ABOUT PSI CHI
Psi Chi is the International Honor Society in Psychology, founded in 1929. Its mission: “recognizing and promoting excellence in the science and application of psychology.” Membership is open to undergraduates, graduate students, faculty, and alumni making the study of psychology one of their major interests and who meet Psi Chi’s minimum qualifications.

Psi Chi is a member of the Association of College Honor Societies (ACHS), and is an affiliate of the American Psychological Association (APA) and the Association for Psychological Science (APS). Psi Chi’s sister honor society is Psi Beta, the national honor society in psychology for community and junior colleges.

Psi Chi functions as a federation of chapters located at over 1,150 senior colleges and universities around the world. The Psi Chi Central Office is located in Chattanooga, Tennessee. A Board of Directors, composed of psychology faculty who are Psi Chi members and who are elected by the chapters, guides the affairs of the Organization and sets policy with the approval of the chapters.

Psi Chi membership provides two major opportunities. The first of these is academic recognition to all inductees by the mere fact of membership. The second is the opportunity of each of the Society’s local chapters to nourish and stimulate the professional growth of all members through fellowship and activities designed to augment and enhance the regular curriculum. In addition, the Organization provides programs to help achieve these goals including conventions, research awards and grants competitions, and publication opportunities.

JOURNAL PURPOSE STATEMENT
The twofold purpose of the Psi Chi Journal of Psychological Research is to foster and reward the scholarly efforts of Psi Chi members, whether students or faculty, as well as to provide them with a valuable learning experience. The articles published in the Journal represent the work of undergraduates, graduate students, and faculty; the Journal is dedicated to increasing its scope and relevance by accepting and involving diverse people of varied racial, ethnic, gender identity, sexual orientation, religious, and social class backgrounds, among many others. To further support authors and enhance Journal visibility, articles are now available in the PsycINFO®, EBSCO®, Crossref®, and Google Scholar® databases. In 2016, the Journal also became open access (i.e., free online to all readers and authors) to broaden the dissemination of research across the psychological science community.

JOURNAL INFORMATION
The Psi Chi Journal of Psychological Research (ISSN 2325-7342) is published quarterly in one volume per year by Psi Chi, Inc., The International Honor Society in Psychology.

For more information, contact Psi Chi Central Office, Publication and Subscriptions, 651 East 4th Street, Suite 600, Chattanooga, TN 37403, (423) 756-2044. www.psichi.org; pschijournal@psichi.org.

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Two and a half years ago, I stepped into a role that was previously occupied by one of the best researchers, academics, mentors, editors, and friends that I have ever met. Taking the position of editor after Dr. Melanie M. Domenech Rodríguez was a daunting task; what I soon realized was that she had created the perfect platform for the Journal to grow in fantastic ways. This editorial summarizes the past 2½ years of the Journal under my leadership, and offers insight to the future of the Psi Chi Journal of Psychological Research.

One of the most notable changes to the Journal is that we now have five associate editors. With the growth of the Journal, it was necessary to grow our editorial team. With input from my extraordinary (and I do not use that word lightly) managing editor, Bradley Cannon, I made the decision to bring on two amazing academics: Dr. Tammy Lowery Zacchilli and Dr. Erin E. Ayala, as well as Dr. Steven Kohn, who spent a year on our team from July 2016 through June 2017. Both Drs. Zacchilli and Ayala continue to bring unique views to the team, and they share the same enthusiasm for Psi Chi as the rest of the current associate editors, Drs. Mary Beth Ahlum, Jennifer L. Hughes, and Steven V. Rouse.

It has been a seamless endeavor assimilating them into our Journal editorial team. Because we accept manuscripts from every field of psychology, it is vitally important that we have a diverse editorial team. These additions have enabled me to assign manuscripts to the associate editors that are more congruent with their area of expertise. Moreover, having a more diverse editorial team solidifies our goal to make sure authors will have the best review possible of their manuscripts. In other words, this is a win-win.

