The Relationships Among Length of Sleep and Performances on Arithmetic, Digit Span, and Digit Symbol Subtests of the WAIS-R in College Students

Mike F. Welsh

Eastern Illinois University

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The Relationships Among Length of Sleep and Performances on Arithmetic, Digit Span, and Digit Symbol Subtests of the WAIS-R in College Students

(TITLE)

BY

Mike F. Welsh

THESIS

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YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING THIS PART OF THE GRADUATE DEGREE CITED ABOVE

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The Relationships Among Length of Sleep and Performances on Arithmetic, Digit Span, and Digit Symbol Subtests of the WAIS-R in College Students

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Abstract

Eighty-one college students (26 Male and 55 Female) were administered the Digit Span, Arithmetic, and Digit Symbol subtests from the Wechsler Adult Intelligence Scale-Revised (WAIS-R). Two questionnaires were given to the participants. The first requested the participant to report their sleep habits over the last 30 days (Past Month Sleep), the night before the tests (Night Before Sleep), and the amount of sleep they feel they need in order to feel well rested (Needed Sleep). While the second asked if they had given their best effort during testing. Upon completion, the subtest scores were explored in order to determine if a relationship existed among the sleep conditions.

As expected, a significant correlation was noted between Night Before Sleep and Digit Symbol Performance. An exploration of gender differences was undertaken in order to determine if any relationships existed among the obtained data. As a result, Males Digit Span performance correlated significantly with Night Before Sleep, while Females performance did not. However, Males scored significantly lower than Females on the Digit Symbol task.

Participants were also separated into a Sleep Deprived or Well Rested group based upon the amount of sleep they reported acquiring on the night prior to the test, and the amount they reported they needed to feel well rested.
expected, an analysis of the data displayed a significant difference between the Sleep Deprived and Well Rested groups on Digit Symbol Performance. Here, the Sleep Deprived group scored significantly lower than the Well Rested group.

The general sleeping patterns of the participants were also assessed. On average, it was determined that both genders felt they needed close to eight hours of sleep in order to feel well rested. However, the participants averaged only a little over seven hours of sleep. Therefore, on average, the majority of participants failed to acquire enough sleep prior to testing. The results also had shown that Females, on average, slept forty minutes longer than Males on the night prior to the tests. It was interesting to note that Females also scored higher on average than Males in all three subtests performances.

In short, Night Before Sleep was shown to have a significant effect on Digit Symbol performance. Also, it appeared that gender differences in ability performance, regarding the Digit Symbol and Digit Span subtests of the WAIS-R, exist.
Acknowledgments

It is over. The skies have cleared, the birds sing, and the wind smiles its approval. Ahhh, the sweet song of accomplishment wisks through my hair. The hard work and dedication has paid off. Therefore, first and foremost, I must thank the Lord my God for aiding me through all the trials and tribulations of my academic studies, as well as allowing me to succeed throughout adversity. I must also mention a couple which has always given me the love and support I sometimes take for granted, my loving parents: Chuck and Veronica Welsh. My father, the hardest working man I have ever known, had taught me to never give up despite all odds or misfortunes. My mother, the most loving and forgiving woman I have known, had taught me to constantly look to the bright side of life and to believe that prayer is powerful. I would not have accomplished this degree if it were not for these two special individuals and a loving and supportive family. I also wish to thank my chair, Dr. Russell Gruber, for taking the time to constantly meet with me and guide the development of the paper, as well as Dr. Ronan Bernas. A very special thank-you goes to Dr. Christine McCormick. Her helpful efforts and soothing words of encouragement went above and beyond the call of duty, and were greatly appreciated. Finally, I wish to thank Dr. Michael Havey for allowing me into the School Psychology program, thus, allowing me the chance of proving myself.
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Chapter 1

Review of Literature

Sleep, generally viewed as a simple phenomenon necessary for restoring energy, is actually a highly complex, multifaceted, series of mental processes that are not currently understood. Most individuals view sleep as a welcome sanctuary where one may, escape the hustle and bustle of everyday life, waking up in the morning, ideally feeling rested. It is a common belief that to perform at one's very best, it is essential that one obtain a "good night's sleep." Yet the actual perception of a good night's sleep is highly contingent upon an individual's personal perception of feeling rested. While there are no concrete guidelines to sleep length and its given effects, it is assumed that most individuals budget their time to sleep enough to function up to their full potential. If deprived of sleep, a variety of negative consequences may result.

Overall, two major facets of sleep have received the vast majority of attention throughout published literature: total sleep deprivation's negative effects on overall performances, and the study of partial sleep deprivation and its disruption of learning and memory. Although seldomly studied, minimal sleep deprivation has also been shown to have a negative affect on an individual's performance.
Sleep Deprivation

Total Sleep Deprivation

A series of studies reviewed by Asken and Raham (1983) reported significant negative effects of sleep deprivation on physicians in residential training programs. As total sleep deprivation periods increased, so too did performance times for completion of various tasks (Asken & Raham, 1983). A more recent review covering sleep literature since 1970 on residents' performances, cited evidence of poor performances on tasks requiring prolonged vigilance following acute sleep loss (Samkoff & Jacquis, 1991).

