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Development of a Five-Dimensional Measure of Adult Sleep Quality

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This article describes the development of a measure of adult sleep quality: the Adult Sleep–Wake Scale (ADSWS). The ADSWS is a self-report pencil-and-paper measure of sleep quality consisting of five behavioral dimensions (Going to Bed, Falling Asleep, Maintaining Sleep, Reinitiating Sleep, and Returning to Wakefulness). Data were collected from three samples. Study 1 describes the derivation of an initial pool of items. Further scale refinement is described in Studies 2 and 3. Construct validity of scores on the ADSWS was examined via correlations between ADSWS scores and scores on (1) two personality variables (Negative Affectivity and Positive Affectivity); (2) three work-related stressors (Interpersonal Conflict, Work Demands, and Job Ambiguity); and (3) three strain outcomes (Depression, Health Complaints, and Frustration). In Study 3, data were collected from participants across three time periods to assess estimates of test–retest reliability and convergent and divergent validity using procedures described by Campbell and Fiske. The findings indicate that the psychometric properties of scores on the ADSWS exceed criteria for use of an instrument in research settings. In addition, across all three studies, scores on ADSWS subscales correlated, as hypothesized, with personality, stressor, and strain variables.

Keywords: *sleep quality; sleeplessness; sleep measurement; sleep behavior; psychometrics; questionnaires*

In recent years, reduced sleep quality has been shown to be an important consequence of shift work and poor environmental and physical work conditions (Akerstedt, Fredlund, Gillbert, & Jansson, 2002a; Ohayon, Lemoine, Arnaud-Briant, & Dreyfus, 2002; Park, Matsumoto, Seo, Cho, & Noh, 2000; Pilcher, Lambert, & Huffcutt, 2000), work-related stress (Kalimo, Tenkanen, Haermae, Poppius, & Heinsalmi,

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2000; Shankar & Famuyiwa, 1991) and even perceptions of pay inequity (Greenburg, 2006). In turn, poor sleep quality has been shown to relate negatively with job performance and cognitive functioning and relate positively with on-the-job accidents (Akerstedt, Fredlund, Gillbert, & Jansson, 2002b; Kelly et al., 1998; Luna, French, & Mitcha, 1997; Veasey, Rosen, Barzansky, Rosen, & Owens, 2002).

Unfortunately, one limitation of current research examining the influence of work-related stress and shift work on sleep is that responses to sleep items on measures of health complaints are often parsed from responses to other scale items and used as an index of sleep quality (e.g., Akerstedt et al., 2004; Loewenthal et al., 2000; Ohayon et al., 2002; Parkes, 1999, 2002). As a result, researchers are likely missing important links between specific individual difference, environmental, and work-related factors and different dimensions of sleep quality. For example, individuals who work rotating shifts might fall asleep quickly relative to others but have reduced ability to maintain sleep, reinitiate sleep following an awakening, or wake up in the morning. Similarly, individuals with high levels of work demands might find it difficult to go to bed, but once in bed, fall asleep easily. Conversely, individuals with high levels of interpersonal conflict at work might find it easy to go to bed but have difficulties falling asleep. The approach to measurement of sleep quality described in this article contrasts with current practice in many research settings.

Instead, this article describes the development of a five-dimensional measure of sleep quality (the Adult Sleep–Wake Scale, ADSWS). The ADSWS is a self-report pencil-and-paper measure developed for use in investigations of the determinants and neurobehavioral significance of variations in adult sleep quality in work, medical, academic, and other settings. Although the ADSWS may be useful in the sleep medicine clinical setting, it is not a screening instrument for specific sleep disorders and does not include items assessing sleep-related breathing disturbances, limb movements during sleep, and so on. The scale is based on a model that views sleep quality as (1) contextually and behaviorally determined, (2) consisting of five behavioral dimensions, and (3) seamlessly integrated with periods of wakefulness (Crosby, LeBourgeois, & Harsh, 2005). Transitions from wakefulness to sleep (Going to Bed) and from sleep to wakefulness (Returning to Wakefulness) are considered important along with sleep initiation at the beginning of the sleep period (Falling Asleep), maintenance of sleep (Maintaining Sleep), and returning to sleep after an awakening during the sleep period (Reinitiating Sleep). Each of these dimensions is believed to have common as well as unique determinants.

A key aspect of the model is that it is applicable across the life span. It served as the basis for the construction of the Children's Sleep–Wake Scale (CSWS; Crosby et al., 2005; LeBourgeois, Avis, Mixon, Olmi, & Harsh, 2004) and a version appropriate for the study of cultural differences in adolescent sleep (LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005). This work is extended in the present study through evaluation of an adult version of the sleep–wake scale in the context of a study of personality factors influencing perceptions of and reactions to work-related stressors.

Method Overview

The set of studies described herein describe the derivation and further refinement of a set of items that best assess the five behavioral aspects of sleep quality as discussed by Crosby et al. (2005), with the ultimate goal of deriving the five best scale items per sleep quality dimension. Study 1 describes the derivation and validation of scores on an initial pool of items. Study 2 describes scale refinement and further validation of scores on a final 25-item measure of the ADSWS. In Study 3, we collected data from participants across three time periods to assess estimates of test–retest reliability. Convergent and divergent validity were also assessed following procedures described by Campbell and Fiske (1959).

Study 1

Initial Scale Development

An initial pool of items was created by modifying, deleting, or adding to items on the child and adolescent versions of the scale. The initial version of the ADSWS consisted of 44 items: 9 items for each dimension except for Returning to Wakefulness, which consisted of 8 items. Thirty-nine of the 44 items were scored on a 3-point scale (*Rarely*, 0 to 1 times; *Sometimes*, 2 to 4 times; *Usually*, 5 to 7 times) in response to the instructions "How often have the following things happened during the past week?" As higher subscale scores were to be indicative of better sleep quality, some items were reverse scored. Five of the 44 items on the ADSWS, one for each dimension, were scored on a 4-point scale. Four of these items asked respondents to estimate the amount of time it took them to (1) go to bed, (2), fall asleep, (3) fall back to sleep after awakening in the night, (4) wake up in the morning (e.g., How long does it usually take to fall asleep after lights out: less than 15 min, 15 to 30 min, 30 to 60 min, more than 60 min). One item asked individuals to estimate how many times they woke up during the night: 0 to 1, 2 to 3, 4 to 5, 6 or more).

Construct Validity Hypotheses: Relationships Between Sleep Quality, Stressors, and Strains

In this study, evidence for the construct validity of ADSWS scores was examined by computing correlations between the five ADSWS sleep dimensions (subscales) and the following: (1) two dispositional variables commonly measured by researchers examining stressor–strain relationships (negative affectivity [NA] and positive affectivity [PA]); (2) three stressor variables previously shown to relate positively with generalized measures of strain (i.e., interpersonal conflict, workload, and job ambiguity); and (3) three strain variables previously shown to be influenced by both environmental and dispositional variables (depression, frustration, and health complaints). These variables were selected based on evidence that somatic, psychological, and behavioral strains are partially the result of individuals' perceptions of work events and their dispositional tendencies (e.g., Beehr & Franz, 1987; Cooper, Dewe, & O'Driscoll, 2001; French, Caplan, & Van Harrison, 1982; Jex, 1998; McGrath, 1976).

