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a thesis submitted to the Faculty of Emory Colleges of Arts and Sciences
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Abstract

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Illicit use of stimulant medication as a study drug has increased on college campuses, with prevalence rates ranging from 4.1% (McCabe et al., 2005) to 34% (DeSantis et al., 2008). Students have anecdotally reported using the medication to filter out background noise when studying (DeSantis et al., 2008). Audiology research has suggested that stimulant medication may improve auditory processing performance in children with ADD/ADHD diagnoses (Tillery et al., 2000). The purpose of the present study was to investigate whether auditory figure-ground difficulties contribute to illicit stimulant use. The study also examined whether illicit stimulant users and non-users differed in sensation seeking and other substance use. The sample consisted of 52 college students without ADHD diagnoses, 24 who reported high difficulty filtering out background noise and 28 who reported low difficulty filtering out background noise. The researchers administered two screening tests of the SCAN:3-A, a memory recall task, and a survey containing items about sensation seeking, substance use, illicit stimulant use, motivations for stimulant use, and perceived effects of stimulants. A chi-squared test of independence found a statistical trend of greater stimulant medication use in the high auditory figure-ground difficulty group. However, when overall drug use was controlled for, the trend disappeared. An independent samples *t*-test found that stimulant users scored significantly higher on the disinhibition sub-scale of the Brief Sensation Seeking Scale (BSSS). A Mann-Whitney *U*-test found that stimulant users also used significantly more alcohol, illicit drugs, and prescription drugs than non-users.

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Do Auditory Figure-Ground Difficulties Contribute to Illicit Stimulant Use?

The stimulants that make up the first-line pharmacotherapy for the treatment of Attention Deficit Hyperactivity Disorder (ADHD) are methylphenidate (Ritalin), dextroamphetamine (Dexedrine), and mixed-salts amphetamine (Adderall), with Adderall being the most prevalent of the three (DeSantis, Webb, & Noar, 2008; McCabe, Knight, Teter, & Weschler, 2005). According to numerous studies, there has been an increase in the medical prescriptions for these stimulant medications, due to a rise in the past two decades of ADHD diagnoses among school-aged children (DeSantis et al., 2008; Hall, Irwin, Bowman, Frankberger, & Jewett, 2005; Olfson et al., 2003, as cited in McCabe et al., 2005; Robison, Sclar, Skaer, & Galin, 1999).

The American Psychiatric Association in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) stated that the prevalence rate of ADHD is 3-7% of school-aged children (as cited by the Centers for Disease Control and Prevention [CDC], 2011). Between 2003 and 2007, according to parent surveys, there was a 22% increase in ADHD diagnosis with an average increase of 5.5% per year. These surveys found that in 2007, the national prevalence rate for ADHD was 9.5%, or 5.4 million children between the ages of 4-17, with 66.3%, or 2.7 million, of these children prescribed stimulant medication treatment.

According to the CDC (2011), even higher rates of ADHD diagnosis have been found in research studies of community samples. Some studies have found a disproportionate relationship between the number of children in a sample diagnosed with ADHD and the number of children prescribed ADHD stimulant medication. For instance, researchers found that in a sample of school-aged children in North Carolina, prescriptions for stimulant medication were incompatible with the current guidelines, leading to the conclusion that stimulant medication may be prescribed at an excessive rate (Angold et al. 2000, as cited in Hall et al., 2005). Only

3.4% of children met the full criteria for an ADHD diagnosis, yet 7.3% of the sample was prescribed stimulant medication (Angold et al. 2000, as cited in Hall et al., 2005).

DEA data reveal that between 1990 and 2000, Ritalin (a brand name of methylphenidate) production rose by approximately 900% (Hall et al., 2005). Between 2000 and 2002, Ritalin production only rose by a further 40%, due to the introduction of Concerta and Metadate (other brand names of methylphenidate) to the market (Hall et al., 2005). The production of amphetamines including Dexedrine and Adderall rose by 5,767% between 1993 and 2001 (Hall et al., 2005). From a global perspective, the use of prescription stimulants is higher in the US than any other country (Berbatis et al, 2002, as cited in McCabe et al., 2005), and the vast majority of the world's methylphenidate is used by the US (Woodworth 2000, as cited in McCabe et al., 2005).

There are other conflicting findings regarding stimulant medication. One study found that prescriptions for ADHD medication have remained stable since 1996 (Zuvekas, Vitiello, & Norquist, 2006). Jensen et al. (1999) found that only 12.5% of children across an epidemiological sample who met the diagnostic criteria for ADHD received stimulant medication, suggesting that ADHD medication is underprescribed, rather than overprescribed.

Two extremities are presented in the ADHD literature: the underprescription and overprescription of stimulant medication. Since researchers access their information from different databases, it is difficult to definitively assess the findings. Presumably, both instances are occurring and many practitioners are likely not closely observing the appropriate diagnostic criteria and prescription guidelines (Reeves & Schweitzer, 2004).

Public Health Concerns and Abuse Potential of ADHD Medication

Although stimulants can be highly effective for the treatment of ADHD symptoms, the high potential for their abuse and illicit use have led to concerns within the public health community (Kollins, MacDonald, & Rush, 2001, as cited in McCabe et al, 2005; Wilens et al., 2008). Both methylphenidate (Ritalin, Concerta, and Metadate) and amphetamine (Adderall, Dexedrine, and Desoxyn) are classified as Schedule II substances, indicating that they are controlled substances with high potential for abuse (DeSantis et al., 2008; Hall et al., 2005;Wilens et al., 2008). Therefore, Adderall, Ritalin, and Dexedrine are placed under strict guidelines by the DEA: they have a limit of 30 days worth of doses, no refills, and are enforced with DEA production quotas (DeSantis et al., 2008).

Illicit Use of Stimulant Medication on College Campuses

In this paper, the word "stimulant" refers to stimulants commonly prescribed for ADHD, unless otherwise noted. Other stimulants, nicotine and caffeine, are discussed as well.

The school-aged children who were prescribed stimulant medication at an increasing rate between 1990 and 2002 (Hall et al., 2005), or at least until 1996 (Zuvekas et al., 2006), are now college-aged students, many of whom bring their medications with them to their college campuses (Hall et al., 2005).

Recent studies have raised concerns over the alarming rate of illicit use of prescription stimulants among college students (Babcock & Byrne, 2000; DeSantis et al., 2008; Hall et al., 2005; McCabe et al., 2005; McCabe et al., 2006; Rabiner et al., 2009; Teter, McCabe, LaGrange, Cranford, & Boyd, 2006; Wilens et al., 2008). The increased quantity of stimulants on college campuses may be contributing to students diverting their medication and illicit use of such medication at high rates. For example, McCabe et al. (2006) found that 54% of undergraduates who were prescribed stimulant medication were approached to sell, trade, or give away their stimulants.

McCabe et al. (2006) found that illicit use of prescription medications was second to marijuana as the most common form of drug use among college students. Within the class of prescription medications, stimulant medications came in at second place, with a 5% annual rate, falling just behind pain medications, with a 9% annual rate (McCabe et al., 2006). Stimulant medication had the highest illicit use to medical use ratio, and the number of illicit users exceeded the number of medical users (McCabe et al., 2006). Additional studies, described below, have more specifically addressed the illicit use of prescription stimulants in national samples of college students, as well as illicit use at individual college campuses.

Rates of illicit use. Babcock and Byrne (2000) administrated the first known survey regarding illicit use of stimulants at college campuses. They found a 16% lifetime rate of recreational use at a public liberal-arts college (Babcock & Byrne, 2000).

