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Nonmedical Psychostimulant Use and Sleep among Adolescents and Emerging Adults

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Abstract

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Rates of nonmedical psychostimulant use among emerging adults have been previously examined using self-report, but rates among adolescents have not been well documented. Additionally, few studies have examined the relation of nonmedical psychostimulant use and sleep. One purpose of this study was to examine rates of nonmedical psychostimulant use and sleep among adolescents and emerging adults utilizing the same self-report measures. The second goal was to compare objective measures of sleep among emerging adult nonmedical psychostimulant users and non-users.

Using an online survey adolescents (n=62) and emerging adults (n=583) were asked about past and current nonmedical use of psychostimulants and sleep quality, as measured with the Pittsburgh Sleep Quality Index. Emerging adults were more likely to use psychostimulants nonmedically than adolescents [$\chi^2(1, N = 592) = 13.93$; $p < .001$, odds ratio = 7.5]. Emerging adults (M = 7.73, SD = 3.58) also self-reported worse quality sleep than adolescents (M = 6.36, SD = 3.97)[$F(1, 570) = 5.34$, $p < .05$]. Additionally, adolescents reported significantly more average sleep per night in hours (M = 7.77, SD = 1.71) than emerging adults (M = 6.97, SD = 1.51) [t (1, 644) = 3.90; $p < .01$].

Objective measures of sleep, using actigraphy, and of nonmedical use, using urinalysis, were obtained from a sub-set of 14 nonmedical using and 14 non-using emerging adults. Among users, total sleep time was significantly lower on nights preceding use (M = 310.71, SD = 116.89) than on nights not preceding use (M = 419.63, SD = 87.69) [F (1, 79) = 15.06; $p <$ 0.001]. No difference was found between nights following use when compared to nights not following use.

This study confirms that emerging adults are more likely than adolescents to use psychostimulants nonmedically and that emerging adults report poorer sleep quality and shorter sleep times than adolescents. Additionally, it seems that emerging adult users utilize psychostimulants to compensate for shortened total sleep time on the previous night.

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Overview of Abbreviations

ADHD/ADD – Attention Deficit Hyperactivity Disorder/Attention Deficit Disorder

ADHD Rating Scale-IV – Attention Deficit Hyperactivity Disorder Rating Scale-IV

ANOVA – analysis of variance

ASCITUS – Adolescent Sleep, Caffeine Intake, and Technology Use Questionnaire

AW-64 – Actiwatch-64, a brand of actigraph

DASS – Depression Anxiety Stress Scale

DEA – United States Drug Enforcement Administration

DV – Dependent Variable

GC/MS – Gas Chromatography/Mass Spectrometry

GPA – Grade Point Average

H – Hypothesis

IV – Independent Variable

M – Mean

MANOVA – Multivariate Analysis of Variance

PBI – Problem Behavior Inventory

PDA – Personal Digital Assistant

PSQI – Pittsburgh Sleep Quality Index

RQ – Research Question

SAT – Scholastic Aptitude Test

SD – Standard Deviation

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Nonmedical Psychostimulant Use and Sleep among Adolescents and Emerging Adults

The purpose of this study was to examine nonmedical psychostimulant use and sleep among adolescents attending high school and emerging adults attending college. A relation between nonmedical psychostimulant use and subjective measures of sleep quality was found in the pilot study for the current study. This study not only includes objective measures of sleep and psychostimulant use but also improves our understanding of the relation between sleep and nonmedical use of prescription stimulants from a developmental perspective by including both adolescents and emerging adults.

Nonmedical Psychostimulant Use

For this study, "stimulants" are operationally defined broadly as drugs that increase alertness, activity, and mood such as caffeine and nicotine (Julien, Advokat, & Comaty, 2007). "Psychostimulants" are operationally defined for this study as a specific category of stimulants utilized for the treatment of Attention Deficit Hyperactivity Disorder and Attention Deficit Disorder (ADHD/ADD) such as methylphenidate (Ritalin), *dl*-amphetamine (Adderall), and *d*-amphetamine (Dexadrine; Julien et al., 2007). ADHD/ADD is defined as a pattern of behaviors made up of hyperactive-impulsive behaviors and/or inattentive behaviors in several settings beginning before the age of seven (American Psychiatric Association [*DSM-IV-TR*], 2000). Each of the above drugs have been classified as Schedule II drugs by the United States Drug Enforcement Administration (DEA), meaning that while these drugs have been approved to treat some medical disorders, their abuse potential is high (Kollins, MacDonald, & Rush, 2001; United States DEA, 2008).

Use of psychostimulant medications in ways that have not been medically indicated, including use of psychostimulants obtained by faking symptoms, (nonmedical psychostimulant

use) is problematic because it can lead to increased anxiety, increased blood pressure, and overdose resulting in death (Prudhomme White, Becker-Blease, & Grace-Bishop, 2006). Furthermore, nonmedical psychostimulant use has been linked to co-morbid and subsequent abuse of recreational drugs (Advokat, Guidry, & Martino, 2008; Barrett, Darredeau, Bordy, & Pihl, 2005; McCabe & Teter, 2007; Teter, McCabe, Cranford, Boyd, & Guthrie, 2005; Wu, Pilowsky, Schlenger, & Galvin, 2007).

Though most research on nonmedical use has focused on prevalence rates and motives of emerging adults who use psychostimulant drugs without prescriptions, few studies have assessed sources through which nonmedical users obtain these drugs (Low & Gendaszek, 2002; Teter et al., 2005). There is evidence that patients diagnosed with ADHD/ADD divert their prescription medications by giving or selling them to friends and acquaintances (Arria et al., 2008; Darredeau, Barrett, Jardin, Pihl, 2007). Furthermore, emerging adults with valid psychostimulant prescriptions are often not compliant and engage in psychostimulant misuse, including taking higher than recommended doses or medicating too frequently (Arria et al., 2008; Darredeau et al., 2007). Methods of obtaining psychostimulant drugs, including diversion, were collected in the current study. Additionally, motives for using psychostimulants nonmedically, such as to increase alertness and to get high, which are common among college students (Teter et al., 2005), were examined among both college and high school students in this study.

Use of non-prescription stimulants, such as caffeine, have also been found to affect sleep and daytime functioning. Specifically, caffeine reduces total sleep time, and increases sleep latency (Karacan et al., 1976; Roehrs & Roth, 2008). Furthermore, regular use of even low doses of caffeine can have detrimental effects on sleep (Roehrs & Roth, 2008). Because caffeine use is quite common and is related to sleep disruption, caffeine use was assessed in the current study on

the survey via the Adolescent Sleep, Caffeine Intake, and Technology Use Questionnaire (ASCITUS) with all participant and through voice memos provided by objective participants only, outlined below (Calamaro, Mason, & Ratcliffe, 2009). The ASCITUS is a survey developed specifically to measure caffeine intake and includes typical caffeinated beverages, energy drinks of various sizes, and caffeinated foods such as Rocket Chocolates (Calamaro et al., 2009).

Adolescents.

Overall, there is a paucity of research examining nonmedical psychostimulant use among adolescents. In one of the few studies examining nonmedical psychostimulant use among adolescents, Poulin found that 8.5% of children in grades 7, 9, 10, and 12 reported using psychostimulants non-medically during the previous year (Poulin, 2001). This study also determined that adolescents with legitimate psychostimulant prescriptions who misused their prescription were more likely to engage in drug diversion than those who used their medications as prescribed (Poulin, 2001).

Another study included a survey of school nurses about in-school administration of psychostimulants. A sharp decrease in at-school administration by nurses due to extended-release formulas of psychostimulants (for students with ADHD/ADD) was associated with a subsequent reduction in psychostimulant diversion, theft, and misuse (DuPont, Bucher, Wilford, & Coleman, 2007). DuPont and colleagues (2007) note that development of extended-release formulas, allowing reduction of in-school administration might assist in increasing parental control of psychostimulant use. Increased parental control would mean that adolescents would not have such ready access to the drugs, curbing adolescents' ability to use the drug nonmedically or divert the drug to other students. However, it is possible that parents do not control

administration of these medications as tightly as schools, particularly among adolescents, providing the potential for psychostimulant misuse and diversion.

A cross-sectional study of prescription and over-the-counter drug use among adolescent outpatients at a substance abuse facility over four years demonstrated a significant increase in nonmedical use of methylphenidate from 2% to 12% (Marsh, Key, & Payne, 2000). Although use of other drugs such as marijuana, alcohol, and cocaine were also analyzed, the only drug showing a rise in use across time was methylphenidate (Marsh et al., 2000). A later study found that among adolescents admitted to an addiction treatment center, 23% reported lifetime non-medical use of psychostimulants and 6% reported current misuse (Williams, Goodale, Shay-Fiddler, Gloster, & Chang, 2004). Because these studies were conducted on samples of adolescents with substance-abuse problems, it is reasonable to expect rates of nonmedical psychostimulant use to be significantly lower in the general population. However, as noted above, similar prevalence rates have been found in public school systems (Poulin, 2001).

No study of nonmedically using adolescents considered motives for psychostimulant use. However, Williams and colleagues (2004) found that methylphenidate abuse was common in substance-abusing adolescents who had an eating disorder. In light of this finding and because a common side effect of psychostimulants use is weight loss, the current study included "weight loss" as a possible motive for nonmedical use in addition to the motives typically found in studies of emerging adults, discussed below (Barkely, McMurray, Edelbrock, & Robbins, 1990).

Emerging adults.

Most research on nonmedical psychostimulant use has focused on emerging adults in college settings from small liberal art schools (Babcock & Byrne, 2000) to mid-sized universities (Prudhomme White et al., 2006) to large universities (Teter, McCabe, Boyd, & Guthrie, 2003).

Prevalence rates of nonmedical psychostimulant use range from 5.3% to 20% (DuPont et al., 2008; McCabe, 2008). Additionally, in a study of both college attending and community emerging adults and late adolescents, a lifetime nonmedical psychostimulant use prevalence rate of 5.5% was found, with students significantly more likely to use nonmedically than nonstudents (Wu et al., 2007). The findings of Wu and colleagues (2007) suggest a need for further research on nonmedical psychostimulant use among emerging adults attending college institutions, which was the goal of the current study.

Several studies of nonmedical psychostimulant use by emerging adults have also investigated motives for using these drugs. Two of the most popular reasons for emerging adults' nonmedical psychostimulant use are to improve concentration while working or studying, and for recreation (Barrett et al., 2005; DuPont, Coleman, Bucher, Wilford, 2008; Teter et al., 2003). Additionally, nasal administration or "snorting" of psychostimulants for recreational use is common at rates from 12.7% (Babcock & Byrne, 2000) to 50% (Barret et al., 2005 among nonmedical users). Such recreational use has a high abuse and increased risk for abusing other drugs (Kollins et al., 2001; McCabe & Teter, 2007; National Institute of Drug Abuse, 2006). Comorbid drug abuse among nonmedical psychostimulant users has also been reported (Advokat et al., 2008; Arria et al., 2008; McCabe, 2008; McCabe, Knight, Teter, & Wechsler, 2005; McCabe, Teter, & Boyd, 2006; Teter et al., 2005). Specifically, a link between non-medical psychostimulant use and increased rates of alcohol and marijuana use and dependence has been found in several cross-sectional studies (Arria, et al. 2008; McCabe & Teter, 2007; Teter, et al. 2005) with nonmedical psychostimulant users reporting higher rates of comorbid drug use than college students who used other drugs. However, no causal direction of nonmedical psychostimulant use and use of other drugs has been established.

Sleep and Medically Approved Psychostimulant Use

One understudied effect of nonmedical psychostimulant use is sleep disturbance. Several studies examining sleep among a variety of child and adult samples using medically indicated psychostimulants are reviewed before sleep and nonmedical psychostimulant use among adolescents and emerging adults is specifically addressed.

Children diagnosed with ADHD/ADD who are prescribed immediate-release forms of methylphenidate show disturbance in sleep onset and total sleep time (Corkum, Panton, Ironside, MacPherson, & Williams, 2008). However, adults with ADHD/ADD using methylphenidate show increased sleep efficiency and have subjective reports of more restorative sleep (Sobanski, Schredl, Kettler, & Alm, 2007). Moreover, sleep deprived participants without ADHD/ADD demonstrate an increased preference for methylphenidate; participants provided with only four hours in bed with preference assessed at 9:00 a.m., preferred methylphenidate over a placebo. When participants were permitted eight hours in bed, this finding was reversed, suggesting that among healthy adults desire for psychostimulants hinges on sleep deprivation regardless of whether psychostimulants affect sleep (Roehrs, Papineau, Rosenthal, & Roth, 1999). Military investigations have found that psychostimulants, specifically *d*-amphetamine and modafinil, are effective in combating sleepiness among adults and delaying sleep onset (Eliyahu, Berlin, Hadad, Heled, & Moran, 2007).

Adolescent sleep and psychostimulant use.

Adolescents tend to sleep less than children, though their need for approximately nine hours of sleep is about the same (Jenni & Carskadon, 2005). This reduction in sleep time has been attributed to a biological phase shift in adolescents' circadian rhythm during puberty that drives them to go to sleep at later times than in childhood (Carskadon, Vierira, & Acebo, 1993;

Carskadon, Wolfon, Acebo, Tzischinsky, & Seifer, 1998). Adolescent sleep phase shift in conjunction with early school start times truncates the sleep period for many adolescents on school days and has been related to chronic sleep deprivation (Carskadon et al., 1998).

Sleep deprivation among adolescents is of particular importance because it has been associated with poor academic performance measured with grades, achievement tests, ratings by teachers and examinations of neurocognitive functioning (Beebe, Rose, & Amin, 2008; Buckhalt, Wolfson, & El-Sheikh, 2009; Carney, Edinger, Meyer, Lindman, & Istre, 2006; Wolfson & Carskadon, 1998). A more immediate danger and public safety issue of sleep deprivation in this age group is drowsy driving. Without the typical eight hours of sleep and/or with prolonged continuous wakefulness (18-21 hours), slower reaction times and more driving errors occur (Hutchens et al., 2008; Philip et al., 2005). In fact, being awake continually for 17 hours, which most people do on a daily basis, is equivalent to a blood alcohol concentration of 0.05 (Dawson & Reid, 1997). The risks of drowsy driving are compounded because adolescents and young adults are at risk for drinking and driving, and among adults, legal levels of alcohol with extended wakefulness have been linked to higher accident rates than illegal levels of alcohol in well-rested individuals (Howard et al., 2007).

Thus, the additional contribution of nonmedical psychostimulant use may compound these problems. Only our pilot work has previously included the relation between nonmedical psychostimulant use and sleep among emerging adults. The most closely related area regards adolescent and emerging adult sleep related to *medically approved* psychostimulant use, which is briefly reviewed here.

Among children and adolescents, *d*-amphetamine and methylphenidate use was associated with insomnia and sleep difficulty compared to a baseline period with no drugs used

to treat and placebo, respectively (Ahmann et al., 1993; Barkely et al., 1990; Efron, Jarman, & Barker, 1997). However, the relation between nonmedical psychostimulant use and sleep among adolescents not diagnosed with ADHD/ADD is unknown.

Emerging adult sleep and psychostimulant use.

Young adults, who take longer to fall asleep than middle age adults, sleep approximately 7.5 hours - significantly less than adolescents, but significantly more than those 30 and over who sleep an average of 6.5 hours on weekdays and 7 hours on weekends (Geisler et al., 2006; Groeger, Zijlstra, & Dijk, 2004; National Sleep Foundation, 2009).

Using actigraphy, which is a method of examining sleep using recordings of motion, Boonstra and colleagues (2006) demonstrated that adults with unmedicated ADHD/ADD experienced longer sleep latency and lower sleep efficiency than control participants. When methylphenidate was administered, the ADHD/ADD adults experienced later bedtimes and shorter sleep durations but also demonstrated an increase in sleep consolidation (Boonstra et al., 2006). These results suggest that although adults with ADHD/ADD have baseline sleep problems, some of those problems are exacerbated by methylphenidate use providing support for the notion that psychostimulants will be related to worse sleep parameters in nonmedical users than non-users.

In conditions of purposeful sleep deprivation, shift work specifically, methamphetamine improved performance on motor tasks and subjective report of alertness (Hart, Ward, Haney, Nasser, Foltin, 2003). Though the current study examined sleep and psychostimulant use from the point of drug use leading to sleep problems, it is possible that sleep problems, such as intentional sleep deprivation due to studying, may lead to use of psychostimulant drugs. More evidence of the possible bi-directionality of sleep and drug use can be found in the impulsivity

literature. Experimental sleep deprivation has been linked to a propensity to engage in higher rates of delayed discounting, a measure of impulsivity, than non-sleep deprived emerging adults, and impulsivity, which is related to high rates of drug abuse, has been linked to high rates of insomnia (Carroll, Anker, Mach, Newman, & Perry, 2010; Reynolds & Shiffbauer, 2004; Schmidt, Gay, Ghisletta, & Van der Linden, 2010). This research could be used as evidence to argue that impulsivity leads to both sleep problems and drug abuse or that sleep deprivation leads to impulsivity and, therefore, subsequent drug abuse. The current study provided information examining the relation between sleep problems and prescription drug abuse.

Both objective and subjective measures of sleep and psychostimulant use were utilized in the present study. Specifically, self-report of sleep and sleep quality as well as psychostimulant use was collected from adolescents and emerging adults using online surveys. Among emerging adults, a sample of nonmedical users and a control sample had their sleep objectively monitored and had levels of psychostimulants used objectively measured.