Disposition variables. NA has been defined as the tendency of individuals to experience and/or report high levels of negative emotionality; react negatively to stressful situations; maintain high levels of negative affect even in the absence of stress; and manifest high levels of physiological and psychological symptoms (e.g., Clark & Watson, 1991; Watson & Clark, 1984). PA has been defined as the degree to which individuals experience an overall sense of well-being and general life engagement, exhibit positive emotions, and experience high levels of energy, enthusiasm, and concentration (Tellegen, 1985; Watson, 1988; Watson, Clark, & Tellegen, 1988). Research has shown that scores on measures of NA and PA correlate positively and negatively, respectively, with scores on measures of psychological, behavioral, and somatic strain, including measures that contain items indexing sleep quality (e.g., Fortunato, 2004; Fortunato, Jex, & Heinisch, 1999; Spector, Chen, & O'Connell, 2000; Spector & O'Connell, 1994). Therefore, we hypothesized that scores on measures of NA and PA will correlate negatively and positively, respectively, with scores on the five dimensions of the ADSWS.

Stressors. Interpersonal conflict is defined as the quality of individuals' relationships; workload is defined as "the amount of work an employee has to do" (Jex, 1998, p. 15); and job ambiguity is defined as the extent to which clear work-related expectations have been communicated and understood. Research has shown that scores on measures of interpersonal conflict, workload, and job ambiguity tend to correlate positively with scores on various measures of strain, including anxiety, depression, frustration, and health complaints (e.g., Fortunato, 2004; Fortunato et al., 1999; Kahn & Byosiere, 1992; Motowidlo, Packard, & Manning, 1986). Therefore, we hypothesized that scores on all three stressor variables will correlate negatively with scores on the five dimensions of the ADSWS.

Strains. A review of commonly used measures of depression (psychological strain) and health complaints (somatic strain) indicates that sleeplessness is often used as an indicator of both. Conversely, frustration is considered an affective type of strain that assesses the extent to which individuals are frustrated with specific aspects of their work environment (e.g., coworkers). Thus, we hypothesized that scores on each of the five dimensions of the ADSWS will correlate negatively with scores on all three strain measures and that scores on each of the five dimensions of the ADSWS will correlate more highly with scores on measures of health complaints and depression than scores on a measure of frustration.

Although research examining the relationships between personality and job stressors on sleep quality is relatively nonexistent, correlation coefficients ranging from .10 to .40 are typically observed in studies examining the relationships between personality characteristics, such as NA, and job stressors and strains (e.g., Fortunato, 2004; Jex, 1998). As such, we anticipate that the correlation coefficients in this study would generally be observed to be in the same range.

Differences Between Correlated Correlation Coefficients

The utility of making a distinction between the five dimensions of sleep depends in part on whether the different dimensions of sleep quality are truly distinct from one another. Although scales can be constructed purposely so as to maximize factor differences between them, it is important to assess the extent to which dispositional and environmental influences affect the five dimensions of sleep quality differently. Thus, we examined how the two dispositional, three stressor, and three strain variables correlated differently with the five dimensions on the ADSWS using Williams's (1959) correction of Hotelling's T statistic (see Cohen & Cohen, 1983; May & Hittner, 1997; Steiger, 1980). Effect sizes for correlation differences (q) were calculated using procedures described in Cohen (1988). According to Cohen, small, medium, and large effect sizes (i.e., differences between correlation coefficients) would correspond to q values of .10, .30, and .50, respectively.

Method

Participants. In Study 1, the initial ADSWS was given to 467 undergraduate students (120 male, 347 female) who participated in exchange for extra credit. Sixty-one percent were Caucasian, 34% were African American, and 5% were of other races. Thirty-five percent of participants were freshmen, 23% sophomores, 18% juniors, and 20% seniors. The average age of the participants was 21.3 years. Research participants completed questionnaires in supervised groups after signing an informed consent approved by the institutional review board.

Measures. We measured NA using the 20-item Strain-Free Negative Affectivity Scale (SFNA; Fortunato & Goldblatt, 2002) and PA using the 22-item Sociability-Free Positive Affectivity Scale (SFPA; Fortunato & Mincy, 2003). We also measured interpersonal conflict, work demands, and job ambiguity using Spector and Jex's (1998) four-item interpersonal conflict scale, Karasek's (1979) six-item work demands scale, and Breaugh and Colihan's (1994) nine-item job ambiguity scale. Because our sample consisted of college students, items were reworded where necessary to include school as the work environment (e.g., "I get into arguments at school often," "School often leaves me little time to get things done," and "I know what my teachers consider satisfactory performance."). Finally, we also measured depression, health complaints, and frustration using Quinn and Shephard's (1974) nine-item depression scale, Goldberg's (1978) 10-item General Health Questionnaire, and Peters, O'Connor, and Rudolf's (1980) three-item frustration scale. Coefficient alpha estimates of reliability for scores on the above measures are shown in Table 1.

Results and Discussion

Item exclusion. The analytic strategy that we employed in this study was as follows: a series of coefficient alpha estimates of reliability (including corrected item–total correlations) were computed to determine which items among the set of items for each dimension correlated best with the total set of items and yielded the highest overall coefficient alpha estimate of reliability. In addition, a series of principal component analyses using oblimin rotation were also calculated using the correlation matrix of scores on the sleep quality items. Because we developed a set of sleep quality items based on a theoretical framework that indicated that there are five positively related dimensions of sleep quality, we computed a series of principal components analyses in which (1) the number of factors to be extracted was fixed to equal five and (2) oblimin rotation in which the delta value was left in its default setting ($\delta = 0$). In general, after each set of analyses, items were eliminated if scores on those items (1) correlated poorly with scores on the appropriate summated scale (i.e., corrected item–total correlations $< .30$) in the reliability estimate analyses, (2) correlated poorly with the hypothesized latent variable in the principal component analyses (pattern coefficients $< .30$ and structure coefficients $< .40$), or (3) correlated highly on multiple latent factors (i.e., multiple pattern coefficients $> .40$ and structure coefficients $> .50$).

Based on the above criteria, we retained four Going to Bed items, four Falling Asleep items, five Maintaining Sleep items, five Reinitiating Sleep items, and seven Returning to Wakefulness items. In retrospect, several of the excluded items contained content that did not appear to be good indicators of sleep quality for adults. Coefficient alpha estimates for scores on the five sleep quality subscales and their confidence intervals, computed using central approach procedures discussed by Fan and Thompson (2001), are shown in Table 1.