McCabe et al. (2005) studied rates of illicit use of stimulant medication based on a national sample of 119 four-year colleges in the United States. The researchers found an overall 6.9% lifetime rate, and a 4.1% past-year rate (McCabe et al., 2005). The past-year rate at individual colleges ranged from 0-25%, with 10% of the colleges having a rate of 10% or higher (McCabe et al., 2005). A study of 9,161 students at a large, public Midwestern research university found an annual rate of 5% (McCabe et al., 2006). Hall et al. (2005) found a lifetime rate of 13.7%, with a 17% rate among males and an 11% rate among females at a Midwestern college campus. Out of 4,580 college students, Teter et al. (2006) found an 8.3% lifetime rate and a 5.9% past-year rate. Rabiner et al. (2009) investigated illicit stimulant use at one private and one public university in the Southeast and found past-year rates of 8.8 and 9.0, respectively.

DeSantis et al. (2008) found a particularly high lifetime rate of 34% from a sample of 1,811 students at a large Southeastern University.

Demographic and risk factors. Researchers have studied demographic factors that predict illicit use of stimulant medication among college students. Risk factors include being male (DeSantis et al., 2008; McCabe et al., 2005; Rabiner et al., 2009), being Caucasian (DeSantis et al., 2008; McCabe et al., 2005; Rabiner et al, 2009; Teter et al., 2006), being an upperclassman (DeSantis et al., 2008), having a lower self-reported GPA (McCabe et al., 2005; Rabiner et al., 2009), and attending a college with more competitive admission standards (McCabe et al., 2005).

A predictor of illicit stimulant medication use for both men and women is knowledge of fellow students who illicitly use stimulants (Hall et al., 2005). Accessibility is an additional risk factor for men, and being offered stimulants is a risk factor specific to women (Hall et al., 2005).

Motivational factors and attitudes. Students report various motivational factors for illicitly using stimulant medication. Hall et al. (2005) found that students illicitly used stimulants because they felt pressure from time commitments, and believed that sleepiness and fatigue made it difficult for them to study. Of the students in Hall et al.'s (2005) study who reported illicit stimulant use, 27% took stimulants during finals week and 15.4% took stimulants before tests. Illicit users in Teter et al.'s (2006) study reported they used stimulants to help with concentration (65.2%), help them study (59.8%), and increase their alertness (47.5%). DeSantis et al. (2008) also found that illicit use of stimulants was highest when students were under academic stress: 72% of illicit users took stimulants "to stay awake to study," and 66% of illicit users took stimulants "to concentrate on work." Rabiner et al. (2009) found that the top three reasons college students used stimulants were to increase concentration when studying, to study longer, and to feel less restless while studying.

Recreational stimulant medication use has also been investigated. Hall et al. (2005) found that 12% of illicit stimulant users reported having used the drug when they partied. Teter et al. (2006) reported that 31% of illicit users took stimulant medication to get high, and 29% of illicit users took stimulant medication to experiment.

DeSantis et al. (2008) conducted 175 interviews with students. The participants reported that stimulants were both accessible and stigma-free on their college campus. Of all survey takers, 82% reported that stimulants were either “very easy” (39%) or “somewhat easy” (43%) to obtain.

Perceived effects. Many students who illicitly used stimulant medications reported positive effects. In one study, for every academically related motive, at least 74% of users reported the effect was either “often” or “always” achieved (Rabiner et al., 2009). These academic motives were: to increase concentration when studying (89%), to concentrate better in class (87%), to study longer (89%), to feel less restless in class (74%), to feel less restless while studying (81%), and to keep better track of assignments (75%). In the interviews in DeSantis et al.’s (2008) study, illicit users reported reduced fatigue and increased reading comprehension, interest, cognition, and memory. Hall et al. (2005) found that 14% of illicit users reported a positive effect of stimulants on academic achievement in the long run.

Substance use. Illicit use of stimulant medication has been shown to be correlated with other substance use. One study found that illicit stimulant users were more likely to use alcohol, cigarettes, marijuana, cocaine (McCabe et al., 2005, Rabiner et al., 2009), ecstasy (McCabe et al., 2005), and inhalants (Rabiner et al., 2009). Hall et al. (2005) found that 15% of stimulant users took the medication with alcohol, and 21.2% of stimulant users took the medication with other drugs.

Legal stimulants include caffeine and nicotine. These substances were included in the study to investigate students who use legal stimulants as study-aids but might be opposed to illegal behaviors, such as illicit stimulant use. Differences in self-reported or measured figure-ground difficulties between users and non-users of legal substances might suggest that there is an additional population of students who could benefit from treatment for auditory figure-ground difficulties.

Sensation seeking. Sensation seeking is a personality trait defined by the "seeking of varied, novel, complex, and intense sensations and experiences, and the willingness to take physical, social, legal, and financial risks for the sake of such experience" (Zuckerman, 1994, p.27). Sensation seeking is a trait that has been found to be a strong predictor of various behavior problems, including smoking, alcohol use, and illicit drug use (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002). Sensation seekers have been found to underestimate the risks involved in problem behaviors (Zuckerman, 1979, as cited in Hoyle et al., 2002). Due to their high rates of alcohol and drug consumption, illicit stimulant users are considered high in risk-taking (Rabiner et al., 2009).

Self-reported auditory figure-ground difficulties. Some students reported using stimulants to reduce the distraction of background noise while focusing on schoolwork. DeSantis et al. (2008) were able to capture this phenomenon due to the in-depth interviews that formed the qualitative portion of their study. One student named "John" claimed that Adderall "blocked out outside noise" thus providing him "focus and concentration" (DeSantis et al., 2008). Another participant, "Tara," agreed that the use of stimulants "zones [her] out to all the outside noises around [her]" (DeSantis et al., 2008). Although there is anecdotal evidence that college students illicitly use stimulant medication to filter out background noise, no research has empirically documented the phenomenon. The current study used this anecdotal evidence, along with evidence presented below regarding the effect of stimulant medication on auditory processing deficits in children diagnosed with Attention Deficit Disorder (ADD), to investigate the relationship between stimulant medication and auditory figure-ground difficulties in a population of college students without ADD/ADHD diagnoses. Auditory figure-ground difficulties are defined as difficulties in attending to foreground auditory stimuli in the presence of competing background noise.

Effect of Stimulant Medication on Auditory Processing in Children with ADHD

While children diagnosed with ADD and ADHD typically have normal hearing, they often display difficulties filtering out background noise (Tillery, Katz, and Keller, 2000). Some audiology researchers suggest that ADHD medication, such as methylphenidate, may correct or partially correct auditory processing deficits (Tillery et al., 2000). Gascon, Johnson, and Burd (1986) observed that when children were treated for ADD/ADHD with central nervous system stimulants, their performance on auditory processing tests improved.

Further studies have been conducted in the field of audiology investigating the effect of stimulant medication on auditory processing abilities of individuals with ADHD (Freyaldenhoven, Thelin, Plyler, Nabelek, & Burchfield, 2005; Keith and Engineer, 1991; Tillery, Katz, & Keller, 2000). Keith and Engineer (1991) studied the effect of methylphenidate on auditory processing abilities in a sample of 20 children diagnosed with ADD or ADHD, as measured by the three subtests of The Tests for Auditory Processing Disorders in Adolescents and Adults (SCAN-3:A): the Competing Words- Free Recall (CW-FR) Subtest, the Auditory

Figure Ground (AFG) Subtest, and the Filtered Words (FW) subtest. The CW-FR Subtest is a dichotic listening test in which a different speech stimulus is presented to each ear simultaneously. The CW-FR Subtest purportedly measures an individual's auditory maturation level (Keith & Engineer, 1991). A low score on the subtest may indicate that the individual is susceptible to auditory attentional difficulties (Keith & Engineer, 1991). The participants scored significantly higher on the CW-FR Subtest while under the effect of methylphenidate (Keith & Engineer, 1991). The AFG Subtest measures the ability to discriminate an auditory stimulus in the presence of background noise (Moss & Sheiffele, 1994). Although the children slightly increased their scores while on methylphenidate, the difference was not statistically significant (Keith & Engineer, 1991). Keith and Engineer (1991) noted that although there were not significant findings for children with ADHD, this might be due to the uniform intensity of the speech babble. Since the background noise was monotone, it may have allowed for the children to adjust to the babble and did not reflect background noise in real-world conditions. The test may still identify individuals who are significantly impacted by background noise and may not be able to adjust to the uniformity of the speech babble (Keith and Engineer, 1991).