Along these lines, staying awake for a minimum or 24 consecutive hours, or total sleep deprivation, has been shown to have a negative affect on cognitive performance. For instance, verbal recognition reaction time to a stimulus digit was examined by Tharp (1978). Eighteen men between the ages of 18 and 32 received 27 to 30 hours of complete sleep deprivation. Such deprivation led to significantly slower stimulus recognition times than for non-deprived individuals.

The ability to attempt and correctly answer written computational mathematical problems following 48 hours of sleep deprivation was studied by Bonnet (1980). Deprived individuals completed significantly fewer mathematical problems, within a time constraint, than a well rested control group. Deprived individuals attempted fewer
problems within the given time limit, and obtained lower scores than controls. Clearly, sleep deprivation negatively affected mathematical ability as measured by the non deprived group's superior math scores.

**Minimal Sleep Deprivation**

A variety of studies regarding measures and causes of sleepiness were reviewed by Roth, Roehrs and Zorick (1982). Both minimal (as little as two hours) and total sleep loss, were reported to produce decrements in unspecified performance tasks.

Correspondingly, the amount of sleep the night before a task has been shown to directly affect performance. Over 300 resident physicians were given a wide variety of multiple choice questions within their field of expertise. A significant correlation was found between performances and the amount of sleep the night before the examination. Well-rested participants demonstrated a thirty percentile point increase in score between sleep deprived and well rested participants (Jacques, Lynch & Samkoff, 1990).

**Partial Sleep Deprivation**

Sleep disturbances at specific time intervals, or partial sleep deprivation, have produced similar results. Kahn and Fisher (1968) examined the relationship between the amount of Rapid Eye Movement sleep (REM), the state of sleep that has been found to be associated with high levels of brain activity, and cognitive performance. Non-disturbed
sleep was significantly correlated with cognitive performance. Performances measured were Full Scale scores on the Wechsler Adult Intelligence Scale (WAIS), Wechsler Memory Scale, and a coding task. All were significantly associated with the amount of non-disturbed sleep the participants were allowed to receive, with an increase in REM sleep disturbances leading to lower scores on standardized measures of intelligence.

Karni, Tanne, Rubenstein, Askenasey and Sagi (1994) further studied REM deprivation, finding evidence that forced auditory arousal from REM sleep significantly hindered one's ability to perform on a visual discrimination task, while participants without disruptions performed significantly better than their baseline performance levels. Thus, learning and memory consolidation were found to be strongly dependent on sleep.

In an earlier study, similar findings determined REM sleep disturbances affected memory consolidation and the acquisition of new information (Benson, Cohen & Zarcone, 1978). Specifically, a significant deterioration on the WAIS's Digit Span subtest, commonly associated with short term memory (STM), was found; a reduction of sleep had a negative affect on STM. In a recent study by Bonnet and Arand (1995), ten individuals diagnosed with insomnia, who were awake 60 minutes a night after initially falling asleep, also significantly displayed a decreased
ability in various STM tasks including the WAIS Digit Symbol subtest.

Sleep Deprivation and Crisis

While it is clear that a lack of sleep impairs one's ability to function at an optimal level physically, emotionally, or cognitively, evidence suggests that individuals possess an ability to overcome these ill-effects during crucial situations. Storer, Floyd, Gill, Givsti and Ginsberg (1989) determined that medical pediatric residents were somehow able to overcome negative effects on coordination, dexterity, and cognition caused by sleep deprivation periods of 24 and 34 hours. In response to research which supports opposite findings, the article suggested that sleep impaired residents were able to maintain previous levels of performances in crucial, possibly life-threatening, situations. An ability to overcome the ill-effects of sleep deprivation may be explained by the presence of increased adrenaline produced by the "fight or flight" process within the brain. The ability to overcome the negative affects of sleep deprivation, although interesting, may be quite rare. Realistically, individuals are not presented with crisis situations on a regular basis and therefore the effects of sleep on cognitive performance are usually consistent across all empirical research.
Given that individuals possess an ability to overcome negative sleep deprivational effects, one is forced to question if performance in cognitive tasks reflects individuals' actual cognitive ability, or simply their motivation to perform up to their true potential in less than crisis situations.

Lindley, Smith and Thomas (1988) came across the same issue during a study regarding ability scores and standardized intelligence measurement. Specifically, a coding subtest was used which was similar to digit symbol in that an alphanumeric (number or letter) was to be coded next to its corresponding-but-dissimilar alphanumeric, based upon a key during the subtest. Participants were separated between high and low IQ groups. Individuals were given a coding alphanumeric (A for C, 2 for 4), or a copying alphanumeric (A for A, 2 for 2) task. Results indicated that higher IQ students were able to code significantly faster than the lower IQ group, while lower IQ group scored significantly higher during the copying task than the high IQ group. This finding suggested that the higher IQ group may not have been motivated to do their best on the copying task.

With motivational concerns in mind Lindley and Smith (1992) decided to conduct the same study using an incentive (lottery ticket system) in an attempt to highly motivate both subject groups. Individuals received lottery tickets
for participating in the study, thus holding motivation constant and reducing motivational variance across both subject groups. One-hundred-sixty-one college students took part in the study. The results reflected no support for a motivational hypothesis as findings were similar to their 1988 study. Thus, Lindley and Smith believed the relationship between ability and test performance appeared to be cognitive rather than motivational.