The five-factor solution explained 57% of the variance in individuals' scores. Initial eigenvalues were 5.98, 3.39, 2.03, 1.63, and 1.12, respectively, each accounting for 23.92%, 13.54%, 8.12%, 6.51%, and 4.48% of variance. The rotated solution yielded eigenvalues of 2.47, 4.18, 3.04, 3.52, and 4.06, respectively. The pattern and structure coefficients (in parentheses) for the retained items on their respective factors are as follows: Falling Asleep, .61 (.65), .57 (.67), .45 (.55), and

Table 1
Scale Means, Standard Deviations, Coefficient Alpha Estimates of Reliability, and Correlation Coefficients Between Scores on the Measured Variables From Sample 1, $N = 486$

	Mean	*SD*	α (95% CI)	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Negative Affectivity	5.11	.83	.86 (.85 to .88)	1.0												
2. Positive Affectivity	5.72	.69	.89 (.87 to .90)	.20	1.0											
3. Interpersonal Conflict	1.89	.91	.80 (.77 to .83)	.08	−.28	1.0										
4. Work Demands	3.52	1.22	.83 (.80 to .84)	.12	.02	.25	1.0									
5. Ambiguity	2.61	1.07	.91 (.90 to .92)	.05	−.38	.11	−.04	1.0								
6. Depression	3.18	.93	.78 (.75 to .80)	.21	−.41	.22	.15	.41	1.0							
7. Health Complaints	4.88	1.09	.89 (.87 to .90)	.23	−.34	.24	.27	.31	.75	1.0						
8. Frustration	4.28	1.26	.51 (.42 to .57)	.23	−.15	.18	.31	.22	.42	.41	1.0					
9. Going to Bed	0.00[a]	.73	.71 (.67 to .75)	.05	.07	−.16	−.11	−.14	−.17	−.22	−.14	1.0				
10. Falling Asleep	0.00[a]	.76	.76 (.72 to .79)	−.12	.11	−.23	−.12	−.18	−.34	−.41	−.15	.41	1.0			
11. Maintaining Sleep	0.00[a]	.71	.80 (.77 to .83)	−.15	.14	−.19	−.12	−.16	−.33	−.38	−.16	.17	.52	1.0		
12. Reinitiating Sleep	0.00[a]	.76	.82 (.79 to .84)	−.12	.13	−.20	−.04	−.15	−.25	−.29	−.06	.24	.53	.42	1.0	
13. Returning to Wakefulness	0.00[a]	.72	.86 (.83 to .87)	−.23	.18	−.10	−.10	−.15	−.32	−.38	−.26	.28	.25	.23	.08	1.0

Note: Correlations above |.09| are statistically significant at the $p < .05$, two-tailed level. Correlation coefficients above |.12| are statistically significant at the $p < .01$, two-tailed level. α = coefficient alpha estimate of reliability with 95% confidence intervals (CIs) in parentheses.
a. Because some of the items in these scales were measured on a different metric than the others, all scores were standardized before creating scales. Thus, the scale means on these five measures are 0.00.

.37 (.51); Returning to Wakefulness, .84 (.82), .79 (.78), .79 (.79), .69 (.67), .68 (.70), .65 (.68), and .58 (.65); Going to Bed, .82 (.81), .76 (.75), .63 (.65), and .59 (.63); Maintaining Sleep, .80 (.81), .69 (.67), .68 (.70), .67 (.70), and .51 (.59); Reinitiating Sleep, .79 (.79), .79 (.79), .79 (.77), .71 (.73), and .65 (.71). (A table displaying the communalities and the pattern and structure coefficients for the final set of 25 items retained in Study 1 is available on request.) Finally, the component correlations were as follows: Factor 1 (Falling Asleep) correlated .06, .11, .13, and .31 with Factors 2 through 5 (Returning to Wakefulness, Going to Bed, Maintaining Sleep, and Reinitiating Sleep), respectively; Returning to Wakefulness correlated .25, .18, and .09, respectively, with Factors 3 through 5; Going to Bed correlated with .15 and .19 with Factors 4 and 5, respectively; and Maintaining Sleep correlated .29 with Factor 5.

To verify the five-factor structure of scores on the ADSWS, we also analyzed our data using parallel analysis (Thompson & Daniel, 1996) and minimum average partial criterion procedures (O'Connor, 2000). In the former, eigenvalues generated from a set of random data are compared with those derived from the actual data set. The number of factors retained is determined by how many eigenvalues in the actual data are larger than the corresponding eigenvalues from the random data. In the latter, the number of components is determined by an examination of a series of matrices of squared correlations (O'Connor, 2000). In Study 1, both sets of procedures indicated that there were only four stable factors. Note that the difference between the fifth random eigenvalue and the actual eigenvalue was .09.

Correlations between sleep quality subscales. Because four of the retained items were measured using a 4-point scale, whereas the rest were measured using a 3-point scale, scores on each item were standardized prior to creating subscales. As shown in Table 1, with one exception (the correlation between scores on Reinitiating Sleep and Returning to Wakefulness), scores on all the sleep quality subscales correlated positively and statistically significantly with one another at the $p < .05$ level, two-tailed. Note that none of the correlation coefficients are above .53.

Construct validity evidence. We hypothesized that scores on measures of NA, stressors, and strains would relate negatively to scores on the five dimensions of the ADSWS, whereas scores on a measure of PA would relate positively with scores on the five dimensions of the ADSWS. As shown in Table 1, these hypotheses were generally supported: scores on the measures of NA, the three stressor variables, and the three strain variables all correlated negatively with scores on the five sleep dimension subscales; scores on PA correlated positively with scores on the five sleep dimension subscales.

Discriminant validity evidence. Table 2 shows the results of tests for differences between correlated correlation coefficients. For sleep quality and personality measures, the only significant comparisons were between the Going to Bed and

Table 2
Tests of Differences Between Correlated Correlation Coefficients in Study 1

Sleep Quality Dimensions	NA	PA	IPC	WD	AMB	DEPR	HC	FRUST
Going to Bed	$-.05^{a}$	$.07^{a}$	$-.16$	$-.11$	$-.14$	$-.17^{abc}$	$-.22^{abc}$	$-.14^{a}$
Falling Asleep	$-.12$	$.11$	$-.23^{a}$	$-.12$	$-.18$	$-.34^{a}$	$-.41^{ad}$	$-.15^{bc}$
Maintaining Sleep	$-.15$	$.14$	$-.19$	$-.12$	$-.16$	$-.33^{b}$	$-.38^{be}$	$-.16^{d}$
Reinitiating Sleep	$-.12$	$.12$	$-.20$	$-.04$	$-.15$	$-.25$	$-.29^{de}$	$-.06^{bde}$
Returning to Wakefulness	$-.23^{a}$	$.18^{a}$	$-.10^{a}$	$-.10$	$-.15$	$-.32^{c}$	$-.38^{c}$	$-.26^{ace}$

Note: Letter superscripts that are the same in a column of data indicate a statistically significant difference at the $p < .05$, two-tailed level between the correlation coefficient for one sleep scale and the variable at the top of the column and the correlation coefficient between a second sleep scale and the same variable. For example, the correlation between NA and "Going to Bed" was statistically significantly smaller than the correlation between NA and "Waking Up." NA = negative affectivity; PA = positive affectivity, IPC = interpersonal conflict, WD = work demands; AMB = perceived ambiguity; DEPR = depression; HC = health complaints; FRUST = frustration.

Returning to Wakefulness dimensions. These comparisons suggest that people with high NA scores, compared with those with low NA scores, tended to have a more difficult time returning to wakefulness in the morning than they did with going to bed at night, $t(485) = 3.33$, $p < .01$, $q = .18$ (Cohen, 1988). In contrast, for those with high PA scores, compared with those with low PA scores, ease of waking in the morning was greater than the ease of going to bed at night, $t(485) = -1.96$, $p < .05$, $q = .11$. These differences represent differences in the variance shared $(r_1^2 - r_2^2)$ of approximately 3% to 5% (Cohen, 1988).

