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Development and Validation of the Sleep Inertia Questionnaire (SIQ) and Assessment of Sleep Inertia in Analogue and Clinical Depression

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Abstract

Sleep inertia is the transitional state from sleep to wake. Research on sleep inertia is important in depression because many people with depression report having difficulty getting out of bed, which contributes to impairment and can impede the implementation of interventions. The first aim was to develop and validate the first self-report measure of sleep inertia, the Sleep Inertia Questionnaire (SIQ). The second aim was to compare reports of sleep inertia across three groups: (1) No-to-Mild-Depression, (2) Analogue-Depression, and (3) Syndromal-Depression. The SIQ demonstrates strong psychometric properties; it has good to excellent internal consistency, strong construct validity, and SIQ severity is associated with less prior sleep duration. Sleep inertia is more severe in the Analogue-Depression and Syndromal-Depression groups compared to the No-to-Mild-Depression group. In conclusion, the SIQ is a reliable measure of sleep inertia and has potential for improving the assessment of sleep inertia in clinical and research settings.

Keywords

Psychometric properties; self-report measure; sleep inertia; depression

INTRODUCTION

Sleep inertia is the normal transitional state of lowered arousal and impaired performance following sleep. Several lines of evidence suggest that studies of sleep inertia are particularly important in mood disorders. Most notably, people with mood disorders often report considerable difficulty getting out of bed (Cassano et al. 2009; Ritter et al. 2012). This can be associated with significant impairment and can impede the optimal

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Disclosures

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Conflict of Interest Statements: Jennifer C. Kanady and Allison G. Harvey report no conflicts of interest.

Informed Consent Statements: All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964. Informed consent was obtained from all participants before being included in the study.

Animal Rights: No animal studies were carried out by the authors for this study.

implementation of interventions for mood disorders, particularly activity scheduling (Cuijpers et al. 2007) and behavioral activation (Hopko et al. 2003). In addition, Ohayon and colleagues (2000) found that over half of a sample of people reporting confusion, slowed thinking/speech, and memory problems upon awakening also reported depressed mood. Moreover, polymorphisms in the circadian genes of NPAS2 and CLOCK are implicated in sleep inertia severity (Gamble et al. 2011) and polymorphisms in these same genes are associated with mood disorders (Soria et al. 2010). Related to this finding, people with mood disorders are more likely to report circadian dysfunction when compared to healthy people (see Germain and Kupfer, 2008 for review) and circadian dysfunction is associated with heightened sleep inertia severity (Roenneberg et al. 2003). Depression is also associated with increased daytime napping (Basta et al. 2007; Foley et al. 2007; Peth et al. 2012) and sleep inertia is a prevalent and problematic feature following daytime naps (e.g., Achermann et al. 1995; Muzet et al. 1995). Finally, reduced total sleep time is a common complaint of people with depression (Benca et al. 1992) and reduced total sleep time is one of the strongest correlates of sleep inertia (Balkin and Badia 1988; Dinges 1990). Taken together, we propose that improving our understanding of, and our ability to assess, sleep inertia may result in new ways to help people with depression.

To date, the primary focus of research on sleep inertia has been to identify correlates of sleep inertia and factors affecting sleep inertia duration and severity. A range of sleep inertia correlates has been investigated. These can be grouped into four clusters: cognitive, behavioral, physiological, and emotional. Sleep inertia is most commonly characterized by cognitive and behavioral deficits such as decreased alertness (Achermann et al. 1995; Jewett et al. 1999), slowed reaction times, increased number of errors and lapses (Feltin and Broughton 1968; Goodenough et al. 1965; Seminara and Shavelson 1969), slowed speech (Ohayon et al. 2000), impaired decision making (Bruck and Pisani 2000), confusion, difficulties getting out of bed, and the inability to resist sleep (Dinges 1990). Sleep inertia can also be associated with physiological and emotional difficulties as well. Indeed, loss of coordination and balance (Wilkinson and Stretton 1971), hypovigilance (Jewett et al. 1999), anxiety (Hou et al. 2007), and irritability (Weissbluth and Weissbluth 1992) can all be features of this sleep-wake transitional state. The severity and duration of the cognitive, behavioral, physiological, and emotional correlates of sleep inertia are influenced by many factors such as prior sleep duration (Balkin and Badia 1988; Dinges 1990), core body temperature (Weissbluth and Weissbluth 1992; Wilkinson and Stretton 1971), and the sleep stage immediately prior to awakening (Feltin and Broughton 1968; Fort and Mills 1972; Webb and Agnew 1964).