Statement of the Problem

The purpose of this study was to examine nonmedical psychostimulant use and sleep among adolescents attending high school and emerging adults attending college. Additionally, this study included a measure of mood as it related to sleep and nonmedical psychostimulant use among adolescents and emerging adults. In all, the goal of this study was to provide an enhanced overview of nonmedical psychostimulant use among both adolescents and emerging adults as well as how nonmedical use of these drugs is associated with objectively recorded sleep.

Research Questions (RQ) and Hypotheses (H)

Research Questions for Nonmedical Psychostimulant Use.

RQ1: How do prevalence rates of nonmedical psychostimulant use differ between adolescents attending high school and emerging adults attending college?

H 1 a: Emerging adults will report higher rates of nonmedical psychostimulant use than adolescents.

Rationale for RQ1 hypotheses.

Prevalence rates of nonmedical psychostimulant use by emerging adults are between 5.3% and 20% (DuPont et al., 2008; McCabe, 2008). Only one study has measured prevalence rates of nonmedical use in adolescents, found to be 8.5%, which is within the use range of emerging adults (Poulin, 2001). However Arnett (2005) discussed emerging adults' developmental contexts, such as identity formation and instability in life and residence, as a factor in explaining the high rate of drug use compared to other life-span periods. No study has looked at more than one cohort at a time nor has a single study included both emerging adult and adolescent samples using the same survey. Because emerging adults in college typically experience more autonomy than high school students and often cohabitate in dormitories with access to psychostimulants, we expect higher rates of non-medical psychostimulant use among emerging adults attending college than among adolescents attending high schools when examining these cohorts at the same time using the same survey and administration method.

Research Questions for Subjective Sleep Data.

RQ2: How will sleep quality differ for adolescent and emerging adult non-users and nonmedical users?

H 2 a: Overall, adolescents will have poorer subjective sleep quality than emerging adults, as measured with the Pittsburgh Sleep Quality Index (PSQI).

H 2 b: For adolescents subjective sleep quality will be poorer for nonmedical users than non-users.

H 2 c: For emerging adults subjective sleep quality will be poorer for nonmedical users than non-users.

Rationale for RQ2 hypotheses.

First, a main effect of age is expected on the PSQI because adolescents are subject to a delayed sleep phase shift in addition to early school start times, which truncates the sleep period (Carskadon et al., 1993; Carskadon et al., 1998). Because sleep phase shift has been related to puberty, it is likely that emerging adults will not experience this shift as strongly (Carskadon et al., 1993). Additionally, college students are able to schedule their own classes at preferred times as opposed to adolescents, who are required to attend school at a set time. Because college students can self-schedule classes for later start times if they experience sleep phase shift and have more opportunities for naps, school start times do not necessarily encumber the sleep period and, thus, sleep quality.

Additionally, pilot data for the current study examining sleep and nonmedical psychostimulant use found that after accounting for a variety of demographic variables, nonmedical psychostimulant use was related to poorer sleep quality than in non-users. Therefore, we expect that for both age periods, psychostimulants will be related to poor sleep quality. An additional interaction of age and nonmedical psychostimulant use is expected with adolescent users experiencing the worst sleep quality due to normally occurring sleep phase shift, truncation of the sleep period by school start times, and the stimulant effects of nonmedical psychostimulant use (Carskadon et al., 1993; Carskadon et al., 1998).

Research Questions for Objective Sleep Data

RQ3: How will objective sleep measures differ between emerging adults who use psychostimulants nonmedically and emerging adults who do not use psychostimulants?

H 3 a: Total sleep time will be shorter for nonmedical psychostimulant users than for non-users.

H 3 b: Sleep efficiency will be lower for nonmedical psychostimulant users than for non-users.

H 3 c: Sleep latency will be longer for nonmedical psychostimulant users than for non-users.

Rationale for RQ3 hypotheses.

Pilot data for the current study demonstrated that nonmedical use was related to poor overall subjective sleep quality, poor subjective sleep quality, and higher sleep disturbance than non-users. On average college students, regardless of nonmedical psychostimulant use status, scored above the threshold of poor sleep quality (Carney et al., 2006; Scott-Sheldon, 2008). However, even after accounting for a high base-rate of poor quality sleep in this age group, nonmedical psychostimulant users reported significantly poorer sleep quality than non-users in the pilot study. Because the PSQI and actigraphy have both been validated against polysomnography, the gold standard of sleep measurement, we expect that objective measures of sleep will be worse for nonmedical users than non-users. However, Boonstra and colleagues (2006), found that methylphenidate was related to consolidated sleep in a sample of adults diagnosed with ADHD/ADD, suggesting that sleep pressure is higher in psychostimulant users than when there is no presence of psychostimulants. Sleep pressure increases with extended periods of wakefulness, and we expect that psychostimulants will extend wake periods in users leading to longer sleep latencies and shorter total sleep times.

Method

Data were collected using two methods. For Phase I, self report information concerning prevalence and motives for nonmedical psychostimulants was collected from adolescents and emerging adults via an identity-protected online survey. Phase II actigraphy and survey data were collected from a) emerging adults who were currently using psychostimulants nonmedically and b) non-user controls. Phase II participants also completed the survey used for Phase I.

Participants

Phase I.

Adolescent Group.

Participants were recruited using the following methods: fliers posted and handed out in and around local high schools, businesses, malls, movie theaters, sporting events, YMCAs and Boys and Girls clubs; online advertising, groups, and personal contact on facebook.com; postings on local cable television channels; postings on multiple radio station websites; postings on various groups for teenagers (local 4-H, HI-Y, Future Farmers of America, YoungLife websites, dosomething.org) and their parents (Greater Morgantown Area Youth Commission, Morgantown Parent Zone, postings on West Virginia University eNews), multiple postings on craigslist.com, an opinion-editorial piece in the Dominion Post, multiple postings on Twitter.com, via word-of-mouth (emails to school clubs such as choir, at community events such as Morgantown Kids Day, by teachers of health and psychology classes at local high school, by group leaders at Adventure West Virginia, at summer camps, contacting West Virginia Governor's Schools and Honor's Leadership Academy, announcements to a local cross-country camp, and during sleep-focused talks given to five high school health classes). High school

students were invited to complete the survey online using surveymonkey.com. Consent and assent were obtained online in order to reduce subject burden. Each adolescent participant completing the survey was entered into a drawing for a $50 gift card (1 gift card randomly awarded for every 50 completed surveys). The winner of the $50 gift card was chosen by sorting the data file with adolescent participants at the beginning, putting the range into a random number generator, and finding the corresponding row to the random number. This recipient was chosen with fewer than 50 complete adolescent surveys. An Institutional Review Board amendment was submitted to improve participants' chances of winning (one $20 gift card for every 15 completed surveys) and encourage higher response rates. Completed surveys were obtained from 12 participants between Institutional Review Board approval and the end of data collection, and so no $20 gift cards were awarded. Once data were downloaded and the winner was determined, a receipt for the gift card was mailed to the winner asking for what store the gift card would be preferred. The gift card was then sent and all names and addresses used to send gift cards were permanently deleted from the files to ensure subsequent identity protection.

Emerging Adult Group.

Participants were recruited via undergraduate psychology classes at West Virginia University using announcements about the study in their classes, word of mouth, and fliers advertising the study placed in the Life Sciences Building. Participant consent was obtained by providing a cover letter at the beginning of the online survey. To protect their identities, the emerging adult group did not provide identifying information such as names. College students received extra credit points in their undergraduate psychology class for participation in the study. Extra credit was shown to be an adequate compensation for college students in the pilot study. This compensation, awarded via the Sona system, which records the amount of time college

students spend participating in approved online surveys, was awarded to emerging adults completing the online survey. Records of time, without records of what studies students complete, are sent to instructors, who then provide students with extra credit. Though the Sona system was used to access the survey, the survey was completed via surveymonkey.com.

Materials

Psychostimulant Use and Sleep Survey.

Research suggests no differences in responses for surveys concerning sensitive issues using paper versus anonymous online administration have been found (Uriell & Dudley, 2009). Furthermore, Uriell and Dudley (2009) examined paper and internet-based surveys and participant confidence that responses were, in fact, anonymous. Confidence levels were lower for the internet-based survey, however perceived lower anonymity levels did not appear to be related to response differences among the two survey administration methods (Uriell & Dudley, 2009). Therefore, for the current study online survey administration was used.

Statistical power for survey.

We recruited 645 participants for this phase of the study, 583 college students and 62 high school students. Using the Gpower program, a power analysis was conducted (Faul & Erdfelder, 1992). With an expectation of a large effect size ($d = 0.40$) a sample size of $n = 19$ per group ($N = 76$) was the goal to obtain adequate power = 0.80, when comparing adolescents to emerging adults and nonmedical users to non-users (adolescent non-users, adolescent nonmedical users, emerging adults non-users, emerging adults nonmedical users). This sample size is lower than the sample size necessary with the expectation of medium effect size ($d = 0.25$) which would be $n = 54$ per group ($N = 324$). Because prevalence rates of nonmedical users was

expected to be lower than medical users and non-users, target sample sizes were slightly increased from the number obtained using Gpower for a large effect size.

The survey began with a section asking about demographic information, specifically participants' year in high school or college, age, race and ethnicity, parents' marital status, parents' education, number of siblings, unweighted grade point average from the last grading period, Scholastic Aptitude Test (SAT) scores either with or without the written section, ACT scores, whether the participant had a set bedtime and what time, whether the participant had a job and how many hours per week, involvement in fraternities or sororities, living arrangement, and highest level of education the participant hoped to complete.

Psychostimulant use.

No survey regarding nonmedical use of psychostimulants has been validated. Thus, ours was a modified version of a survey previously developed for pilot data collection based on other surveys examining nonmedical psychostimulant use among college samples (Barrett et al., 2005; McCabe, Knight, et al., 2005; McCabe, Schulenberg, et al., 2005; Teter et al., 2005). This survey included measures of duration and frequency of use of a variety of psychostimulants as well as motives for use, routes of administration, and how the drugs were obtained. A reproduction of the entire survey is in Appendix A.

Sleep.

Sleep and sleep quality were measured using the Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI consists of seven component scores (each ranging from 0 to3) that are summed for a global sleep quality score (range 0-21) reflecting the previous month. Higher scores indicate worse sleep quality, and a global PSQI score ≥5 is considered the clinical cutoff between good and poor sleep quality among adult and

college-age samples (Buysse et al., 1989; Carney et al., 2006). Components of the global sleep score measure sleep quality, sleep latency, and sleep duration, habitual sleep efficiency, sleep disturbance, use of over-the-counter and/or prescription sleep medications, and daytime dysfunction. A reproduction of the survey and scoring rubric is in Appendix B.

ADHD/ADD symptomology.

ADHD/ADD symptomology was measured using the ADHD Rating Scale – IV (DuPaul, Power, Anastopoulos, & Reid, 1998). This measure was used both as a screening device for high ADHD/ADD symptomology for participants in Phase II and for data collection in the online survey for Phase I and Phase II. The ADHD Rating Scale-IV is an 18-item inventory measuring ADHD/ADD symptomology according to the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (American Psychiatric Association [*DSM-IV-TR]*, 2000) criteria for ADHD/ADD. Kooij and colleagues (2008) did a comparison of several surveys measuring ADHD/ADD symptomology among adults and found that the ADHD Rating Scale-IV is an effective screening tool for ADHD/ADD symptomology with high reliability between reporters (Chronbach's alpha was between .7-.8), good convergent validity, and good divergent validity (Kooij et al., 2008).

Caffeine use.

Caffeine use was determined using the ASCITUS, a survey developed specifically to measure caffeine intake, sleep, and technology use among adolescents (Calamaro et al., 2009). The ASCITUS lists 19 caffeinated beverages, from tea to energy drinks, for which responders can choose the size and number of the beverage or other caffeinated items such as Rocket Chocolates and caffeine pills consumed on an average day. Typical caffeine intake was determined by multiplying the daily quantity of each drink by its caffeine content and summing

for each participant. The caffeine content of each drink was determined using manufacturer websites (gathered in January of 2009) and participant report of drink size (Calamaro et al., 2009).

Mood

Mood was measured using the Depression Anxiety Stress Scale (DASS; Lovibond & Lovibond, 1995) which is a 42-item instrument with subscales measuring symptoms of depression, anxiety, and stress for the previous week. Each item is scored on a 0-3 scale based on whether the responder marks "Did not apply to me at all," "Applied to me to some degree, or some of the time," " Applied to me a considerable degree, or a good part of the time," or "Applied to me very much, or most of the time." Antony and colleagues (1998) examined the psychometrics of the DASS and found high reliability (Cronbach's alphas were .97 for depression, .92 for anxiety, and .95 for stress). The DASS subscales were also highly correlated with other commonly used measures of depression, anxiety, and stress. The DASS has also been successfully used to examine levels of depression, anxiety, and stress among emerging adult samples (Bayram & Bilgel, 2008; Gudjonsson et al., 2008). Among adolescent samples the DASS has been shown to be useful in measuring factors of negative mood and physiological arousal (Duffy, Cunningham, & Moore, 2005).

Risk-taking behaviors.

Survey responders also completed the Problem Behavior Inventory (PBI). The PBI is a 29-item instrument used to measure frequency for a variety of problem behaviors, such as theft, physical violence, and inappropriate behaviors during the previous 12 months. Participants mark whether they have engaged in that behavior "never," "once or twice," "3 or 4 times," " once a month," "2-3 times a month," "once a week," "2-3 times a week," or "almost every day" in the

previous year. Haynes and colleagues (2006) found that drug abusing adolescents who experienced insufficient sleep were more likely to report aggressive behaviors and thoughts than when they experienced adequate sleep. Another study by O'Brien and Mindell (2005) demonstrated that adolescents with sleep problems were more likely to engage in risk-taking behaviors. The results of these studies are particularly interesting within the context of the current study in that the drugs being abused by nonmedical users are stimulants, which could disrupt sleep and, thus, possibly make subsequent problem behaviors more likely.

Phase II.

Phase II used actigraphy to objectively measure sleep among emerging adults engaging in nonmedical psychostimulant use and controls with no history of psychostimulant use. Objective urinalysis was used to quantify drug use among participants.

Participants in Phase II were 28 college students: 14 college students who reported currently nonmedical psychostimulant use and 14 control students who reported no previous or current psychostimulant use. Recruitment advertisements were placed in public areas of university buildings and presented in undergraduate psychology and biology classes. Additionally, a short description of Phase II inclusion and exclusion criteria and contact information was provided at the end of the college student version of the Phase I survey. A brief verbal screen was used to determine inclusion criteria: age $\geq$18 and nonmedical psychostimulant use or nonuse and exclusion criteria: diagnosis of ADHD/ADD or diagnosis of a sleep disorder. Participants also completed the ADHD Rating Scale-IV; any participant scoring >9 was excluded and provided with a reference list for mental health and addiction resources due to psychostimulant status as a Schedule II drugs. Phase II participants completed the same online survey designed to examine the relation between stimulant use and sleep on the last day of the

study described above. Control participants were matched as closely as possible to nonmedical psychostimulant users on gender, ethnicity, year in school, housing, parent education, SAT/ACT scores, involvement in fraternities or sororities, whether the participant had a regular bedtime and, if so, what time, and whether the participant had a job and, if so, how many hours worked per week. When possible, nonmedical users recruited for the study were asked to refer a matched control.

Participants for this phase were administered informed consent and Health Insurance Portability and Accountability Act authorization. Additionally, a Certificate of Confidentiality was obtained from the National Institutes of Health and the National Institute on Drug Abuse providing protection to participants who disclose sensitive information about illicit nonmedical psychostimulant use by allowing researchers to avoid disclosing information about participants in any "Federal, State, or local civil, criminal, administrative, legislative, or other proceedings" (Confidentiality Certificate, 2009). Besides consent form, all forms and surveys identified the participant only by number, and all data were stored on password and firewall protected computers and/or in locking filing cabinets to protect participants' identity.

For this phase of the study, participants were compensated $50 for completing the one-week protocol. Compensation was provided on a prorated scale with $10 in cash being paid on Days 2, 4, and 6 and $20 in cash being paid on Day 7 following confirmation of protocol adherence and return of hardware. One participant withdrew from the study early, and was compensated using the above prorated scale.

Statistical power for actigraphy analyses.

A Multivariate Analysis of Variance (MANOVA) was used to examine how users/non-users differ on total sleep time, efficiency, and sleep onset latency. For the effect size found in a

previous study examining methylphenidate in nonmedical users using polysomnography (1.96) and alpha=0.05, we need 20 total participants (Roehrs et al., 1999). This means that with 20 participants, statistical analyses would likely have enough power to avoid a Type II error, which would occur if results were statistically non-significant even though there are actual differences among the groups.

Actigraphy.

Participants in Phase II wore an actigraph continuously for one week. Each nonmedical user and matched control began the study on the same day, which was scheduled according to the nonmedical user's preference. The purpose of this scheduling was to attempt to collect data during a time when the nonmedical user would be likely to use psychostimulants because students often use these drugs to study for exams or work on term papers rather than using psychostimulants on a regular basis (Dupont et al., 2008; Teter et al., 2005). During the study, nonmedical users were instructed to use psychostimulants as they typically would and non-users were asked to continue abstaining from psychostimulant use.

An actigraph is a device used to identify sleep and wake periods and is worn on the participants' non-dominant wrist. Actigraphy is a valid method for recording activity levels used to identify periods of sleep and wake in non-laboratory settings among both adolescents and adults (de Souza et al., 2003, Jean-Louis et al., 1996; Johnson et al., 2007; Sadeh & Acebo, 2002). There are various scoring algorithms to differentiate between sleep and wake with polysomnography agreement rates ranging from 97-99% in normative samples (de Souza et al., 2003; Jean-Louis et al., 1996). Because any period indicating motionlessness could be scored as a sleep period, a sleep/wake diary and a watch on/watch off diary were completed by each participant so that the researcher could determine whether a period of motionless was sleep.