Many differences were found in how the different strain measures correlated with the different sleep quality subscales. First, Falling Asleep, Maintaining Sleep, and Returning to Wakefulness scores correlated more negatively with depression scores than did Going to Bed scores, $t(485) = 3.72$, 3.04, and 2.99, $p < .05$, $q = .17$, .16, and .16, respectively. Second, Returning to Wakefulness scores correlated more negatively with frustration scores than did Going to Bed, Falling Asleep, and Reinitiating Sleep scores, $t(485) = 2.33$, 2.10, 3.45, $p < .05$, $q = .11$, .10, and .20, respectively. Third, Falling Asleep and Maintaining Sleep scores correlated more negatively with frustration scores than did Reinitiating Sleep scores, $t(485) = 2.07$ and 2.08, $p < .05$, $q = .09$ and .10, respectively. Fourth, Falling Asleep, Maintaining Sleep, and Returning to Wakefulness scores correlated more negatively with health complaints scores than did Going to Bed scores, $t(485) = 4.32$, 3.16, and 3.31, $p < .01$, $q = .21$, .18, and .18, respectively. Fifth, Falling Asleep and Maintaining Sleep scores correlated more negatively with health complaints scores than did Reinitiating Sleep scores, $t(485) = 3.04$ and 2.06, $p < .05$, $q = .14$ and .10, respectively.

Differences between strain measures. We had hypothesized that health complaints and depression would correlate more negatively with sleep quality than frustration. As shown in Table 2, (1) scores on the health complaints measure correlated more negatively with scores on the Falling Asleep, Maintaining Sleep, and Reinitiating Sleep subscales than did scores on the frustration measure, $t(485) = -2.73$, $p < .01$, $q = .29$, $t(485) = -1.87$, $p < .05$ (one-tailed), $q = .28$, and $t(485) = -2.08$, $p < .05$, $q = .24$ and (2) scores on the depression measure correlated more negatively with scores on the Falling Asleep, Maintaining Sleep, and Reinitiating Sleep subscales than did scores on the frustration measure, $t(485) = -2.75$, $p < .01$, $t(485) = -1.89$, $p < .05$ (two-tailed), and $t(485) = -2.10$, $p < .05$, $q = .20$, .18, and .19, respectively. We also note that scores on the health complaint measure correlated more negatively with scores on the Falling Asleep and Returning to Wakefulness subscales than did scores on the depression measure, $t(485) = -2.40$, $p < .01$ and $t(485) = -2.02$, $p < .05$, $q = .08$ and .07, respectively. Thus, we found partial support for our hypothesis: People with depression or numerous health complaints symptoms reported lower sleep quality than people with high levels of frustration.

In summary, scores on the five sleep quality dimensions demonstrated good reliability and behaved as predicted with respect to the personality, stressor, and strain variables: people high in NA and people reporting high levels of stress and strain tended to sleep less well, on average, than people low in NA and people reporting low levels of stress and strain, whereas people high in PA tended to sleep better than people low in PA. Moreover, the five sleep quality dimensions correlated differently with personality, stressor, and strain variables. However, we note that with respect to our tests of differences between correlated correlation coefficients presented in the above paragraphs, these differences represent differences in the variance shared ($r_1^2 - r_2^2$) of approximately 3% to 8% (Cohen, 1988). Thus, although statistically significant and generally consistent with our hypotheses, the differences that we report above are relatively small.

Studies 2 and 3

Item Revision

Although the results of Study 1 were encouraging, a few aspects of the ADSWS were cause for concern and prompted us to revise the scale. First, several of the initial items did not appear to be appropriate for an adult population. Recall that the initial pool of the ADSWS items were items taken from a version of the scale designed for children or adolescents. Second, because we adopted two different metrics, we ended up with items that were scored using two different scales. As a result, all items were standardized to create scales for each sleep quality dimension. By doing so, however, information was lost on how individuals' mean scores compared with the mean of the scale itself. Third, three of our coefficient alpha estimates of reliability were at or below .80. As Henson (2001) summarized, different sources cite different standards of adequacy for reliability estimates depending on how a particular measure is being used. For example, for basic research purposes, Nunnally (1978) and Nunnally and Bernstein (1994) stated that internal consistency estimates above .80 are adequate, whereas for applied settings, internal consistency estimates above .90 are generally required. Because (1) we are designing a measure of sleep quality for research use primarily, (2) the number of items in a measure influences reliability estimates (as items increase, reliability estimates increase), and (3) measures of low reliability pose a threat to statistical conclusion validity (Cook & Campbell, 1979), our goal was to maximize internal consistency reliability estimates using the fewest possible items (ideally five items per sleep quality subscale).

In response to these concerns, we revised the wording of several items and generated additional items that better reflected the relevant dimensions of sleep quality in adults. The revised scale consisted of 11 Going to Bed items, 9 Falling Asleep items, 9 Maintaining Sleep items, 9 Reinitiating Sleep items, and 8 Returning to Wakefulness items. In addition, we changed the scale metric for all items to a 6-point scale in an attempt to increase response variability and eliminate the necessity to standardize each item before creating mean scores for all participants. For all but five items, respondents were asked to indicate how frequently certain sleep-related behaviors occurred on the following scale: "Never" (0%), "Once in a While" (20%), "Sometimes" (40%), "Quite Often" (60%), "Frequently, but Not Always" (80%), and "Always" (100%). The remaining five items, one per dimension, were also scored on a 6-point scale but with different anchors. For example, in the Going to Bed scale, respondents were asked to estimate "How long does it usually take you to fall asleep after 'lights out'": (1) $<$ 15 min, (2) 15 to 30 min; (3) 30 to 45 min; (4) 45 to 60 min; (5) 60 to 90 min; (6) $>$ 90 min.

Method—Study 2

Participants. Participants consisted of 718 college students from a medium-sized southern university who participated in the research in return for extra credit. Participants were largely women (72.4%) and either Caucasian (51.4%) or African American (45.3%). Ninety percent of participants were between the ages of 18 and 23, 6.0% were between the ages of 24 and 30; 2.5% between 31 and 40; and 1.5% were 41 or older. All subjects signed an informed consent.

Measures. In addition to the revised ADSWS, we used the same measures of NA, PA, interpersonal conflict, work demands, ambiguity, depression, frustration, and health complaints described in Study 1.

Method—Study 3

Participants. The purpose of Study 3 was to assess the test–retest reliability of scores on the revised ADSWS. Volunteers were solicited from four undergraduate classes at a medium-sized southern university. Participants were largely female (72.5%). Fifty-six point one percent (56.1%) of participants were Caucasian, 39.8% were African American, and 4.1% were "other." The average age of the participants was 22.3 years. Seventy-six point eight percent (76.8%) of participants were between the ages of 18 and 23, 16.6% were between the ages of 24 and 30, 2.9% between 31 and 40, and 1.7% were 41 years old or older. All subjects signed an informed consent.

Procedure. The revised ADSWS was administered in class three times during the academic semester. The first administration (Time 1) occurred during the second week of class. The second administration (Time 2) took place at about the midpoint of the semester (approximately 7 weeks), and the third administration (Time 3) took place during the second to last full week of classes (approximately 12 weeks). Because of attrition, sample sizes decreased for each administration: $n = 166$ (Time 1), $n = 149$ (Time 2), and $n = 107$ (Time 3).