Sleep inertia has typically been assessed by performance on cognitive and/or behavioral tasks, via self-report measures of alertness, and with electroencephalogram-recordings of brain activity upon awakening (Marzano et al. 2011). While there is no doubt that these approaches have progressed the field, such methodologies are not ideal for use in clinical practice, for longitudinal and naturalistic studies, nor for capturing the idiosyncratic experience of sleep inertia. Therefore, we suggest that a self-report measure of sleep inertia is needed. Accordingly, the overarching goal of the present study was to develop and validate a self-report measure of sleep inertia, the Sleep Inertia Questionnaire (SIQ). Development and validation of the SIQ is important because, with further validation, the

SIQ has potential to aid in easy assessment of the different correlates of sleep inertia (i.e., cognitive, behavioral, emotional, and physiological), it can progress research on the important ramifications of this sleep-wake transitional state, and will identify important and idiosyncratic sleep inertia treatment targets.

The present study has two aims, which were addressed using two separate samples. The first aim was to devise, and then assess the psychometric properties of the SIQ and revise the SIQ as necessary in order to enhance its psychometric properties. The first aim was completed using an undergraduate student sample from the University of California, Berkeley. The second aim was to compare reports of sleep inertia severity and duration across three groups: (1) a no depression to mild depression student group (No-to-Mild-Depression Group), (2) a non-treatment seeking, moderate to severe depression student group (Analogue-Depression Group), and (3) a treatment seeking, community group with major depressive disorder (Syndromal-Depression Group). Based on previous research, we hypothesized that the Analogue-Depression and Syndromal-Depression groups would report similar levels of sleep inertia severity and duration and that the Analogue-Depression and Syndromal-Depression groups would report greater sleep inertia severity and longer sleep inertia duration compared to the No-to-Mild-Depression group.

METHODS

Development and Description of the SIQ

The initial pool of items for the SIQ was generated via two sources: (1) a careful review of the literature and (2) by conducting open-ended interviews with 10 non-patients. For the former, items were selected if they fitted clearly into one of the four sleep inertia constructs highlighted in the literature: cognitive, behavioral, physiological, or emotional. These items were then discussed with members of our research team that includes experts in sleep and mood disorders. For the latter, 10-non patients were asked the question: “Please describe the process of waking up as you experience it.” The 10 non-patients consisted of five graduate students and five undergraduate students within the psychology department of UC Berkeley who responded to a recruitment email sent by the research team. These 10 people were intentionally selected because they reported having a hard time getting out of bed in the morning and therefore might have an easier time generating potential sleep inertia items. From these two sources, an initial list of 35 items was created. After compiling this list, the 35 SIQ items and the open-ended question, “Please describe the process of waking up as you experience it” was administered electronically to 23 undergraduate students. Undergraduates were asked to highlight any items that were not easily understandable and to describe their process of waking up in detail. This process did not eliminate nor yield any additional SIQ items. Following the electronic administration, members from the research team (N=6) then met to review each SIQ item. This final step resulted in the creation of the 30-item SIQ, which was used in the analyses for the first aim of the present study.

Each item of the SIQ is rated on a scale from 1 (not at all) to 5 (all the time) with higher scores indicating greater sleep inertia severity. The SIQ introduces each question with the phrase, “*On a typical morning in the last week, after you wake up, to what extent do you . . . “* The research team carefully considered this timeframe of focus. Many widely utilized self-

report measures of sleep such as the Insomnia Severity Index (ISI; Morin et al. 2011) and Pittsburg Sleep Quality Index (PSQI; Carpenter and Andrykowski 1998) ask about a typical night of sleep in the past month. The SIQ focuses on a shorter period of recall for two reasons. First, asking about the last week as opposed to the last month minimizes measurement error by relying on more recent memory (Cansino 2009). Second, sleep inertia is dependent on a number of variables (e.g., prior sleep duration, sleep stage upon awakening, timing of sleep) and therefore, one week may look different than another week in the same month. The SIQ also includes a question about sleep inertia duration: "How long does it take you to 'come to' in the morning (please indicate hours or minutes)."

Participants

To examine the first aim, 356 undergraduate students of the University of California, Berkeley completed the SIQ (age: 20.45 ± 2.41; 188 female). Race and ethnicity of the sample reflected the diversity of California universities (40.4% Caucasian, 44.7% Asian, 1.9% African American, 2.2% Hawaiian/Pacific Islander, 0.0% American Indian/Alaska Native, 9.8% Hispanic, 0.5% declined to answer). A student sample was selected to examine the psychometric properties of the SIQ because this method allowed for efficient and economical completion of an appropriately powered exploratory factor analysis. Indeed, student samples are often used to establish psychometric properties of new instruments (e.g., Dozois et al. 1998; Fresco et al. 2007; Watson and Clark 1988). Moreover, sleep inertia is a robust phenomenon and is prominent in students (e.g, Tassi et al. 2006; Miccoli et al. 2008).