One of our biggest endeavors was to promote and implement the Open Science Badges program (see https://cos.io/our-services/open-science-badges/). The members of the Open Science Collaboration created three badges that can be applied to manuscripts that meet their criteria. Specifically, the badges recognize open science practices, and they demonstrate research in which the researchers share their data, materials, and/or preregister. In addition, the Journal created our own badge that represents replication research. In our field, most want to be the researcher with the cutting-edge project, but we, at the Journal, believe that there is a need to acknowledge that replications are necessary, important, and worthy of publication. As a result, you will find four badges offered through the Psi Chi Journal (see Figure 1).

With continuing support and positive guidance from Dr. Jon Grahe (Psi Chi Past-President, 2017-18), we took the support of the badges a step further with the release of the Journal’s first-ever Special Issue. For the first time, we asked long-standing associate editor Dr. Steve Rouse from Pepperdine University (CA) to be the invited editor. Once the call for abstracts came out, Dr. Rouse went through the submissions and invited nine authors to submit their manuscripts. Of the nine, eight were published, with one receiving all four badges. Dr. Rouse was extremely committed to the success of the Special Issue, and because of that commitment, the Issue was well-received, and articles are already being cited. Due to the success of the Special Issue, we are now collaborating with Dr. Melanie M. Domenech Rodríguez (current Psi Chi President, 2018-19) on a Special Issue focusing on “Education, Research, and Practice for a Diverse World.” We anticipate this issue to be published in the summer of 2019. This issue supports the presidential initiative and a goal of our Journal.

Additionally, in my tenure as Editor, I have been committed to having at least one invited editorial in each issue. My goal is to offer manuscripts that professors can use in the classroom to support learning, as well as having editorials that are informative for all readers. One of my personal favorites is “Institutional Review Board: Ally Not Adversary”
unique responsibility and privilege to polish and platform for empirical research, we feel that it is our whole. As the leaders of Psi Chi’s sole publication universities have student journals—but there is only impact of our authors’ research. Many colleges and continue increasing the quality, dissemination, and resources, and doctoral-level guidance, we seek to faculty. Further, through invited editorials, example possible for undergraduates, graduate students, and process as educational and as manageable as

https://www.psichi.org/page/JN_Submissions

and he also crafted an outstanding example masked pages and sponsor statements. Together, Lauren Bradley has put into making our submission page Additionally, I appreciate all the hard work that Director), and Bradley Cannon (Managing Editor). I have received from Psi Chi staff members Susan Iles (Communications Director), Martha Zlokovich (Executive Director), Lauren Surmann (Graphic Designer), and Bradley Cannon (Managing Editor). Additionally, I appreciate all the hard work that Bradley has put into making our submission page very clear. He has created templates for writing cover pages and sponsor statements. Together, Lauren and he also crafted an outstanding example masked manuscript posted on that page (see https://www. psichi.org/page/JN_Submissions).

Our goal for the future is to make the publishing process as educational and as manageable as possible for undergraduates, graduates, students, and faculty. Further, through invited editorials, example resources, and doctoral-level guidance, we seek to continue increasing the quality, dissemination, and impact of our authors’ research. Many colleges and universities have student journals—but there is only one Psi Chi Journal, which represents our Society as a whole. As the leaders of Psi Chi’s sole publication platform for empirical research, we feel that it is our unique responsibility and privilege to polish and showcase our members’ best work, which is why we have taken such care to develop our incredible and diverse doctoral-level associate editor and peer-review team. Further, in representing our Society, we are eager to continue finding ways to work closely with the many different groups within the Psi Chi Society such as the Diversity Committee, Research Committee, and Awards and Grants Committee. Through collaboration, we feel that all parties will benefit and be better able to support Psi Chi’s mission: recognizing and promoting excellence in the science and application of psychology.

References


Author Note. Debi Brannan, https://orcid.org/0000-0001-8636-7097, Psychology Department, Behavioral Sciences Division at Western Oregon University, Editor for the Psi Chi Journal of Psychological Research.