Gascon et al. (1986) also hypothesized that stimulant treatment would improve performance on auditory processing tests in children with ADD and ADHD. Their sample consisted of 23 children diagnosed with ADD (Gascon et al., 1986). Among the central auditory processing tests were the staggered spondaic word test (the SSW), which is a dichotic listening test, and three subtests of the Willeford central auditory test battery: a competing sentence test (the CST), a filtered speech test (FST), and a rapidly alternating speech test (RAST) (Gascon et al., 1986). Improvement in performance was defined as improvement from baseline on at least two tests while in the medicated condition (Gascon et al., 1986). Seventy-nine percent of the sample improved on auditory processing test performance after stimulant treatment (Gascon et al., 1986).

In another study, fifteen boys aged six to ten who were diagnosed with ADD were compared with ten "control" boys without an ADD diagnosis (Cook et al., 1993). The study took place over six weeks. The boys with ADD took a placebo over the first three weeks of the experimental period followed by three weeks with methylphenidate treatment (Cook et al., 1993). The control boys were not given a drug or placebo (Cook et al., 1993). The following tests were administered after a three-week period and six-week period: speech audiometry, the SSW test, and three subtests of the Willeford test battery: the Binaural Separation Test (BST), the FST, and the Rapidly Alternating Speech Test (RAST) (Cook et al., 1993). The ADD group responded to methylphenidate treatment with improved performance for some measures of the Central Auditory Processing Disorder (CAPD) battery (Cook et al., 1993). There was a significant drug effect for the BST and the RAST (Cook et al., 1993). According to the researchers, stimulants such as methylphenidate seem to be a useful treatment for symptoms of CAPD in addition to symptoms of ADD (Cook et al., 1993).

Another study investigated a sample of 32 subjects, each diagnosed with CAPD and ADHD (Tillery et al., 2000). When the children were under the influence of methylphenidate, their performance improved on the ACPT, a test measuring auditory attention (Tillery et al., 2000). However, their performance did not significantly improve on the SSW test, the PS test (a sound blending test), or the Speech-in-Noise test (an auditory figure-ground test).

The effect of stimulant medication on auditory processing has also been studied in college-aged students. A study on fifteen college-aged females diagnosed with ADD/ADHD found that stimulant medication significantly decreased the "acceptable noise level" (ANL) of the participants, meaning that they were more willing to accept high levels of background noise while on medication (Freyaldenhoven, Thelin, Plyler, Nabelek, and Burchfield, 2005). The increased willingness to accept background noise while in the medicated condition may suggest that these changes were due to systematic improvement in auditory processing (Freyaldenhoven et al., 2005).

The above-mentioned research studies present conflicting evidence as to whether stimulant medication is an effective treatment for auditory processing symptoms. Due to the presence of confirmatory evidence that stimulant medication may significantly improve performance on auditory processing tasks, this question merits further scientific evaluation.

Although this area of research evokes the issue of whether ADD and CAPD are overlapping disorders, the present study does not delve into the controversy. Previous research points out that despite the overlap between ADHD and CAPD, individuals may have auditory processing deficits without attentional deficits (Cook et al., 1993). The investigators are specifically interested in whether individuals in the general population without an ADHD diagnosis may be illicitly taking stimulant medication because they believe that the medication helps relieve auditory processing symptoms.

The Present Research Question and Hypotheses

With the large body of evidence that stimulant medication has become a popular study and recreational drug among college students without prescriptions to the medication, there is a need to better understand factors contributing to this illicit use. The primary purpose of the current study was to examine whether auditory processing difficulties, actual or perceived, contribute to illicit use of stimulant medication in college students without ADHD diagnoses. The motivation for the research was grounded in anecdotal evidence of students illicitly using stimulants to filter out background noise, as well as audiology evidence suggesting that stimulant medication may improve performance on auditory processing measures. The study also investigated predictors and correlates of illegal stimulant use at a Southeastern moderate-sized liberal arts university. We hypothesize that:

Hypothesis 1: Self-reported auditory figure-ground symptoms will increase the likelihood of poor performance on auditory-processing measures.

Hypothesis 2: Self-reported auditory figure-ground symptoms will increase the likelihood of use of "study-aids" in the form of substances.

> **Hypothesis 2a:** Self-reported auditory figure-ground symptoms will increase the likelihood of illicit stimulant use.
>
> **Hypothesis 2b:** Self-reported auditory figure-ground symptoms will increase the likelihood of caffeine consumption to concentrate on schoolwork.
>
> **Hypothesis 2c:** Self-reported auditory figure-ground symptoms will increase the likelihood of cigarette consumption to concentrate on schoolwork.

Hypothesis 3: Users and non-users of "study-aids" in the form of substances will differ on measures of auditory processing performance.

> **Hypothesis 3a:** Illicit stimulant users will perform differently from non-users on measures of auditory processing.
>
> **Hypothesis 3b:** Cigarette users will perform differently from non-users on measures of auditory processing.
>
> **Hypothesis 3c:** Caffeine users will perform differently from non-users on measures of auditory processing.

Hypothesis 4: Students who illicitly use stimulants will report higher levels of sensation seeking.

Hypothesis 5: Students who illicitly use stimulants will report higher levels of substance use.

Hypothesis 5a: Students who illicitly use stimulant medication will report higher levels of alcohol use.

Hypothesis 5b: Students who illicitly use stimulant medication will report higher levels of illicit drugs and prescription drugs.

Hypothesis 5c: Students who illicitly use stimulant medication will report higher levels of cigarette use.

Method

Participants

Prior to data collection, an a priori power analysis was conducted to determine the sample size. To achieve power of .80 at an alpha level of .05, the sample size should have been 62 with 31 in each auditory figure-ground group. The assumption of the power analysis was a .20 proportion of illicit use in the auditory low figure-ground group and a .50 proportion of illicit use in the high auditory figure-ground group. Due to the limited time frame, the data analysis included only 52 participants.

The research design consisted of a recruitment survey followed by an experimental phase. Participants in the recruitment survey were 330 undergraduate students at Emory University. Of the students who submitted the survey, 236 were female (71.5%) and 94 were male (28.5%).

For the experimental phase, 150 students were contacted and invited back to participate. Of the 150 students who qualified, 54 participated in the second phase. Two of these students were excluded from the subsequent analyses. One was excluded for not being a primary English speaker and one was excluded for being a freshman. The sample had 10 males (19.2%) and 42 females (80.8%). The participants were 67.3% White, 13.5% Black or African American, 9.6% Asian, 5.7% Hispanic or Latino, and 3.8% Mixed. There were 10 sophomores (19.2%), 18 juniors (34.6%), and 24 seniors (46.2%).

The Institutional Review Board (IRB) at Emory University approved the study protocol. All participants filled out a pen-and-paper consent form before the experimental phase.

Procedure

Students were recruited on the Internet and asked to take a preliminary survey. The survey was administered during the Spring 2012 semester at the university over a six-week period. The email invitation to participate in the preliminary survey contained the survey link and informed students of the exclusions (listed below), the possibility of being invited to a second experimental stage of the study, and their eligibility to enter a drawing for one of two $25 Starbucks gift cards should they qualify to participate in the second phase of the study.

The recruitment email was sent to students on Emory's online community, as well as all public conferences. The public conferences are online forums used to facilitate communication among the university population. There are conferences for campus organizations, academic divisions, and university discussions. A Facebook event also was made and sent to all of the investigator's Facebook friends on the Emory network. The Facebook event was private and invitees could not see the other students on the guest list.

