly correlated with any of the sleep hygiene behaviours. This is contrary to expected findings and previous research (Kor & Mullan, 2011), which found GNG performance index as a measure of behavioural inhibition predicted sleep hygiene over and above the effects of past behaviour and theory of planned behaviour variables.

Past behaviour was predictive of making the bedroom and sleep environment restful and avoiding anxiety and stress provoking activity before bed, but not predictive of avoiding going to bed hungry or thirsty. This suggests that past behaviour is not always predictive of future sleep hygiene behaviour. Previous research has suggested that past behaviour is usually the best predictor of future behaviour (Ouellette & Wood, 1998). Avoiding going to bed hungry or thirsty was also the only sleep hygiene behaviour predicted by WCST perseverance as an indicator of cognitive flexibility. These results suggest that perhaps when avoiding going to bed hungry or thirsty barriers are often present which prevent behavioural consistency that is necessary for the prediction of future behaviour from past behaviour. Future research could investigate the potential barriers to performing this behaviour, to better determine the nature of this behaviour.

No EF tasks were able to predict avoiding stress and anxiety provoking activity before bed. This is surprising, considering previous literature has found GNG performance to be associated with anxiety (Sehlmeyer, et al., 2010). It may be that self-regulation is not utilised in avoiding stress and anxiety, but rather other factors play a role. Stress and arousal have been previously associated with poor sleep efficiency (Morin, Rodrigue, & Ivers, 2003), and therefore identifying the determinants of avoiding anxiety and stress-provoking activity before bed is important. Previous cognitive-behavioural therapy based interventions have successfully improved insomnia (Wang, et al., 2005), which suggests that cognitive and reasoned constructs such as attitudes, subjective norms and perceived behavioural control as found in the theory of planned behaviour (Ajzen, 1985) may be more relevant in stress-related sleep hygiene behaviours.

Limitations

University undergraduate students were sampled for this study. Whilst the results need only to be generalised to other university students given the focus of the study, even this should be done with caution. Young females were over-represented, and students who are older and/or male may show different patterns of results, which should be investigated with further research.

The study was conducted over the internet, rather than under supervised settings. The advantage of this method of data collection is that it enabled participants to choose to complete the study when it was convenient for them. In addition, Whitehead (2007) cited a number of relevant advantages of internet-based surveys, such as not being dependent on keeping appointments, and increased disclosure. If such a study was to be expanded into an intervention, internet administration would improve cost-efficiency on a larger scale.

There are however limitations to conducting surveys over the internet, which may partly explain why behavioural inhibition was not predictive of behaviour in the current study. By completing the study independently rather than in a controlled environment, both speed and accuracy may have been compromised, which were the major components to the EF tasks tested. This could partially explain why overall the EF tasks were less predictive of sleep hygiene behaviour than expected. If the setting compromised the results, then other EFs may still be relevant to sleep hygiene, and future studies could test whether variations between supervised and non-supervised experimental settings affect results. However, some measures of EF were still predictive of sleep hygiene, and therefore with further research, conducting surveys over the internet may offer efficient and cost-effective method of testing EF.

Implications and Future Directions

The current study contradicts the work of Kor and Mullan (2011), and suggests that behavioural inhibition does not play a major role in sleep hygiene. In order to bring about changes in sleep hygiene, behavioural inhibition may not be the most appropriate EF construct to target. However, given the possible limitations of experimental setting, the relationship between behavioural inhibition and sleep hygiene needs to be further investigated within alternative settings and populations.

The findings of the current study suggest that cognitive flexibility (as measured with the WCST) is important to sleep hygiene, and therefore promising avenues for developing sleep hygiene interventions are opened. However, as these findings are only predictive, further research is first needed to first determine whether manipulating cognitive flexibility does result in improvements in sleep hygiene. Such research could involve training individuals on cognitive flexibility, and comparing their sleep hygiene to those who were not trained to improve their cognitive flexibility. In addition, it would be useful to determine whether cognitive flexibility is important for other sleep hygiene behaviours, as well as other aspects of sleep such as quality and quantity.

Conclusions

Given that sleep hygiene is poor amongst university students (Brown, et al., 2002) and has been associated with psychological, behavioural and cognitive problems (Pilcher, et al., 1997), it is important to identify ways in which sleep hygiene in university students can be improved. The current study, in exploring the relationship between EF and sleep hygiene, found that cognitive flexibility was predictive of some aspects of sleep hygiene, whereas behavioural inhibition appears less relevant than previously assumed. One potential avenue for improving sleep hygiene in university students is through manipulating cognitive flexibility, although further research is required before ruling out other components of self-regulation and executive function as influences on sleep hygiene.

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Table 1.