Correspondence concerning this article should be addressed to Debi Brannan, Assistant Professor, Psychological Sciences Department, Behavioral Sciences Division, Western Oregon University, 345 N. Monmouth Ave. Monmouth, OR 97361. E-mail: brannand@wou.edu

(Yes, it’s possible).
effect by suicide is an increasing problem in the United States, particularly in the Midwest and Rocky Mountain regions (Suicide Prevention Resource Center, 2018). Among young people, the suicide death rate is lower than that of adults. However, reports on suicide attempts in college student samples suggest that suicide is a significant issue for the college population (Nadroff, Nazem, & Fiske, 2011), and college populations may be more vulnerable to a contagion effect, where one on-campus suicide may lead to several more. There is significant stigma in talking about suicide and seeking mental health care (Sudak, Maxim, & Carpenter, 2008), resulting in a strong reluctance in those at risk of suicide to seek help for themselves. Lewiecki and Miller (2013) reported that 55% of suicide attempts are impulsive and not preceded by a great deal of planning, so there may not be time to connect the person at risk of suicide to those considered most capable of treating the causes of suicide, namely mental health providers. People at risk of suicide also tend to be more likely to reach out to personal contacts and relationships before seeking help from a professional (Seward & Harris, 2016). This suggests that suicide intervention training needs to be in the hands of friends, family members, and other trusted individuals who can guide the person toward additional help in a caring way. Using a first-aid type model for suicide intervention training is a way to help everyday caregivers be prepared to help a friend or family member who is at risk. For a problem where stigma represents a significant barrier to self-help, having a caring partner in help-seeking is vital.

Research on the effectiveness of suicide intervention training tends to focus on proximal outcomes immediately after the training takes place. However, very few studies have examined longer term effects. Suicide intervention training has been found to have a positive impact on attitudes and knowledge about suicide in college and work environments (Cross, Matthieu, Cerel, & Knox, 2007). Confidence to intervene increased
when the training included role-playing, although this was only with a small subset of a college sample (Quinn-Lee, 2017). The intervention training, Question, Persuade, Refer (QPR), has also demonstrated immediate and follow-up gains in knowledge about suicide risks and asking about suicide intent for college campus resident advisors (Tompkins & Witt, 2009). However, the follow-up gains were the same for the untrained comparison group. Because QPR does not typically include a role-playing element, both the trained and untrained RA group might have shown gains due to experience and practice. Many researchers have suggested that intervention trainings like QPR need to include a focus on communication skills (Pasco, Wallack, Sartin, & Dayton, 2012) and exercises to increase self-efficacy for asking about suicide directly (Herron, Patterson, Nugent, & Troyer, 2016).

Suicide intervention training may also include several elements that are potentially unnecessary when examined from a curriculum standpoint. To maximize effectiveness in the least amount of time, components of suicide intervention training should clearly identify benefits for each component of the training. Although QPR is listed in the best practices registry from the Substance Abuse and Mental Health Services Administration, there are a number of criticisms both for the rigor of the research demonstrating effectiveness (Herron et al., 2016) and from intervention specialists who find the QPR presentation somewhat cumbersome from a pedagogical and practical standpoint (Quinn-Lee, 2017).

We designed Brief Suicide Intervention Training (BSIT) to maximize the impact of each element in the training by examining prior research on effective pedagogy and existing effective suicide intervention programs. Any effective suicide intervention training program would (a) present specific information to increase awareness, (b) explore the common barriers preventing intervention, (c) inform participants about risk factors and warning signs, (d) increase behavioral intentions through role play, (e) discuss motivational strategies for increasing safety, and (f) provide local resources for further help.

Suicide awareness information may be a useful component of training so that participants understand the importance and need for the training (particularly important if it is a mandated training in a workplace, for example). Awareness of local community suicide “hotspots” facilitates intervention by those most likely to have an opportunity to intervene. Meta-analysis showed that restricting access to means, encouraging help-seeking, and increasing likelihood of intervention by a third-party is effective for reducing suicide at community hot-spots (Pirkis et al., 2015).