Freshmen were excluded from the sample since previous research has found that students are significantly more likely to illicitly use stimulant medication after their first year (DeSantis et al., 2008). Students with learning disabilities, ADD/ADHD diagnosis, hearing problems, or a primary language other than English were also excluded from the study.

The preliminary survey was taken on the participants' computers. The experimental phase was conducted in The Psychological Center in the Department of Psychology at the university. The students were free to skip any items they wished.

The objective of the preliminary survey was to select two groups of participants for the experimental phase: one with self-reported difficulties filtering out background noise, and one without self-reported difficulties filtering out background noise. The key items on the survey addressed the ability to filter out background conversations in a variety of contexts. The 25% of students who reported the highest level of difficulty filtering out background noise, as well as the 25% of students who reported the lowest level of difficulty filtering out background noise, were invited to come back for the experimental phase.

One hundred and fifty of the 330 students (45.45%) who filled out surveys qualified for the second phase of the survey. Of those 150 students, 54 (36%) chose to participate in the experimental phase and 52 (34.67%) qualified for the analyses. The second-phase participants formed two groups: a group with high self-reported auditory figure-ground difficulties (n = 28) and a group with low self-reported auditory figure-ground difficulties (n = 24). There were 20 (83.33%) females and 4 (16.67%) males in the high auditory figure-ground difficulties group. There were 22 (78.57%) females and 6 (21.43%) males in the low auditory figure-ground difficulties group.

The investigators contacted the students who qualified for the second phase through email. The participants were told that the experimental phase would be completely confidential, that the investigators could not link the students to their responses, and that each student would be given a study ID number to protect his or her confidentiality.

Measures

Phase 1

Recruitment survey. The preliminary survey asked for demographic information including school email address, gender, class year, race/ethnicity, whether English was the student's primary language, major, and GPA (to the nearest tenth). The survey assessed in two separate questions the effect background conversations and background music had on ten activities: taking notes in class, studying for an exam, writing a paper, reading a textbook, taking an exam, solving a math problem, carrying on a conversation, reading a novel for pleasure, text messaging, and watching television or film. The items were rated on a Likert scale of 1-9, with 1 being "*not distracting at all*" and 9 being "*extremely distracting*."

For the purpose of recruitment for the second phase and the analyses, the following items were excluded from the above questions: carrying on a conversation, text messaging, and watching television or film. The items were excluded because there was a lack of range in participant responses.

The next question asked students to rate their study environment preferences on a Likert scale of 1-9, with 1 being "*I do not prefer at all*" and 9 being "*I strongly prefer*." The options included a group study floor, a communal floor, and a silent study area. Each study environment was given a specific description along with its counterpart in the university's library.

The last questions addressed the study's exclusions and asked students if they were diagnosed with a learning disability, ADD/ADHD, or hearing problems. Finally, the survey asked if the student would be willing to come into the laboratory for a phase 2 experimental test should they qualify.

Phase 2 (experimental)

SCAN-3:A screening tests. The Tests for Auditory Processing Disorders in Adolescents and Adults (SCAN-3:A) (Keith, 2009) is a CAPD test battery designed to screen for auditory processing disorders in examinees aged 13-50. In the present study, the test was used to measure auditory processing abilities in a general population of college students who were not diagnosed with hearing problems, learning disabilities, or ADD/ADHD.

Two of the screening tests were given to participants: the Auditory-Figure Ground Screening Test at 0 dB Signal-to-Noise Ratio (AFG 0 dB) and the Competing Words- Free Recall Screening Test (CW-FR). The subtests were administered and scored according to the instructions in the instrument's manual. The investigator (RW) who administered the test was trained by a psychologist (AA) to administer, score, and interpret the results of the test. The test was given in a quiet office in the Psychology building at a comfortable listening level that was well above the specified audiometric threshold. The test was on a CD-ROM and was given on the investigator's computer with stereo headphones that met the requirements stated in the test manual. Raw scores were converted into scaled scores that control for age of the examinee. The mean scaled score for each age group is 10 with a standard deviation of 3. Scaled scores range between 1 and 19.

The test manual for the SCAN-3:A provided information about the reliability of the instrument. Keith (2009) conducted a pilot study of 58 adolescents and adults with two administrations of the test battery within 29 days. The sample size used in the pilot study was lower than the size expected of a standardization sample (Eigenbrood, 2010). The average corrected stability coefficient for the composite of the Pearson's product-moment correlation was .78. According to Keith (2009), the test displayed "excellent stability" with 93% of participants meeting the same pass/fail criterion for the AFG 0 dB screening test for both administrations, and 90% of participants meeting the same pass/fail criterion for the CW-FR. The internal consistency reliability coefficient for the 20-39 age group, which is the age group being studied in the present study, was .72 for the AFG 0 dB and .79 for the CW-FR. These correlations do not meet the suggested criteria for diagnostic tests (Eigenbrood, 2010). The inter-scorer reliability was very high at .98 to .99. The content validity of the test was reviewed as insufficient, since the author did not provide scientific evidence for the development of the test scores (Eigenbrood, 2010). The construct validity was lacking as well, which weakens the diagnostic capability of the test (Eigenbrood, 2010). The reviewer also noted that the theoretical explanation for the SCAN is lacking a comprehensive rationale (Eigenbrood, 2010).

AFG 0 dB. The AFG 0 dB was the first subtest administered to each participant. The AFG 0 dB evaluates an individual's ability to process speech in the presence of competing background noise (Keith, 2009). The test presents a list of monosyllabic words in the presence of multitalker speech babble at a 0 dB speech-to-noise ratio. The researcher administered and scored the test items according to the test manual.

CW-FR. The CW-FR is a dichotic listening task that purportedly measures the maturation of the neurological pathways of the auditory system. In the present study, it was used more generally as an additional measure of auditory processing. The test was not used as a screening tool but as a measure that could potentially differentiate between groups of students that self-reported low and high auditory processing difficulties.

A test word was presented to the right ear while another test word was simultaneously presented to the left ear. The participant was then asked to repeat both words in any order. There were a total of twenty test words, with ten presented to each ear. The test was administered and scored according to the instructions in the test manual.

Memory recall task. The investigators developed this task as a third measure of auditory processing. Participants were given one and a half minutes to study a word-list followed by one minute to immediately recall the words by writing them down on a separate piece of paper. Unlike most memory recall tasks in which subjects hear the word list being read and then orally repeat the words, this measure was created to capture a more realistic study environment. The procedure occurred under two conditions: one in which there was a television clip (Cosbyshow, 2008) playing in the background, as well as a control condition without background noise. The order of the silence and noise conditions was counterbalanced among participants to control for an order effect. The word-lists each contained twenty words (Appendix A), each with one to two syllables and four to eight letters that were randomly generated from an online Paivio, Yuille and Madigan Word Pool (2007). The word pool contains 925 nouns scaled for word frequency in printed text. The researchers subtracted the background-noise score from the control score to obtain the total score for the task.

Survey overview. The survey used in the experimental phase contained questions pertaining to factors that may be related to the illicit use of stimulant medication by college students. The survey included demographics, the Brief Sensation Seeking Scale (BSSS) (Hoyle et al., 2002), alcohol use, drug use, cigarette use, prescription medication use, stimulant medication use, motivations for illicit stimulant medication use including motivations regarding auditory figure-ground difficulties, and perceived effects of illicit stimulant medication use including auditory figure-ground effects. The portion of the survey containing questions about alcohol use, substance use, and illicit use of stimulant medication was an abbreviated form of the online survey titled “ADHD Medication Use in College Students” created by Rabiner et al. (2009). Many questions were removed since they did not pertain to the focus of the present study. There were some questions added about auditory figure-ground difficulties, as well as questions about legal substances used to aid in concentration while studying. Additionally, the questions pertaining to the effects of stimulant medication were changed from a six-point Likert scale to a nine-point Likert scale.

Demographics. Each participant was asked his or her gender, year in school, race/ethnicity, major, and GPA to the nearest tenth.