The second aim was examined using two different samples: the same undergraduate student sample used for the first aim and a community sample. The undergraduate students were allocated to one of two groups: (1) a no depression to mild depression, student group (No-to-Mild-Depression Group; N=259) and (2) a non-treatment seeking, moderate to severe depression, student group (Analogue-Depression Group; N=97). In order to meet criteria for the No-to-Mild-Depression group, participants had to score less than 10 on the Quick-Inventory of Depressive Symptomatology, Self-Report (QIDS-SR < 10), which is a standard and valid measure of current depressive symptoms (Rush et al. 2003). In order to meet criteria for the Analogue-Depression group, participants had to score greater than or equal to 10 on the QIDS-SR. A score of 10 or greater in the QIDS-SR is indicative of moderate to severe depression (Rush et al. 2003). The community sample was recruited as part of an NIMH-funded study examining the efficacy of cognitive therapy for treatment of depression. The community sample comprised the third group: a treatment seeking, community group with major depressive disorder (Syndromal-Depression Group; N=48). Participants in the Syndromal-Depression group met DSM-5 criteria for current major depressive disorder, they scored at least a 26 on the Inventory of Depressive Symptomatology, Self Report (IDS-SR; Rush et al. 1996), which is equivalent to a 10 on the QIDS-SR (Trivedi et al. 2004), and they were interested in receiving cognitive therapy for their symptoms. In sum, for the second aim, there were a total of three groups: (1) a no depression to mild depression student group (No-to-Mild-Depression Group), (2) a non-treatment seeking, moderate to severe depression student group (Analogue-Depression Group), and (3) a treatment seeking, community group with major depressive disorder (Syndromal-Depression Group).

The analogue approach to studying symptoms of psychopathology has been successful in a number of areas including the role of worry in generalized anxiety disorder (Roemer et al. 1997), key processes in social phobia (Clark 2001), the study of obsessive-compulsive disorder (Burns et al. 1995; Sternberger and Burns 1991), and the function of personality traits in depression (Enns et al. 2000). Using analogue samples when studying sleep inertia in depression has two important strengths: it allows for rapid and sizeable data collection and it means that the SIQ can be piloted in an efficient manner.

Procedure

The Committee for Protection of Human Subjects at the University of California, Berkeley approved all procedures described in this section. To examine the first aim, the SIQ was administered to participants online via Qualtrics (Qualtrics, Provo, UT). After electronically signing the consent form, participants completed a battery of self-report measures and semi-structured interviews including the SIQ, QIDS-SR, Pittsburg Sleep Quality Index (PSQI; Carpenter and Andrykowski 1998), Composite Scale of Morningness (CSM; Smith et al. 1989), and sleep diaries. Information about participant age, race, ethnicity, and gender was also collected. To examine the second aim, the same information from the first aim was used for the No-to-Mild-Depression and Analogue-Depression student groups. Data for the Syndromal-Depression group was collected as part of the pre-treatment stage of the NIMH-funded study. Major depressive disorder diagnoses of the Syndromal-Depression group were confirmed using the Structured Clinical Interview for DSM-IV-TR Axis I disorders (SCID; First et al. 1995). Additionally, the SIQ along with several other self-report measures including the PSQI and IDS-SR were administered during the pre-treatment stage.

Statistical Analyses

Aim One: Assessment of Psychometric Properties—To examine the psychometric properties of the SIQ, an exploratory factor analysis (EFA) was conducted followed by analyses of scale reliability, construct validity, and convergent validity. Following each analysis, SIQ items were removed as necessary in order to enhance the psychometric properties of the SIQ.

Selection of Items for the Exploratory Factor Analysis: Items were selected for the exploratory factor analysis based on the following criteria (Ree et al. 2005): (1) Items were deleted if they were not easily understandable. We deleted one item, *'To what extent do you feel terrible upon awakening'* because of the ambiguity of the descriptor "terrible" in this question. We did not eliminate any additional items based on this criterion. (2) Items were deleted if they did not employ the full response range of the scale. No items were deleted based on this criterion. (3) Items were deleted if they were often skipped. The percentage of missing values for each item was examined. No item had a missing value rate of above 5%. Therefore, no items were discarded due to high rates of missing values. (4) Items were deleted if they were overly redundant. To assess for item redundancy, the correlation matrix of the 30 items was inspected. Items that showed a correlation of above 0.60 with other items were examined to determine if this could be explained by highly similar content (Rapee et al. 1996; Ree et al. 2005). This resulted in the deletion of one item, *' To what extent do you think about how you could get more sleep*' since this item was highly similar

to the item, '*To what extend to you wish you could sleep more.*' Although other items showed a correlation of above 0.60, these items were not considered redundant and were therefore not removed from subsequent analyses.