Periods of sleep and wake were monitored with actigraphy. Participants in Phase II wore the Actiwatch-64 (AW-64) actigraph produced by Philips-Respironics (Mini Mitter) continuously for one week on their non-dominant wrist. Actigraphs work by coding movement mathematically using an accelerometer that detects movements as small as 0.05 g-force in the AW-64 (Mini Mitter, 2005). Movement is recorded in a cumulative manner for the epoch, or time period indicated. At the end of each epoch, the total amount of movement within that epoch period is stored. For this study, the actigraphs were set to collect movement data in 15-second increments, which is the highest resolution recording possible using this device. At this recording level, the AW-64 is able to collect and store movement data on 64 KB of memory for 11.3 days, which is in excess of the seven days necessary for this study. The AW-64 is also equipped with an event marker button, which participants were asked to push when they were in bed, ready to go to sleep. The dimensions of the AW-64 are 29 x 37 x 12, and it weighs 16 grams without the watch band (Mini Mitter, 2005). Data were analyzed using Actiware® Software Version 5.4.

Sleep/wake states.

In order to score periods of sleep and wake, both actigraphy and the sleep/wake diary, described below, were utilized. The sleep period was determined using participant report of sleep onset and advancing in time to a period of two consecutive minutes (8 epochs) of no movement. The wake period was scored in the same way. Figure 1 clarifies how sleep and wake periods were scored. After wake and sleep periods were manually scored and checked, Actiware software 5.2 calculated total sleep time, sleep efficiency, and sleep onset latency as described below. Naps were categorized as any sleep period marked by the participant and scored by the researcher as sleep meeting the following criteria: a sleep period between the hours of 8:00 am and 12:00 am lasting fewer than 180 minutes (3 hours) with a subsequent and previous scored

sleep period lasting at least 270 minutes (4.5 hours). Unless noted, naps are not included in measures of sleep. (Insert Figure 1 here.)

Total sleep time.

Total sleep time was determined by the Actiware software by calculating the number of epochs manually scored as sleep, described above, and multiplying that number by the epoch length, which was 15 seconds in this study. Each epoch was scored as sleep or wake based on amount of activity. The Actiware software measured not only the 15-second epoch being scored, but also the two minutes preceding and following that epoch. The activity count of each epoch of the preceding and following two minutes was multiplied by a set value (1/5 for the minutes directly preceding and following and 1/25 for the two minutes adjacent to the 1/5 value minutes). The activity count for the epoch being examined plus the activity for the preceding and proceeding two minutes was added and compared a medium level threshold value of 40. If the activity count was ≤ 40, the epoch was scored as sleep, and if the epoch was > 40, the epoch was scored as wake.

Sleep Efficiency.

Sleep efficiency is a measure of how much of the time one spends in bed as compared to time sleeping, with higher efficiencies indicating more of the sleep period spent asleep. The Actiware software calculated sleep efficiency by dividing the total sleep time, described above, by the total amount of time between sleep onset and offset. This number was then multiplied by 100 to determine the percent sleep efficiency.

Sleep Onset Latency.

Sleep onset latency is the time between when sleep onset is marked with the Personal Digital Assistant (PDA) and when the sleep period began, according to actigraphy scoring of sleep periods, described above.

Personal Digital Assistant.

The brand of PDA used in this study was the Palm Zire 72. Software created with Bruner Consulting, Inc. specifically for use by our laboratory was downloaded onto each PDA. This software included electronic versions of a sleep diary and a watch on/off diary, outlined in more detail below. Electronic diaries were particularly useful because rates of protocol adherence are higher with electronic diaries than paper diaries (Stone, Shiffman, Schwartz, Broderick, & Hufford, 2002). Participants were instructed to mark each time they removed or put on the actigraph, when they were going to bed for the night, when they were waking up for the day, and the beginning and end of any nap. In addition to the diaries, the PDAs were equipped with a voice recorder that was utilized in the current study as a means for participants to note instances of nonmedical psychostimulant use. Specifically, participants were asked to make time and date stamped voice recordings noting the type of drug, quantity, and dosage (if known) of psychostimulants, methamphetamine, cocaine, marijuana, alcohol, and any caffeine consumed after 9:00 p.m. Participants were provided with a reminder card outlining expectations of sleep/wake diary use, watch on/off diary use, voice memo use, and event marker use. At the end of the data collection week, data from the PDA were downloaded as a Microsoft Excel file and voice recordings were transcribed as Microsoft Notepad files onto a password protected computer in a locked laboratory. Upon confirmation of data download, all files were deleted from the PDA, and once voice recordings were transcribed, the voice recordings were deleted from the computer.

Sleep and watch diaries.

Participants were instructed to use the sleep/wake diary to record when they were going to bed for the night, when they awoke for the day, and when any naps were taken. These entries were then date and time stamped. There was also an option to provide post hoc recordings of sleep and wake times should the participant not mark sleep/wake in real time. Similarly, participants used the watch on/off diary to mark each time they removed or put on their AW-64. Post hoc entries were also available for the watch diary. These diaries, in conjunction with actigraph recordings, were used to identify sleep and wake periods for analyses.

Urinalysis.

Researchers met with participants daily to administer five-panel drug tests in the sleep laboratory in the Life Science Building, which houses a private bathroom, at participants' convenience. Nonmedical psychostimulant usage or nonuse was verified with urine samples provided by participants daily with a five-panel Instant-View® brand Multi-Drug Screen Urine Test for amphetamine, methamphetamine, cocaine, opiates, and marijuana metabolites, providing either a positive or negative result for presence of each of those drugs. Five-panel urine test results were examined by the researcher to determine if the test is positive for each of the above drugs and results were recorded. On-site drug screens for amphetamines have been found to have between 83-95% sensitivity and between 98-100% specificity (Leino, Saarimies, Gronholm, & Lillsunde, 2001). The frequency with which urine samples were collected is due to the period of detection with urine samples, which is 1-3 days, depending on a variety of variables such as dosage, weight, and metabolism (Bogema, 1998; Erowid, 2008). A reproduction of the specifications for the five-panel tests can be found in Appendix C.

At the end of the week of data collection, researchers met with participants in the sleep laboratory to collect and download actigraphy systems to assure protocol compliance. Afterward, participants were escorted to the Clinical Chemistry Laboratory at West Virginia University Hospital where participants provided a urine sample for the gas chromatography/mass spectrometry (GC/MS) analysis. The GC/MS was used to detect the quantity of amphetamine metabolite present in participants' urine. The GC/MS was conducted on the all Phase II participants and provided quantitative values of amphetamine, methamphetamine, methylenedioxyamphetamine (MDA), and methylenedioxymethamphetamine (MDMA, Ecstasy). A reproduction of the specimen requisition used by the Clinical Chemistry Lab is in Appendix D.

Preliminary Analyses

Before hypothesis testing begins, data were cleaned. Pairwise deletion of missing data was used in order to utilize all available data for each analysis. Skew and kurtosis were analyzed for each demographic variable to ensure a normal distribution and frequencies were analyzed for demographic variables.

Main Analyses

RQ1: How do prevalence rates of nonmedical psychostimulant use differ between adolescents attending high school and emerging adults attending college?

Analysis.

A two-tailed t-test was used to examine *RQ* 1. School status — high school or college — was the independent variable (IV) and rate of nonmedical use was the dependent variable (DV).

RQ2: How does subjective sleep quality differ for adolescent and emerging adult non-users and nonmedical users?

Analysis.

To examine *RQ*2, a factorial mixed analysis of variance (ANOVA) was conducted using age group (adolescent or emerging adult) as one independent variable (IV), use category (nonmedical user, non-user) as the second IV, and subjective sleep quality (global PSQI score) as the dependent variable (DV).

Research Questions for Objective Sleep Data

RQ3: How do objective sleep measures differ between emerging adults who use psychostimulants nonmedically and emerging adults who do not use psychostimulants?

Analysis.

A MANOVA was used to examine *RQ*3. Use category (nonmedical users, non-users) was the IV, and sleep parameters (total sleep time, sleep efficiency, sleep latency) were the DVs.

Results

Phase I

Log-on numbers for the online survey were 212 adolescents and 632 emerging adults. However, only 62 adolescents and 583 emerging adults completed the survey. As expected, emerging adults were significantly older (M = 20.25, SD = 2.03) than adolescents (M=16.16, SD = 1.34) [t (1, 649) = -16.44; $p < .001$; Cohen's d = 2.38]. Demographic characteristics of adolescents and emerging adults can be found in Table 1. (Insert Table 1 here.)

Skew and kurtosis were calculated for all demographic and outcome variables of interest. Because of the relatively large sample size of Phase I, values above three were considered skewed or kurtotic (Field, 2005). Of these variables, PBI scores were skewed (5.82) and kurtotic (53.21), and daily caffeine intake (in milligrams) was both skewed (9.47) and kurtotic (137.18). Because the skew and kurtosis for both PBI and caffeine were in the same direction for both

adolescents and emerging adults, these variables were not transformed, allowing for easier interpretation of results.

Participants were categorized into psychostimulant non-users (n=513) (those with no ADHD/ADD diagnosis, no current or previous use of psychostimulants, and no prescription for psychostimulants), nonmedical users (n=79) (those with no ADHD/ADD diagnosis, no prescription for psychostimulants, and current or previous use of psychostimulants), medical users (n=62) (those with a diagnosis of ADHD/ADD, with a prescription for psychostimulants, and current or previous psychostimulant use), medical non-users (n=9) (those with a diagnosis of ADHD/ADD or with a prescription for psychostimulants, and no current or previous use of psychostimulants), and medical misusers (n=3) (those with a diagnosis of ADHD/ADD or with a prescription for psychostimulants who also endorsed any nonmedical motive for psychostimulant use).

To address *RQ1*, which examined whether prevalence rates of nonmedical psychostimulant use differ between adolescents attending high school and emerging adults attending college, school status was categorized as either being in high school or college. Participants were asked, for Adderall, Ritalin/Concerta, Dexedrine, and Provigil/Nuvigil, if they had used each drug and how many times, on average, they used each drug. Rates of use were calculated by adding the average doses of each drug taken per week. Only those participants classified as non-users or nonmedical users were included in these analyses. Adolescents and emerging adults did not differ on rates of use when users, non-users, and medical users were included within the adolescent and emerging adult groups [t (1, 445) = -1.81; p = .07].

To further investigate whether emerging adults and adolescents differed on nonmedical use, a chi-square analysis was conducted for age group (adolescents, emerging adults) and use

category (non-users, nonmedical users). The rate of participant psychostimulant use differed by school status [$\chi^2(1, N = 592) = 13.93$; $p < .001$, odds ratio = 7.5] with emerging adults in college being 7.5 times more likely to use psychostimulants nonmedically than high school students according to an odds ratio.

To address *RQ*2, examining how subjective sleep quality differed for adolescent and emerging adult non-users and nonmedical users, only non-users and nonmedical users were included in the factorial mixed ANOVA conducted to compare the relation of age group (adolescent, emerging adult) and use category (non-user, nonmedical user) on sleep quality (global PSQI score). The main effect of age group [$F(1, 570) = 5.34$, $p < .05$; Cohen's $d = 0.36$] was significant with adolescents (M = 6.36, SD = 3.97) reporting better sleep (as indicated by lower scores on the PSQI) than emerging adults (M = 7.73, SD = 3.58), contrary to our hypothesis. The main effect of use category [$F(1, 570) = 8.34$, $p < .01$; Cohen's $d = 0.42$] on sleep quality was also statistically significant with users reporting poorer sleep (M = 8.83, SD = 3.15) than non-users (M = 7.40, SD = 3.68). However, the interaction effects of age group and use category on sleep quality could not be determined because no adolescents were classified as a nonmedical user.

Because no adolescents were classified as non-users, they were excluded from the following analysis. An ANOVA was conducted to examine how subjective sleep quality (global PSQI) differed for use categories of emerging adults including ADHD/ADD diagnosed users of psychostimulants (non-users, nonmedical users, medical users). A significant effect of use category on sleep quality was found, $F(1, 575) = 6.45$, $p < .01$. Specifically, Bonferroni follow-up tests demonstrated that non-users (M = 7.54, SD = 3.62) displayed significantly better sleep quality than nonmedical users (M = 8.83, SD = 3.15) ($p < .05$; Cohen's $d = 0.38$) and better sleep

quality than medical users (M = 8.72, SD = 3.44) ($p < .05$; Cohen's $d = 0.33$). Nonmedical users and medical users did not differ significantly on sleep quality. An independent samples t-test was used to examine average sleep time, as determined with a single item on the PSQI asking how many average hours of sleep for the previous month the respondent obtained, among adolescents and emerging adults. Adolescents reported significantly more average sleep per night (M = 7.77, SD = 1.71) than emerging adults (M = 6.97, SD = 1.51) [t (1, 644) = 3.90; $p < .01$; Cohen's d = 0.50].

To determine whether use groups (non-users, nonmedical users, and medical users) differed on ADHD/ADD symptomology, an ANOVA with ADHD Rating Scale-IV scores as the DV was conducted. Medical non-users and medical misusers were not included in this analysis due to the low number of participants classified as each. The overall ANOVA, shown in Figure 2, was significant [$F(2, 644) = 20.19$, $p < .001$], and Bonferroni posthoc analyses demonstrated significantly lower ADHD Rating Scale-IV scores among non-users (M = 10.13, SD = 8.30) than nonmedical users (M=13.65, SD = 8.82; Cohen's $d = 0.41$) and significantly lower scores among non-users than medical users (M = 17.00, SD = 12.24; Cohen's $d = 0.66$). No differences in ADHD Rating Scale-IV scores were found between nonmedical users and medical users, however, the trend of ADHD Rating Scale-IV scores could be used as support for the idea that nonmedical users might possibly be self-medicating ADHD/ADD symptoms. (Insert Figure 2 here).

Phase II

Data for Phase II were collected between January 29, 2010, and March 25, 2010. This period of time overlapped with the midterm of the spring semester. No nonmedical users were able to refer an appropriate matched control, so controls were recruited using flyers posted in

public areas of campus, advertisements in psychology classes, advertisements at the end of the online survey used for Phase I, and word of mouth. One potential participant for the using group was ineligible for the study due to ADHD/ADD diagnosis, and three potential participants (two for the using group and one for the control group) scored above nine on the ADHD Rating Scale-IV and were excluded from participation.

On average, nonmedical users' urinalysis visits were at 1:27 p.m., and non-users visits were, on average, at 1:47 p.m. Among the 14 users, eight participants (57.14%) had at least one five-panel urine screen positive for amphetamine, and nine participants (64.29%) had at least one self-report of psychostimulant use. Among users only, five-panel tests for amphetamine were positive on 14.6% of the days, an average of fewer than one positive amphetamine screen per participant (.9), and users self-reported psychostimulant use on 24.4% of nights, or an average of 1.4 per user. For all participants in Phase II, self report of use or nonuse and five-panel urine screens for amphetamine matched on 94% of the days. On 4.2% of days, use of a psychostimulant was reported with no corresponding positive amphetamine screen on the same or subsequent day. In particular, one user reported taking Focalin (dexmethylphenidate) on two days, but had a negative urine screens, one user reported taking Adderall (*dl*-amphetamine) on two days with negative urine screens, and a third user reported taking Concerta (methylphenidate) on five days with negative urine screens. It is possible that participants believed they were using a psychostimulant, but were, in fact, using a different drug. Finally, positive five-panel urine screens for amphetamine were found on 1.9% of days with no participant self-report of psychostimulant use, with one participant screening positive on two days and two participants screening positive on one day each. All participants who had a positive GC/MS had at least one prior five-panel screen for amphetamine and prior self-report of

psychostimulant use. Of the 22 self-reported psychostimulant administrations, 16 (72.7%) occurred before 4:00 pm and six (27.3%) occurred after 4:00 pm.

Twenty-eight emerging adults (14 users and 14 non-users) participated. Users and non-users did not differ significantly on any demographic variables (see Table 2). Participants' sleep/wake patterns were objectively monitored for seven days and six nights via wrist actigraphy. Partial data from one participant who withdrew from the study after five days and four nights for personal reasons was included in analyses. Skew and kurtosis were calculated for all demographic variables and variables of interest. As with Phase I data, values above three were considered skewed or kurtotic (Field, 2005), and all variables were within this range.

Acebo and colleagues (1999) suggest that for adolescents, five to seven nights of recording are necessary to determine various values of sleep measures. Three users and three non-users had fewer than five sleep onset latency scores due to non-adherence to protocol instructions to push the event marker on the actigraph upon getting into bed. Therefore, data from these six participants were excluded from sleep onset latency scores only. However, these participants did complete the PDA-based sleep diary, permitting analyses of total sleep time and sleep efficiency.

To address *RQ*3, which examined how objective sleep measures differed between emerging adults who use psychostimulants nonmedically and emerging adults who do not use psychostimulants, a MANOVA was conducted using status (nonmedical user, non-user) as the IV and nighttime sleep measures (total sleep time, sleep efficiency, and sleep latency averaged over the week) as the DVs. Using the Wilks' lambda test statistic, the omnibus MANOVA was not significant [$F(3, 19) = 0.34$; $p = 0.80$].