BSSS. The Brief Sensation Seeking Scale (Hoyle et al., 2002) is an abbreviated and adapted form of the SSS-V (Zuckerman et al., 1978, as cited in Hoyle et al, 2002). The eight-item scale consists of two items from each of the four main dimensions of sensation seeking: experience seeking, boredom susceptibility, thrill and adventure seeking, and disinhibition (Appendix B). Each item was rated on a five-point Likert scale from "*strongly disagree"* to "*strongly agree*."

Hoyle et al. (2002) found internal consistency in the measure among age, sex, and ethnic groups in a study with over 7,000 adolescents between the ages of 13 and 17.

Alcohol use. Participants were asked how many occasions they drank alcohol in the past month, how many alcoholic drinks they had on a typical day when they drank in the past month, and the greatest number of drinks they consumed within a two-hour period in the past month.

Drug use. Students were asked on how many occasions in the past six months they had used marijuana, cocaine, LSD, other psychedelics, and ecstasy.

Tobacco use. Students were asked whether they currently smoke, how much they had smoked in the past month, whether they smoke to concentrate on schoolwork, how many times they had smoked to concentrate on schoolwork in the past six months, and whether they had ever smoked to concentrate on schoolwork.

Caffeine use. Participants were asked if they consume caffeine to help them concentrate on schoolwork, and if yes, on how many occasions in the past six months.

Illicit use of prescription medications. Participants were asked on how many occasions they used non-prescribed sedatives and opiates in the past six months.

Illicit use of stimulant medication, motivation for use, and perceived effects. For the purpose of this study, illicit use of stimulant medication is defined as the use of stimulant medication without a prescription. Students were given a list of commonly prescribed stimulants and asked if they had ever taken these medications prior to the beginning of college and since the beginning of college. The students were asked about motivations for illicit use of stimulant medication (Appendix C). The students were asked to rate on a Likert Scale of 1-9, with 1 being "*not helpful at all*" and 9 being "*extremely helpful*," the perceived effects of stimulant medication (Appendix D). There was also a N/A option for students had not experienced the given effect.

Results

There were 28 (53.85%) students in the group with low self-reported auditory figure-ground difficulties and 24 (46.15%) students in the group with high self-reported auditory figure-ground difficulties. Fourteen (26.92%) students in the sample reported illicit use of stimulant medication. In the low auditory figure-ground difficulties group, 17.8% (n = 5) reported illicit stimulant use. In the high auditory figure-ground group, 37.5% (n = 9) reported illicit stimulant use (Table 1).

There were no significant differences in sample characteristics between illicit stimulant users and non-users (Table 2). A Mann-Whitney U-test was conducted to measure differences in self-reported ability to filter out background music between stimulant users (n = 14, sum of ranks

= 371) and non-users (*n* = 38, sum of ranks = 1007). There was no significant difference (*U* = 266, *p* = 1.000). The researchers used an independent samples *t*-test to compare the GPA's between illicit stimulant users and non-users. The two groups did not significantly differ (Users: *M* = 3.586, *SD* = .23; Non-users: *M* = 3.479, *SD* = .36), *t* (50) = 1.033, *p* = .306; 95% CI [-.1008, .3143]).

Differences in sample characteristics between the low auditory figure-ground group and the high auditory figure-ground group were evaluated. The researchers used Mann-Whitney *U*-test to investigate whether the low (*n* = 28) and high (*n* = 24) groups differed in study environment preferences and their self-reported ability to filter out background music. Differences were significant for group study floor preferences (*U* = 169, *p* = .003, *r* = -.413; sum of ranks: low group = 857, high group 469), silent study floor preferences (*U* = 114, *p* = .000, *r* = -.561; sum of ranks: low group = 492, high group: 834), and ability to filter out background music (*U* = 74.5, *p* = .000, *r* = -.666; sum of ranks: low group = 480.5, high group =897.5). The groups did not differ significantly in preferences for communal floor (*U* = 301, *p* = .661; sum of ranks: low group = 679, high group = 647). The low and high figure-ground groups differed significantly in GPA's with an alpha level of .1 (Low: *M* = 3.436, *SD* = .07; High: *M* = 3.60, *SD* = .23), *t* (44.412) = -1.796, *p* = .079, 95% CI [-.3309, .0190], *d* = -.049). Levene's test indicated unequal variances (*F* = 11.093, *p* = .002), so degrees of freedom were adjusted from 50 to 44.412.

Motivations and Perceived Helpfulness of Stimulant Medication

The motivations for illicit stimulant use are reported in Table 3. The perceived helpfulness of illicit stimulant use for different tasks, rated on a Likert scale from 1-9, is reported in Table 4. The researchers found that 100% of illicit stimulant users reported using the drug to study and to help write papers or do other schoolwork. Academic motivation was not the only purpose of stimulant medication; 28.6% of users reported using stimulant medication "to get high." The vast majority (78.6%) of users gave a score between 7 and 9 for helpfulness of stimulant medication to better concentrate when studying (*M* = 7.786) and writing a paper or doing other schoolwork (*M* = 7.714). Nearly all illicit stimulant users (92.9%) gave a score between 7 and 9 for helpfulness of stimulant medication to help them feel less tired and study longer (*M* = 8.071). Although many students did not report screening out background noise as a motivation, over half (57.14%) rated the perceived helpfulness of stimulants between a 7and a 9 to filter out background noise when studying (*M* = 6.357) and when writing a paper or doing other schoolwork (*M* = 7.214).

Tests of Hypotheses

Hypothesis one. An independent samples *t*-test was conducted to investigate if the low and high auditory figure-ground-difficulties groups differed in their performances on the three measures of auditory processing. There was no significant difference between the groups on the AFG 0 dB Screening Test (Low group: *M* = 7.35, *SD* = 1.60; High group: *M* = 6.92, *SD* = 1.74), *t* (50) = .718, *p* = .328, 95% CI [-.599, 1.265]. At an alpha level of .1, the low and high groups performed significantly different on the CW-FR screening test (Low group: *M* = 6.86, *SD* = 4.34; High group: *M* = 4.92, *SD* = 3.48), *t* (50) = 1.76, *p* = .082, 95% CI [-.274, 4.155], *d* = .494. The groups did not significantly differ on the memory recall task (Low group: *M* = 2.64, *SD* = 3.21; High group: *M* = 2.13, *SD* = 2.92), *t* (50) = .604, *p* = .549.

A repeated-measures ANOVA was conducted for the memory recall task. There was an order x condition effect for the memory recall task (*F* (1, 41) = 19.835, *p* = .000). When the experimental factor of membership to the low or high auditory figure-ground group was added to the analysis, no three-way interaction was found (F (1, 41) = .320, p = .575). This means that the order x condition interaction did not vary between low and high auditory figure-ground difficulty groups. Thus, the order x condition interaction did not impact the results of the independent samples *t*-test that measured differences in memory recall task performance between the low and high auditory figure-ground groups.

Pearson correlations were conducted to see if performances on the three auditory processing tests were correlated. Scores on the AFG 0 dB screening test were significantly correlated with scores on the CW-FR screening test, r = .372, n = 52, p = .007. Scores on the AFG 0 dB screening test were not significantly correlated with scores on the memory recall task, r = -.07, n = 52, p = .624. Scores on the CW-FR screening test were not significantly associated with scores on the memory recall task, r = -.13, n = 52, p = .364.

Hypothesis two. A chi-squared test of independence was used to examine if there were differences between the low and high auditory figure-ground groups regarding use of the following study-aid substances: stimulant medication, caffeine, and cigarettes. There were no significant differences found between groups; however, there was a statistical trend of higher stimulant use in the group with high auditory figure-ground difficulties (χ^2 = 2.53, df = 1, p = .111) (Table 5).