Exploratory factor analysis: Since a factor analysis has not yet been performed on the SIQ, it was considered appropriate to perform an exploratory factor analysis rather than a confirmatory factor analysis on the data. A maximum likelihood exploratory factor analysis with oblique (Direct Quartimin) rotation and Kaiser Normalization was performed on the 28 SIQ items, as the variables were expected to be correlated. Missing values were replaced with the mean value for that item. Several items did not load highly on any factor and therefore were excluded from subsequent analyses. These items included: (1) *To what extend do you feel frustrated about having to wake up,* (2) *To what extent do you feel fatigued,* (3) *To what extent do you fall back asleep after getting out of bed,* (4) *To what extent do you need caffeine to 'wake up,'* (5) *To what extent do you think about or assess your energy level,* (6) *To what extent do you feel irritable,* and (7) *To what extent do you calculate the amount of sleep you actually got?* We did not include the question asking about sleep inertia duration (i.e., *"How long does it take you to 'come to' in the morning?"*) in the exploratory factor analysis because this question was not created to assess the duration of a particular sleep inertia correlate and instead is meant to assess the duration of sleep inertia broadly. Thus, we did not expect this question to load on any particular factor. However, we suggest this question be included in the SIQ as information about the duration of sleep inertia will likely inform whether there is need for intervention.

Scale Reliability: To examine the internal consistency of the factors (e.g., scale reliability), Cronbach alpha coefficients were calculated for the SIQ total score as well as the four factors of the SIQ determined by the EFA. Factors that did not incur a Cronbach alpha of at least 0.70 were considered for exclusion.

Construct Validity: Construct validity was assessed using Pearson correlations, which examined the relationship between the four SIQ factors and SIQ total score. Given that each of these factors is measuring the same construct – sleep inertia – high correlations were expected.

Convergent Validity: For convergent validity, Pearson correlations were performed. Correlation coefficients were inspected in order to investigate the association between the factors and total score of the SIQ and measures of average total sleep time (TST) from the week prior, morningness, and sleep quality. Average TST was assessed using sleep diaries, morningness was assessed using the total score from the CSM, and sleep quality was assessed using the total score from the PSQI. We chose these particular measures because sleep inertia is more severe following sleep deprivation (Balkin and Badia 1988; Dinges 1990), the CSM has questions pertaining to the process of waking up and sleep inertia is negatively associated with eveningness (Roenneberg et al. 2003), and sleep inertia is more severe when sleep is more disturbed (Tassi and Muzet 2000).

Aim Two: Comparison Across Groups—The second aim was to compare reports of sleep inertia severity and duration across three groups: (1) No-to-Mild-Depression, (2)

Analogue-Depression Group and (3) Syndromal-Depression. Before examining group differences in sleep inertia severity and duration, group differences in gender, age, average TST, and average QIDS-SR and PSQI scores were examined using a one-way analysis of variance (ANOVA). In order to examine differences in QIDS-SR scores, the IDS-SR scores of the Syndromal-Depression Group were first converted to QIDS-SR scores based on the Trivedi et al. (2004) guidelines. Age and PSQI scores significantly differed between the groups; participants in the Syndromal-Depression group were significantly older and had higher PSQI scores than the Analogue-Depression and No-to-Mild-Depression groups. However, we did not conduct an analysis of covariance to control for baseline differences based on Miller and Chapman's (2001) recommendation against this practice. Next, to examine between-group differences in sleep inertia severity, an omnibus ANOVA was performed for each of the four SIQ factors. As the SIQ is a novel self-report measure and we were interested in examining idiosyncratic sleep inertia differences across groups, we performed a follow-up ANOVA for each SIQ item for the significant SIQ factors. To account for multiple comparisons, post-hoc Bonferroni corrections were applied by dividing alpha of 0.05 by the total number of comparisons performed (i.e., 0.05÷21=0.002; p=0.002). We also calculated partial eta squared (η_p^2) as a index of effect size and interpreted η_p^2 based on Ferguson's (2009) guidelines (i.e., small effect≈0.04; moderate effect≈0.25; large effect≈0.64). To examine between-group differences in sleep inertia duration, an ANOVA was again performed.

RESULTS

Aim One: Assessment of Psychometric Properties

An exploratory factor analysis with oblique rotation and Kaiser Normalization was performed on the SIQ. Inspection of the break in slope on the scree plot indicated that four factors should be retained in the final solution. These four factors accounted for 58.54% of the total variance and were labeled as follows: physiological, responses to sleep inertia, cognitive, and emotional. Factor loadings are listed in Table 1.

To estimate the internal consistency of the factors, Cronbach alpha coefficients were calculated and are presented in Table 2. The total SIQ score, physiological factor, and cognitive factor demonstrated excellent internal consistency with an alpha of above 0.90. With an alpha of above 0.80, the responses to sleep inertia factor and emotional factor demonstrated good internal consistency (Gliem and Gliem 2003). Pearson correlation coefficients between the SIQ factors and the total SIQ score are also presented in Table 2. The scale intercorrelations on the SIQ were moderate to very strong, indicating good construct validity.

To assess convergent validity, Pearson correlations were performed examining the relationship between the SIQ and measures of average TST, morningness, and sleep quality. Results are presented in Table 3. Total SIQ score, the physiological factor, and the cognitive factor were significantly correlated with average TST. More specifically, decreases in TST were associated with increases in SIQ scores, indicating more severe sleep inertia. The responses to sleep inertia factor and emotional factor were not significantly associated with

prior sleep duration. The SIQ total score and SIQ factors were not significantly correlated with CSM or PSQI scores.