Cognitive Variables

The Wechsler Adult Intelligence Scale - Revised (WAIS-R), is widely recognized as a comprehensive, reliable, and valid measure of adult cognitive functioning, resulting in an Intelligence Quotient (IQ). Wechsler (1991) defined IQ as "...the capacity to deal effectively, with his or her environment." IQ's are estimated by standardized instruments in an attempt to assess various mental abilities. It is important to note that not all intelligent behavior can be measured, tested, or estimated by any standardized test, and that an all-encompassing IQ test does not exist. In an attempt to estimate a wide variety of mental abilities, standardized tests attempt to quantify several different aspects of intelligent functioning. The WAIS-R is comprised of eleven subtests. Ten of these subtests form three main factors or areas of cognitive functioning: Verbal Comprehension, Perceptual Organization,
and Freedom from Distractibility. Freedom from Distractibility (FD), is a statistically derived factor consisting of two subtests (Arithmetic and Digit Span). For purposes of this study, the WAIS-R's Arithmetic, Digit Span and Digit Symbol subtests were studied in further detail. These three subtests have been shown, in varied earlier studies, to be influenced by amount(s) of sleep.

It should be noted that prior to this study's completion, the WAIS-R has been updated, renormed, and amended, although nothing significant to this study was changed. This updated copy was named the Wechsler Adult Intelligence Scale - Third Edition (WAIS-III). Although the WAIS-III continues to use the Digit Symbol subtest, it was re-named "Coding." Further, the Freedom from Distractibility Factor was also re-named "Working Memory." However, this factor continues to incorporate the Arithmetic and Digit Span subtests as before.

**Digit Symbol**

Digit Symbol, also commonly referred to as "Coding", requires an individual to copy a symbol matched to a single numerical digit within a 90 second time constraint. Sattler (1988) stated that Digit Symbol is used in order to tap the ability to learn an unfamiliar task, involving the ability to learn combinations of symbols and shapes and the ability to make decisions quickly and accurately. Its score is used in the calculation of the WAIS-R's Full Scale Intelligence
Quotient (FSIQ), although Digit Symbol is not included in the WAIS-R's three main factors of intelligence. However, due to its adequate subtest specificity, (subtest variance that is not due to errors of measurement and is distinctive to the subtest), it is considered useful for determining the FSIQ (Sattler, 1988).

Arithmetic and Digit Span

Freedom from Distractibility is the ability to attend-to, concentrate, compute, retain, and remember numbers using mathematical computations and/or rehearsal. The two subtests of the WAIS-R associated with its interpretation are called Arithmetic and Digit Span. Specifically, Arithmetic requires one to understand and compute mathematical equations, while Digit Span requires an individual to remember and retrieve a list of numbers from their short term memory (STM). Like the Digit Symbol subtest, the FD factor has been found to be affected by REM sleep disturbances (Benson, et al. 1978). Additionally, total sleep deprivation has been associated with decreased computational mathematic performance as previously mentioned (Bonnet, 1980).

Deming, Zhenyun, Shad and Shanxun (1991) reviewed the effect of sleep on short term memory. Good and poor sleepers STM performances were studied on morning versus evening ability. STM performances regarding individual differences in length of sleep were also studied. Sleep was
Sleep Performance

shown to have a major effect on STM. Good sleepers were found to have better STM's than poor sleepers based on an unspecified Digit Span subtest from a college-aged population (Deming et al. 1991).

Sleep and Young Adults

In a recent study, Tiholov, Zawallich and Janzen (1996) produced evidence that physically unhealthy individuals obtained lower cognitive performance scores on coding and symbol search tasks, than healthy ones. Edell and Ek (1992) discussed sleep as a dimension in lifestyles promoting good health. Disturbed sleep was mentioned as leading to early symptoms of psychophysiological ill health, a general ability to adjust, and finally disease (Edell & Ek, 1992).

This is of particular concern, considering findings reported by Clarkdon (1990) who examined sleep patterns of adolescents and concluded that many fail to get enough sleep. Various school related reasons for awakening, along with social activities requiring that one stay up late, was said to result in "poor sleep hygiene" which may cause a wide variety of negative effects.

Along these lines, Morrison, McGee and Stanton (1992) determined that 33% of approximately 1,000 adolescents reported having difficulties with their sleep patterns. A later study showed that from a pool of approximately 380 adolescents, 46% reported that they failed to receive enough
sleep; 62% wished to take a nap in order to get more rest for the day; 37% actually take naps throughout the day, and 15% fall asleep in class as a result of not receiving enough sleep. It was interesting to note that of adolescents classified as chronic poor sleepers, 42% believed they sleep enough. Forty-seven percent of occasional poor sleepers and 63% of good sleepers reported the same (Levy, Gray, Leech, Zvagulis & Pless, 1986). These findings suggest evidence for variability among late adolescents/young adults on their opinions of what constitutes a "good night's sleep."

In a later study, Montgomery (1983) examined the relationship between self-reports of uncommon tiredness and grade point average (GPA) among college undergraduates. Contrary to the authors expectations, no differences were found between gender or GPA on total hours slept.