A binary logistic regression was performed to investigate whether being in the low or high auditory figure-ground group predicted stimulant use (Table 6A). The trend of greater illicit stimulant use in the high group disappeared when drug use was controlled for (Table 6B). A composite drug score was created by adding the number of substances used for each participant, including alcohol, cigarettes, illegal drugs, and illicit use of prescription drugs. The mean of the composite drug scores was 1.87 with a standard deviation of 2.03. Participants who had used four or more substances were grouped together as drug-users, since they were one *SD* above the mean.

Hypothesis three. The investigators used an independent samples *t*-test to examine whether there was a difference in measures of auditory processing performance between users and non-users of the following study-aids: stimulants, caffeine, and cigarettes. The only significant finding was that participants who reported using cigarettes as a study-aid scored significantly differently on the CW-FR screening test than did participants who did not report using cigarettes as a study-aid (Cigarette users: $M = 2.25$, $SD = 1.26$; Cigarette non-users: $M = 6.27$, $SD = 4.05$), $t\ (9.927) = -4.685$, $p = .001$, 95% CI [-5.935, -2.106], $d = -1.34$ (Table 7). Levene's test indicated unequal variances ($F = 8.052$, $p = .007$), so degrees of freedom were adjusted from 50 to 9.927.

Hypothesis four. An independent samples *t*-test was conducted to find if there was a group difference between illicit stimulant users and non-users in sensation seeking. There was no significant difference between the groups on the overall scale (illicit stimulant users: $M = 3.35$, $SD = .76$; stimulant non-users: $M = 3.09$, $SD = .75$), $t\ (50) = 1.09$, p = .293, 95% CI [-.218, .730]. The only sub-scale of the BSSS that significantly differed between illicit stimulant users and non-users was the disinhibition subscale (illicit stimulant users: $M = 3.39$, $SD = 1.20$; stimulant non-users: $M = 2.54$, $SD = 1.03$), $t\ (50) = 2.54$, $p = .014$, 95% CI [.178, 1.5280 $d = .765$. (Table 8).

Hypothesis five. A Mann-Whitney *U*-Test was performed to test for differences between illicit stimulant users ($n = 14$) and non-users ($n = 38$) in alcohol, illegal drug, and prescription drug use. Stimulant users drank alcohol on significantly more occasions in the past month ($U = 108$, $p = .001$, $r = -.463$; sum of ranks: users = 529, non-users = 849), consumed significantly more alcohol drinks on a typical day (U = 134, p = .005, r = -.386; sum of ranks: users = 239, non-users = 1139), and drank significantly more drinks during a two-hour period (U = 123, p = .003, r = -.416; sum of ranks: users = 514, non-users = 864). Illicit stimulant users also used other illegal drugs significantly more than illicit stimulant non-users: marijuana (U = 97, p = .000; r = -.538; sum of ranks: users= 540, non-users = 838), cocaine (U = 133, p = .000, r = -.642; sum of ranks: users = 504, non-users = 874), LSD (U = 209 , p = .004, r = -.404; sum of ranks: users= 428, non-users = 950), other psychedelics (U = 190, p = .001, r = -.471; sum of ranks: users = 447, non-users = 931), and ecstasy (U = 177.5, p = .001, r = -.457; sum of ranks: users = 459, non-users = 918). Illicit stimulant users used significantly more sedatives (U = 133, p = .000, r = -.642; sum of ranks: users = 504, non-users = 874). At an alpha level of .1, illicit stimulant users consumed significantly more opiates (U = 222, p = .076, r = -.246; sum of ranks: users = 415, non-users = 963). A chi-squared test of independence was conducted to see if there was a difference in cigarette consumption between illicit stimulant users and non-users. A significant difference was found at an alpha level of .05 (χ^2 = .933, df = 1, p = .017).

Discussion

The main purpose of the present study was to investigate whether college students with high difficulty screening out background noise were more likely to illegally use stimulant medication than college students with low difficulty screening out background noise. The secondary aims of the study were to find if the auditory processing performance measures were correlated with self-reported auditory-figure ground difficulties and to investigate characteristics of illegal users of stimulant medication, including demographic information, sensation seeking, and substance use. The participants in the experimental phase were selected based on their results on a recruitment survey asking about their ability to filter out background noise. The students who reported the least and most auditory figure-ground difficulties were invited to participate the experimental phase. Freshmen and individuals with learning disabilities, ADD/ADHD diagnoses, or hearing problems were excluded from phase 2. In phase 2, students were administered the AFG 0 dB and CW-FR Screening Tests of the SCAN:3-A, a memory recall task, and a survey asking about sensation seeking, substance use, and illicit stimulant use.

The sample size of the present study was particularly small, with only 52 participants. Therefore, the rate of illicit stimulant use and demographic information in the sample cannot be compared to other epidemiological studies or studies with large sample sizes. The results should be interpreted cautiously in relation to other studies since the small sample size cannot allow for salient comparisons.

The present study found an illicit stimulant use rate of 26.9% for illicit use of stimulant medication since the beginning of college. A similar rate of 25% was found in one of the universities in McCabe et al.’s (2005) study. DeSantis et al. (2008) also found a high illicit stimulant use rate of 34%.

The study did not find differences in illicit stimulant medication use among demographical categories, including gender, race, and class year. Previous studies found that males (DeSantis et al., 2008; McCabe et al., 2005; Rabiner et al., 2009), Caucasians (DeSantis et al., 2008; McCabe et al., 2005; Rabiner et al., 2009; Teter et al., 2006), and upperclassmen (DeSantis et al., 2008) were significantly more likely to engage in illicit stimulant medication use. There was also no significant difference between the GPA’s of illicit stimulant users and non-users, which is not consistent with previous research (McCabe et al., 2005; Rabiner et al., 2009). The lack of significant differences in sample characteristics between groups is likely explained by the small sample size. Additionally, males only made up 19.2% of the sample.

The low and high self-reported auditory figure-ground difficulties groups differed significantly only in performance on the CW-FR Screening Test. Keith and Engineer's (1991) similar finding may help explain this result. In that study, children diagnosed with ADD significantly improved their performance on methylphenidate on the CW-FR, but only showed slight improvement on the AFG 0 dB (Keith & Engineer, 1991). Keith and Engineer (1991) explained that since the speech babble was presented at uniform intensity, participants might have adjusted to the background noise. Since background noise of uniform intensity does not reflect real-world conditions, the AFG 0 dB screening test might not be the most appropriate measure to examine differences between individuals with low and high self-reported auditory figure-ground difficulties. Also, the measures used to test auditory processing may not have adequately captured the phenomenon of screening out background noise in an academic setting or in the context of performing academic tasks. Alternatively, the participants might not have been accurate in their assessment of their ability to screen out background noise.

Performances on the two SCAN: 3-A screening tests, the AFG 0 dB and the CW-FR, were correlated with each other. However, performance on the memory recall task was not correlated with performance on either screening portion of the SCAN:3-A. A possible explanation is that the two tasks did not capture the same real-world phenomenon. Additionally, the lack of separation between auditory figure-ground groups, described below, could have limited the findings of the study.

Due to the small size of the sample, it was not possible to select participants only at the extreme ends of the auditory figure-ground spectrum, as the investigators hoped might be possible. The findings might have been stronger in the expected direction had there been a larger phase 1 sample enabling a greater separation in self-reported difficulties between experimental groups.

The low and high auditory figure-ground difficulties groups did not significantly differ in study-aid substance use, including stimulant medication, caffeine, and cigarettes. The main finding of the research was the statistical trend for greater stimulant use in the high figure-ground difficulty group. This finding lends support to the investigators' hypothesis that the perception of auditory figure-ground difficulties may lead to increased illicit use of stimulants. However, when drug use was controlled for, there was no longer an independent effect of illicit stimulant use. Although there is no definitive explanation, this important result suggests that the primary predictor of illicit stimulant use may be drug use in general. The significant difference between illicit stimulant users and non-users on the disinhibition scale on the BSSS lends further support that illicit stimulant use may be part of an overall trend of problematic behavior within a subset of college students. The two items that form the disinhibition scale are "I like wild parties" and "I would love to have new and exciting experiences, even if they are illegal." This subscale characterizes students who are socially disinhibited, expressed by their partying and their willingness to partake in illegal activities.