Results and Discussion

Item inclusion. The analytic strategy that we employed in Studies 2 and 3 was essentially identical to that used for Study 1. However, rather than relying on the results of a single sample of participants to determine which items to retain, we continually assessed the consistency of our findings from Studies 2 and 3 to reduce the ADSWS to what appeared to be the best five items for each sleep quality dimension across both studies. In general, we retained those items that correlated most strongly with both the summated scale in the reliability analyses and the appropriate latent factors in the principal components analyses, while minimizing reductions in coefficient alpha estimates of reliability as a result of item deletion. In general, reducing the subscales to five items each resulted in only negligible loss in score reliability from the first set of analyses. Coefficient alpha estimates of reliability for scores from Sample 2 are shown in Table 4, and coefficient alpha estimates of reliability for scores from Sample 3 are shown in Table 5.

Table 3 shows the final set of items, the pattern and structure coefficients, and communalities for scores from Sample 2, and the unrotated eigenvalues and percent of variance explained for the five-factor principal components solution. The five factors explained 66% of score variance and had interfactor correlations ranging from |.12| to |.46| (see bottom of Table 3).

For Sample 3—Time 1, the five-factor solution explained 69.5% of score variance. Initial eigenvalues were 8.52, 3.90, 1.95, 1.72, and 1.27, respectively, each accounting for 34.09%, 15.61%, 7.79%, 6.69%, and 5.06% of score variance. The

(text continues on p. 505)

Table 3
Pattern and Structure Coefficients (in Parentheses) From the Five-Factor Principal Components Analysis With Oblimin Rotation for the Adult Sleep–Wake Scale for Study 2, $N = 718$

	Component					
Items	1	2	3	4	5	Communalities
1. Reinitiating Sleep						
After waking up during the night, I drift back off to sleep easily	.88 (.90)	.03 (.15)	−.08 (.06)	−.05 (.39)	−.09 (−.45)	.81
After waking up during the night, I roll over and go right back to sleep	.86 (.90)	−.01 (.14)	−.02 (.10)	.04 (.45)	.06 (−.45)	.81
After waking up during the night, I have a hard time going back to sleep (R)	.84 (.83)	.03 (.16)	.06 (.15)	.01 (.38)	.06 (−.35)	.69
How long does it usually take you to go back to sleep after waking during the night? (<5 min; 5 to 10 min; 10 to 15 min; 15 to 20 min; 20 to 30 min; >30 min) (R)	.75 (.79)	−.09 (.07)	.07 (.16)	.01 (.38)	−.08 (−.43)	.64
After waking up during the night, I am calm and relaxed	.70 (.77)	.12 (.24)	−.00 (.13)	.11 (.46)	−.00 (−.40)	.62
2. Returning to Wakefulness						
In general, I find it difficult to get out of the bed in the morning (R)	−.02 (.08)	.87 (.88)	.07 (.33)	−.07 (.11)	−.01 (−.23)	.78
In general, I am slow-to-start in the morning (R)	−.05 (.07)	.87 (.85)	−.01 (.26)	−.05 (.11)	−.03 (−.22)	.73
In the morning, I wake up and feel ready to get up for the day	.08 (.18)	.84 (.83)	.02 (.23)	.01 (.19)	.08 (−.19)	.70
In the morning, I wake up and just can't get going (R)	.09 (.09)	.80 (.83)	.02 (.29)	.08 (−.23)	−.04 (−.26)	.69
In the morning, I wake up rested and alert	.13 (.26)	.78 (.81)	.02 (.28)	.04 (.26)	.02 (−.28)	.67

(continued)

Table 3 (continued)

Items	Component 1	2	3	4	5	Communalities
3. Going to Bed						
In general, I “put off” or delay going to bed (R)	.04 (.11)	.02 (.28)	.89 (.87)	−.04 (.07)	.06 (−.30)	.77
How long do you usually “put off” or delay going to bed (<15 min; 15 to 30 min; 30 to 45 min; 45 to 60 min; 60 to 90 min; >90 min) (R)	−.02 (.10)	−.03 (.23)	.83 (.82)	.07 (.15)	.01 (−.33)	.68
In general, it is very hard for me to go to bed on time (R)	.04 (.17)	.11 (.36)	.71 (.78)	−.03 (.13)	−.09 (−.40)	.64
When it’s time to go to bed, I want to stay up and do other things (e.g., read, work, or watch TV) (R)	−.02 (.09)	.01 (.22)	.65 (.72)	.07 (.12)	.02 (−.25)	.43
In general, I have to make myself go to bed (R)	−.02 (.18)	.04 (.30)	.57 (.65)	−.10 (.14)	−.37 (−.56)	.62
4. Falling Asleep						
After I fall asleep, but during the night, I awaken more than once (R)	−.00 (.39)	−.02 (.17)	.07 (.15)	.88 (.87)	.07 (−.32)	.76
How often do you usually wake up during the night (never; once; twice; three times; four times; more than four times) (R)	.03 (.41)	−.09 (.13)	.07 (.13)	.85 (.84)	.04 (−.32)	.72
After I fall asleep, but during the night, I toss and turn in bed (R)	−.05 (.36)	.13 (.11)	−.08 (.11)	.65 (.74)	−.20 (−.45)	.58
In general, I sleep without arousals or awakenings.	.20 (.47)	−.02 (.11)	.03 (.11)	.62 (.73)	.03 (−.32)	.52
After I fall asleep, but during the night, I am very restless (R)	.00 (.34)	.13 (.15)	−.08 (.15)	.61 (.69)	−.30 (−.55)	.64
5. Maintaining Sleep						
In general, I try to make myself go to sleep (R).	−.08 (.28)	.06 (.29)	.10 (.40)	.00 (.38)	−.74 (−.77)	.61

(continued)

Table 3 (continued)

Items	Component					Communalities
	1	2	3	4	5	
When I am in bed and it is time to fall asleep, I am not sleepy (R)	.10 (.40)	−.07 (.15)	.05 (.31)	−.06 (.45)	−.73 (−.76)	.58
In general, I fall asleep quickly	.16 (.49)	.04 (.25)	−.05 (.26)	.02 (.45)	−.70 (−.78)	.63
How long does it usually take you to fall asleep after lights out? (<15 min; 15 to 30 min; 30 to 45 min; 45 to 60 min; 60 to 90 min; >90 min) (R)	.11(.47)	−.03 (.20)	−.00 (.28)	.13 (.29)	−.68 (−.77)	.63
When I am in bed and it is time to fall asleep, I am unable to settle down (R)	.01 (.40)	.04 (.28)	.06 (.36)	.15 (.28)	−.67 (−.77)	.63
Unrotated eigenvalues	8.15	3.51	2.25	1.50	1.13	
Rotated eigenvalues	5.42	4.58	4.07	4.86	5.65	
Percent variance explained	32.61	14.05	9.02	6.02	4.51	
Factor Correlations						
2	.15					
3	.12	.31				
4	.46	.21	.12			
5	−.45	−.28	−.39	.17		

Note: R = reverse scored item.