Aim Two: Comparison Across Groups

Prior to examining differences in SIQ items, differences between demographic information and self-report measures across the three groups were assessed. Participant demographics and self-report measures for the No-to-Mild-Depression, Analogue-Depression, and Syndromal-Depression groups are presented in Table 4. The three groups didn't differ on gender or average TST. There were significant differences for age, PSQI and QIDS-SR scores. More specifically, the Syndromal-Depression group was significantly older and reported worse sleep quality, indexed by the PSQI, than the No-to-Mild-Depression and Analogue-Depression groups. Moreover, the Analogue-Depression and Syndromal-Depression groups had significantly higher scores on the QIDS-SR, thus more severe depressive symptoms, than the No-to-Mild-Depression group.

To examine group differences in sleep inertia severity, an omnibus ANOVA was performed for each SIQ factor. All SIQ factors – physiological ($F=53.44$; $p<0.001$; $\eta_p^2=0.21$), responses to sleep inertia ($F=3.64$; $p=0.03$; $\eta_p^2=0.02$), cognitive ($F=61.02$; $p<0.001$; $\eta_p^2=0.23$), and emotional ($F=51.09$; $p<0.001$; $\eta_p^2=0.20$) – were significantly different across groups. The Analogue-Depression and Syndromal-Depression groups reliably reported comparable sleep inertia severity to each other and greater sleep inertia severity than the No-to-Mild-Depression group across the four factors. A follow-up ANOVA with post-hoc Bonferroni tests was used to examine group differences between each SIQ item. Scores on every item except the items *'Need an alarm to wake up,' 'Wish you could sleep more,'* and *'Hit the snooze button on the alarm,'* were significantly different across groups with the Analogue-Depression and Syndromal-Depression consistently reporting more severe sleep inertia than the No-to-Mild-Depression group. Effect sizes for each analysis ranged from small to moderate. An ANOVA was also used to examine group differences in sleep inertia duration. The Analogue-Depression group reported significantly longer sleep inertia duration than the No-to-Mild-Depression group. Results are presented in Table 5.

DISCUSSION

The overarching goal of the present study was to develop and validate a self-report measure of sleep inertia to assess the cognitive, behavioral, physiological, and emotional correlates of this sleep-wake transitional state. By improving our understanding of, and our ability to assess, sleep inertia we hope the field may be better positioned to decrease sleep inertia among people with depression. The first aim was to assess the psychometric properties of the SIQ and to revise the SIQ in order to enhance the psychometric properties. An exploratory factor analysis revealed four factors accounting for 58.54% of the total variance: (1) physiological, (2) responses to sleep inertia, (3) cognitive, and (4) emotional. Notably, these four factors corresponded with the four sleep inertia correlates used to generate the SIQ items (i.e., cognitive, behavioral, physiological, and emotional), with the exception of the responses to sleep inertia factor. Most of the items in the responses to sleep inertia factor are behavioral in nature. However, two of the items, *'Notice that you feel sleepy'* and *'Wish*

you could sleep more' appear to be measuring sleepiness. It is possible that the responses to sleep inertia factor is capturing a sleep inertia construct that is a combination of both behavioral correlates of sleep inertia and related sleepiness.

The internal consistency of the four factors varied from excellent (physiological and cognitive factors) to good (responses to sleep inertia and emotional factors). In terms of construct validity, we expected high intercorrelations because the factors of the SIQ are assessing the same construct: sleep inertia. Indeed, the scale intercorrelations of the SIQ were moderate to very strong, indicating good construct validity. Finally, convergent validity of the SIQ varied. All SIQ factors except the responses to sleep inertia and emotional factor demonstrated a significant negative correlation with TST from the week prior. These findings are broadly consistent with the literature, which suggests that sleep inertia is more severe following periods of reduced sleep (Balkin and Badia 1988; Dinges 1990). The responses to sleep inertia and emotional factors did not correlate with prior sleep duration. This result may be due to the limited number of items in these factors (n=5 and n=3, respectively). Another possible explanation is that TST in this sample is relatively high (approximately 7 hours) and the relationship between sleep inertia and prior sleep duration is stronger when sleep deprivation is more severe (Balkin and Badia 1988; Dinges 1990). Contrary to the original prediction, the SIQ factors did not significantly correlate with the CSM or PSQI, raising the possibility that sleep inertia is a construct that is at least partially independent of eveningness and sleep quality. Notably, the relationship between sleep inertia and eveningness and sleep inertia and sleep quality has been less extensively studied than the relationship between sleep inertia and sleep duration. Therefore, future research is needed to further parse out these relationships.