A MANOVA with Wilks' lambda test statistic was used to examine the relation between sleep parameters (total sleep time and efficiency) and daily amphetamine results of the five-panel tests (positive or negative) among users only. Sleep onset latency was not included in these analyses due to the participant non-adherence to pushing the actigraph event marker, described above. When nocturnal sleep of all users was grouped according to nights following positive amphetamine urine screens versus nights following negative amphetamine urine screens (IV = positive, negative), there was not a statistically significant difference [F (2, 78) = 0.99; p = .38].

However, when all users' nights of sleep were grouped according to night preceding a positive amphetamine urine screen (IV = positive, negative) and examined nocturnal total sleep time and sleep efficiency, the overall MANOVA with Wilks' lambda test statistic was significant [F (2, 78) = 7.83; p < .01]. Follow-up ANOVAs showed no differences for sleep efficiency [F (1, 79) = 3.05; p = .09] on nights preceding a positive versus negative urine screen for amphetamine. However, total sleep time on nights preceding nonmedical psychostimulant use (M = 310.71, SD = 116.89) compared to nights not preceding nonmedical psychostimulant use (M = 419.63, SD = 87.69) was statistically significant [F (1, 79) = 15.06; p < 0.001; Cohen's d = 1.05].

Similarly, when users were grouped according to self-report of psychostimulant use on individual days (IV = used, did not use) and examined for differences in same-night nocturnal total sleep time and sleep efficiency, the overall MANOVA with Wilks' lambda test statistic was significant [F(2, 78) = 4.21; p < .05]. Again, follow-up ANOVAS showed no differences for sleep efficiency [F(1, 76) = .30; p = .58], but a significant difference was found for total sleep time in minutes among positive self-report nights (M = 347.86, SD = 102.67) and negative self-report nights (M = 419.94; SD = 93.99) [F(1, 79) = 8.47; p < .01; Cohen's d = 0.73].

To further investigate total sleep time differences, an ANOVA was conducted to examine whether non-users, users on nights following a positive amphetamine screen, and users on nights preceding a positive amphetamine screen differed on total sleep time. The overall ANOVA, outlined in Figure 3 , was significant [$F(2, 27) = 3.91$; $p < .05$], and post hoc tests with Bonferroni correction showed that total sleep time in minutes for non-users (M = 402.42, SD = 47.79) was significantly higher than total sleep time in minutes for users on nights preceding a positive amphetamine screen (M = 280.66, SD = 135.36; Cohen's $d = 1.20$). No group differences were found for total sleep time on nights following a positive amphetamine screen (M = 343.04, SD = 104.26). (Insert Figure 3 here.)

Seventeen participants (60.7%) had at least one scored nap period during the study, as defined in the Methods section. Of those participants who napped, the average number of naps for the week was 2.58 with an average nap time of 68.02 ($SD = 40.47$) minutes per nap. Nonmedical users and non-users did not differ on frequency of naps (χ^2 (1, $N = 28$) = 4.00, $p = .68$) or duration of naps [$t(44) = 1.53$, $p = .13$]. Among users, naps were not more frequent for days when psychostimulants were used versus days when psychostimulants were not used as measured with a positive or negative five-panel urine screen (χ^2 (1, $N = 102$), = .23, $p = .64$) or as measured with self-report of psychostimulant use (χ^2 (1, $N = 102$) = .30, $p = .59$). Also, naps were not more frequent on days following a positive or negative amphetamine urine screen (χ^2 (1, $N = 105$) = .03, $p = .87$) or self report of psychostimulant use (χ^2 (1, $N = 106$) = 1.01, $p = .32$).

All participants in Phase II completed the online survey administered to participants in Phase I. Group differences (users, non-users) for survey-based variables of interest (daily caffeine intake, overall scores on the ADHD Rating Scale-IV and PBI, and anxiety, stress, and depression scores on the DASS) were examined as seen in Table 3. Only anxiety and PBI scores

were significantly different for users and non-users, with users scoring higher than non-users on both measures. Higher anxiety scores on the DASS were correlated with longer sleep onset latency [r (23) = .61; $p < .01$], but not with total sleep time or sleep efficiency. PBI scores were not significantly correlated with any of the three sleep measures.

(Insert Table 3 here.)

Discussion

Phase I

Consistent with the *RQ*1 hypothesis, emerging adults were much more likely to engage in nonmedical use than adolescents. The finding that emerging adults are more likely to use psychostimulants nonmedically than adolescents is in line with differences in use rates among adolescents and emerging adults found in previous research that examined these age groups separately (Advokat et al., 2008; Low & Gendaszek, 2002; Poulin, 2001). Additionally, that emerging adults were more likely to employ psychostimulants nonmedically is in line with literature noting an increased availability, accessibility, and use of drugs and alcohol in college settings (Arnett, 2005; Prudhomme White et al. 2006; White, Fleming, Kim, Catalano, & McMorris, 2008). Though the completion rate of the survey for adolescents was low, the finding that no adolescents were classified as nonmedical users is quite surprising. Adolescents using psychostimulants nonmedically are more likely than adolescents using psychostimulants medically to engage in comorbid use of cigarettes, alcohol, and marijuana (Poulin, 2001). However, it is likely that the adolescents who self-selected to complete the survey are fundamentally different from adolescents who logged into the survey and did not complete it. Perhaps rates of nonmedical psychostimulant use for adolescents who logged into the survey and prematurely exited it are higher than rates among completers.

Furthermore, significant differences in sleep quality, as measured with the PSQI, were found with adolescents reporting better sleep quality than emerging adults, contrary to the first hypothesis for *RQ*2, and with non-users of psychostimulants reporting better sleep quality than nonmedical users, consistent with the third hypothesis for *RQ*2. These findings are in line with research demonstrating that college students often report insufficient sleep time and poor sleep quality (Carney et al., 2006; Forquer et al., 2008). Such sleep problems among college students have been linked to various health problems and risky behaviors such as drinking and smoking (Vail-Smith, Felts, & Becker, 2009). It is interesting that emerging adults report poorer sleep quality and significantly lower average sleep times than adolescents because adolescents experience a biological drive to stay up later and often experience sleep truncated due to school start times (Carskadon et al., 1993). Findings of lower sleep time and worse sleep quality among emerging adults than adolescents point to the need for research examining normative sleep phase shift among adolescents longitudinally and into emerging adulthood. Perhaps the biologically driven short sleep experienced in early adolescence becomes reinforced by environment (late night interactions with peers, studying, computer use, television) over time contributing to even shorter sleep during emerging adulthood.

We were unable to determine the interaction of age group and use because no adolescents reported nonmedical use. This lack of adolescent nonmedical users is likely a result of the low number of adolescents completing the online survey. Again, it might also be positive news that of those adolescents participating in this study, none reported nonmedical use.

Both medically approved users and nonmedical users reported significantly poorer sleep quality than non-users. This finding, in combination with the fact that both medically approved users and nonmedical users demonstrated significantly higher levels of ADHD/ADD symptoms

than non-users suggests that differences in sleep quality among these groups could be attributed to either psychostimulant use or to ADHD/ADD symptomology. Research has found that adults with diagnosed ADHD/ADD demonstrated better sleep efficiency and subjective sleep quality after treatment with psychostimulants compared to pre-treatment (Sobanski et al., 2008).

Phase II

For *RQ*3, it was hypothesized that nonmedical psychostimulant users would have shorter total sleep times, lower levels of sleep efficiency and longer sleep onset latency than non-users. In the examination of *RQ*3, no differences were found for total sleep time, sleep efficiency, or sleep latency among users and non-users of psychostimulants. In itself, this lack of significant findings for this analysis is interesting. This result suggests that overall those participants choosing to abstain from psychostimulant use are not experiencing significantly better or worse sleep than those participants using psychostimulants illicitly. It might be that any changes in the sleep measures attributable to psychostimulant use are so small that, when averaged with nights users did not use, those effects were washed out. However, it is possible that college students, regardless of drug use status, have such poor and disturbed sleep that any detrimental effects of psychostimulants on sleep are inconsequential, as suggested by other studies examining college students' sleep (Carney et al., 2006; Forquer, Camden, Gabriau, & Johnson, 2008, Lund, Reider, Whiting, & Prichard, 2010). A more nuanced interpretation of sleep time emerged from secondary data analyses.

Surprisingly, in a separate analysis of sleep among users only, no differences were found in total sleep time or sleep efficiency for users on nights following a positive amphetamine screen versus nights following a negative amphetamine screen. However, a significant difference in sleep measures was found for nights following self-reported psychostimulant use. Total sleep

time was significantly shorter on nights following self-reported psychostimulant use than nights following no self-report of use. A review article by Banks and Dinges (2007) suggests that sleep debt accrued by obtaining seven or fewer hours of sleep on a regular basis is linked decrements in response time, cognitive performance, and health. College students are likely to be carrying a significant sleep debt (Carney et al., 2006). Therefore, what may seem like a small reduction in users' sleep time might have real world ramifications. An additional analysis comparing total sleep time among non-users, users on nights following a positive amphetamine screen, and users on nights preceding a positive amphetamine screen demonstrated that non-users obtained significantly more total sleep time than users on nights preceding a positive screen. However, neither of these groups had significantly different total sleep times than users on nights following a positive amphetamine screen. One might suspect that some users take psychostimulants at night to prolong wakefulness and truncate the sleep period due to obligations the following day (class, work, etc.), which is not uncommon among adolescents and emerging adults (Carney et al., 2006; Wolfson & Carskadon, 1998). However, the majority of self-reported psychostimulant use occurred before 4:00 pm suggesting that users took the psychostimulants to compensate for poor or insufficient sleep on the previous night. Additionally, a significant difference in sleep measures for the night preceding a positive amphetamine screen versus all other nights was found among users. Specifically, on the night *preceding* a positive amphetamine screen, users' total sleep time was lower than other nights during the study.

It is curious that these users did not demonstrate statistically significant longer sleep times on nights after positive screens, which would indicate a rebound effect. Rather, it seems that the sleep lost when users take psychostimulants nonmedically is part of a larger sleep debt not being "paid off" which could have effects on daily functioning including test performance

(Carskadon et al., 2004; O'Brien & Mindell, 2005; Wolfson & Carskadon, 1998). This lack of sleep debt being "paid off" is supported by the fact that, among users, naps were no more likely on days when psychostimulants were taken or days following psychostimulant administration (as measured with a urine screen or self-report) than days when psychostimulants were not taken (again, as measured with a urine screen or self-report).

Previous research has indicated that insufficient sleep among adolescents and young adults is related to poor grades, mood disturbance, decreased reaction times, and behavior problems (Carskadon, 1990; Carskadon et al., 2004; Dinges, et al., 1997; O'Brien & Mindell, 2005; Wolfson & Carskadon, 1998). For Phase II of this study, users reported higher levels of problem behaviors and higher levels of anxiety than non-users, supporting those previous findings. Higher levels of problem behavior among users than non-users was not unexpected because, by definition, each participant enrolled as a nonmedical psychostimulant user was engaging in illicit drug use. Additionally, higher PBI scores among users than non-users might be driven by items concerning aggressive behaviors, as previous research has implied a relation between low total sleep time among drug users and aggressive thoughts and behaviors (Haynes et al., 2006). High levels of anxiety were also correlated with longer sleep latency. Though causation cannot be determined using the current data, it is possible that higher levels of anxiety exist among users leading to longer sleep latencies and, thus, poor sleep. Users may be utilizing psychostimulants to combat the daily dysfunction associated with this poor sleep. However, it is also possible that use of stimulants is causing high levels of perceived anxiety or that some other variable, such as stress from school, leads to high levels of anxiety and subsequent psychostimulant use.

Correspondence of participant self-report of psychostimulant use and subsequent five-panel urine screens for amphetamine was quite high, and there were very few instances of positive urine screens for amphetamine with no participant self-report of use or self-report without a positive urine screen. Prior research indicated that when participants know that researchers have the results of urinalyses, they are much more likely to report use accurately (Hamid, Deren, Beardsley, & Tortu, 1999). Additionally, participants in Phase II of the study were informed about the Certificate of Confidentiality protecting their personal information including that of illegal drug use, which likely encouraged honest reporting. Future studies examining psychostimulant use would benefit from utilizing five-panel urine screens, which are relatively inexpensive, to ensure honest reporting among participants. Some participants self-reported psychostimulant use without a corresponding positive urine screen. This lack of correspondence suggests that nonmedical users might be ingesting any number of drugs without knowing what they are taking, adding an addition level of risk to taking unprescribed psychostimulant drugs.

No significant differences were found for ADHD/ADD symptomology, depression, stress, or grade point average (GPA) when psychostimulant users and non-users were compared. Because we screened for ADHD/ADD symptomology and matched on variables such as age, GPA, and gender, the lack of significant differences between users and non-users was expected. However, it is interesting to note that at the end of the study, users reported average ADHD Rating Scale-IV scores higher than the pre-study enrollment criteria cutoff of nine. Furthermore, users were no more likely than non-users to report high levels of mood disturbance in the form of stress or depression, as would be expected according to previous study results. However, these measures were completed by participants on the final day of the study. Future research in this

area would benefit from administering daily measures of mood disturbance, fatigue, and performance to better determine whether the low levels of total sleep time associated with nonmedical use has an effect on measures of daily functioning.

Limitations

The primary limitation of Phase I was the relatively small sample size of adolescents. Though many different methods and strategies to recruit high school students were used, it proved difficult to obtain complete data for these participants. Even with significant compensation, it was challenging getting adolescents to voluntarily complete the survey, which lasted approximately 30 minutes. The small sample size of adolescents resulted in a lack of adolescent participants reporting nonmedical use, which considerably limited our ability to adequately compare adolescent and emerging adult nonmedical users. Perhaps future studies would benefit by offering a smaller reinforcement guaranteed to each participant completing the survey.

One major limitation of Phase II was the lack of experimental control. Ideally, both users and non-users would be recruited for this study, and would be put on an alternating schedule of psychostimulant use and nonuse. Examining nonmedical psychostimulant use experimentally would allow researchers to determine whether non-users would display patterns of sleep disturbance similar to that of users and vice versa. Additionally, the time course of psychostimulants for each participant could not be determined because of different dosages taken, which were often unreported or of time-release versions halved, in addition to the weight and tolerance of each participant. Each of these factors affecting time course contributed to the difficulty attributing differences in sleep measures to use or nonuse of psychostimulants. Furthermore, it would be interesting to include participants with high levels of ADHD/ADD

symptomology and participants with diagnosed ADHD/ADD to examine whether these two groups would demonstrate similar sleep patterns.

Additionally, the cross-sectional nature of this study limits interpretation of some results such as findings concerning differences in anxiety levels among users and non-users and the correlation of high anxiety with longer sleep latencies. A longitudinal design might have allowed for an examination of the change in anxiety scores, sleep measures, and use over time, perhaps capturing variables linked to subsequent nonmedical medical use or protective factors related to nonuse of these drugs. It might also be interesting to include period measures of daily functioning, such as the psychomotor vigilance test, which is an objective measure of reaction times. Furthermore, had equipment been downloaded daily during each urinalysis visit, researchers would have been able to check PDAs and actigraphs for protocol adherence. For example, daily downloads would have provided an opportunity to check whether participants pushed the event marker upon lights out each night. Future studies should take this into consideration and base data analyses on number of usable nights of data. Because of this restriction, we lacked sufficient data to examine sleep onset latency among users.

Summary

Subjective results support the idea that emerging adults are more likely than adolescents to use psychostimulants nonmedically. Moreover, emerging adults who use psychostimulants either medically or nonmedically experienced poorer sleep quality and higher levels of ADHD/ADD symptoms than emerging adults who did not use psychostimulants. Findings from the objective portion of this study suggest that when users experience shortened total sleep time, they use psychostimulants nonmedically to deal with the fatigue and daytime dysfunction that accompanies sleep loss. Perhaps there is a paradoxical effect of psychostimulant drugs on sleep

such that some sleep measures are improved among those diagnosed with ADHD/ADD using the drugs as prescribed – at appropriate times, in approved quantities, in the approved manner of administration – as suggested by Sobanski and colleagues (2007), but other sleep measures deteriorate when psychostimulants are used by those without ADHD/ADD and/or those with ADHD/ADD but not as prescribed – close to bedtime, in inappropriate quantities, administering the drugs in unapproved ways. In order to best understand this, future objectively based research in this area should include participants with an ADHD/ADD diagnosis who both use and do not use their prescribed drugs according to their prescription.

In sum, no group differences were found on objective sleep measures (total sleep time, sleep efficiency, or sleep latency) among psychostimulant users and non-users. However, among users, total sleep time was shorter on nights following self-report of psychostimulant use compared to nights following self-report of nonuse. Total sleep time was also shorter among users on nights preceding a urine screen positive for amphetamine as compared to nights preceding a negative urine screen for amphetamine but not on nights following a positive screen. These results in combination with the fact that users generally reported administration of psychostimulants before 4:00 p.m. suggest that users take psychostimulant drugs to combat the detrimental effects of lower total sleep time on the previous night.

This study adds to the current literature in the areas of psychostimulant misuse and sleep. Specifically, this study demonstrated differences in rates of nonmedical psychostimulant use and in sleep quality among adolescents and emerging adults measured concurrently and with the same measures, which had not been done before. Furthermore, the current study was the first to measure both sleep and nonmedical psychostimulant use objectively with emerging adults, thus

improving our understanding of the relation between sleep and nonmedical use of prescription stimulants among college students, who are at a great risk to engage in nonmedical use.

Based on this and previous research, several new avenues of research examining both sleep and nonmedical psychostimulant use among adolescents and emerging adults needs to be considered. First, future studies utilizing objective measures of sleep and psychostimulants should include adolescents and emerging adults with a diagnosis of ADHD/ADD for a clearer picture of how these drugs relate to sleep measures. Additionally, studies including people with a diagnosis of ADHD/ADD should closely examine adherence to prescription details. For example, it would be interesting to understand differences in sleep measures and impulsivity among young people diagnosed with ADHD/ADD who take their prescription as instructed and young people who skip administrations and/or hoard their prescription for future use.