Table 4
Scale Means, Standard Deviations, Coefficient Alpha Estimates of Reliability, and Correlation Coefficients Between Scores on the Measured Variables From Study 2, $N = 718$

	Mean	*SD*	α (95% CI)	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Negative Affectivity	5.09	.87	.87 (.86 to .89)	1.0												
2. Positive Affectivity	5.59	.68	.87 (.84 to .88)	.24	1.0											
3. Interpersonal Conflict	1.90	1.15	.83 (.81 to .85)	.20	−.10	1.0										
4. Work Demands	4.24	1.29	.83 (.81 to .85)	.32	.16	.22	1.0									
5. Ambiguity	2.41	.96	.89 (.88 to .90)	−.07	−.41	.12	.05	1.0								
6. Depression	2.97	1.43	.90 (.88 to .91)	.27	−.23	.35	.25	.23	1.0							
7. Health Complaints	3.10	1.47	.88 (.87 to .90)	.26	−.12	.25	.27	.16	.62	1.0						
8. Frustration	4.60	1.61	.83 (.80 to .85)	.42	−.02	.18	.49	.15	.40	.42	1.0					
9. Going to Bed	3.54	1.26	.83 (.81 to .85)	−.18	.03	−.09	−.19	−.13	−.29	−.25	−.26	1.0				
10. Falling Asleep	4.14	1.09	.84 (.82 to .86)	−.19	.11	−.10	−.08	−.09	−.30	−.29	−.22	.49	1.0			
11. Maintaining Sleep	3.99	1.15	.83 (.81 to .85)	−.23	.09	−.10	−.11	−.03	−.28	−.33	−.23	.19	.53	1.0		
12. Reinitiating Sleep	4.31	1.19	.89 (.88 to .90)	−.14	.14	−.12	−.11	−.06	−.28	−.27	−.22	.20	.54	.54	1.0	
13. Returning to Wakefulness	3.19	1.21	.90 (.89 to .91)	−.26	.27	−.12	−.12	−.19	−.39	−.32	−.35	.39	.31	.22	.15	1.0

Note: Correlations above |.07| are statistically significant at the $p < 0.05$, two-tailed level. Correlations above |.09| are statistically significant at the $p < 0.01$, two-tailed level. α = Coefficient alpha estimate of reliability with 95% confidence intervals (CIs) in parentheses.

Table 5
Scale Means, Standard Deviations, Coefficient Alpha Estimates of Reliability, and Correlation Coefficients Between Scores on the Sleep–Wake Scales in Study 3 at Times 1, 2, and 3, $N = 166$, 149, and 107

	Mean	*SD*	α (95% CI)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Study 3—Time 1																		
1. Going to Bed	3.60	1.19	.86 (.82 to .89)	1.0														
2. Falling Asleep	4.18	1.10	.87 (.83 to .90)	.51	1.0													
3. Maintaining Sleep	4.02	1.10	.85 (.81 to .88)	.23	.58	1.0												
4. Reinitiating Sleep	4.22	1.24	.91 (.89 to .93)	.20	.50	.53	1.0											
5. Returning to Wakefulness	3.37	1.08	.89 (.86 to .91)	.47	.37	.22	.15	1.0										
Study 3—Time 2																		
6. Going to Bed	3.52	1.19	.88 (.84 to .91)	.67	.46	.33	.22	.51	1.0									
7. Falling Asleep	4.18	1.01	.84 (.79 to .88)	.44	.75	.54	.54	.29	.54	1.0								
8. Maintaining Sleep	4.10	1.04	.84 (.80 to .88)	.23	.53	.75	.53	.16	.32	.64	1.0							
9. Reinitiating Sleep	4.23	1.16	.92 (.87 to .92)	.17	.48	.54	.71	.16	.20	.53	.58	1.0						
10. Returning to Wakefulness	3.36	.99	.85 (.80 to .88)	.42	.32	.12	.12	.76	.51	.26	.20	.12	1.0					
Study 3—Time 3																		
11. Going to Bed	3.63	1.18	.89 (.85 to .92)	.67	.35	.25	.15	.40	.82	.45	.20	.08	.43	1.0				
12. Falling Asleep	4.30	1.09	.88 (.84 to .92)	.40	.77	.48	.56	.37	.46	.77	.58	.55	.30	.45	1.0			
13. Maintaining Sleep	4.09	1.17	.87 (.82 to .90)	.14	.52	.73	.60	.10	.19	.53	.79	.67	.09	.19	.62	1.0		
14. Reinitiating Sleep	4.25	1.25	.93 (.91 to .95)	.10	.49	.61	.72	.08	.19	.49	.58	.81	.05	.17	.66	.73	1.0	
15. Returning to Wakefulness	3.32	.99	.86 (.82 to .90)	.33	.12	.00	−.06	.73	.44	.14	−.01	−.05	.82	.47	.20	−.04	−.01	1.0

Note: Correlation coefficients above |.19| are statistically significant at the $p < 0.05$, two-tailed. α = coefficient alpha estimate of reliability with 95% confidence intervals (CI) in parentheses.

rotated solution yielded eigenvalues of 5.39, 4.65, 5.52, 4.42, and 5.11, respectively. The pattern and structure coefficients (in parentheses) ranged from .46 to .83 (.67 to .85) for the five Falling Asleep items that comprised Factor 1; .72 to .87 (.76 to .89) for the five Returning to Wakefulness items that comprised Factor 2; .70 to .92 (.79 to .92) for the five Reinitiating Sleep items that comprised Factor 3; .52 to .86 (.67 to .85) for the five Going to Bed items that comprised Factor 4; and .56 to .84 (.70 to .86) for the five Maintaining Sleep items that comprised Factor 5. The five factors had interfactor correlations ranging from |.12| to |.42|.

For Sample 3—Time 2, five factors explained 69% of score variance. However, the factor structure was not as clean as those of the other analyses. Instead, Factor 1 (eigenvalue = 8.60, percentage variance explained = 34.40) consisted of the five Maintaining Sleep items [.62 (.70) to .78 (.80)] and two of the Falling Asleep items [.44 (.70) and .59 (.67)]; Factor 2 (eigenvalue = 3.97, percentage variance explained = 15.88) consisted of the five Going to Bed items [.74 (.73) to .84 (.82)] and two Falling Asleep items [.52 (.61) and .56 (.68)]; Factor 3 (eigenvalue = 1.93, percentage variance explained = 7.72) consisted of two Returning to Wakefulness items [.72 (.76) and .68 (.73)] and one Falling Asleep item [−.52 (−.51)]; Factor 4 (eigenvalue = 1.41, percentage variance explained = 5.64) consisted of the five Reinitiating Sleep items [−.67 (.70) to−.93 (.09)]; and Factor 5 (eigenvalue = 1.26, percentage variance explained = 5.65) consisted of three Returning to Wakefulness items [.71 (.74) to .87 (.89)]. The rotated solution yielded eigenvalues of 5.84, 6.11, 1.92, 5.82, and 3.51, respectively. The five factors had interfactor correlations ranging from |.03| to |.48|.

For Sample 3—Time 3, five factors explained 73% of score variance. Initial eigenvalues were 9.25, 4.96, 1.77, 1.24, and 1.04, respectively, each accounting for 36.99%, 19.83%, 7.08%, 4.96%, and 4.21% of score variance. The rotated solution yielded eigenvalues of 5.75, 4.05, 4.88, 6.57, and 6.05. Pattern and structure coefficients (in parentheses) ranged from .52 to .76 (.73 to .89) for the five Reinitiating Sleep items that comprised Factor 1; .65 to .86 for the five Returning to Wakefulness items that comprised Factor 2; −.64 to −.97 (−.76 to −.84) for the five Going to Bed items that comprised Factor 3; −.59 to −.79 (−.74 to −.86) for the five Falling Asleep items that comprised Factor 4; and .52 to .86 (.67 to .88) for the five Maintaining Sleep items that comprised Factor 5. The five factors had interfactor correlations ranging from |.01| to |.43|. (Tables displaying communalities and pattern and structure coefficients for the final set of 25 items retained in Study 3—Times 1, 2, and 3 are available on request.)