Participants who used cigarettes as a study-aid scored significantly lower on the CW-FR Screening Test. However, since all participants who used cigarettes as a study-aid were also illicit stimulant users, it is impossible to independently explain the use of cigarettes in connection with auditory processing difficulties.

The finding that use of alcohol, marijuana, cocaine, LSD, psychedelics, ecstasy, sedatives, and opiates was significantly higher among illicit stimulant users is consistent with previous research (Hall et al., 2005; McCabe et al., 2005; Rabiner et al., 2009). The significantly higher rates of drug use among illicit stimulant users provide further evidence of the disinhibited behavior of many of the illicit stimulant users. Illicit stimulant use is most likely one manifestation of an overall inclination towards social disinhibition.

The most common explicit motivation for using stimulant medication was academic motivation: to help with studying and other schoolwork. The mean rating for the helpfulness of stimulant medication for concentrating better when studying was a 7.786 and the mean rating for the helpfulness of stimulant medication for concentrating better when writing a paper or doing other schoolwork was a 7.714. The mean rating for the helpfulness of stimulant medication to feel less tired to study longer was an 8.071. These findings are consistent with previous research reporting academic motives for illicit stimulant use (DeSantis et al., 2008; Hall et al., 2005; Rabiner et al., 2009; Teter et al., 2006).

A portion of the students (28.6%) reported they used stimulant medication to get high, which has been found as a motivation in previous studies as well (Hall et al., 2005; Teter et al., 2006).

Regarding the main research question, 35.7% of students who illegally used stimulants reported using the medication to filter out background noise when studying for a test and writing papers or doing other schoolwork, and one student reported using stimulant medication to filter out background noise when concentrating in class. Importantly, although only a little over a third (35.7%) of students reported using stimulant medication to filter out background noise for academic purposes when studying or writing a paper, over half (57.14%) rated the stimulants between a 7 and 9 on the 9-point scale for achieving this effect.

The reported motivation and perceived helpfulness of illicitly using stimulants to filter out background noise give reason to continue investigating this phenomenon. The findings are consistent with anecdotal evidence from a previous study by DeSantis et al. (2008), in which interviewed students reported the positive effect of stimulant medication on filtering out background noise. The present study was not able to capture the phenomenon through experimental data, aside from the statistical trend of students reporting high figure-ground difficulties engaging in greater stimulant use.

Limitations

The present study included a sample of college students from one university. The findings may not generalize to the overall population of college students. McCabe et al. (2005) found that illicit stimulant use rates differed with universities' admission standards. However, our illicit stimulant use rate fell within the range found in previous studies. The emphasis placed on confidentiality likely resulted in honest reporting, which may explain the high rate of illicit stimulant use found in the study.

The findings suggest that the auditory-processing performance measures used in the study may not have captured the real-world difficulty of screening out background noise in a study environment.

The present study was limited by a small sample size because of the short time frame for data collection. The study would have been strengthened had the low and high auditory figure-ground groups been at more extreme ends of the auditory processing self-report spectrum. The investigators used participants that scored in the top and bottom 25% of the same on the self-reported measure of ability to screen out background noise. However, the low group covered a large range, with participants' mean scores lying between 1 and 5 on a 9-point Likert scale. In contrast, the high group scored on the extreme end of the scale, with participants' mean scores lying between 7.2 and 9. A greater separation between groups and a smaller range of scores in the low figure-ground difficulties group, would have been optimal.

Future Research

The present study can be considered a pilot study for future research on auditory figure-ground difficulties and illicit stimulant use. Because of reports of the helpfulness of stimulant medication for filtering out background noise, the question remains relevant to the topic of illicit stimulant use in college students. If future studies corroborate the anecdotal findings, the connection between stimulant medication and auditory processing will be better understood. The possibility that the drug may correct or partially correct auditory processing difficulties, as evidenced by the findings with children diagnosed with ADD, provide further incentive to investigate the relationship between stimulant medication and auditory processing (Freyaldenhoven, Thelin, Plyler, Nabelek, & Burchfield, 2005; Gascon, Johnson & Burd 1986; Keith & Engineer, 1991; Tillery, Katz, & Keller, 2000). If researchers find that stimulant medication helps correct auditory processing difficulties, perhaps students with extreme auditory-processing deficits can eventually benefit from controlled stimulant treatment without turning to the illegal market.

In the present study, there was a lack of correlation between self-reported figure-ground difficulties and measured performance on auditory processing measures, except for the CW-FR. Future studies would benefit if researchers can develop auditory processing measures that better capture auditory processing skills as they relate to the college environment.

Future studies should have larger sample sizes in order to have greater statistical power. A larger sample size would also allow for researchers to study more dichotomous low and high auditory figure-ground difficulty groups.

Implications for Intervention

The high frequency of illicit stimulant medication use is alarming from a public-health perspective. College students are engaging in criminal activity involving Schedule II controlled substances at a problematic rate (DeSantis et al., 2008). Dangers of illicit use of stimulant medication include legal consequences (Wilens et al., 2008) and interactions of the drug with other substances, of which many students are unaware (McCabe et al., 2005). Hall et al. (2005) found that some college students mixed stimulant medication with alcohol and other drugs. Other dangers include the cardiovascular effects of stimulant medication, and the potential of stimulants to provoke psychosis in vulnerable individuals. Knowledge is incomplete regarding potential long-term consequences of stimulant medication. The perceived helpfulness and effectiveness of the drug for academic purposes magnify the obstacle towards intervention (DeSantis et al., 2008; Rabiner et al., 2009).

One method of intervention is to focus efforts on the suppliers diverting their medication. Many of the suppliers are prescribed stimulant medication and have a surplus of the medication when they do not take it daily (DeSantis et al., 2008). Programs targeting the suppliers and consumers of stimulant medication could take place during freshman orientation, mandatory health classes offered by the university, and campaigns to raise drug awareness on campus. Additionally, colleges should ensure that the staff of their health care centers and study skills centers are informed of the extent of the problem and know how to properly advise students involved in illicit stimulant use (Wilens et al., 2008).

Conclusion

The present study extended previous research by combining two fields of study, psychology and audiology. Specifically, the researchers related the research inquiry of illicit stimulant use to the role of stimulant medication in improving auditory processing deficits in children with ADD. The researchers found a statistical trend among students with high self-reported auditoryfigure-ground difficulties to engage in greater illicit stimulant medication use. However, the trend disappeared once drug use was entered as an additional predictor of illicit stimulant use. The finding that stimulant users scored significantly higher on the disinhibition scale of the BSSS, along with the results that illicit stimulant users also consumed significantly more alcohol, illegal, and prescription drugs, suggest that illicit stimulant use is part of a greater set of problematic behaviors among a subset of college students. However, the reported use and perceived helpfulness of stimulant medication for filtering out background noise confirm that there is a phenomenon in which students are using stimulant medication to correct for auditory processing difficulties. Therefore, future research should investigate this relationship further with a larger sample of students at more extreme ends of the auditory-figure ground spectrum.