Stigma about mental illness and suicide behavior present a significant barrier to approaching someone to talk about suicide. Both those at risk and those who may care for them experience the negative impact of the stigma surrounding suicide as well as the negative attitudes about help-seeking. This presents both a barrier to asking for help from others and offering help to others who may need or want it. Research has suggested that, for those living in high suicide regions, the more self-stigma and shame people experience, the less likely they are to seek formal or informal help (Reynders, Kerkhof, Molenberghs, & Audenhove, 2015). It would be important for training to address the feelings of embarrassment and stigma that serve as barriers to talking to someone about suicide.

Informing caregivers about risk factors for suicide would seem to be intuitively valuable, but it is also important to discuss the possibility that risk factors may not be obvious or evident, and that people respond differently to life’s challenges. By focusing attention on those verbal and nonverbal behaviors that indicate emotional or psychological pain, intervention training can help validate trainees’ ideas that something is wrong and reduce another barrier to asking about suicide. Understanding what the less obvious signs of suicide are is important to prevent trainees from overlooking someone who does not display stereotypical or obvious risk factors. It is beneficial to remind trainees that directly asking about suicide, even when there may not be many clear risk factors present, is better than the potential consequences of not asking at all.

Asking directly about suicide is more effective than trying to lead indirectly up to it, but it is also very difficult to do initially for most people. Research has shown that even clinicians need training to ask directly about suicide in order to address immediate risk (Meerwijk et al, 2016). Clinicians and psychotherapists who tend to focus on long-term treatment addressing symptoms of depression or other mental health problems can miss signs of immediate suicide risk. Although therapy is vitally important for reducing suicide risk by treating depression and other sources of emotional distress, short-term risks are missed if therapists are not
prepared to directly ask about immediate suicide risk. This study also found that those who received only standard symptom care from clinicians were between one and five times more likely to die from suicide later.

Once trainees are prepared to ask about suicide through role-play, the next barrier is fear over what to do if suicide is the challenge they are facing with the person at risk. Most intervention trainings provide resources for further help, and although that is an essential component to increasing safety, we think the problem of what to do after is more profound. Many intervention trainees express concern about what to say and how to respond on a more personal level after discovering someone is at risk of suicide. Research on the clinical strategy of motivational interviewing may give some indication as to most helpful ways to proceed. Miller and Rollnick (2002) demonstrated the application of motivational interviewing to multiple mental health treatment scenarios where clients are ambivalent about change. The primary idea is to respect and maintain client autonomy while encouraging an atmosphere of collaboration, and encourage exploring the discrepancy between the competing desires of the client and supporting client self-efficacy in their ability to choose change. Zerler (2008) has clarified the application of motivational interviewing to suicidal ideation and suicide risk. He suggests that people considering suicide are experiencing a primary ambivalence about their life. The recommended approach is to continue discussing suicide with the person at risk without pushing toward life or fundamentally making the decision for them. Instead, trainees can stay more neutral and converse about both the suicide feelings and what is holding the person to life. To connect the person at risk to additional resources, trainees can ask if the person at risk is willing to stay safe while they get more help, thus increasing self-efficacy about safety and maintaining a collaborative relationship for safety.

Lastly, intervention training programs need to provide resources for additional assistance that are easily accessible for the relevant context of the trainee, both locally and nationally in scope. Providing resources has been shown to reduce suicidal behavior at long-term follow-up posttreatment (Meerwijk et al., 2016). The Brief Suicide Intervention Training (BSIT) was designed to cover these essential elements in an hour-long group format. There are two versions of the training in use: a standard version and a version designed specifically for use on a college campus.

**Method**

**Participants**
Six hundred forty-two participants voluntarily completed the anonymous evaluation given immediately after the training. Respondents ranged in age from 19 to 81 years with 65% women and 24% men. The ethnicity of respondents matched that of the surrounding community, apart from fewer Native American respondents. Fifteen different trainers presented the BSIT in multiple community contexts such as schools, churches, college campus settings, and other community facilities. The most typical training group size was under 10 participants, but training group size varied from five participants to 150 participants. The training occurred in multiple communities in western Colorado.