The second aim was to compare reports of sleep inertia severity and duration between three groups: (1) No-to-Mild-Depression, (2) Analogue-Depression, and (3) Syndromal-Depression. All items of the SIQ, with the exception of the items, *'Need an alarm to wake up,' 'Wish you could sleep more,'* and *'Hit the snooze button on the alarm,'* demonstrated significant between group differences, with Analogue-Depression and Syndromal-Depression groups consistently reporting greater sleep inertia severity than the No-to-Mild-Depression group. These results are consistent with our hypothesis. Also consistent with our hypothesis, the Analogue-Depression group reported significantly longer sleep inertia duration than the No-to-Mild-Depression group. However, there was not a significant difference between the Syndromal-Depression group and the No-to-Mild-Depression group. One possible explanation for this unexpected finding is that the Analogue-Depression group reported the lowest amount of average TST (6.81 hours) and is younger than the Syndromal-Depression group. Hence, their sleep need is likely to be greater (e.g., Tonetti et al. 2008).

Taken together, the results from the second aim have several important implications. First, these findings suggest that students with moderate to severe symptoms of depression (i.e., the Analogue-Depression group) and adults with a diagnosis of major depressive disorder (i.e., the Syndromal-Depression group) experience severe and long periods sleep inertia. This may partially explain why people with depression have a hard time getting out of bed in the morning (Cassano et al. 2009) and the idiosyncratic experience of sleep inertia may be an important treatment target in depression. In particular, targeting the experience of sleep

inertia may help prevent people with depression from staying in bed for extended periods of time (Cassano et al. 2009; Ritter et al. 2012) and may improve adherence with cognitive-behavioral therapy interventions such as activity scheduling (Cuijpers et al. 2007) and behavioral activation (Hopko et al. 2003). Further, intervention for sleep inertia may also help people more fully engage in their lives (e.g., return to fulltime employment, be able to attend early classes). Second, using a student sample with moderate to severe symptoms of depression (i.e., Analogue-Depression group) appears to be a valid analogue strategy for examining sleep inertia in depression as the results from the Analogue-Depression sample were comparable to those from the community group with major depressive disorder. The advantage of analogue research is that it facilitates piloting, allows complex experimental designs that are not always feasible with community populations, and it allows key questions to be addressed more quickly and inexpensively.

The results from this study should be interpreted in light of several limitations. First, the data from the student sample were collected online. Collecting data in this manner poses several potential problems, including the possibility of lower response rates and greater measurement errors and possible technical difficulties. Indeed, several participants neglected to complete certain aspects of this study. However, these participants represented a very small percentage of the total (<6.0%). Also, less than 5% of participants skipped items on the SIQ and every SIQ item employed the full range of the scale, suggesting that measurement error in this study is minimal. It is perhaps worth noting that collecting data online also poses several benefits, including reduced participant response time and burden, lowered cost, ease of data entry, and participant acceptance of the format (Granello and Wheaton 2004). Despite this, future studies should consider using other formats. Second, we did not collect the time of day for when the SIQ was completed. Hence, we and are not able to control for time of day across the three groups. It is possible that time of day may influence how participants responded to the SIQ. Determining whether the SIQ is affected by time of day and/or controlling for time of day across groups will be an important addition to future studies using this measure. Third, validity of the SIQ would have been strengthened by comparing SIQ scores to performance on behavioral and/or cognitive tasks upon awakening. Notably, traditional cognitive and behavioral tasks often only assess one factor of the sleep inertia experience, whereas the SIQ is meant to capture multiple sleep inertia correlates. Regardless, this type of analysis will be an important next step for SIQ validation. Fourth, given the method employed in the present study we cannot be certain that the SIQ is indeed measuring sleep inertia in people with depression without verifying this assessment with standard polysomnographic procedures (Marzano et al. 2011) and traditional cognitive and behavioral tasks. However, clinical observation is a critical component of research and treatment development (Salkovskis, 2002) and the present study was initially motivated by our clinical observation that many patients with a mood disorder have what appears to be crippling sleep inertia. Although the validity of the SIQ would be strengthened by comparing ratings on the SIQ with an electroencephalogram-recording of brain activity upon awakening and/or performance on cognitive and behavioral tasks, we believe the SIQ in its current form is an important step and has the potential to advance cognitive-behavioral therapy interventions for people with depression (Salkovskis, 2002).

Despite these limitations, this is the first study to develop and validate a self-report measure of sleep inertia, the Sleep Inertia Questionnaire. Development and validation of the SIQ is important because the SIQ allows for easy assessment of the cognitive, behavioral, emotional, and physiological correlates of sleep inertia in a clinical context and can also progress research on why certain populations (e.g., people with a mood disorder) have trouble getting out of bed and performing during the early morning hours. The present study found that the SIQ demonstrates strong psychometric properties; it has good to excellent internal consistency, demonstrates strong construct validity and is associated with sleep duration, one of the strongest correlates of sleep inertia. This study also demonstrates that sleep inertia is more severe and lasts longer in students with moderate to severe symptoms of depression and adults with major depressive disorder when compared to a no-to-mild depression student group. These results may have treatment implications. First, reducing sleep inertia in people with depression may be an important target for intervention. Second, reducing sleep inertia may improve response to cognitive behavioral therapy for depression, particularly response to activity scheduling and behavioral activation. The first step towards researching these possibilities is to establish a measure of sleep inertia. The SIQ has potential for fulfilling this role.