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Table 1.

Demographic Characteristics of Subjective Participants (Phase I)

Variable	Adolescents (n=62)	Emerging adults (n=583)	χ^2
Use category			51.51***
Non-user	56 (90.4%)	441 (75.6%)	
Nonmedical user	0 (0.0%)	76 (13.0%)	
Medical user	0 (0.0%)	61 (10.5%)	
Medical non-user	3 (4.8%)	5 (0.9%)	
Medical misuser	3 (4.8%)	0 (0.0%)	
Year in School			
Freshman	12 (19.4%)	59 (10.1%)	
Sophomore	14 (22.6%)	271 (46.4%)	
Junior	16 (25.8%)	143 (24.5%)	
Senior	20 (32.3%)	111 (19.0%)	
Gender			8.83**
Female	38 (61.3%)	457 (78.1%)	
Male	24 (38.7%)	128 (21.9%)	
Ethnicity			2.87
Caucasian	53 (86.9%)	539 (91.7%)	
African American	2 (3.3%)	20 (3.4%)	
Hispanic	1 (1.6%)	7 (1.2%)	
Other	5 (8.2%)	22 (3.7%)	

Variable	Adolescents (n=62)	Emerging adults (n=583)	χ^2
GPA			8.96
3.5-4.0	34 (54.8%)	212 (36.1%)	
3.0-3.49	16 (25.8%)	205 (34.9%)	
2.5-2.99	9 (14.5%)	128 (21.8%)	
2.0-2.49	2 (3.2%)	36 (6.1%)	
Less than 2.0	1 (1.6%)	6 (1.0%)	
Fraternity or sorority			
Yes	0 (0.0%)	74 (12.8%)	
No	62 (100.0%)	506 (87.2%)	
Parental Marital Status			2.09
Married	38 (61.3%)	365 (62.3%)	
Divorced	15 (24.2%)	151 (25.8%)	
Separated	0 (0.0%)	10 (1.7%)	
Never Married	9 (14.5%)	60 (10.2%)	
Father education level			1.42
Some high school	4 (6.6%)	25 (4.3%)	
High school	17 (27.9%)	163 (27.8%)	
Some college	12 (19.7%)	118 (20.1%)	
College	15 (24.6%)	161 (27.4%)	
Post secondary	13 (21.3%)	115 (19.6%)	
Unknown	0 (0.0%)	5 (0.8%)	

Variable	Adolescents (n=62)	Emerging adults (n=583)	χ^2
Mother education level			7.50
Some high school	1 (1.6%)	12 (2.0%)	
High school	10 (16.4%)	151 (25.7%)	
Some college	11 (18.0%)	117 (19.9%)	
College	18 (29.5%)	186 (31.7%)	
Graduate school	21 (34.4%)	119 (20.3%)	
Unknown	0 (0.0%)	2 (0.3%)	
Desired education level			25.15***
Some high school	2 (3.2%)	0 (0.0%)	
High school	0 (0.0%)	5 (0.9%)	
Some college	1 (1.6%)	25 (4.3%)	
College	20 (32.3%)	120 (20.4%)	
Graduate school	39 (62.9%)	438 (74.5%)	
Living arrangement			364.71***
With parents	56 (90.3%)	32 (5.4%)	
With other relative	2 (3.2%)	8 (1.4%)	
With legal guardian	2 (3.2%)	1 (0.2%)	
Independently	1 (1.6%)	448 (76.2%)	
Residence hall	1 (1.6%)	85 (14.5%)	
Sorority/fraternity	0 (0.0%)	14 (2.4%)	

* $p<.05$, ** $p<.01$, ***$p<.001$

Table 2.

Comparison of Phase II Demographics for Users and Non-users with Frequencies and Percents

Variable	Users (n = 14)	Non-users (n = 14)	χ^2
Year in School			2.3
Freshman	8 (57.1%)	9 (64.3%)	
Sophomore	2 (14.3%)	2 (14.3%)	
Junior	2 (14.3%)	0 (0.0%)	
Senior	2 (14.3%)	3 (21.4%)	
Gender			0.0
Female	10 (71.4%)	10 (71.4%)	
Male	4 (28.6%)	4 (28.6%)	
Ethnicity			0.0
Caucasian	13 (92.9%)	13 (92.9%)	
Other	1 (7.1%)	1 (7.1%)	
GPA			4.9
3.5-4.0	3 (21.4%)	5 (35.7%)	
3.0-3.49	4 (28.6%)	2 (14.3%)	
2.5-2.99	7 (50.0%)	4 (28.6%)	
2.0-2.49	0 (0.0%)	2 (14.3%)	
Less than 2.0	0 (0.0%)	1 (7.1%)	

Variable	Users (n = 14)	Non-users (n = 14)	χ^2
Fraternity or sorority			2.2
Yes	2 (14.3%)	0 (0.0%)	
No	12 (85.7%)	14 (100.0%)	
Parental Marital Status			1.7
Married	7 (50.0%)	7 (50.0%)	
Divorced	6 (42.9%)	4 (28.6%)	
Separated	1 (7.1%)	2 (14.3%)	
Never Married	0 (0.0%)	1 (7.1%)	
Father education level			4.5
Some high school	0 (0.0%)	1 (7.1%)	
High school	5 (35.7%)	6 (42.9%)	
Some college	3 (21.4%)	1 (7.3%)	
College	4 (28.6%)	6 (42.9%)	
Graduate school	2 (14.3%)	0 (0.0%)	
Mother education level			2.0
Some high school	0 (0.0%)	1 (7.1%)	
High school	5 (35.7%)	3 (21.4%)	
Some college	3 (21.4%)	2 (14.3%)	
College	5 (35.7%)	7 (50.0%)	
Graduate school	1 (7.1%)	1 (7.1%)	

Variable	Users (n = 14)	Non-users (n = 14)	χ^2
Desired education level			1.3
Some high school	0 (0.0%)	0 (0.0%)	
High school	0 (0.0%)	0 (0.0%)	
Some college	1 (7.1%)	0 (0.0%)	
College	5 (35.7%)	4 (28.6%)	
Post secondary	8 (57.1%)	10 (71.4%)	
Living arrangement			0.0
Independently	5 (35.7%)	5 (35.7%)	
Residence hall	9 (64.3%)	9 (64.3%)	

Table 3.

Comparison of Phase II Users and Non-users of Psychostimulants on Survey Variables

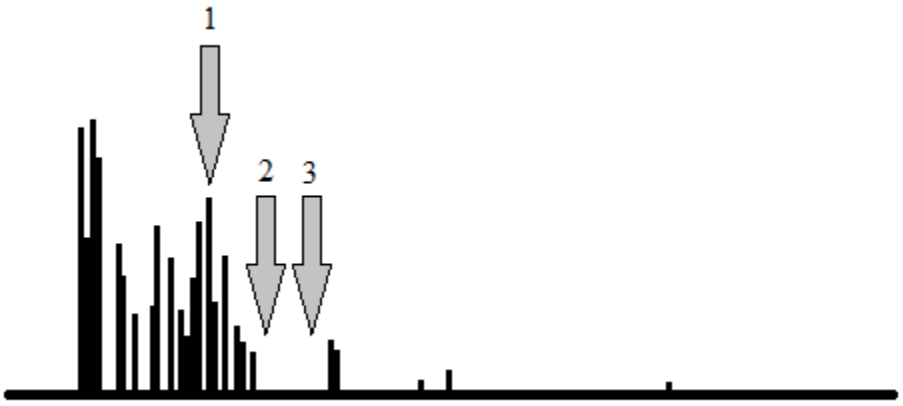
Variable	Non-users (n=14)	Users (n=14)	F	Cohen's *d*
	Mean (SD)	Mean (SD)		
DASS-depression	3.00 (7.13)	3.14 (3.86)	0.04	
DASS-anxiety	1.21 (0.89)	4.86 (5.30)	6.42*	.96
DASS-stress	3.86 (4.02)	8.00 (7.89)	3.01	
ADHD Rating Scale-IV	6.64 (4.96)	12.29 (9.93)	3.62	
PBI	5.14 (5.19)	13.50 (10.96)	6.65*	.97
Daily Caffeine (mg)	465.21 (646.11)	492.40 (650.18)	0.01	

Note. DASS=Depression, Anxiety, and Stress Scale, PBI = Problem Behavior Inventory.

*$p < .05$.

Figure 1.

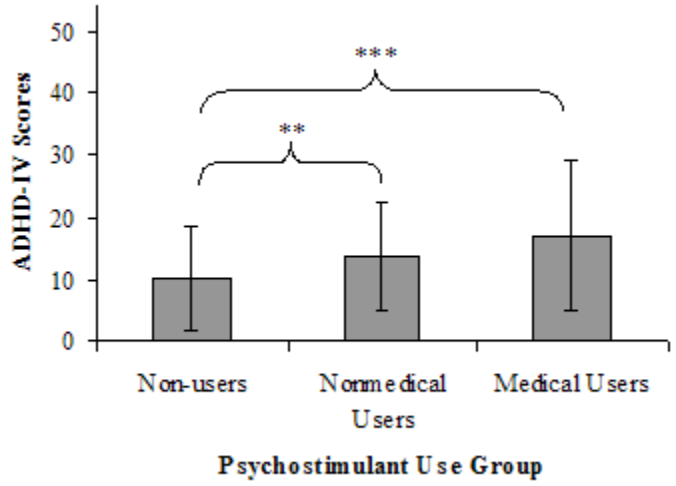
Diagram Denoting How Sleep and Wake Times were Marked on Actigraphy using the PDA-based Sleep and Wake Diary



Note. Each upward inflection represents activity level during a 15 second epoch as measured with an actigraph. Arrow 1 represents the time on the PDA marked as the beginning of the sleep period by the participant. To score the beginning of the sleep period, the researcher finds an eight epoch (two minute) period following Arrow 1. This period is represented with Arrows 2 and 3. The sleep period is then marked at the beginning of this eight epoch period (at Arrow 2).

Figure 2.

ADHD/ADD Symptoms among Non-users, Nonmedical Users, and Medical Users of Psychostimulants

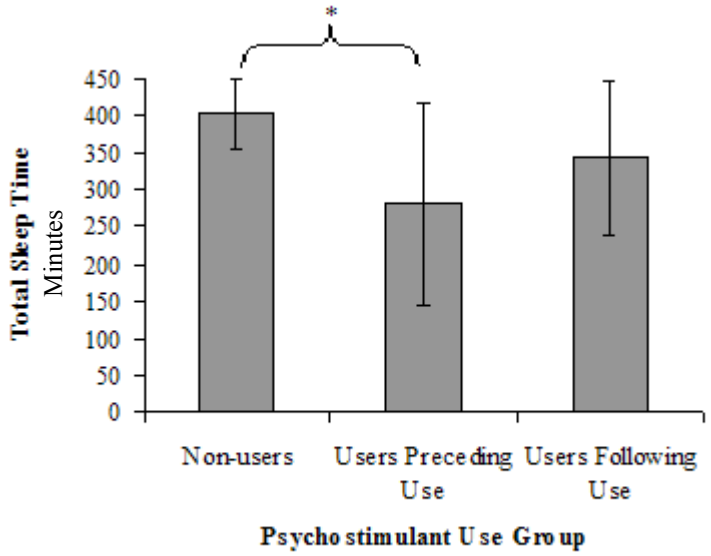


Note. Error bars represent standard deviation.

$^{**}p < .01$, $^{***}p < .001$.

Figure 3.

Comparison of Total Sleep Time for Non-users, Users on Nights Preceding Psychostimulant Use, and Users on Nights Following Psychostimulant Use



Note. Error bars represent standard deviation. Total sleep time is measured in minutes for nights preceding or following use among users and is averaged across six nights for non-users.

*$p < .05$

Appendix A

7. Demographic information

1. Current year in school

- ○ Freshman
- ○ Sophomore
- ○ Junior
- ○ Senior

2. How old are you?

	Age
Age	

3. Gender

- ○ Female
- ○ Male

4. Ethnicity

- ○ White Non Hispanic
- ○ Black or African American
- ○ Hispanic
- ○ Other

5. Most recent term Grade Point Average (GPA) unweighted

- ○ 3.5-4.0
- ○ 3.0-3.49
- ○ 2.5-2.99
- ○ 2.0-2.49
- ○ Less than 2.0

6. What was your score on

	SAT WITHOUT writing section (before 2006)	SAT WITH writing section (2006 and after)	ACT
score			

7. Are you a member of a Greek Society?

- Yes
- No
- Not applicable

8. How many siblings do you have?

siblings

siblings

9. Are your parents

- Married
- Divorced
- Never Married
- Separated

10. What is the highest level of education your father completed?

- Some high school
- High school
- Some college
- College
- Graduate or professional school
- I don't know

11. What is the highest level of education your mother completed?

- Some high school
- High school
- Some college
- College
- Graduate or professional school
- I don't know

12. Do you go to bed around the same time every night?

- No
- Yes

13. If yes, around what time do you go to bed?

	Hour	Minute	AM/PM
Time			

14. What is your housing arrangement?

- With my parents
- With a relative - not my parents
- With a legal guardian
- On my own in a house/apartment
- In a residence hall
- In a sorority/fraternity house
- Other

Other (please specify)

15. Have you ever been diagnosed with Attention-Deficit/Hyperacitivity Disorder (ADHD)?

- Yes
- No

16. Do you have a job

- Yes (If yes, specify hours below)
- No

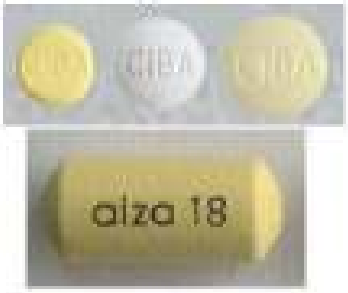
If yes, about how many hours do you work each week (please use numbers only)

17. What is the highest level of education you hope to complete?

- Some high school
- High school
- Some college
- College
- Graduate or professional school

8. Drug use

This is a picture of Ritalin, Concerta (methylphenidates)



1. When, if ever, have you taken Ritalin, Concerta (methylphenidate)?

- ○ Never
- ○ Currently using
- ○ Used in the past month
- ○ Used in the past year

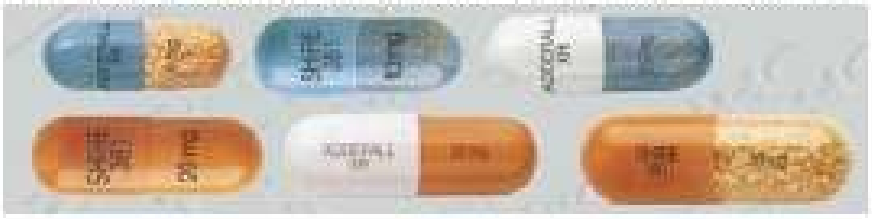
2. If/when you used Ritalin/Concerta (methylphenidates)

How many times do/did you use it EACH WEEK?	☐
How long have you been/did you use it (in MONTHS)	☐

3. Do you think it is OK to use Ritalin, Concerta (methylphenidates) if it was not prescribed to you?

- ○ No
- ○ Yes
- ○ Yes, if used for good reasons like studying

This is a picture of Adderall (mixed-salt amphetamine)



4. When, if ever, have you taken Adderall (mixed-salt amphetamine)?

- ○ Never
- ○ Currently using
- ○ Used in the past month
- ○ Used in the past year

5. If/when you used Adderall (mixed-salt amphetamine)

How many times do/did you use it EACH WEEK?	
How long have you been/did you use it (in MONTHS)	

6. Do you think it is OK to use Adderall (mixed-salt amphetamine) if it was not prescribed to you?

- ○ No
- ○ Yes
- ○ Yes, if used for good reasons like studying

This is a picture of Dexedrine, Dextrostat (dextroamphetamine)

7. When, if ever, have you taken Dexedrine, Dextrostat (dextroamphetamine)?

- ○ Never
- ○ Currently using
- ○ Used in the past month
- ○ Used in the past year

8. If/when you used Dexedrine, Dextrostat (dextroamphetamine)

How many times do/did you use it EACH WEEK?

How long have you been/did you use it (in MONTHS)

9. Do you think it is OK to use Dexedrine, Dextrostat (dextroamphetamine) if it was not prescribed to you?

- No
- Yes
- Yes, if used for good reasons like studying

This is a picture of Provigil/Nuvigil (modafinil)

10. When, if ever, have you taken Provigil, Nuvigil (modafinil)?

- Never
- Currently using
- Used in the past month
- Used in the past year

11. If/when you used Provigil, Nuvigil (modafinil)

How many times do/did you use it EACH WEEK?

How long have you been/did you use it (in MONTHS)

12. Do you think it is OK to use Provigil, Nuvigil (modafinil) if it was not prescribed to you?

- ○ No
- ○ Yes
- ○ Yes, if used for good reasons like studying

9. Drug use 2

1. When, if ever, have you taken caffeine pills?

- ○ Never
- ○ Currently using
- ○ Used in the past month
- ○ Used in the past year

2. If/when you used caffeine pills

How many times do/did you use it EACH WEEK?	
How long have you been/did you use it (in MONTHS)	

3. Do you think it is OK to use caffeine pills?

- ○ No
- ○ Yes
- ○ Yes, if used for good reasons like studying

4. When, if ever, have you used caffeinated drinks (e.g. soda pop, coffee, tea, Red Bull, 5-hour Energy)?

- ○ Never
- ○ Currently using
- ○ Used in the past month
- ○ Used in the past year

5. If/when you used caffeinated drinks (e.g. soda pop, coffee, tea, Red Bull, 5-hour Energy)

How many times do/did you use it EACH WEEK?