**Measures and Procedure**
Participants filled out a program evaluation survey at the end of every training in order to provide feedback to the trainers about the training and if it was helpful to the participants. Data analysis and presentation occurred after institutional review board approval (17-27) was given. The feedback survey was comprised of three sections.

### TABLE 1

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<tr>
<th>Confidence Item</th>
<th>Before Training</th>
<th>After Training</th>
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<tr>
<td>Recognize when someone might be at risk of suicide</td>
<td>5.96 2.32</td>
<td>8.11 1.47</td>
<td>-28.77 (603)</td>
<td>≤ .001</td>
</tr>
<tr>
<td>Ask directly about suicide</td>
<td>5.79 3.07</td>
<td>8.48 1.68</td>
<td>-26.99 (606)</td>
<td>≤ .001</td>
</tr>
<tr>
<td>Be with someone while they talk about suicide</td>
<td>6.69 2.79</td>
<td>8.69 1.51</td>
<td>-22.70 (599)</td>
<td>≤ .001</td>
</tr>
<tr>
<td>Help someone at risk choose safety</td>
<td>6.54 4.79</td>
<td>8.58 1.51</td>
<td>-11.02 (600)</td>
<td>≤ .001</td>
</tr>
<tr>
<td>Know how to find more help using resources</td>
<td>6.01 2.75</td>
<td>8.91 1.37</td>
<td>-28.91 (604)</td>
<td>≤ .001</td>
</tr>
</tbody>
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*Note: Comparison ratings of confidence made after training concluded.*
Confidence rating. The trainers presented the outcome measure immediately following the training. Participants rated their confidence in five intervention behaviors before and after the training, for example, “How confident are you that you can ask directly about suicide.” The confidence items were rated on a 10-point scale from 1 (not at all confident) to 10 (100% confident). Reliability for this scale is \( \alpha = .85 \).

Beliefs about suicide. Eleven additional items were adapted from the Beliefs About Suicide Survey (\( \alpha = .69 \)) used by Tompkins and Witt (2009). The adaptations included shortening the survey to accommodate the available time, creating some reversal items to ensure that respondents were reading each item carefully and clarified that each item was assessing only one belief. An example of a reversal item is, “I’m uncomfortable being responsible for discussing suicide with someone at risk.” Each item was rated for participant agreement on a scale from 1 (not at all) to 7 (agree completely). These questions cover two training content areas, beliefs relevant to training content (6 items), and beliefs about barriers to suicide intervention (5 items). Reliability for the revised survey used in this sample is \( \alpha = .41 \).

The survey concludes with four questions about trainer adherence to the content. Some demographic questions are also provided (age, gender, ethnicity, occupation, and zip code).

Results
We used paired-samples \( t \) tests to assess changes in confidence for each intervention behavior from before to after the training. All comparisons showed statistically significant gains in confidence for the five confidence items. The before and after confidence ratings (as rated after the training) demonstrated statistically significant positive increases; shown in Table 1.

To take a more meaningful look at the Beliefs About Suicide Survey, we examined four categories (quartiles) of average confidence ratings after the training. Participants were assigned to group by quartile so that the highest confidence quartile rated a 4, second quartile a 3, third quartile a 2, and lowest quartile a 1. The analysis demonstrated that participants who were more confident agreed more strongly with the training content items and agreed less with the barriers to intervention items. Table 2 presents the effect of confidence after the training on training content, \( F(3, 500) = 26.21, p \leq .001, \eta^2 = .14 \), and on barriers to intervention, \( F(3, 500) = 37.15, p \leq .001, \eta^2 = .18 \).

Discussion
Results of this study demonstrated immediate positive responses to BSIT training in the desired direction. Participants believed that the training increased their confidence to recognize when someone is at risk, ask directly about suicide, be with someone while they talk about suicide, help someone at risk choose safety, and find more help using resources.