College students were examined regarding anxiety, mood, and overall alertness on performance tasks. None of these variables were shown to have a significant relationship to the WAIS Digit Symbol task or an unspecified arithmetic subtest (Zimmerman-Tansella, 1984).

Sleep and Adults

Research reported by Kotulak (1998) determined that from a national Sleep Foundation's survey of 1,000 American adults, nearly two out of every three people did not get the often recommended eight hours of sleep per night. A third of those questioned acquired less than six hours of sleep.
Further, the study reported that the amount of sleep the average adult acquires per night was 6:57, approximately one hour less than the amount recommended to function at an optimal cognitive capacity.

**Present Study**

The object of this study was to gain additional knowledge concerning sleep and its effect on selected tasks of cognitive functioning.

Length of sleep is a variable commonly associated with performance on a wide variety of cognitive tasks. While there has been considerable research regarding various degrees of sleep deprivation and their effects on task performances, little has been done to examine the effects of sleep length on subtests of standardized measurements of intelligence. Since error is inherit in any measurement, it is important to reduce any possible confounding factor in an attempt to acquire reliable and valid estimates of true intelligence scores. If sleep associated effects are found to have an affect on IQ, either positive or negative, it would be important for professionals to understand which subtests may be more susceptible to sleep effects.

The WAIS-R is comprised of two primary factors, as well as additional groupings of subscales. The first, named Verbal Comprehension, incorporates subtests which tap verbal problem solving abilities. The second named, Perceptual Organization, taps non-verbal problem solving ability.
Freedom from Distractibility is a third factor which refers to an individual's ability to attend-to, concentrate, compute or retain, and remember numerical information (Williams & Dykman 1994). Subtests which comprise with this factor are Arithmetic and Digit Span. Arithmetic involves mental computational ability while attending to needed, as opposed to distracting, information from verbally presented questions. Digit Span involves the ability to retain and verbally reproduce a sequence of numbers, either forward or backward as instructed, from verbally presented numbers of equal or greater lengths. This subtest is frequently associated with short term memory. Digit Symbol requires an individual to copy a symbol matched to a single numerical digit within a time constraint. This subtest is associated with hand-eye speed and accuracy, as well as making decisions quickly and accurately.

All subtests of the WAIS-R were included in the factor analysis, with three factors identified. The Freedom from Distractibility factor displayed inconsistent loadings of three subtests: Digit Span, Arithmetic, and Digit Symbol. These three subtests were found to relate most clearly within age groups 16 to 17 and 20 to 24 (Sprandel 1995). Therefore, studying the effects of sleep deprivation on these subtests using late adolescents/young adults, would serve as a useful starting point in exploring sleep as a possible confounding factor in intelligence measurement.
Further, an exploration of gender differences will be undertaken in order to determine if any relationship(s) exist among the obtained data.
Participants

Eighty-seven undergraduate psychology students volunteered to participate. Six were eliminated because they indicated that they had not given their best effort throughout testing. This resulted in a final sample size of 81 (26 men and 55 women, mean age = 18.90, SD = 1.18).

Materials

Participants were administered a questionnaire to collect information regarding their age, gender, class rank, and sleep history patterns (See Appendix A). Specifically, they were asked questions about their sleep habits regarding: length of sleep on an average night, approximate time they fell asleep and woke-up last night, and estimated length of sleep typically needed in order to feel well rested. A questionnaire was also utilized in order to assess if the participants believed that they had given their best effort throughout the tests (See Appendix B).

The Digit Symbol, Arithmetic, and Digit Span subtests from the Wechsler Adult Intelligence Scale-Revised, along with their related implementation materials, were used for standardized ability measurements (Wechsler, 1981).

Procedure

At the time of testing, the questionnaire and a randomly assigned number were distributed to each
participant. Identification numbers were used to randomize the order in which participants were selected for testing. When selected, the participants were individually escorted to a testing room where the Digit Symbol, Arithmetic, and Digit Span subtests from the WAIS-R were administered in a counterbalanced order. Second and third year Eastern Illinois University School Psychology graduate students, well versed in administrating the WAIS-R, as well as a faculty member from the Psychology Department, administered the subtests. After the subtests had been administrated, the effort questionnaire was given for the participant to complete. Upon completion, the participants were given a debriefing statement and provided with a phone number to call if any further information was desired. With the exception of the order of administration, the Digit Span, Arithmetic, and Coding subtests were administered and scored based on the standard instructions for each subtest as specified by the WAIS-R’s administration manual.

For the purpose of dividing participants into well rested and sleep deprived groups, sleep deprivation was defined as a condition occurring when a participant was unable to acquire an amount of sleep, the night before testing, which was more than thirty minutes less sleep than the amount they reported they needed in order to feel well rested. Thirty minutes was selected because it allowed for a reasonable number of participants in both groups.
Individuals who fit this category were placed into the Sleep Deprived group. Participants who acquired an amount of sleep equal to or greater than what they reported was needed to feel well rested, were assigned to the Well Rested group. Participants who acquired slightly less than the amount (up to a thirty minute deficiency) of sleep they reported to feel well rested, were not assigned to either subject group. Analyses were correlations among all variables and t-tests between groups of well rested versus sleep deprived individuals.