How long have you been/did you use it (in MONTHS)

6. Do you think it is OK to use caffeinated drinks (e.g. soda pop, coffee, tea, Red Bull, 5-hour Energy)?

- No
- Yes
- Yes, if used for good reasons like studying

7. When, if ever, have you used cigarettes?

- Never
- Currently using
- Used in the past month
- Used in the past year

8. If/when you used cigarettes

How many times do/did you use it EACH WEEK?

How long have you been/did you use it (in MONTHS)

9. Do you think it is OK to use cigarettes?

- No
- Yes
- Yes, if used for good reasons

10. When, if ever, have you used alcohol?

- ○ Never
- ○ Currently using
- ○ Used in the past month
- ○ Used in the past year

11. If/when you used alcohol

How many times do/did you use it EACH WEEK?	☐
How long have you been/did you use it (in MONTHS)	☐

12. Do you think it is OK to use alcohol?

- ○ No
- ○ Yes
- ○ Yes, if used for good reasons

13. When, if ever, have you used marijuana?

- ○ Never
- ○ Currently using
- ○ Used in the past month
- ○ Used in the past year

14. If/when you used marijuana

How many times do/did you use it EACH WEEK?	☐
How long have you been/did you use it (in MONTHS)	☐

15. Do you think it is OK to use marijuana?

- ○ No
- ○ Yes
- ○ Yes, if used for good reasons

10. Psychostimulant use

Please answer the following questions ONLY if you have EVER used Ritalin, Concerta (methylphenidates), Adderall (mixed-salt amphetamine), Dexedrine, Dextrostat (dextroamphetamine), Provigil, Nuvigil (modafinil).

1. How did you take these drugs? (check all that apply)

- [ ] orally (mouth)
- [ ] nasally (nose)
- [ ] injection

2. Why have you used these drugs? (check all that apply)

- [ ] I have a prescription
- [ ] to help me concentrate and increase alertness
- [ ] to enhance my work/study performance
- [ ] to counteract other drugs
- [ ] to give me a high
- [ ] curiosity/experimentation
- [ ] social reasons
- [ ] as a weight loss method
- [ ] to help me sleep
- [ ] other

Other (please specify)

3. How did you obtain these drug(s)? (check all that apply)

- [ ] prescribed to me for real symptoms and taken as recommended
- [ ] prescribed to me for real symptoms and NOT taken as recommended
- [ ] prescribed to me for made-up symptoms
- [ ] prescribed to a friend and given or sold to me
- [ ] prescribed to a family member

4. If you have a prescription for these drug(s), have you ever given or sold your drug(s) to someone else?

- ○ Yes
- ○ No
- ○ Not applicable

5. If you have a prescription for these drug(s), have you ever taken more pills than prescribed at once?

- ○ Yes
- ○ No
- ○ Not applicable

6. If you have a prescription for these drug(s), have you ever taken your drugs more frequently than prescribed?

- ○ Yes
- ○ No
- ○ Not applicable

11. PSQI

The following questions relate to your usual sleep habits during the PAST MONTH ONLY. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, when have you usually gone to bed at night?

	Hour	Minute	AM/PM
Usual bed time:			

2. During the past month, how long has it usually taken you to fall asleep each night?

	Minutes
Number of minutes:	

3. During the past month, when have you usually gotten up in the morning?

	Hour	Minute	AM/PM
Usual getting up time:			

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.)

	Hours	Minutes
Hours of sleep per night:		

5. For each of the following questions, check the one best response. Please answer all questions.

During the past month, how often have you had trouble sleeping because you...

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a) Cannot get to sleep within 30 minutes	○	○	○	○
b) Wake up in the middle of the night or early morning	○	○	○	○
c) Have to get up to use the bathroom	○	○	○	○
d) Cannot breathe comfortably	○	○	○	○
e) Cough or snore loudly	○	○	○	○
f) Feel too cold	○	○	○	○
g) Feel too hot	○	○	○	○
h) Had bad dreams	○	○	○	○
i) Have pain	○	○	○	○
j) Other reason(s)	○	○	○	○

Other (please specify) _____

6. During the past month, how would you rate your sleep overall?

○ Very good

○ Fairly good

○ Fairly bad

○ Very bad

7. During the past month...

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
How often have you taken medicine (prescribed or "over the counter") to help you sleep?	○	○	○	○
How often have you had trouble staying awake while driving, eating meals, or engaging in social activity?	○	○	○	○

8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

- ○ No problem at all
- ○ Only a very slight problem
- ○ Somewhat of a problem
- ○ A very big problem

12. ADHD Rating Scale - IV

Mark the option that best described your behavior over the past week.

1. Mark the option that best describes your behavior over the past week.

	Never or Rarely	Sometimes	Often	Very Often
1. Fail to give close attention to details or make careless mistakes in schoolwork.	○	○	○	○
2. Fidget with hands or fee or squirm in seat.	○	○	○	○
3. Have difficulty sustaining attention in tasks or activities.	○	○	○	○
4. Leave seat in classroom or in other situations in which remaining seated is expected.	○	○	○	○
5. Do not listen when spoken to directly.	○	○	○	○
6. Run about or move around excessively in situations when it is inappropriate.	○	○	○	○
7. Don't follow through on instructions and fail to finish work.	○	○	○	○
8. Have difficulty engaging in leisure activities quietly.	○	○	○	○
9. Have difficulty organizing tasks and activities.	○	○	○	○
10. Are "on the go" or act as if "driven by a motor."	○	○	○	○
11. Avoid tasks (e.g., schoolwork, homework) that requires sustained mental effort.	○	○	○	○
12. Talk excessively.	○	○	○	○
13. Lose things necessary for tasks or activities.	○	○	○	○
14. Blurt out answers before questions have been completed.	○	○	○	○
15. Are easily distracted.	○	○	○	○
16. Have difficulty waiting turn.	○	○	○	○
17. Are forgetful in daily activities.	○	○	○	○
18. Interrupt or intrude on others.	○	○	○	○

13. Adolescent Sleep, Caffeine Intake, and Technology Use Questionnaire

1. On a school night, what time do you usually go to bed?

	Hour	Minute	AM/PM
Time			

2. On a weekend night, what time do you usually go to bed?

	Hour	Minute	AM/PM
Time			

3. Have you ever had difficulty with falling asleep or sleeping through the night on weekdays?

- Yes
- No (If no, skip to Question #5)

4. If yes, how often?

- Not applicable
- 1 day/week
- 2 days/week
- 3 days/week
- 4 days/week
- 5 days/week
- 6 days/week
- 7 days/week

5. Have you ever had difficulty with falling asleep or sleeping through the night on weekends?

- Yes
- No (If no, skip to Question #8)

6. If yes, how often?

- Not applicable
- 1 day/week
- 2 days/week
- 3 days/week
- 4 days/week
- 5 days/week
- 6 days/week
- 7 days/week

7. If you have difficulty falling asleep or sleeping through the night, what do you think may cause difficulty falling asleep? (Check best response(s))

- [ ] Stress at school
- [ ] Stress at home
- [ ] Relationship with peers
- [ ] Relationship with family
- [ ] Eating habits
- [ ] Too many drinks with caffeine
- [ ] Sleep habits
- [ ] A physical issue
- [ ] Too much homework
- [ ] Other

Other (please specify)

8. Do you have a television in your room?

- ○ Yes
- ○ No

9. Do you have a computer in your bedroom?

- ○ Yes
- ○ No

10. Do you own a cell phone?

- ○ Yes
- ○ No

11. Do you own an iPod or MP3 player?

- ○ Yes
- ○ No

12. After 9 pm at night, do you do any of the following: mark all that apply, providing the number of hours each night

	Hours each night
Watch TV	
Texting friends	
Online with friends (IM, Facebook, MySpace)	
Talking on the phone	
Playing computer games	
Watching DVD/videos	
Listening to iPod/PodCast	
Homework	
Other	

13. What time do you wake up on school days

	Hour	Minute	AM/PM
Range from			
to			

14. How do you wake up in the morning? (Check all methods that you use to wake up.)

- ☐ Household morning noise
- ☐ My alarm (clock, iPod, Blackberry, etc.) wakes me up
- ☐ Pet wakes me up
- ☐ I wake up on my own
- ☐ My parents/roomate wakes me up

15. If you use an alarm, how many times do you reset it before you wake up? (Check all that apply)

- ☐ 1-2 times
- ☐ 2-3 times
- ☐ 3-4 times
- ☐ 4-5 times

16. Do you find it hard to stay awake during the day?

- ○ Yes
- ○ No

17. If you find it hard to stay awake during the day, do you have a hard time staying awake in school?

- Yes
- No
- Not applicable

18. During a school day, how many times a day do you usually fall asleep during classes? (If none, put zero)

- 0
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10

19. If you have a hard time staying awake in school, what time of the day do you find that you are most sleepy DURING SCHOOL and have trouble staying awake?

- before lunch
- after lunch
- not applicable

20. Do you come home and take naps during the week, after school?

- Yes
- No

21. Do you ever take naps on the weekend?

- Yes
- No

22. Do you ever drink any drinks with caffeine?

- Yes
- No

23. How many caffeinated beverages will you have each day, if any? Please mark how many of each and mark the size of the cup, bottle, or can.

	# of cans or cups each day	size
Tea-Regular/Iced		
Coffee-Regular/Iced		
Cappuccino or Latte		
Iced frappucino-type drink		

24. How many caffeinated beverages will you have each day, if any? Please mark how many of each and mark the size of the cup, bottle, or can.

	# of cans or cups each day	size
CocaCola - Regular/Flavored/Diet/Zero		
Mountain Dew or Mountain Dew AMP		
Dr. Pepper - Regular/Flavored/Diet		
Pepsi - Regular/Flavored/Diet/Zero		

25. How many caffeinated beverages will you have each day, if any? Please mark how many of each and mark the size of the cup, bottle, or can.

	# of cans or cups each day
Full Throttle (16 ounces)	
Vault (16 ounces)	
Red Bull (10 ounces)	
Bawls (10 ounces)	
AMP Energy Drink (8 ounces)	
KMX, Orange or Blue (8 ounces)	
Fuze (18 ounces)	
Boo-Koo (24 ounces)	

26. How many caffeinated beverages will you have each day, if any? Please mark how many of each and mark the size of the cup, bottle, or can.

	# of cans or cups each day	size
Monster		

27. How many caffeinated beverages will you have each day, if any? Please mark how many of each and mark the size of the cup, bottle, or can.

	# of cans or cups each day	size
Jolt		

28. How many caffeinated beverages will you have each day, if any? Please mark how many of each and mark the size of the cup, bottle, or can.

	# of cans or cups each day	size
SoBe Adrenaline Rush		

14. ASCITUS part 2

1. Do you take any of these other forms of caffeine?

	Number each day
Rocket chocolates	
NoDoz or other caffeine tablets	
other	

Other (please specify)

2. Do you ahve a drink with caffeine during the school day to stay awake?

- ○ Yes
- ○ No (If no, answer "Not applicable" to Question #3)

3. On a normal day, what time do you prefer to drink a beverage with caffeine?

Time	

4. Do you have your driver's license?

- ○ Yes
- ○ No

5. If you have your driver's license, do you ever feel tired when you are driving?

- ○ Yes
- ○ No
- ○ I do not have my driver's license

6. Have you ever swerved the car, drifted into the other lane, or went off the side of the road because you fell asleep or dozed off at the wheel (NOT from drugs or alcohol)?

- Yes
- No
- I do not have my driver's license

7. Have you ever hit a car or any object because of falling asleep or dozing off (NOT from drugs or alcohol)?

- Yes
- No
- I do not have my driver's license

8. Have you ever driven while sleepy?

- Yes
- No
- I do not have my driver's license

9. Do you drink caffeinated drinks to stay awake to drive?

- Yes
- No
- I do not have my driver's license

10. How many hours of sleep do you get each night during the week on a school night?

- 3-5 hours
- 6-8 hours
- 8-10 hours
- 10-12 hours
- 12 or more hours

11. How many hours of sleep do you get each night during the weekend?

- 3-5 hours
- 6-8 hours
- 8-10 hours
- 10-12 hours
- 12 or more hours

15. DASS

Please read each statement and mark the option which indicates how much the statement applied to you over the PAST WEEK. There are no right or wrong answers. Do not spend too much time on any statement.

1. In the past week

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of the time	Applied to me very much, or most of the time
1. I found myself getting upset by quite trivial things	○	○	○	○
2. I was aware of dryness of my mouth	○	○	○	○
3. I couldn't seem to experience any positive feeling at all	○	○	○	○
4. I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)	○	○	○	○
5. I just couldn't seem to get going	○	○	○	○
6. I tended to over-react to situations	○	○	○	○
7. I had a feeling of shakiness (e.g., legs going to give way)	○	○	○	○

2. In the past week

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of the time	Applied to me very much, or most of the time
8. I found it difficult to relax	○	○	○	○
9. I found myself in situations that made me so anxious I was most relieved when they ended	○	○	○	○
10. I felt that I had nothing to look forward to	○	○	○	○
11. I found myself getting upset rather easily	○	○	○	○
12. I felt that I was using a lot of nervous energy	○	○	○	○
13. I felt sad and depressed	○	○	○	○
14. I found myself getting impatient when I was delayed in any way (e.g., lifts, traffic lights, being kept waiting)	○	○	○	○

3. In the past week

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of the time	Applied to me very much, or most of the time
15. I had a feeling of faintness	○	○	○	○
16. I felt that I had lost interest in just about everything	○	○	○	○
17. I felt I wasn't worth much as a person	○	○	○	○
18. I felt that I was rather touchy	○	○	○	○
19. I perspired noticeably (e.g., hands sweaty) in the absence of high temperatures or physical exertion	○	○	○	○
20. I felt scared without any good reason	○	○	○	○
21. I felt that life wasn't worthwhile	○	○	○	○

4. In the past week

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of the time	Applied to me very much, or most of the time
22. I found it hard to wind down	○	○	○	○
23. I had difficulty in swallowing	○	○	○	○
24. I couldn't seem to get any enjoyment out of the things I did	○	○	○	○
25. I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)	○	○	○	○
26. I felt down-hearted and blue	○	○	○	○
27. I found that I was very irritable	○	○	○	○
28. I felt I was close to panic	○	○	○	○

5. In the past week

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of the time	Applied to me very much, or most of the time
29. I found it hard to calm down after something upset me	○	○	○	○
30. I feared that I would be "thrown" by some trivial but unfamiliar task	○	○	○	○
31. I was unable to become enthusiastic about anything	○	○	○	○
32. I found it difficult to tolerate interruptions to what I was doing	○	○	○	○
33. I was in a state of nervous tension	○	○	○	○
34. I felt I was pretty worthless	○	○	○	○
35. I was intolerant of anything that kept me from getting on with what I was doing	○	○	○	○

6. In the past week

	Did not apply to me at all	Applied to me to some degree, or some of the time	Applied to me to a considerable degree, or a good part of the time	Applied to me very much, or most of the time
36. I felt terrified	○	○	○	○
37. I could see nothing in the future to be hopeful about	○	○	○	○
38. I felt that life was meaningless	○	○	○	○
39. I found myself getting agitated	○	○	○	○
40. I was worried about situations in which I might panic and make a fool of myself	○	○	○	○
41. I experienced trembling (e.g., in the hands)	○	○	○	○
42. I found it difficult to work up the initiative to do things	○	○	○	○

16. PBI

The following questions ask you about things that you have done in the past 12 months. Please answer how often you have done the following things. Again, remember that your answers are CONFIDENTIAL.

1. How many times in the past year (12 months) have you purposely damaged or destroyed property belonging to your parents or other family members?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

2. How many times in the past year (12 months) have you purposely damaged or destroyed property belonging to a school?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

3. How many times in the past year (12 months) have you purposely damaged or destroyed property that did not belong to you, not counting family or school property?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

4. How many times in the past year (12 months) have you stolen money or other things from your parents or other members of your family?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

5. How many times in the past year (12 months) have you stolen or tried to steal something at school or work, such as someone's coat from a classroom, locker, or cafeteria, or a book from the library?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

6. How many times in the past year (12 months) have you stolen or tried to steal something worth $5 or less (other than from parents, school or work)?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

7. How many times in the past year (12 months) have you stolen or tried to steal things worth between $5 and $50 (other than from parents, school, or work)?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

8. How many times in the past year (12 months) have you stolen or tried to steal something worth more than $50 (other than from parents, school or work)?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

9. How many times in the past year (12 months) have you stolen or tried to steal a motor vehicle such as a car or motorcycle?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

10. How many times in the past year (12 months) have you taken a vehicle for a ride or drive without the owner's permission?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

11. How many times in the past year (12 months) have you broken or tried to break into a building or vehicle to steal something or just to look around?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

12. How many times in the past year (12 months) have you knowingly bought, sold or held stolen goods or tried to do any of these things?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

13. How many times in the past year (12 months) have you carried a hidden weapon other than a plain pocket knife?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

14. How many times in the past year (12 months) have you attacked someone with the idea of seriously hurting or killing that person?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

15. How many times in the past year (12 months) have you been involved in a gang fight?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

16. How many times in the past year (12 months) have you hit or threatened to hit one of your parents?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

17. How many times in the past year (12 months) have you hit or threatened to hit a teacher or another adult, who was not your parent?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

18. How many times in the past year (12 months) have you hit or threatened to hit other students?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

19. How many times in the past year (12 months) have you sold marijuana?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

20. How many times in the past year (12 months) have you sold hard drugs such as heroin, cocaine, LSD, or other hard drugs?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

21. How many times in the past year (12 months) have you cheated on school tests?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

22. How many times in the past year (12 months) have you been suspended from school?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

23. How many times in the past year (12 months) have you skipped classes without an excuse?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

24. How many times in the past year (12 months) have you been loud, rowdy, or unruly in a public place -- disorderly conduct that you might get arrested for?