Pearson correlations between baseline executive function and follow-up behaviour

	GNG PI	GNG Lat	IGT	Stroop Lat	Stroop Score	TOL FMT	TOL Score	WCST	Beh1	Beh2	Beh3
GNG PI	1	-.118	-.166	-.085	-.183*	-.071	.183*	.194	-.054	-.042	-.028
GNG Lat		1	.180*	-.104	-.019	.094	.138	-.007	-.126	-.030	-.214*
IGT			1	-.062	.012	.025	.035	.214*	-.095	-.145	-.118
Stroop Lat				1	-.032	.116	.150	.076	-.029	-.088	.107
Stroop Score					1	-.127	-.315**	-.105	.100	-.120	-.026
TOL FMT						1	.264**	.175	.121	.078	.036
TOL Score							1	.118	-.097	-.020	-.123
WCST								1	-.042	-.261*	-.031
Beh1									1	.087	.290**
Beh2										1	.119
Beh3											1
Mean	18.5	969.10	1751	200.78	-13.55	8765	31.77	50.5	4.74	5.54	4.50
SD	1.04	85.17	618.67	450.62	16.63	5207	4.041	16	1.62	1.62	1.91
Min	12.50	363	150	-1126	-79	2704	15	20.35	1	0	0
Max	21.15	1000	3050	1573	8.16	36875	36	86.21	7	7	7

Note. *p<.05 **p<.001

Baseline measures: GNG PI=go/no-go performance index, GNG Lat= no-go latency, IGT= Iowa gambling task mean final total, Stroop Lat= Stroop mean interference length, Stroop Score= Stroop mean interference score, TOL FMT=tower of London mean first move time, TOL Score= TOL mean total score, WCST = Wisconsin card sort task perseverance.

Follow-up measures: Beh1= making bedroom restful, Beh2= avoiding going to bed hungry or thirsty, Beh3= avoiding anxiety before bed.

Table 2.

Multiple regression: Predicting sleep hygiene with past behaviour and WCST perseverance

Model		β	t	R^2	ΔR^2	p
Bedroom restful						
Step 1	Past behaviour	.558	6.313			<.001
				312	.	<.001
Step 2	Past behaviour	.558	6.273			<.001
	WCST perseverance	.031	0.348			.729
				.313		<.001
					.001	.729
Step 3	Past behaviour	.540	5.672			<.001
	WCST perseverance	-.119	-0.415			.679
	Interaction	.159	0.551			.583
				.315		<.001
					.002	.583
Avoid hunger/ thirst						
Step 1	Past behaviour	.179	1.707			.091
				.032		.091
Step 2	Past behaviour	.142	1.370			.174
	WCST perseverance	-.239	-2.308			.023
				.088		.018
					.056	.023
Step 3	Past behaviour	.169	1.616			.110

	WCST perseverance	-.279	-2.628			.010
	Interaction	-.163	-1.524			.131
				.112		.016
					.024	.131
Avoid anxiety						
Step 1	Past behaviour	.335	3.332			.001
				.112		.001
Step 2	Past behaviour	.338	3.340			.001
	WCST perseverance	-.050	-0.497			.620
				.115		.005
					.003	.620
Step 3	Past behaviour	.339	3.367			.001
	WCST perseverance	-.060	-0.591			.556
	Interaction	-.131	-1.300			.197
				.132		.007
					.017	.197

Note. Interaction= interaction between past behaviour and WCST perseverance. β = standardised coefficient, R^2 = total variance explained, ΔR^2= change in total variance explained.

Table 3.

Predicting sleep hygiene from past behaviour and GNG latency

Model		β	t	R^2	ΔR^2	p
Bedroom restful						
Step 1	Past behaviour	.546	6.735			<.001
				.300		<.001
Step 2	Past behaviour	.545	6.740			<.001
	GNG latency	-.116	-1.432			.155
				.313		<.001
					.013	.155
Step 3	Past behaviour	.545	6.701			<.001
	GNG latency	-.115	-1.418			.159
	Interaction	-.024	-0.294			.769
				.304		<.001
					.001	.769
Avoid hunger/ thirst						
Step 1	Past behaviour	.188	1.968			.052
				.035		.052
Step 2	Past behaviour	.188	1.965			.052
	GNG latency	-.033	-0.342			.733
				.036		.143
					.001	.733
Step 3	Past behaviour	.186	1.931			.056

	GNG latency	-.041	-0.423			.673
	Interaction	-.069	-0.709			.480
				.041		.224
					.005	.480
Avoid anxiety						
Step 1	Past behaviour	.331	3.615			<.001
				.110		<.001
Step 2	Past behaviour	.301	3.240			.002
	GNG latency	-.154	-1.656			.101
				.132		.001
					.023	.101
Step 3	Past behaviour	.287	2.901			.005
	GNG latency	-.269	-0.888			.377
	Interaction	.120	0.401			.689
				.134		.002
					.001	.689

Note. Interaction= interaction between past behaviour and GNG latency, β = standardised coefficient, R^2 = total variance explained, ΔR^2= change in total variance explained.