It was hypothesized that sleep deprived individuals would show lower performance scores than well-rested individuals on all three subtests of the WAIS-R. Although gender differences were not expected, they were examined.
Chapter 3
Results

With regard to Needed Sleep, participants reported that they, on average, needed slightly more than eight hours of sleep in order to feel well rested. Specifically, Males averaged 8:14 (SD = 1:10) while Females averaged 8:13 (SD = 1:19). Thus, Male and Female Needed Sleep averages were virtually identical, as presented in Table I.

Table I.
Mean Sleep, Standard Deviation, and Range of Scores for Males (N = 26) and Females (N = 55) Among Sleep Conditions

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Needed Sleep</td>
<td>8:14</td>
<td>1:10</td>
</tr>
<tr>
<td>Past Mth Slp</td>
<td>7:19</td>
<td>1:07</td>
</tr>
<tr>
<td>Night Bf Slp</td>
<td>7:01</td>
<td>1:53</td>
</tr>
</tbody>
</table>

For Past Month Sleep, the amount of sleep normally received during the last 30 days prior to testing, participants reported that they, on average, normally received seven hours and nineteen minutes of sleep. Males averaged 7:19 (SD = 1:07), while Females averaged 7:18 (SD = 1:17). The average scores for Past Month Sleep in Males and Females were 55 minutes below their reported Needed Sleep
averages. Thus, on average, participants reported that they normally sleep approximately one hour less than they need in order to feel well rested on a daily basis. (See Table I)

The amount of sleep the participants reported having slept the night before testing (Night Before Sleep) averaged seven hours and twenty-one minutes. Males averaged 7:01 (SD = 1:53) while Females averaged 7:42 (SD = 2:01). Both genders reported receiving less sleep than they needed in order to feel well rested (Males = -1:13, Females = -0:31). (See Table I)

Table II.

Mean Sleep Difference, Standard Deviation, and Range of Sleep Difference Among Well Rested and Sleep Deprived Participants for Males and Females

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>N</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rested</td>
<td>0:53</td>
<td>0:55</td>
<td>9</td>
<td>even to +2:30</td>
</tr>
<tr>
<td>Deprived</td>
<td>-2:35</td>
<td>0:56</td>
<td>15</td>
<td>-1:28 to -4:15</td>
</tr>
<tr>
<td>Females</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rested</td>
<td>1:33</td>
<td>1:35</td>
<td>21</td>
<td>even to +5:30</td>
</tr>
<tr>
<td>Deprived</td>
<td>-2:10</td>
<td>1:58</td>
<td>27</td>
<td>-0:40 to -10:00</td>
</tr>
</tbody>
</table>

As shown on Table II, the amount of sleep for the Sleep Deprived group averaged -2:35 for Males (SD = 0:56), and -2:10 for Females (SD = 1:58). The Well Rested group
averaged 0:53 of extra sleep for Males ($SD = 0:55$), and 1:33 of extra sleep for Females ($SD = 1:35$). The range for the Sleep Deprived group was -1:28 to -4:15 for Males, and -0:40 to -10:00 for Females. The range of sleep difference for the Well Rested group ranged from an even amount to +2:30 for Males, and +5:30 for Females. It should be noted that 11 participants (two Males and nine Females) from the total of 81 participants reported sleeping patterns that did not meet the Sleep Deprived or Well Rested categories.

Table III.
Correlation Coefficients Among Variables for Males, Females, and Combined

<table>
<thead>
<tr>
<th>Subscale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males and Females ($N = 81$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Digit Span</td>
<td>----</td>
<td>.061</td>
<td>.031</td>
<td>-.047</td>
<td>.122</td>
<td>.183</td>
</tr>
<tr>
<td>2. Arithmetic</td>
<td>----</td>
<td>----</td>
<td>.200</td>
<td>-.119</td>
<td>.004</td>
<td>.067</td>
</tr>
<tr>
<td>3. Coding</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>.097</td>
<td>-.084</td>
<td>.312**</td>
</tr>
<tr>
<td>4. Past Mth Sleep</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>.256*</td>
<td>.443**</td>
<td></td>
</tr>
<tr>
<td>5. Needed Sleep</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>.091</td>
<td></td>
</tr>
<tr>
<td>6. Night Bf Sleep</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td></td>
</tr>
</tbody>
</table>

| Males ($N = 26$)      |       |       |       |       |       |       |
| 1. Digit Span        | ----  | .303  | .296  | .241  | .241  | .561**|
| 2. Arithmetic        | ----  | ----  | .310  | -.158 | -.040 | -.001 |
| 3. Coding            | ----  | ----  | ----  | .224  | -.269 | .309  |
| 4. Past Mth Sleep    | ----  | ----  | ----  | .448* | .547**|
| 5. Needed Sleep      | ----  | ----  | ----  | ----  | .333  |
| 6. Night Bf Sleep    | ----  | ----  | ----  | ----  | ----  |
Participants scaled scores ranged from 4 to 16 (M = 10.99, SD = 2.29). Males averaged 10.92 and Females 11.02 as presented in Table IV. The difference between the average scores was not significant (t = -0.174). A Pearson Product Correlation, as presented in Table III, indicated that participant’s scores did not have a significant relationship with Past Month Sleep (r = -0.047), Needed Sleep (r = 0.122) or Night Before Sleep (r = 0.183). However, when correlations between Night Before Sleep and test scores were run separately for Males and Females, a significant correlation was found for Males (r = 0.561, p < 0.01) but not Females (r = 0.040). Thus, Digit Span scores in Males correlated positively with amounts of Night Before Sleep.