Similar to Study 1, to verify that our data supported our five-dimensional model of sleep quality, we also analyzed data of Studies 2 and 3 using parallel analysis and minimum average partial criterion procedures. On average, these analyses provided support for the five-dimensional model of sleep quality. Specifically, the minimum average partial correlation procedures indicated there were five stable factors in all four data sets (Study 2 and Study 3—Times 1, 2, and 3), whereas the parallel analyses indicated that there were five stable factors when Study 2 and Study 3—Time 1 data were analyzed and four stable factors when Study 3—Times 2 and 3 data were analyzed. Note that the difference between the fifth random eigenvalues and the actual eigenvalue for Study 3—Time 2 data and Study 3—Time 3 data were .12 and .36, respectively.

Correlations Between Sleep Quality Subscales and Test–Retest Reliabilities

As shown in Table 4, scores on all the sleep quality subscales correlated positively with one another in Study 2. In Study 3, on average (across the three time periods), Going to Bed scores correlated positively with Falling Asleep, Maintaining Sleep, Reinitiating Sleep, and Returning to Wakefulness scores ($Mr = .50$, .25, .19, and .48, respectively), Falling Asleep scores correlated positively with Maintaining Sleep, Reinitiating Sleep, and Returning to Wakefulness scores ($Mr = .56$, .56, and .28, respectively). Maintaining Sleep scores correlated positively with Reinitiating Sleep and Returning to Wakefulness scores ($Mr = .61$ and .13) and Reinitiating Sleep scores correlated positively with Returning to Wakefulness scores ($Mr = .08$).

Test–retest reliability. The correlations between scores on corresponding sleep quality scales at Times 1, 2, and 3 are shown in Table 5. Test–retest reliability coefficients ranged from .67 to .82.

Correlations With Disposition, Stressor, and Strain Variables

As in Study 1, it was hypothesized that scores on a measure of NA and the stressor and strain variables would relate negatively to scores on the ADSWS, and scores on a measure of PA would relate positively to scores on the ADSWS. As shown in Table 4, these hypotheses were supported and consistent with Study 1: People high in NA and people who reported high levels of stress and strain tended to sleep less well than people low in NA and people who reported low levels of stress and strain, whereas people high in PA tended to sleep better than people low in PA.

Discriminant validity evidence. Table 6 shows the results of tests for differences between correlated correlation coefficients. People high in NA, compared with people low in NA, tended to have more difficulty Returning to Wakefulness than they did Going to Bed, $t(718) = 2.04$, $p < .01$, $q = .08$ and more difficulty Maintaining Sleep and Returning to Wakefulness than they did Reinitiating Sleep, $t(718) = 2.59$ and 2.65, $p < .01$, $q = .09$ and .11, respectively. Conversely, individuals high in PA, compared with low-PA individuals, tended to wake up more easily in relation to Going to

Table 6
Tests of Differences Between Correlated Correlation Coefficients in Study 2

Sleep Quality Dimension	NA	PA	IPC	WD	AMB	DEPR	HC	FRUST
Going to Bed	$-.18^{a}$	$.03^{a}$	−.09	$-.19^{a}$	$-.13^{a}$	$-.29^{a}$	−.25	$-.26^{a}$
Falling Asleep	−.19	$.11^{b}$	−.10	$-.08^{a}$	$-.09^{b}$	$-.30^{b}$	−.29	$-.22^{b}$
Maintaining Sleep	$-.23^{b}$	$.09^{c}$	−.10	−.11	$-.03^{ac}$	$-.28^{c}$	−.33	$-.23^{c}$
Reinitiating Sleep	$-.14^{bc}$	$.14^{d}$	−.12	−.11	$-.06^{d}$	$-.28^{d}$	−.27	$-.22^{d}$
Returning to Wakefulness	$-.26^{ac}$	$.27^{abcd}$	−.12	−.12	$-.19^{bcd}$	$-.39^{abcd}$	−.32	$-.35^{abcd}$

Note: Letter superscripts that are the same in a column of data indicate a statistically significant difference at the $p < .05$, two-tailed level between the correlation coefficient for one sleep scale and the variable at the top of the column and the correlation coefficient between a second sleep scale and the same variable. For example, the correlation between NA and "Going to Bed" was statistically significantly smaller than the correlation between NA and "Waking Up." NA = negative affectivity; PA = positive affectivity, IPC = interpersonal conflict, WD = work demands; AMB = perceived ambiguity; DEPR = depression; HC = health complaints; FRUST = frustration.

Bed, Falling Asleep, Maintaining Sleep, and Reinitiating Sleep, $t(466) = 4.77$, 2.96, 3.11, and 2.14, $p < .05$, $q = .24$, .17, .19, and .15, respectively.

Regarding the correlations between the stressor and sleep quality variables (1) scores on Going to Bed scores correlated more negatively with work demands than did scores on Falling Asleep, $t(718) = 2.99$, $p < .05$, $q = .11$; (2) scores on Going to Bed also correlated more negatively with scores on job ambiguity than did scores on Maintaining Sleep, $t(718) = 2.14$, $p < .05$, $q = .10$; and (3) scores on Returning to Wakefulness correlated more negatively with scores on job ambiguity than did scores on Falling Asleep, Maintaining Sleep, and Reinitiating Sleep, $t(718) = 2.35$, 3.54, and 2.77, $p < .05$, $q = .10$, .13, and .16, respectively. Thus, people who reported high levels of work demands found it more difficult to go to bed than to fall asleep, whereas individuals who reported high levels of job ambiguity found it more difficult to go to bed than to stay asleep. Moreover, people who reported high levels of job ambiguity found it more difficult to wake up in the morning than they did falling asleep, staying asleep, and reinitiating sleep on an awakening.

We also found many differences in how the sleep quality subscales correlated with the different strain measures. First, Returning to Wakefulness scores correlated more negatively with depression scores than did scores on any of the other sleep quality subscales, $t(718) = 2.74$, 2.37, 2.71, and 2.77, $p < .05$, $q = .11$, .10, .12, and .12, respectively. Second, scores on Returning to Wakefulness also correlated more negatively with frustration scores than did scores on any of the other sleep quality subscales, $t(718) = 2.41$, 3.28, 2.91, and 3.06, $p < .05$, $q = .07$, .14, .13, and .14, respectively. Thus, people who reported high levels of depression and people who reported high levels of frustration reported the most difficulty waking up in the morning relative to going to bed, falling asleep, staying asleep, and reinitiating sleep on an awakening.

Differences between strain measures. We had hypothesized that scores on measures of depression and health complaints would correlate more negatively with scores on the ADSWS than would frustration scores. As shown in Table 6, we found partial support for this hypothesis: Depression scores correlated more negatively with Falling Asleep scores than did frustration scores, $t(718) = 2.10$, $p < .05$, $q = .09$, and health complaint scores correlated more negatively with Maintaining Sleep scores than did frustration scores, $t(718) = 2.70$, $p < .05$, $q = .06$. We also found that health complaint scores correlated more negatively with Maintaining Sleep scores than did depression scores, $t(718) = 1.97$, $p < .05$, $q = .05$, whereas depression scores correlated more negatively with Returning to Wakefulness scores than did health complaint scores, $t(718) = 2.37$, $p < .01$, $q = .08$.