- ○ Never
- ○ Once or twice
- ○ 3 or 4 times
- ○ Once a month
- ○ 2-3 times a month
- ○ Once a week
- ○ 2-3 times a week
- ○ Almost every day

25. How many times in the past year (12 months) have you been drunk in a public place?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

26. How many times in the past year (12 months) have you bought or provided liquor for a minor (someone under 21, not including yourself)?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

27. How many times in the past year (12 months) have you tried to cheat someone by selling them something that was worthless or not what you said it was?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

28. How many times in the past year (12 months) have you used force or strong-arm methods to get money or things from others?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

29. How many times in the past year (12 months) have you avoided paying for such things as movies, bus or subway rides, and food?

- Never
- Once or twice
- 3 or 4 times
- Once a month
- 2-3 times a month
- Once a week
- 2-3 times a week
- Almost every day

Appendix B

Pittsburgh Sleep Quality Index (PSQI)

Subject #: _____

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. *During the past month*, when have you usually gone to bed at night?
USUAL BED TIME:_____

2. *During the past month*, how long has it usually taken you to fall asleep each night?
NUMBER OF MINUTES:_____

3. *During the past month*, when have you usually gotten up in the morning?
USUAL GETTING UP TIME:_____

4. *During the past month*, how many hours of actual sleep did you get at night?
(This may be different than the number of hours you spend in bed.)
HOURS OF SLEEP PER NIGHT:_____

For each of the following questions, check the one best response. Please answer all questions.

5. *During the past month, how often have you had trouble sleeping because you...*

		Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
(a)	Cannot get to sleep within 30 minutes	_____	_____	_____	_____
(b)	Wake up in the middle of the night or early morning	_____	_____	_____	_____
(c)	Have to get up to use the bathroom	_____	_____	_____	_____
(d)	Cannot breathe comfortably	_____	_____	_____	_____
(e)	Cough or snore loudly	_____	_____	_____	_____
(f)	Feel too cold	_____	_____	_____	_____
(g)	Feel too hot	_____	_____	_____	_____
(h)	Had bad dreams	_____	_____	_____	_____
(i)	Have pain	_____	_____	_____	_____
(j)	Other reason(s), please describe: _____	_____	_____	_____	_____
	How often during the past month have you had trouble sleeping because of this?	_____	_____	_____	_____

6. *During the past month*, how would you rate your sleep quality overall?
Very good: _____ **Fairly good:** _____ **Fairly bad:** _____ **Very bad:** _____

During the past month...

		Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
7.	How often have you taken medicine (prescribed or "over the counter") to help you sleep?	_____	_____	_____	_____
8.	How often have you had trouble staying awake while driving, eating meals, or engaging in social activity?	_____	_____	_____	_____

9. *During the past month*, how much of a problem has it been for you to keep up enough enthusiasm to get things done?
No problem at all _____ **Only a very slight problem** _____ **Somewhat of a problem** _____ **A very big problem** _____

Scoring Instructions for the Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) contains 19 self-rated questions. The 19 self-rated items are combined to form seven "component" scores, each of which has a range of 0-3 points. In all cases, a score of "0" indicates no difficulty, while a score of "3" indicates severe difficulty. The seven component scores are then added yield one global score, with a range of 0-21 points, "0" indicating no difficulty and "21" indicated severe difficulties in all areas.

Scoring proceeds as follows:

#2 score: ____

Response	Score
≤ 15 minutes	0
16-30 minutes	1
31-60 minutes	2
> 60 minutes	3

#4 score: ____

Response	Score
> 7 hours	0
6-7 hours	1
5-6 hours	2
< 5 hours	3

#5a score: ____ **#5b score: ____**
#5c score: ____ **#5d score: ____**
#5e score: ____ **#5f score: ____**
#5g score: ____ **#5h score: ____**
#5i score: ____ **#5j score: ____**

Response	Score
Not during the past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

#6 score: ____

Response	Score
"Very good"	0
"Fairly good"	1
"Fairly bad"	2
"Very bad"	3

#7 score: ____

Response	Score
Not during the past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

#8 score: ____

Response	Score
Not during the past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

#9 score: ____

Response	Score
No problem at all	0
Only a very slight problem	1
Somewhat of a problem	2
A very big problem	3

Component 1: Subjective Sleep Quality
#6 score: ____ = ***Component 1 score:*** ____

Component 2: Sleep Latency
#2 score: ____ + **#5a** score: ____ = ____
0 = 0; 1-2 = 1; 3-4 = 2; 5-6 = 3
= ***Component 2 score:*** ____

Component 3: Sleep Duration
#4 score: ____ = ***Component 3 score:*** ____

Component 4: Habitual Sleep Efficiency
#3 (getting up time): _____ - **#1** (bedtime): _____ = number of hours in bed: ____
#4 (number of hours slept): ____ / number of hours in bed: ____ = ____ x 100 = Habitual Sleep Efficiency ____%

>85% = 0; 75-84% = 1; 65-74% = 2; <65% = 3
= ***Component 4 score:*** ____

Component 5: Sleep Disturbances
Sum of **#5b-5j**: ____
0= 0; 1-9 = 1; 10-18 = 2; 19-27 = 3
= ***Component 5 score:*** ____

Component 6: Use Of Sleeping Medication
#7 score: ____ = ***Component 6 score:*** ____

Component 7: Daytime Dysfunction
#8 score: ____ +**#9** score: ____ = ____
0 = 0; 1-2 = 1; 3-4 = 2; 5-6 = 3
= ***Component 7 score:*** ____

Global PSQI Score
Add 7 component scores together =
Global PSQI Score: ____

Appendix C

Instant-View® Multi-Drug Screen Urine Test Specifications

INSTANT-VIEW® Multi-Drug Screen Urine Test CE

INSTRUCTIONS FOR USE

One Step Assay
Rapid Visual Results
For Qualitative In Vitro Diagnostic Use

INTENDED USE

The *Multi-Drug of Abuse Urine Test* is a rapid qualitative immunoassay for screening the use of one or more drugs. The device detects any combination of the drugs or drug metabolites at or above the specified cut-off levels. It is for health care professional use only.

Abbreviation	Test	Cutoff
AMP	Amphetamine	1000 ng/ml
BAR	Barbiturates	200 ng/ml
BZD	Benzodiazepine	300 ng/ml
COC	Cocaine	300 ng/ml
MET	Methamphetamine	1000 ng/ml
MET500*	Methamphetamine	500 ng/ml
MOR	Morphine	2000 ng/ml
MOR300*	Morphine	300 ng/ml
MTD	Methadone	300 ng/ml
PCP	Phencyclidine	25 ng/ml
PPX	Propoxyphene	300 ng/ml
TCA	Tricyclics	1000 ng/ml
THC	Marijuana/Hashish	50 ng/ml
XTC	MDMA or Ecstasy	500 ng/ml

** Not SAMHSA levels.*

This test provides only a preliminary result. A more specific alternate chemical method must be used in order to obtain a confirmed analytical result. Gas Chromatography / Mass Spectromeny (GC/MS) or High Performance Liquid Chromatography (HPLC) is the preferred confirmatory method. Clinical consideration and professional judgment should be applied to any drug of abuse test result, particularly when preliminary positive results are obtained.

SUMMARY

Amphetamine (AMP)

The detection of amphetamines in human urine has been widely used to assess the abuse of amphetamines. Amphetamines are central nervous system stimulating drugs. They may induce alertness, wakefulness, increased energy, reduced hunger and overall feeling of well being. Overdose and extended usage of amphetamines may lead to substance abuse, which may cause severe and/or permanent damage to the human nerve system. Amphetamines appear in the urine within three hours after administration (any type), and be present for about 24-48 hours after the last dose.

Barbiturates (BAR)

Barbiturates are central nervous system depressants and used as hypnotic sedatives. Overdose and extended usage of barbiturates may lead to severe and/or permanent damage to the human nervous system. Barbiturates are classified as (1) ultra-short, (2) short-intermediate, and (3) long-acting. The duration range of the ultra short-acting compounds, secobarbital, pentobarbital etc. is from fifteen (15) minutes to six (6) hours. The duration range of the intermediate acting compounds, amobarbital, etc. is from three (3) to twenty-four (24) hours. The duration range of the long-acting compounds, phenobarbital etc. is from fifteen (15) to forty-eight (48) hours.

The most commonly abused barbiturates are short- and intermediate-acting agents. The long-acting agents are rarely subject to abuse. Barbiturate derivatives are excreted into urine in varying amounts of unchanged drug and metabolites. Long-acting barbiturates are excreted with a higher percentage of unchanged drugs in the urine, while shorter-acting barbiturates, secobarbital and amobarbital, are extensively metabolized and excreted in the urine with a smaller percentage of unchanged drugs.

Benzodiazepines (BZD)

Benzodiazepines, including Alprazolam, Diazepam, Lorazepam, Triazolam, Chlordiazepoxide, Flurazepam and Temazepam are sedative, hypnotic and anti-anxiety drugs commonly used as tranquilizers. Most benzodiazepines are extensively metabolized in the liver and excreted in the urine as metabolites. The benzodiazepines have a low potential for physical or psychological dependence. However, the same as other central nervous system stimulating drugs, they may induce drowsiness and muscle relaxation. Chronic abuse of benzodiazepines may result in intoxication, similar to drunken behavior. Overdose and extended usage of benzodiazepines may lead to coma and possibly death. Benzodiazepines may remain effective for 4-8 hours. The members of the benzodiazepine family are absorbed at different rates and their effects may vary with the absorption rate. They are excreted in the urine primarily as their parent compounds or an inactive metabolite (oxazepam glucuronide) that are only detectable for one (1) to two (2) days. Oxazepam, a common metabolite of many benzodiazepines that is also a marketed drug (Serax), may remain detectable if in urine for up to one week. That makes oxazepam a useful marker of benzodiazepines abuse.

Cocaine (COC)

Cocaine is a nervous system stimulant that can be addictive. Cocaine may appear in urine for only few hours after use, whereas the benzoylecgonine, a hydrolytic degradation product of cocaine, may be detectable in urine over 2 days after taking cocaine. Therefore the detection of benzoylecgonine in human urine is widely used to evaluate cocaine usage.

Methamphetamine (MET and MET500)

Methamphetamine in over dosage causes restlessness, confusion, anxiety, hallucinations, cardiac arrhythmias, hypertension, hyperthermia, circulatory collapse, convulsions, and coma. Methamphetamine has been implicated in fatal poisonings following both intravenous and oral administration. Chronic abusers may develop paranoid psychosis. D-Methamphetamine (d-desoxyephedrine, Desoxyn, Methedrine) is the N-methyl derivative of amphetamine. It is utilized in the treatment of obesity. Methamphetamine is administered by oral, nasal insufflations, or intravenous injection with duration of 2-4 hours. Methamphetamine undergoes some N-demethylation to amphetamine, its major active metabolite. During normal conditions, up to 43% of a dose is eliminated with about 4-7% as amphetamine. In acidic urine, up to 76% is found as unchanged drug and 7% as amphetamine in 24 hours, whereas in alkaline urine the corresponding values are 2% and less than 0.1%. Methamphetamine urine concentrations of 0.5-4.0 mg/L are commonly observed during the first 24 hours after ingestion of 10 mg. Methamphetamine concentrations of 24-333 mg/L (average, 142) were observed in the urine of methamphetamine abusers.

Morphine (MOR and MOR300)

Morphine is a popular marketed drug (Serax) for treatment of moderate to severe pain. It is also a common metabolite of opiates [morphine, codeine (methyl-morphine), and heroin (semi-synthetic derivatives of morphine)]. The opiates are administered either by smoking, intravenous injection, intramuscular injection or oral ingestion. Adverse or toxic effects of opiates usage include papillary constriction, constipation, urinary retention, nausea, vomiting, hypothermia, drowsiness, dizziness, apathy, confusion, respiratory depression, hypotension, cold and clammy skin, coma, and pulmonary edema. Death may occur following an over dosage.

The duration of effect of morphine is 3-6 hours. Morphine is metabolized extensively, with only 2-12% excreted as unchanged morphine in the urine. Heroin is rapidly metabolized to morphine in the body; the pattern of urinary excretion of heroin is similar to that of morphine. Codeine is also extensively metabolized; 10-15% of the dose is demethylated to form morphine and norcodeine. It has been reported that the unchanged morphine may remain detectable in urine for up to one week, which make morphine a marker of opiates abuse.

Methadone (MTD)

Methadone, also called Dolophine, Methadose and Amidone, possesses many of the pharmacologic properties of morphine and is approximately equipotent as an analgesic when administered parenterally. Unlike morphine, however, methadone produces marked sedative effects with repeated administration as a result of drug accumulation. Methadone has been used as a major substitute for opiates, such as heroin, morphine, and codeine in drug maintenance treatment clinics. It is administered either orally or by intravenous or intra-muscular injection. The duration of effect of methadone is 12-24 hours. Its major urinary excretion products are methadone, EDDP (2-ethylidene-1, 5-dimethyl-3, 3-diphenylpyrrolidine), and EMDP (2-ethyl-5-methyl-3, 3-diphenylpyrrolidine). The percentage of methadone excreted unchanged in urine is 5-50%, much higher than EDDP and EMDP, of the dose in 24 hours. Large individual variations in the percentage of unchanged methadone excreted in urine have been observed due to urine pH, urine volume, dose and rate of metabolism, etc. Methadone has been found remaining in urine at levels higher than 1,000 ng/ml 24 hours after overdose. Therefore the concentration of methadone in human urine has been used as a marker of methadone abuse.

Phencyclidine (PCP)

Phencyclidine (PCP), also called Angel Dust, Hog, and Killer Weed, is a popular drug of abuse, as well as being a legitimate veterinary tranquilizer. It is self-administered either by smoking, nasal insufflations, intravenous injection or by oral ingestion. Its duration of effect is 2-4 hours, and psychosis may last for weeks. PCP has three major metabolites; however, the percentage of an intravenous dose excreted unchanged in urine is 30-50% in the 72 hours. Only 2% of a dose in excreted in feces. An average of 77% of an intravenous dose is excreted in urine and feces in 10 days. Therefore, the PCP in human urine has been used as a marker of PCP abuse. Concentrations of unchanged drug in the urine of ambulatory users of PCP are most frequently between 0.04 and 3.4mg/L.

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Propoxyphene (PPX)

Propoxyphene is a prescription drug for the relief of pain. Propoxyphene hydrochloride (Darvon, Dolene, and others) is available in 32mg and 65mg capsules; propoxyphene napsylate (Darvon-N) is available in 100mg tablets or as a suspension. It is structurally related to methadone. Overdose of the drug can affect the brain region and cause euphoria as many opioids do. The progressive symptomatology of propoxyphene includes analgesia, stupor, respiratory depression, and coma, etc. The half-life of propoxyphene is 8-24 hours. Following oral administration, propoxyphene reaches its peak in 1 to 2 hours. There is great variability between subjects in the rate of clearance. The percentage of excreted unchanged propoxyphene in urine is less than 1%. The major metabolite of propoxyphene is norpropoxyphene. Therefore, the detection of norpropoxyphene is widely used for the testing of propoxyphene abuse. The half-life of norpropoxyphene is about 30 hours, and its accumulation with repeated doses may be responsible for some of the toxicity observed.

Tricyclics (TCA)

Tricyclic Antidepressants (TCA) are a group of antidepressant drugs that contain three fused rings in their chemical structure. TCA can be taken orally or intramuscularly (IM). The progressive symptomatology of TCA includes agitation, confusion, hallucinations, hypertonicity, seizures, and EKG changes. The half-life of TCA varies from few hours to few days. The commonly used tricyclic antidepressants are excreted with a very low percentage of unchanged drugs in the urine, less than 1%. Therefore, detecting TCA or metabolites of TCA in human urine has been used for screening the abuse of TCA. This test is able to detect amitriptyline, desipramine, imipramine and nortriptyline at a cut off level of 1,000 ng/ml.

Marijuana (THC)

Tetrahydrocannabinols (THC, Δ-9-THC, Δ-1-THC) are the most active of the principle constituents, as well as the major metabolites, of cannabinoids such as marijuana and hashish. Cannabinoids have been used as central nervous system depressants. Overdose and extended usage of cannabinoids may lead to substance abuse, which may cause severe and/or permanent damage to the human nerve system. The detection of THC in human urine is widely used to evaluate the abuse of cannabinoids.

MDMA (Ecstasy, XTC)

MDMA is an abbreviation of the chemical methylenedioxymethamphetamine. It also has street names such as Ecstasy, X, XTC, E, Love Doves, Clarity, Adam, Disco Biscuits, and Shamrocks. MDMA is a stimulant with hallucinogenic tendencies. It is described as an empathogen since it releases mood-altering chemicals, such as cartooning and L-dopa, in the brain and may generate feelings of love and friendliness. MDMA is a Class A drug, in the same category as heroin and cocaine. The adverse effects of MDMA use include elevated blood pressure, hyperthermia, anxiety, paranoia, and insomnia. Overdoses of MDMA can be fatal, often resulting in heart failure or heat stroke.