T-tests comparing the Sleep Deprived group (M= 10.98), and the Well Rested group (M = 11.13), indicated no significant difference between groups (t = -0.254, p = 0.80;
see Table V). A second t-test was then conducted to assess whether a possible gender difference existed between the Well Rested and Sleep Deprived groups. Results indicated that Sleep Deprived Females Digit Span score averaged 11.26 ($SD = 2.51, N = 27$), while the Well Rested Females averaged 10.57 ($SD = 2.09, N = 21$). As expected, this difference was not found to be significant. Although a significance test for Males was conducted, caution was suggested throughout its interpretation due to the small sample size. Only nine males averaging a score of 12.00 comprised the Well Rested Group, while the Sleep Deprived group consisted of 15 Males who averaged a score of 10.47 (See Table IV). The difference approached, but failed to achieve, significance ($t = -1.725, p = .098$).

Table IV.
Mean Scores and Standard Deviations Among Gender for Well Rested, Sleep Deprived, and Total Participant Groups

<table>
<thead>
<tr>
<th></th>
<th>Well Rest.</th>
<th>Sleep Dep.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Males</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>12.00</td>
<td>10.47</td>
<td>10.92</td>
</tr>
<tr>
<td>$SD$</td>
<td>2.31</td>
<td>1.96</td>
<td>2.19</td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>10.57</td>
<td>11.26</td>
<td>11.02</td>
</tr>
<tr>
<td>$SD$</td>
<td>2.09</td>
<td>2.51</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>Arithmetic</td>
<td>Sleep Performance</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------</td>
<td>-------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well Rest.</td>
<td>Sleep Dep.</td>
<td>Total</td>
</tr>
<tr>
<td><strong>Males</strong></td>
<td><strong>M = 9.00</strong></td>
<td><strong>9.00</strong></td>
<td><strong>9.04</strong></td>
</tr>
<tr>
<td></td>
<td><strong>SD = 2.65</strong></td>
<td><strong>2.73</strong></td>
<td><strong>2.54</strong></td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td><strong>M = 9.62</strong></td>
<td><strong>9.52</strong></td>
<td><strong>9.42</strong></td>
</tr>
<tr>
<td></td>
<td><strong>SD = 1.94</strong></td>
<td><strong>1.97</strong></td>
<td><strong>2.07</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Digit Symbol</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Well Rest.</td>
<td>Sleep Dep.</td>
</tr>
<tr>
<td><strong>Males</strong></td>
<td><strong>M = 11.89</strong></td>
<td><strong>10.47</strong></td>
</tr>
<tr>
<td></td>
<td><strong>SD = 2.80</strong></td>
<td><strong>2.10</strong></td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td><strong>M = 13.81</strong>****</td>
<td><strong>12.52</strong>****</td>
</tr>
<tr>
<td></td>
<td><strong>SD = 2.36</strong></td>
<td><strong>1.74</strong></td>
</tr>
</tbody>
</table>

**Note.** * Difference between numbers was significant: \( p < .01 \),
** Difference between numbers was significant: \( p < .05 \).

**Arithmetic**

Participants' scaled scores ranged from 5 to 16 (\( M = 9.3, SD = 2.22 \)). Males averaged 9.04 (\( SD = 2.54 \)) and Females averaged 9.42 (\( SD = 2.07 \); See Table IV). As presented in Table III, correlations exploring possible relationships among Arithmetic and Past Month, Needed, and Night Before Sleep yielded non significant results (\( r = -.103, .027, \) and .085 respectively).
T-tests comparing the Well Rested group ($\bar{x} = 9.58$, $SD = 2.28$), and the Sleep Deprived group ($\bar{x} = 9.33$, $SD = 2.25$; See Table V), indicated no significant difference ($t = -0.432$, $p = .667$).

**Digit Symbol**

Average scores from all the participants ranged from 8 to 18 ($M= 12.54$, $SD = 2.42$). Males averaged 11.19 while Females average a much higher 13.18 as presented in Table IV. A T-test concluded that this difference was significant at $p < 0.01$ ($t = -3.73$). Aside from this, Digit Symbol was found to correlate positively with Night Before Sleep ($r = .312$, $p < 0.01$), but not with Past Month Sleep, ($r = .097$) or Needed Sleep ($r = -.084$) as presented in Table III. In reference to Night Before Sleep, a correlation was conducted in order to determine a possible gender relationship. Both Male ($r = .309$, $p = .124$) and Female ($r = .259$, $p = .056$) correlations approached, but failed to achieve, significance.