We note again that the differences between correlated correlation coefficients presented in the above paragraphs and summarized in this paragraph represent differences in the variance shared ($r_1^2 - r_2^2$) of approximately 3% to 8% (Cohen, 1988). Thus, although statistically significant and generally consistent with our hypotheses, the differences that we report above are relatively small.

Additional construct validity evidence. According to Campbell and Fiske (1959), the best method for examining the reliability of scores on a scale as well as the convergent and divergent validity of scores on a measure is by using the multitrait–multimethod procedure, a process for examining the extent to which a measure is jointly defined by its method and by its attribute-related content. Campbell and Fiske (1959) and Nunnally and Bernstein (1994) noted that although reliability is best assessed using the monotrait–monomethod approach, in practice this commonly involves examining the intrascale item correlations or item–total correlations of scores within a single administration of a scale. In the present study, by design, we maximized these correlations when selecting the final items for inclusion in the ADSWS.

Second, Campbell and Fiske (1959) noted that although convergent validity involves demonstrating that two independent methods of inferring an attribute lead to similar findings, this has often involved correlating scores on a new measure with scores on existing measures of the same or similar trait (i.e., monotrait–multimethod). In Study 3, we consider each test administration a separate method. As a result, the high correlations between scores on corresponding measures of the same sleep quality dimension indicate convergence among like measures. These correlations are shown in Table 5 and are the test–retest reliability estimates reported in a previous paragraph.

Campbell and Fiske (1959) also noted that although divergent validity involves determining whether a scale's scores measure something different from scores on existing instruments, this has often involved showing that scores on scales designed to measured different traits do not correlate to an extremely high degree. In general, scores on scales purported to measure the same thing should correlate more highly among themselves than with scores on scales measuring different things (heterotrait–heteromethod). Moreover, divergent validity is demonstrated when scores on measures purported to measure the same trait correlate more strongly among themselves regardless of the measurement method used than scores on measures that purportedly measure different traits using the same method (heterotrait–heteromethod).

In the present study, we considered the different time administrations to be different methods of measurement and examined the former by comparing the average correlations among scores within each of the sleep quality dimensions at Times 1, 2, and 3 with the average correlations among scores between sleep quality dimensions at Times 1, 2, and 3. We examined the latter by comparing the average correlations among scores within each of the sleep quality dimensions across Times 1, 2, and 3 with the average correlation among scores on different dimensions measured at the same time. An examination of the correlations shown in Table 5 shows that the average correlations between Time 1, Time 2, and Time 3 scores within each of the sleep quality dimension (.72 to .76) were higher than (1) the average correlations between Time 1, Time 2, and Time 3 scores across sleep quality dimensions (.26 to .44) and (2) the average correlations among scores measured at the same time (.38, .39, and .34). Thus, our findings provide evidence for the divergent validity of scores on the ADSWS, at least in terms of interdimensional divergence.

General Discussion

This article provides evidence for the psychometric soundness of scores on the ADSWS, a 25-item five-dimensional measure designed for use in research on the determinants and neurobehavioral significance of adult sleep quality. The coefficient alpha estimates and test–retest correlation coefficients suggest that the reliability of scores on measures of Going to Bed, Falling Asleep, Maintaining Sleep, Reinitiating Sleep, and Returning to Wakefulness are each more than adequate for use in research settings. The five-factor solution consistently explained more variance than the average reported by Henson and Roberts (2006) for exploratory factor analyses in the literature. The validity findings support use of the instrument in studies of the relationship between sleep quality and personality, stressful environments, and outcome measures in work and academic settings. That is, scores on all of the sleep quality subscales correlated positively with one another and in the hypothesized direction with NA, PA, and the work-related stressors and strains. Moreover, scores on the sleep quality measures tended to, as hypothesized, correlate more strongly with scores on measures of health complaints and depression than with scores on frustration.

The data obtained also provided support for the general hypothesis that scores on the different behavioral dimensions of sleep quality would correlate differently with scores on the personality and work-related stress and strain measures. Findings consistent across both studies include the following: people high on NA, compared with their low-NA counterparts, and people reporting high levels of depression compared with those reporting low levels of depression, reported greater difficulty waking up than going to bed, whereas people high on PA, compared with individuals low in PA, tended to find it easier to wake up than to go to bed. Moreover, people who reported high levels of frustration, compared with those reporting low levels of frustration, tended to find it more difficult to wake up than to go to bed, fall asleep, stay asleep, and reinitiate sleep. Other findings from Study 2 are notable as the data from Study 2 were collected with improved items and a six-point response set. These findings indicated that, in general, (1) people high on NA, compared with low-NA individuals, tended to have more difficulty maintaining sleep than reinitiating sleep; (2) people who reported high levels of job ambiguity, compared with those who reported low levels of job ambiguity, tended to report more difficulty waking up than falling asleep, maintaining sleep, and reinitiating sleep and also reported more difficulty falling asleep than maintaining sleep; and (3) people who reported high levels of work demands, compared with those who reported low levels of work demands, tended to have more difficulty going to bed than falling asleep. Although further research is needed to replicate these findings and to explore the causal links between these variables, it would appear that investigations of sleep quality in work and academic settings would benefit from assessment of the multiple ways that sleep quality may vary.

Strength and Limitations

One strength of this research effort is that the development and inclusion of the ADSWS items was based on multiple data collection efforts. However, one limitation of this research is that data were collected from college students. This poses a threat to the external validity of our findings. Additional research is recommended in which the psychometric properties of ADSWS scores are examined using samples drawn from other populations of adults (e.g., full-time employees). We also note that the stressor measures we used to assess the relationships between work-related stress and sleep quality were originally designed for use among organizational employees. However, although we revised the wording of these measures so that the school environment was the operative work environment, further research is needed using organizational employees to assess the substantive relationships between work-related stress and the different dimensions of sleep quality.

A second limitation of the set of studies reported in this article is that the parallel analyses and minimum average partial correlation procedures used to verify factor structure of scores on the ADSWS did not entirely support the five-dimensional nature of the ADSWS: Although the minimum average partial tests supported the five-factor structure of scores on the ADSWS in four of the five analyses, the parallel analyses supported the five-factor structure of scores in only two of the five analyses. Because the theory on which the ADSWS was developed indicates that there are five dimensions of sleep quality, and given the findings reported in this manuscript, we believe it is reasonable to conclude for now that the ADSWS is a viable measure for assessing five dimensions of sleep quality. However, further research is needed to confirm the five-factor structure of scores on the ADSWS.

Conclusion

This article indicates that ADSWS scores can be valid indicators of adult sleep patterns and potentially useful when examining the relationship between work-related stress and strain and sleep quality. Future research is recommended examining the construct validity of ADSWS scores using working adults as well as the extent to which other environmental and individual difference variables differentially affect the different dimensions of sleep quality and the occupational consequences (accidents, reduced job performance) that may result from reduced sleep quality. Moreover, future research is also recommended examining the effects of the variety of other hypothesized influences of sleep quality as they apply to organizational employees, such as economic stress, work–family conflict, organizational culture and climate factors, and the many psychosocial stressors that organizational workers experience, such as perceptions of unfairness and workplace incivility.

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