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APPENDIX

The Sleep Inertia Questionnaire (SIQ)

Please use the following scale to answer the questions below:

	1 = Not at all	**2 = A little**	**3 = Somewhat**	**4 = Often**	**5 = All the time**
On a **typical morning in the past week**, after you wake up, to what extent do you …					
1.	Have problems getting out of bed?	1	2	3	4	5
2.	Need an alarm to wake up?	1	2	3	4	5
3.	Hit the snooze button on the alarm?	1	2	3	4	5
4.	Bump into and drop things?	1	2	3	4	5
5.	Notice that you move more slowly?	1	2	3	4	5
6.	Notice that you feel sleepy?	1	2	3	4	5
7.	Notice your eyes feeling heavy, sore, or itchy?	1	2	3	4	5
8.	Notice your arms and/or legs feeling tired or heavy?	1	2	3	4	5
9.	Notice that your mind feels groggy, fuzzy or hazy?	1	2	3	4	5
10.	Notice that you get winded more easily?	1	2	3	4	5
11.	Notice that it is difficult to keep your balance?	1	2	3	4	5
12.	Notice that you feel tense?	1	2	3	4	5
13.	Feel anxious about the upcoming day?	1	2	3	4	5
14.	Dread starting your day?	1	2	3	4	5
15.	Wish you could sleep more?	1	2	3	4	5
16.	Have difficulty concentrating?	1	2	3	4	5
17.	Find that you think more slowly?	1	2	3	4	5
18.	Find that you think react more slowly?	1	2	3	4	5
19.	Find that you make more mistakes/errors?	1	2	3	4	5
20.	Can’t imagine being able to wake up?	1	2	3	4	5
21.	Have difficulty getting your thoughts together?	1	2	3	4	5
22.	How long does it take you to ‘come to’ in the morning? _____ minutes.					
	22b. How many days per week is this the case? _____.					

Table 1

SIQ Items and factor loadings of the SIQ items

Factor/Item	Factor Loadings			
	1	2	3	4
Factor 1: Physiological				
Notice that it is difficult to keep your balance	0.85			
Bump into and drop things	0.75			
Notice that you get winded more easily	0.63			
Notice your arms and/or legs feeling tired or heavy	0.61			
Notice your eyes feeling heavy, sore, or itchy	0.53			
Notice that you move more slowly	0.53			
Notice that your mind feels groggy, fuzzy, or hazy	0.47			
Notice that you feel tense	0.47			
Factor 2: Responses to Sleep Inertia				
Need an alarm to wake up		0.70		
Wish you could sleep more		0.69		
Notice that you feel sleepy		0.63		
Hit the snooze button on the alarm		0.54		
Have problems getting out of bed		0.46		
Factor 3: Cognitive				
Find that you think more slowly			−1.04	
Find that you react more slowly			−0.77	
Have difficulty concentrating			−0.69	
Find that you make more mistakes/errors			−0.67	
Have difficulty getting your thoughts together			−0.59	
Factor 4: Emotional				
Feel anxious about the upcoming day				−0.63
Dread starting your day				−0.56
Can’t imagine being able to wake up				−0.41

Note: Loadings below 0.40 not shown.

Table 2

Construct Validity and Internal Consistency

	SIQ Total	Physiological	Responses to SI	Cognitive	Emotional	Cronbach α
SIQ Total	1					0.95
Physiological	0.94***	1				0.92
Responses to SI	0.70***	0.48***	1			0.81
Cognitive	0.92***	0.84***	0.51***	1		0.94
Emotional	0.86***	0.77***	0.47***	0.78***	1	0.86

*** $p < 0.001$

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Table 3

Pearson correlations between SIQ Factors and Measures of TST, Morningness, and Sleep Quality

	SIQ Total	Physiological	Responses to SI	Cognitive	Emotional
Average TST for the Week (N=353)	−0.15**	−0.13*	−0.08	−0.17*	−0.08
CSM Total (N=345)	0.03	0.05	0.07	0.06	0.05
PSQI Total (N=337)	−0.03	−0.03	−0.03	0.01	0.04

*** $p < 0.001$;

** $p < 0.01$;

* $p < 0.05$

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Table 4

Participant Demographics and Self-Report Measures

	(1) No-to-Mild-Depression (N=259)	**(2) Analogue-Depression (N=97)**	**(3) Syndromal-Depression (N=48)**	**χ^2**	**Direction[b]**
Gender	**51.0% female**	**57.7% female**	**54.2% female**	**2.53 $F_{(2,401)}$[a]**	
Mean Age (SD)	20.39 (2.60)	20.63 (1.77)	44.27 (10.97)	608.32***	3>1&2
Mean QIDS-SR Score (SD)	6.23 (4.13)	17.59 (2.23)	16.48 (3.67)	217.64***	2&3>1
Mean PSQI Score (SD)	4.45 (2.72)	4.24 (2.48)	9.31 (3.55)	64.10***	3>1&2
Average TST: Hours (SD)	7.14 (1.13)	6.81 (1.42)	7.00 (1.90)	2.25	

a * $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

b Indicates the direction of the relationship.