The Sleep Deprived Group achieved an average Digit Symbol score of 11.79, while the Well Rested group achieved an average score of 13.83 (See Table V). This difference of 2.04 points was significant at the $p < .01$ level ($t = -3.543$) indicating that Well Rested participants scored significantly higher in Digit Symbol than the Sleep Deprived group. Once again a significance test was conducted in order to address the issue of a possible gender
relationship. As presented in Table IV, Well Rested Females scored significantly higher than Females who were Sleep Deprived ($M = 13.81$ and $M = 12.52$ respectively; $t = -2.183, p < .05$). With regard to Males, while scores were in the expected direction, once again the small sample size led to non significant findings ($t = -1.316, p = .170$; Sleep Deprived $M = 10.47$, Well Rested $M = 11.89$).

Table V.

Mean Scores, Standard Deviations and Differences Between Sleep Deprived and Well Rested Groups

<table>
<thead>
<tr>
<th>Digit Span</th>
<th>Sleep Deprived</th>
<th>Well Rested</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>10.98</td>
<td>11.13</td>
<td>0.15</td>
</tr>
<tr>
<td>SD</td>
<td>2.33</td>
<td>2.21</td>
<td>0.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arithmetic</th>
<th>Sleep Deprived</th>
<th>Well Rested</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>9.33</td>
<td>9.58</td>
<td>0.25</td>
</tr>
<tr>
<td>SD</td>
<td>2.25</td>
<td>2.28</td>
<td>0.03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Digit Symbol</th>
<th>Sleep Deprived</th>
<th>Well Rested</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>11.79</td>
<td>13.83</td>
<td>2.04*</td>
</tr>
<tr>
<td>SD</td>
<td>2.10</td>
<td>2.51</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Note. *$p < .01$
Chapter 4
Discussion

An examination of Past Month (reported average over past 30 days), Needed (reported amount of sleep to feel well rested), and Night Before Sleep (amount reported the night before testing) conditions with the Digit Span, Arithmetic, and Digit Symbol subtests of the WAIS-R, revealed that for Males and Females combined, Night Before Sleep was significantly correlated with Digit Symbol performance. Thus, the more sleep, on average, participants acquired the night before the examination, the better they scored on the Digit Symbol task.

Correspondingly, T-tests revealed that Sleep Deprived participants (less sleep than needed prior to testing) scored significantly lower on the Digit Symbol task than the Well Rested participants. However, here again when Males and Females were examined separately, scores for Sleep Deprived versus Well Rested Females reached significance, while scores for Males, approached, but did not achieve significance. This is clearly due to sample size, since the actual difference in means was greater for Males (1.42) than Females (1.29).

The significant relationship between sleep acquired the night prior to testing and Digit Symbol performance, supports findings from a previous study by Bonnet and Arand (1995). Here, individuals who were awake sixty minutes or
more after they initially fell asleep, scored significantly lower than a control group on Digit Symbol performance.

Night Before Sleep was also noted to significantly correlate with Male Digit Span performance. The greater the amount of sleep, on average, Males were able to acquire, the higher were their Digit Span scores. When scores for Females were examined separately, as well as with the combined scores of both Males and Females on Digit Span Performance, the correlations failed to achieve significance.

Although the amount of sleep Males acquired the night before testing had a significant relationship with their performance scores on the Digit Span task ($r = .566$, $p < .01$), the same did not hold true for the Sleep Deprived versus Well Rested groups. Neither Males nor Females scores, combined or separate, for the Sleep Deprived versus Well Rested groups were determined to have a significant difference with their Digit Span performance. However, for Males this lack of a significant difference on Digit Span performance, between the Sleep Deprived and Well Rested groups, may to be due to small sample size.

Although determined not to be significant for Females, an overall correlation between Digit Span performance and Night Before Sleep was expected for two reasons. First, a previous study found that a reduction of REM sleep was determined to have a negative affect on Digit Span
performance (Benson et al. 1978). Also, the amount of sleep the night before an examination was shown to directly affect cognitive performance (Jacques et al. 1990). Therefore, although an overall relationship was expected for both Males and Females, it was surprising to note that only Male Digit Span performance significantly correlated with the amount of sleep acquired the night before testing.

As a result of Jacques et al. (1990) study, significant relationships with Arithmetic as well as Digit Symbol were also expected. However, all correlations and relationships among Male and Female Arithmetic performances failed to achieve significance. It appears that in this study Male and Female Arithmetic performance did not have a relationship with Sleep Deprivation or the amount of sleep acquired the night before and testing. This is in contrast to findings that Arithmetic ability was significantly affected when participants received 48 hours of total sleep deprivation (Bonnet, 1980).

An examination of reported levels of Past Month Sleep, Needed Sleep, and Night Before Sleep was conducted to determine differences between Males and Females. As a result, both Males and Females reported that they, on average, normally had received virtually identical amounts of sleep over the past 30 days (7:19 and 7:18 respectively). Similarly, both Males and Females, on average, reported that they needed virtually identical amounts of sleep in order to
feel well rested (8:14 and 8:13 respectively). However, a gender difference was noted between the reported amount of sleep Males and Females acquired the night before the examination (Night Before Sleep). Females reported acquiring approximately 40 minutes more sleep than did the Male participants on average (7:42 and 7:01 respectively).

It was determined that Females generally acquired more sleep than males the night before testing. Both genders reported that they, on average, failed to acquire the amount of sleep they reported they needed in order to feel well rested on the day of testing. On average, Male and Female participants were generally not well rested (at the time of testing), even though Females slept 40 minutes longer than Males prior to the test.