The postraining evaluation showed positive understanding of the content of the training and reduced agreement with attitudes that would be barriers to intervention. Scores on content knowledge were higher in those highest in confidence at the end of training. Likewise, those who were most confident at the end of training reported the lowest agreement with barriers to intervention. Effect sizes for the statistically significant results were strong, which suggests that the differences in confidence as rated immediately after the training are both robust and have clear practical implications for the training. These findings occurred in a large cross section of the populace, across multiple trainers, multiple settings, and multiple western Colorado communities.

These results showed a clear benefit to the 1-hour training, at least immediately following the training, where people were more likely to reach out and help someone in distress who may be at risk of suicide, and were willing to engage in behaviors (like asking directly about suicide) that could save a life. A key strength of the training was its adaptable nature, so that awareness information and information about signs of suicide can be adapted in the presentation to best match the group and community.

Although BSIT was not designed to increase self-help under conditions of suicide risk, it showed...
those at risk that there are caring people willing to hear about suicide and that there are resources and places that can help. The primary goal of BSIT was to provide enough information to everyday people so that they could connect someone at risk of suicide to further professional help. We also hope to increase help-seeking overall by increasing helpers’ willingness to talk about suicide and providing resources.

Essential future research should include long-term follow-up of the effects of the brief training. Although increasing confidence is important, it is even more important to show that the beneficial effects of training last over time and that confidence does not degrade. It would also be valuable to see if the training had beneficial effects on the likelihood of carrying out a suicide intervention over time. Future research could also explore how to reach those with the least confidence at the end of the training, for example, exploring the impact of a longer time spent for role-playing. Most of the existing suicide intervention programs could benefit from pedagogical research to demonstrate which components of the training will increase impact and efficiency. A prerequisite to any follow-up study would be to increase the reliability of the beliefs about suicide measure, by using more items, and refining existing items.

This study was limited by the brief nature of the posttraining survey, with both training content and barriers to intervention being assessed with only a few items, thus the low reliability. The need to keep the posttraining survey short so that respondents would have time to fill out the survey was felt to be important with the 1-hour time frame. Another key limitation was that respondents reported on their confidence before and after the training only after the training. In other words, we asked them to rate their increase in confidence with a before and after comparison. Although this is not ideal from a research point of view, this method was the most practical for training evaluation purposes where there were multiple trainers in multiple settings. By focusing the second part of the analysis on the after-training confidence measure, we were able to show clear positive benefits of the training aside from the pre-post comparison.

References


Author Note. Susan E. Becker, Colorado Mesa University; and Kayla L. Cottingham, Colorado Mesa University. The Western Colorado Suicide Prevention Foundation supports this work.

Correspondence concerning this article, as well as requests for permission to give the Brief Suicide Intervention Training (BSIT) in a local community, should be addressed to Susan E. Becker, Colorado Mesa University, 1100 North Ave Grand Junction CO 81501. E-mail: sbecker@coloradomesa.edu
Nonprescribed stimulant use (NPSU), defined as using stimulants such as Adderall, Vyvanse, and Ritalin that have not been prescribed, is becoming a norm—especially on college campuses. This study evaluated possible predictive factors of academic NPSU in college students. We hypothesized that students would be more likely to misuse stimulants if they (a) perceived NPSU to be safe, (b) perceived NPSU to be ethical, (c) were academically extrinsically motivated, (d) perceived their college environments to be competitive, and (e) perceived NPSU to be common. Participants (N = 270; 59% women, 41% men) were undergraduate students at a small, Christian, liberal arts university in Southern California, recruited from an online research participation management system. Spearman Rho correlations were calculated, and significant relationships were found between NPSU and perceptions of NPSU commonality (r = .18, p = .006) as well as NPSU ethicality (r = .20, p < .001). These relationships remained significant even when controlling for the covariate of age: NPSU commonality, r(226) = .15, p = .03; NPSU ethicality, r(226) = -.14, p = .04. The implications of these findings are discussed.
Nonprescribed Stimulant Use in a College Setting | Pfund, Miller-Perrin, and Rouse

al., 2012). Garnier-Dykstra et al. (2012) also found that approximately 46% of students used stimulants within the year of their first offer.