1 = No-to-Mild-Depression; 2 = Analogue-Depression; 3 = Syndromal-Depression

Table 5

The Sleep Inertia Questionnaire: Means, Standard Deviations, and Differences Across Groups

	GROUPS (1) No-to-Mild Depression (N=259)	(2) Analogue-Depression (N=97)	(3) Syndromal-Depression (N=48)			
Questions[a]	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	$F_{(2,401)}$ [b]	η_p^2	**Direction**[c]
Factor 1: Physiological						
Notice that it's difficult to keep your balance?	1.66 (0.94)	2.64 (1.29)	2.29 (1.40)	30.81*	0.13	2&3>1
Bump into and drop things?	1.73 (1.00)	2.58 (1.19)	2.29 (1.24)	24.19*	0.12	2&3>1
Notice that you get winded more easily?	1.82 (1.02)	3.04 (1.27)	2.77 (1.39)	47.28*	0.19	2&3>1
Notice your arms/legs feeling tired or heavy?	2.12 (1.15)	3.15 (1.26)	2.94 (1.39)	29.48*	0.13	2&3>1
Notice your eyes feel heavy, sore or itchy?	2.38 (1.19)	3.19 (1.33)	3.38 (1.24)	23.45*	0.11	2&3>1
Notice that you move more slowly?	2.22 (1.13)	2.95 (1.14)	3.17 (1.14)	23.90*	0.11	2&3>1
Notice that your mind feels groggy/fuzzy/hazy?	2.52 (1.16)	3.40 (1.20)	3.50 (1.20)	28.41*	0.13	2&3>1
Notice that you feel tense?	1.91 (1.10)	3.18 (1.26)	3.21 (1.03)	58.88*	0.23	2&3>1
Factor 2: Responses to Sleep Inertia						
Need an alarm to wake up?	4.01 (1.27)	4.07 (1.19)	3.44 (1.43)	4.67		
Wish you could sleep more?	3.81 (1.23)	3.91 (1.16)	4.12 (1.04)	1.50		
Notice that you feel sleepy?	3.11 (1.12)	3.64 (1.13)	3.81 (0.94)	13.60*	0.06	2&3>1
Hit the snooze button on the alarm?	3.41 (1.50)	3.88 (1.28)	3.09 (1.60)	5.57		
Have problems getting out of bed?	2.93 (1.17)	3.38 (1.22)	3.56 (1.18)	8.92*	0.04	2&3>1
Factor 3: Cognitive						
Find that you think more slowly?	2.28 (1.14)	3.42 (1.27)	3.27 (1.32)	39.35*	0.16	2&3>1
Find that you react more slowly?	2.23 (1.14)	3.38 (1.26)	3.15 (1.34)	37.73*	0.16	2&3>1
Have difficulty concentrating?	2.46 (1.10)	3.66 (1.14)	3.54 (1.01)	51.76*	0.21	2&3>1
Find that you make more mistakes/errors?	2.13 (1.09)	3.32 (1.24)	3.06 (1.41)	42.21*	0.17	2&3>1
Have difficulty getting your thoughts together?	2.08 (1.04)	3.40 (1.17)	3.35 (1.26)	64.46*	0.24	2&3>1
Factor 4: Emotional						

	GROUPS (1) No-to-Mild Depression (N=259)	(2) Analogue-Depression (N=97)	(3) Syndromal-Depression (N=48)			
Questions[a]	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	$F_{(2,401)}$[b]	η_p^2	**Direction**[c]
Feel anxious about the upcoming day?	2.29 (1.18)	3.40 (1.26)	3.60 (1.03)	46.76*	0.19	2&3>1
Dread starting your day?	2.01 (1.17)	3.09 (1.32)	3.25 (1.31)	40.13*	0.17	2&3>1
Can't imagine being able to wake up?	1.82 (1.06)	2.76 (1.28)	2.46 (1.24)	26.64*	0.12	2&3>1
Sleep Inertia Duration (minutes)	35.71 (49.94)	66.05 (77.93)	52.09 (47.14)	10.68*	0.05	2>1

[a] SIQ items were introduced with the phrase, *"On a typical morning in the last week, after you wake up, to what extent do you …"*

[b] Bonferroni corrections were applied.

* indicates a significance level of $p < 0.002$.

[c] Indicates the direction of the relationship.

1 = No-to-Mild-Depression; 2 = Analogue-Depression; 3 = Syndromal-Depression