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Table 1

Frequencies of Illicit Stimulant Use in Low and High Auditory Figure-Ground Groups

Group	% of group using stimulants (*n*)	% of sample (*N* = 52)	χ^2	*P*-Value
Low	17.8% (*n* = 14)	9.6%	2.53	.111
High	37.5% (*n* = 38)	17.3%		

Table 2

Sample Characteristics of Stimulant Users and Non-Users

Characteristic	% of Users	% of Non-Users	% of Sample	χ^2	*P*- value
Gender					
Male	28.57	15.79	19.23	1.076	.300
Female	71.43	84.21	80.77		
Race/Ethnicity					
White	78.57	63.16	67.30	5.021	.375
African-American	0	18.42	13.46		
Hispanic	0	7.89	5.67		
Asian	14.29	7.89	9.62		
Other	7.14	2.63	3.85		
Year in School					
Sophomore	7.14	23.68	19.23	1.964	.285
Junior	35.71	34.21	34.62		
Senior	57.14	42.11	46.15		

Table 3

Motivations for Illicit Stimulant Users

	n reporting motivation	% of total users (*n* = 14)
To get high	4	28.6
To help study	14	100
To help write a paper/do other schoolwork	14	100
To help concentrate in class	3	21.4
To help filter out background noise when studying	5	35.7
To help filter out background noise when writing a paper/other schoolwork	5	35.7
To filter out background noise when concentrating in class	1	7.1

Table 4

Perceived Helpfulness of Stimulant Medication

Helped me…	*M*	1-3 (*n*, %)	4-6 (*n*, %)	7-9 (*n*, %)	N/A (*n*, %)
Concentrate better in class	7.643	1 (7.1)	3 (21.4)	3 (21.4)	7 (50)
Concentrate better when studying	7.786	0 (0)	3 (21.4)	11 (78.6)	0 (0)
Concentrate better when writing paper/other schoolwork	7.714	0 (0)	3 (21.4)	11 (78.6)	0 (0)
Be able to study longer	8.071	1 (1.9)	0 (0)	13 (98.1)	0 (0)
Feel less restless in class	6.929	3 (21.4)	3 (21.4)	1 (7.1)	7 (50)
Feel less restless when studying	5.786	2 (14.3)	4 (28.6)	8 (57.1)	0 (0)
Keep better track of assignments	7.000	2 (14.3)	4 (28.6)	2 (14.3)	6 (42.9)
Filter out background noise when studying	6.357	1 (7.1)	5 (35.8)	8 (57.1)	0 (0)
Filter out background noise when paying attention in class	7.714	1 (7.1)	3 (21.4)	3 (21.4)	7 (50)
Filter out background noise when writing a paper/other schoolwork	7.214	1 (7.1)	3 (21.4)	8 (57.1)	2 (14.3)
Filter out background noise when socially conversing	7.214	1 (7.1)	4 (28.6)	3 (21.4)	6 (42.9)

Table 5

Differences in Study-Aid Use Among Low and High Groups

	χ^2	*P*-value	*df*
Stimulant Medication	2.53	.111	1
Caffeine	.03	.862	1
Cigarettes	1.451	.228	1

Table 6A

Figure-ground Self-Report as a Predictor of Stimulant Use

Model estimates	Coefficient	Significance	Odds ratio
Constant	.511	.226	
Low/High	1.015	.118	2.760
Model Summary	Value	Significance	
Chi-square	2.548	.110	
Cox-Snell R-square	.048		
Nagelkerke R-square	.069		

Table 6B

Figure-ground Self-Report as a Predictor of Stimulant Use when Controlling for Drug Use

Model estimates	Coefficient	Significance	Odds ratio
Constant	-5.235	.019*	
Low/High	.737	.322	2.089
Drug Use	3.192	.006**	24.33
Model Summary	Value	Significance	
Chi-square	13.704	.000***	
Cox-Snell R-square	.232		
Nagelkerke R-square	.337		

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

Table 7

Differences in Measured Test Performance between Study-aid Users and Non-users

		M	*SD*	*df*	*t*	*p-value*
AFG 0 dB	Stimulant User	7.07	1.73	50	-.065	.949
	Stimulant Non-User	7.11	1.66			
	Caffeine User	7.03	1.66	50	-.334	.740
	Caffeine Non-User	7.19	1.69			
	Cigarette User	6.25	1.26	50	-1.06	.293
	Cigarette Non-User	7.17	1.68			
CW-FR	Stimulant User	5.50	4.11	50	-.496	.627
	Stimulant Non-User	6.13	4.06			
	Caffeine User	5.71	4.52	50	-.576	.590
	Caffeine Non-User	6.33	3.29			
	Cigarette User	2.25	1.26	50	-4.68	.001*
	Cigarette Non-User	6.27	4.05			
Memory Recall Task	Stimulant User	3.00	2.66	50	.85	.400
	Stimulant Non-User	2.18	3.20			
	Caffeine User	2.06	2.66	50	-.97	.337
	Caffeine Non-User	2.90	3.59			
	Cigarette User	2.75	2.75	50	.233	.817
	Cigarette Non-User	2.38	3.11			

* $p < .001$

Table 8

Differences in Sensation-Seeking Between Illicit Stimulant Users and Non-Users

		M	*SD*	df	*t*	p-value
Experience Seeking	Users	3.54	.97	50	.16	.875
	Non-Users	3.49	1.01			
Boredom Susceptibility	Users	3.54	.87	50	-.01	.989
	Non-Users	3.54	.83			
Thrill and Adventure Seeking	Users	2.93	1.04	50	.35	.728
	Non-Users	2.80	1.19			
Disinhibition	Users	3.39	1.20	50	2.54	.014*
	Non-Users	2.54	1.03			
Overall Sensation-Seeking	Users	3.35	.76	50	1.09	.293
	Non-Users	3.09	.75			

* $p < .05$

Appendix A

Word Lists for Memory Recall Task

A
Soil
Palace
Star
Shore
Clothing
Flesh
Spirit
River
Coin
Flag
Earth
Dust
Cell
Flood
Cattle
Plant
Marriage
Cabin
Vessel
Passion

B
Boulder
Pleasure
Army
Prayer
Love
Slave
Creature
Moment
Skin
Shame
Theory
Kiss
Dress
Length
Shadow
Woman
Prison
Seat

Appendix B

The Brief Sensation Seeking Scale

1) I would like to explore strange places. *

2) I get restless when I spend too much time at home. **

3) I like to do frightening things. ***

4) I like wild parties. ****

5) I would like to take off on a trip with no pre-planned routes or timetables. *

6) I prefer friends who are excitedly unpredictable. **

7) I would like to try bungee jumping. ***

8) I would love to have new and exciting experiences, even if they are illegal. ****

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* Experience seeking subscale

** Boredom susceptibility subscale

*** Thrill and adventure seeking subscale

**** Disinhibition subscale

Appendix C

Motivations for Illicit Stimulant Use

1) Since beginning college, have you ever taken any medication(s) used to treat ADHD even though you did not have a prescription for the medication (s) **to get high?**
2) Since beginning college, have you ever taken any medication(s) used to treat ADHD even though you did not have a prescription for the medication (s) **to help you study?**
3) Since beginning college, have you ever taken any medication(s) used to treat ADHD even though you did not have a prescription for the medication (s) **to help you write a paper or do other schoolwork?**
4) Since beginning college, have you ever taken any medication(s) used to treat ADHD even though you did not have a prescription for the medication (s) **to help you concentrate in class?**
5) Since beginning college, have you ever taken any medication(s) used to treat ADHD even though you did not have a prescription for the medication (s) **to filter out background noise when studying for a test?**
6) Since beginning college, have you ever taken any medication(s) used to treat ADHD even though you did not have a prescription for the medication (s) **to filter out background noise when writing a paper or doing other schoolwork?**
7) Since beginning college, have you ever taken any medication(s) used to treat ADHD even though you did not have a prescription for the medication (s) **to filter out background noise when concentrating in class?**

Appendix D

Perceived Effects of Stimulant Medication

If you have taken ADHD stimulant medication without a prescription, how helpful do you think the medication has been for you pertaining to the following activities?

1) Helped me concentrate better in class.
2) Helped me concentrate better when writing a paper or doing other schoolwork.
3) Helped me study longer.
4) Helped me feel less restless in class.
5) Helped me feel less restless when studying.
6) Helped me keep better track of my assignments.
7) Helped me screen out background noise when studying.
8) Helped me screen out background noise when writing a paper or doing other schoolwork.
9) Helped me screen out background noise when paying attention in class.
10) Helped me screen out background noise when socially conversing.