MDMA belongs to a "family" of man-made drugs; its "relatives" are MDA (methylenedioxyamphetamine), the parent drug of MDMA, and MDEA (methylenedioxyethylamphetamine), also know as EVE, the sister of MDMA. They all have the amphetamine-like effects. MDMA is administered either by oral ingestion or intravenous injection. MDMA tablets come in different sizes and colors, and often have logos such as doves on them. Its clinical dose is 50-100mg; the threshold toxic dose is 500mg. The effects of the MDMA begin 30 minutes after taking. They peak in an hour and last for 2-3 hours. Sixty five percent (65%) of MDMA is excreted unchanged in urine and it is detectible in the urine for up to 3 days after use.

PRINCIPLE OF THE PROCEDURE

The Multi-Drug of Abuse Urine Test device consists of any combination between one (1) to twelve (12) individual test strip(s) for the drug(s) being tested. The assay is a one-step lateral flow chromatographic immunoassay based on the principle of competition for limited antibody binding sites between the drug or drug metabolite(s) in the sample and a drug-protein conjugate immobilized on a porous membrane support.

During test, the urine sample migrates to the testing area of the membrane by capillary action, mobilizing the colored antibody conjugates. Then the antibody conjugates move along the membrane to the testing area. In the absence of the drug or if the drug concentration is below the cutoff limit in the sample, the colored conjugates attach to the drug antigen immobilized in the test line region, forming a burgundy-colored band (T line). When the drug is present in the sample, the drug or drug metabolite(s) compete for the limited antibody binding sites. If the drug concentration is at or above the cutoff limit, the drug will saturate all the binding sites of the antibody, preventing the attachment of the colored conjugates to the antigen in the test line area of the membrane. Therefore the colored line will not form.

The control line (C line) serves as an internal quality control of the system. It should always appear as a burgundy-colored band regardless of the presence of the drug.

REAGENTS AND MATERIALS SUPPLIED

- 25 test devices, each sealed in a foil pouch with a desiccant and a dropper pipette (20 devices for 7-12 test panel)
- 1 package insert (Instructions for Use)

MATERIALS REQUIRED BUT NOT PROVIDED

- Specimen collection container
- Timer

PRECAUTIONS

1. The instructions must be followed exactly to obtain accurate results.
2. Do not open the sealed pouch, unless ready to conduct the assay.
3. Do not use expired devices.
4. Dispose of all specimens and used assay materials as potentially bio-hazardous.
5. Do not use the test if you are colored-blind.

STORAGE AND STABILITY

- Store the product at room temperature 15-30°C (59-86°F). Each device may be used until the expiration date printed on the label if it remains sealed in its foil pouch.
- Do not freeze and / or expose this kit to temperatures over 30°C (86°F).

SPECIMEN COLLECTION

- Each urine specimen must be collected in a clean container. Do not combine specimens.
- Specimens may be kept at 15-30°C (59-86°F) for 8 hours, at 2-8°C for up to 3 days and at -20°C or lower for long term storage.

ASSAY PROCEDURE

IMPORTANT: REFRIGERATED SPECIMENS AND OTHER TEST MATERIALS, INCLUDING DEVICES, MUST BE EQUILIBRATED TO ROOM TEMPERATURE BEFORE TESTING.

1. Bring the pouch to room temperature before opening.
2. Remove the test device from the sealed pouch and label it with specimen identification.
3. Remove the cap from the device, add urine sample to the device using either "Dip Method (I)" or "Dropper Method (II)" as follows:

I. DIP METHOD

a) Dip the sample well end of the device into the specimen.
Note: The sample well must be completely immersed in the urine sample and the tip of the arrows in the device's window must be above the sample surface.
b) Start the timer.
c) Remove the device from the specimen after 10 seconds.
d) Replace the cap back onto the device. Set the device on a clean and level surface.
e) Read results between 4-7 minutes.

II. DROPPER METHOD (Recommended for small sample volumes.)

a) Set the device on a clean and level surface.
b) Use the provided dropper to pick up the urine sample, fill the sample to the mark.
c) Transfer all of the urine sample in the dropper to the sample well of the device. Avoid trapping air bubbles in the sample well.
d) For a 2-sided panel (7-12 tests), turn the device over to the other side and add a full dropper of urine sample (up to the mark on the dropper) to the sample well on side 2.
e) Start the timer.
f) Read results between 4-7 minutes.

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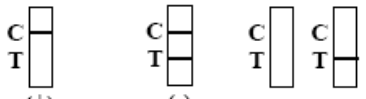
INTERPRETATION OF RESULTS

***IMPORTANT*: Do not read test results after seven (7) minutes. The T Line should always be interpreted independently of the C Line. Do not compare color intensity of one test to another.**



Preliminary Positive:

If the C line appears and there is no T line, the test indicates a positive result for that particular drug.

Note: Samples with preliminary positive results should be confirmed with a more specific method before a positive determination is made.

Negative:

If the C line and the T line both appear, the test indicates that the level for the corresponding drug or its metabolites is below the cutoff level.

Note: A very faint T line should be considered negative.

Invalid:

If no C line develops within 4 minutes on any test strip, the test is invalid. In this case repeat the assay with a new test device. If the result is still invalid, stop using the test device and contact the manufacturer.

QUALITY CONTROL

Built-in Control Features

This test contains a built-in control feature, the C line. The appearance of the burgundy C line indicates an adequate volume of specimen has been absorbed and the capillary flow has occurred. The C line should always appear. If the Control line does not develop within 5 minutes, review the entire procedure and repeat test with a new device.

External Quality Control

Users should always follow the appropriate federal, state, and local guidelines concerning the running of external quality controls. SAMHSA recommends that the concentration of drug(s) in positive and negative controls be approximately 25% above and below the cutoff concentration of the assay.

LIMITATIONS

1. This kit is for *professional in vitro* diagnostic use only.
2. Results obtained by this device provide only a preliminary qualitative analytical test result. A more specific alternate method must be used in order to obtain a confirmed analytical result.
3. This product is designed for testing human urine only.
4. Adulterants such as bleach or other strong oxidizing agents may produce erroneous test results. When suspected, collect a fresh specimen and repeat the test with a new device.
5. Samples in which bacterial contamination is suspected should not be used. These contaminants may interfere with the test and cause false results.

EXPECTED VALUES

This test is capable of detecting each drug and/or drug metabolite specified in human urine at or above its specific cutoff concentration indicated in the intended use section on page 1.

PERFORMANCE CHARACTERISTICS

Accuracy

A comparison study was performed at three different Physician's Office Laboratories (POL) and a Reference Laboratory. Clinical samples were blind labeled and tested for each analyte (drug or drug metabolite). Each sample was tested at each site, with the multi-drug of abuse urine test device, and compared to GC/MS or HPLC/MS results. The test results are grouped into drug free, below 75% cutoff (Negative), above 125% cutoff (Positive), between 75% cutoff and cutoff, between cutoff and 125% cutoff according to the analyte concentrations from GC/MS for all analytes except TCA, which was tested with HPLC/MS. Overall, this device agrees with the results from the selected analytical method more than 90% for each analyte. The test results are tabulated below.

Method			HPLC/MS					
Multi-Drug of Abuse Urine Test			Drug-free	Negative <=75% Cutoff	75% Cutoff to Cutoff	Cutoff to 125% Cutoff	Positive >125% Cutoff	Overall
Drug	Cutoff (ng/ml)							
TCA	1000	Positive	0	0	2	8	12	/
		Negative	40	10	8	0	0	/
		Total	40	10	10	8	12	80
		Agreement	100%	100%	80%	100%	100%	97.5%

Method			GC/MS					
Multi-Drug of Abuse Urine Test			Drug-free	Negative <=75% Cutoff	75% Cutoff to Cutoff	Cutoff to 125% Cutoff	Positive >125% Cutoff	Overall
Drug	Cutoff (ng/ml)							
AMP	1000	Positive	0	0	37	15	148	/
		Negative	176	76	23	1	0	/
		Total	176	76	60	16	148	476
		Agreement	100%	100%	38.3%	93.8%	100%	92%
BAR	200	Positive	0	0	0	27	140	/
		Negative	200	12	20	1	0	/
		Total	200	12	20	28	140	400
		Agreement	100%	100%	100%	96.4%	100%	99.8%
BZD	300	Positive	0	0	7	32	144	/
		Negative	168	24	25	0	0	/
		Total	168	24	32	32	144	400
		Agreement	100%	100%	78%	100%	100%	98.3%
COC	300	Positive	0	0	9	24	164	/
		Negative	188	4	11	0	0	/
		Total	188	4	20	24	164	400
		Agreement	100%	100%	55%	100%	100%	97.8%
MET500	500	Positive	0	0	6	24	152	/
		Negative	220	36	22	16	0	/
		Total	220	36	28	40	152	476
		Agreement	100%	100%	78.6%	60%	100%	95.4%
MET	1000	Positive	0	0	12	24	136	/
		Negative	200	16	12	0	0	/
		Total	200	16	24	24	136	400
		Agreement	100%	100%	50%	100%	100%	97%
MOR300	300	Positive	0	0	13	24	136	/
		Negative	180	12	11	0	0	/
		Total	180	12	24	24	136	376
		Agreement	100%	100%	45.8%	100%	100%	96.5%
MOR	2000	Positive	0	0	2	28	144	/
		Negative	132	64	30	0	0	/
		Total	132	64	32	28	144	400
		Agreement	100%	100%	93.8%	100%	100%	99.5%
MTD	300	Positive	/	0	10	36	144	/
		Negative	/	192	18	0	0	/
		Total	/	192	28	36	144	400
		Agreement	/	100%	64.3%	100%	100%	97.5%
PCP	25	Positive	/	0	8	32	160	/
		Negative	/	184	16	0	0	/
		Total	/	184	24	32	160	400
		Agreement	/	100%	66.7%	100%	100%	98%
PPX	300	Positive	0	0	0	8	30	/
		Negative	40	10	10	2	0	/
		Total	40	10	10	10	30	100
		Agreement	100%	100%	100%	80%	100%	98%
THC	50	Positive	0	0	11	17	156	/
		Negative	160	36	13	3	0	/
		Total	160	36	24	20	156	396
		Agreement	100%	100%	54.2%	85%	100%	96.5%
MDMA	500	Positive	0	0	2	9	10	/
		Negative	40	10	9	0	0	/
		Total	40	10	11	9	10	80
		Agreement	100%	100%	82%	100%	100%	97.5%

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Reproducibility

Reproducibility of each test was evaluated on replicate assays of three production lots with spiked samples at four levels: drug-free, 75% cutoff, 125% cutoff and 200% cutoff. For AMP, COC, MET500, MOR300, THC and MDMA tests, the devices were tested for three consecutive days, six replicates per day, for a total of eighteen tests for each control. For BAR, BZD, MET, MOR, MTD, PCP, PPX and TCA tests, the devices were tested for five consecutive days, five times per day, for a total of 25 assays for each control. The results indicate 100% precision for the replicate within each lot and no appreciable inter-lot variation across the three different lots of devices.

Cross Reactivity

The cross reactivity of the test was evaluated by spiking drug free samples with structurally related compounds. Compounds producing positive response are listed below.

Drug	Related Compounds	Concentration (ng/ml)	Related Compounds	Concentration (ng/ml)
AMP	*d-Amphetamine*	*1000*	*d-,l-Amphetamine*	*1000*
	l-Amphetamine	*20,000*	*3,4-methylenedioxyamphetamine (MDA)*	3000
BAR	*Amobarbital*	*250*	*Phenobarbital*	*200*
	Barbital	*250*	*Pentobarbital*	*250*
	Butabarbital	*300*	*Secobarbital*	*200*
	Butalbital	*200*		
BZD	*Alprazolam*	*300*	*Lormetazepam*	*300*
	Bromazepam	*500*	*Medazepam*	*300*
	Clobazem	*1500*	*Nitrazepam*	*250*
	Chlonazepam	*500*	*Nordiazepam*	*400*
	Diazepam	*200*	*Prazepam*	*250*
	Desmethyldiazepam	*300*	*Triazolam*	*300*
	Flurazapam	*300*	*Oxazepam*	*300*
	Lorazepam	*450*		
COC	*Cocaine*	*300*	*Isoxsuprine*	*1500*
	Benzoylecgonine	*300*		
MET500	*d-Methamphetamine*	*500*	*l-Amphetamine*	*10,000*
	l-Methamphetamine	*25,000*	*3,4-methylenedioxyamphetamine (MDA)*	*50,000*
	d-Amphetamine	*50,000*		
MET	*d-Amphetamine*	*50,000*	*3,4-methylenedioxyamphetamine (MDA)*	*50,000*
	l-Amphetamine	*10,000*		
MOR300	*Morphine*	*300*	*Morphine-glucuronide*	*500*
	Codeine	*300*		
	Ethyl Morphine	*300*	*Meperidine*	*30000*
	Hydromorphine	*400*	*Oxycodone*	*1000*
MOR	*Codeine*	*2000*	*Morphine-glucuronide*	*3000*
	Ethyl Morphine	*2000*		
	Hydro morphine	*2500*	*Meperidine*	*30,000*
MTD	*(-)-a-Methadol*	*800*	*(-)-a-Acetylmethadol (LAAM)*	*1000*
PCP	*Methylphenidate*	*25,000*	*Tenocyclidine*	2,000
	Pheniramine	*25,000*		
PPX	*Propoxyphene*	*300*	*2-ethyl-1,5-dimethyl-3,3-diphenylpyrroline (EDDP, Methadone Metabolite)*	*200,000*
	Norpropoxyphene	*300*		
	Methadone	*1,350,000*		
TCA	*Nortriptyline*	*1,000*	*Clomipramine*	*5,000*
	Amitriptyline	*1,000*	*Doxepin*	*3,000*
	Imipramine	*800*	*Protriptyline*	*2,000*
	Desipramine	*800*	*Perphenazine*	*75,000*
	Nordoxepine	*1,000*	*Promazine*	*15,000*
	Cycolbenzaprine	*1,500*	*Trimipramine*	*2,000*
THC	*11-nor-D-8-THC-9-COOH*	*50*	*11-hydroxy-D-9-THC*	*100*
	11-nor-D-9-THC-9-COOH	*50*	*9-Tetrahydrocannabinol*	*10,000*
	Cannabonol	*10,000*		
MDMA	*methylenedioxyamphetamine (MDA)*	*2000*	*Methylenedioxyethylamphetamine(MDEA)*	*1000*

Interference

To determine the interference of structurally unrelated analytes, each test analyte was evaluated, using the analyte specific urine test device, in both drug free urine pools and urine pools spiked with the cutoff level of each analyte.

Common substances listed in this table were found not to interfere with the test results at the concentration of 100 µg/ml		
Acetaminophen	*Oxalic Acid*	*Ethanol*
Acetylsalicylic Acid	*Caffeine*	*Lidocaine*
Amikacin	*(+)-Chlorpheniramine*	*Penicillin-G*
Amitriptyline	*Cocaine*	*Phenylpropanalamine*
Ampicillin	*Codeine*	*Ranitidine*
Arterenal	*Cortisone*	*Salicyclic Acid*
Aspirin	*Methadone*	*Thioridazine*
Atropine	*Methanol*	*Trifluoperazine*
Benzoic Acid		

Biological Analytes	Concentration	Biological Analytes	Concentration
Albumin	*200 µg/ml*	*pH*	*5.0 – 9.0*
Bilirubin	*100 µg/ml*	*Specific Gravity*	*1.002 – 1.035 g/ml*
Creatine	*100 µg/ml*	*Uric Acid*	*100 µg/ml*
Glucose	*200 µg/ml*	*Vitamin C (L-Ascorbic Acid)*	*100 µg/ml*
Hemoglobin	*100 µg/ml*		

There is a possibility that other substances and/or factors not listed above may interfere with the test and cause false results. (e.g., technical or procedural errors)

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Appendix D

West Virginia University Hospitals Laboratories Urine Specimen Requisition

RESEARCH STUDY SPECIMEN REQUISITION **WEST VIRGINIA UNIVERSITY HOSPITALS** **MORGANTOWN, WV 26505-8009**	Name: _____ Identifying number: _____ **ACCN**
DATE AND TIME COLLECTED: **ORDERING MD: _____** **BEEPER #: _____** **Phone: _____**	**Order in Sunquest:** Z___-Identifying number
Title: **PI:**	
Check mark the testing that is needed: **IRB #:**	

Appendix E

No, really – the BEST and EASIEST brownies ever
Warning: you will forsake boxed brownies forever.

10 tbs. unsalted butter (1 ¼ sticks)
1 ¼ cups sugar
¾ cup + 2 tbs. unsweetened cocoa powder
¼ tsp. salt
½ tsp. vanilla extract
2 eggs, cold
½ cup flour
2/3 cup nuts, optional

Preheat oven to 325ºF.

Melt butter in the microwave. Mix in sugar, cocoa, and salt. Allow mixture to cool a bit until it's warm, but no longer hot. It might not be smooth at this point – that's OK. With a wooden spoon* mix in vanilla. Then add the eggs one at a time until each is well incorporated. Next mix in the flour until you can't see it anymore, and continue to beat it for 40 more strokes (Why? See: *). Then stir in nuts (or chocolate chips or whatever extra goodie you prefer; but trust me, these are divine without a bunch of extra stuff).

Pour mixture into a greased or parchment lined 8x8 inch baking pan. Bake until toothpick inserted into center comes out clean (around 30 minutes, but start checking at 25 minutes).

Once cooled, dig in. If you want a pretty presentation then you might want to place the brownies in the refrigerator until they are more solid to make slicing cleaner.

*Why wooden? I don't know. Baking is sometimes like graduate school, just do what you're told because those people know more than you do.