These findings support those of three previously cited studies. Clarkdon (1990) reported that late adolescents generally fail to acquire enough sleep, while Morrison et al. (1992), reported that approximately half of all studied late adolescents had failed to acquire enough sleep. This finding also reported marked variability in a amount of sleep which was considered to be a “good nights sleep.” Kotulak (1998) reported that most American adults did not, on average, get the often recommended eight hours of needed sleep per night.

Based upon the findings of this study, it appears that although Male and Female beliefs regarding the amount of
sleep they need in order to feel well rested are very similar, Females actually acquire more sleep on average than males. It was interesting to note that Females scored higher, on average, on every subtest (See Table VI). This may be influenced by the fact that Females generally had slept longer on the night before the test, than Males.

Table VI.

<table>
<thead>
<tr>
<th>Subtests</th>
<th>Digit Span</th>
<th>Arithmetic</th>
<th>Digit Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Males</strong></td>
<td>M = 10.92</td>
<td>9.04</td>
<td>11.19*</td>
</tr>
<tr>
<td></td>
<td>SD = 2.19</td>
<td>2.54</td>
<td>2.43</td>
</tr>
<tr>
<td><strong>Females</strong></td>
<td>M = 11.02</td>
<td>9.42</td>
<td>13.18*</td>
</tr>
<tr>
<td></td>
<td>SD = 2.35</td>
<td>2.07</td>
<td>2.15</td>
</tr>
</tbody>
</table>

* Difference between numbers is significant p < .01.

Both genders in this study reported marked variability in reported beliefs of the amount of sleep they need in order to feel well rested, Males ranged from a low of 6:00 to a high of 10:30; and females ranged from a low of 5:00 to a high of 12:00. However, it was interesting to note as previously mentioned, both Males' and Females' amount of sleep needed in order to feel well rested, averaged out to
an almost identical amount (Males = 8:14, Females 8:15). (See Table I)

It is important to note that similar to Katulak's (1998) findings, the majority of the participants in this study generally received one hour less sleep over the past 30 days (Past Month Sleep minus Needed Sleep), than they reported they needed in order to feel well rested. The obtained results further indicated that with regard to certain tasks, this lack of sleep negatively affects performance. Specifically, both Male and Female hand-eye speed and accuracy or coordination, abilities directly related to Digit Symbol performance, were affected. In addition, Males' general short term memory skills (Digit Span performance) were affected. These abilities may very well carry over across settings and have a negative impact on individuals day to day functioning throughout their work or leisure time. This is of particular importance as it is clear that many, if not most American adults and late adolescent/young adults, routinely fail to acquire enough sleep.

Further, it is important for School Psychologists and other professionals to note that the amount of reported sleep the night before an examination had a significant effect on the Digit Symbol task (for Males and Females), as well as the Digit Span task (for Males) from the WAIS-R. The amount of sleep one receives the night before testing,
Sleep Performance 32

may well be a confounding factor for other tasks associated with intelligence measurement, aside from Digit Symbol and Digit Span. Further research on the amount of sleep acquired before an examination and standardized measurements of intelligence may prove beneficial. It appears that there are also gender differences which should be addressed concerning ability measurement, as Females scored higher on average than Males in all three subtests. Especially within the Digit Symbol task, scores for Females were significantly higher on average than scores for Males.

In conclusion, it appears that gender differences in ability performance, regarding the Digit Symbol and Digit Span subtests of the WAIS-R, exist. Also, the amount of sleep the participants acquired the night before the tests have been shown to have a significant effect on some ability performance. Knowing that gender turned out to be a significant variable in this study, it would have been beneficial to structure the analysis of the data differently. Namely, an analysis of variance between Sleep Conditions and Gender variables would have proven to be beneficial. It would also have been helpful to increase the overall number of our sample size, especially the amount of men within the study. Lastly, while our study used a 30 minute deficiency (Night Before Sleep from Needed Sleep) as the criteria for being Sleep Deprived, it might be beneficial to increase this amount in order to ensure that
the individual's who were classified as Sleep Deprived were truly "Sleep Deprived." A further exploration upon what amount of sleep deficiency truly constitutes an individual as being Sleep Deprived would also be beneficial.
References


Sleepiness: Its measurement and determinants. *Sleep, 5*, 128-134.


Appendix A

Sleep Questionnaire

Number Assigned __________ Gender M F (Circle one)

Birthday _____/_____/_____ Class Rank _________________

1. On average, how many hours do you normally sleep each night? ______ & ______
   Hours Minutes

2. On the basis of your past experience throughout the last 30 days, how much sleep do you need to feel well rested? ______ & ______
   Hours Minutes

3. To the best of your recollection, at what time did you fall asleep last night? ______ & ______
   Hour Minute

4. To the best of your recollection, at what time did you wake up? ______ & ______
   Hour Minute
Appendix B

**Effort Questionnaire**

Your participation has been greatly appreciated!

**Please enter your assigned number here: ____**

1. Do you feel that you gave your best effort in completing the tasks given to you today? Circle One
   - Yes
   - No

2. If you answered “No” to question number one, please take a brief moment and explain why in the space provided below.

________________________
________________________
________________________
________________________
________________________