Research has uncovered several motivations for NPSU in college students. First, students may simply be unaware of the consequences of NPSU. For example, students may not be aware of health and academic risks associated with NPSU. In one study comparing Greek life members to non-Greek life members, the former were more likely to report having misused stimulants. However, they were also more likely to view them as safer than alcohol, marijuana, and other illegal substances (Dussault & Weyandt, 2013). There is also evidence that NPSU may negatively impact academic achievement. On average, students who misuse stimulants are generally less academically successful than their nonusing counterparts (Weyandt et al., 2014). Students might also be unaware of the legal consequences of NPSU. Although state laws regarding the misuse of these controlled substances vary, some of the stricter states have fines ranging from $10,000 to $500,000, with a possibility of a lifetime in prison for NPSU (Weyandt et al., 2016). In general, students who find NPSU riskier are more likely to report that they have never misused stimulants (Benson et al., 2015).

A second reason for NPSU among college students could be that students are willing to look beyond the high stakes of misuse to meet certain goals. Research has shown that 54% of NPSU is for academic purposes such as to improve concentration, improve study skills, and stay awake in order to study longer (Benson et al., 2015). Another study found that approximately 66% of participants misused stimulants in order to enhance alertness and nearly 57% misused these prescriptions in order to improve their academic performances (Bossaer et al., 2013).

Further evidence of NPSU for academic purposes is illustrated by patterns of use and misusers’ intentions. Stimulant consumption peaks around midterms and final exam seasons in order to enable students to stay awake all night and study for these exams right before they happen (Garnier-Dykstra et al., 2012). Hartung and colleagues (2013) compared use of stimulants among those with a prescription, those with a prescription who took more than their doctor prescribed (medical misusers), those without a prescription who misused (nonmedical misusers), and those who did not use stimulants. They found that the nonmedical users were more likely to misuse stimulants to study more effectively, and the medical misusers were the group most likely to misuse stimulants in order to improve academic performance. The most effective way to succeed academically and for long-term learning, however, is through more consistent and sustained effort of studying instead of a short, condensed burst of effort (Dodge, Williams, Marzell, & Turrisi, 2012). Most first-time users, usually during the beginning of their college experience, actually try drugs such as Adderall or Ritalin because of motives driven by curiosity. However, later on during their college experience, students are driven by academic motives such as staying awake to study and increasing concentration (Garnier-Dykstra et al., 2012).

There appear to be many reasons surrounding NPSU in college students including a desire for academic success as well as misperceptions of the consequences of NPSU. However, little research has examined more complex motivations contributing to NPSU. The purpose of the current study was to examine various factors that could be related to the growing prevalence of NPSU. Understanding why so many students misuse stimulants and correcting any misperceptions could be important in combatting the growing norm of NPSU on college campuses.

Perceptions of NPSU as Academic Dishonesty

If the primary intention behind NPSU is academic improvement, then an additional factor that could lead to NPSU is a failure to consider it to be academic dishonesty. NPSU as a means to enhance academic performance could arguably be a form of cheating. One study found that many students who misused stimulants claimed that using the drug itself was not actually wrong because they were able to test their own responsible behaviors by choosing the situations in which it was appropriate and inappropriate to misuse (Petersen, Nørgaard, & Traulsen, 2015). However, students’ acknowledgement that some situations are inappropriate for NPSU indicates that there is some recognition that NPSU might be unethical. This admission raises the questions of when NPSU becomes an ethical issue, and whether NPSU is a form of academic dishonesty when used in an academic setting. The perception that NPSU is not academic dishonesty could contribute to the increasing use of NPSU on college campuses.

To test the perceived ethics of academic NPSU, one study examined students’ perceptions of a hypothetical situation in which a student took an
Adderall to do better on a midterm and another student used anabolic steroids to do better in a race, resulting in both students performing better on their given tasks than they had anticipated. When considering both situations, the majority of the 1,200 male participants not only considered the hypothetical student who took Adderall to be less of a cheater, but many also believed that he was taking a more necessary step in order to succeed in comparison with the anabolic steroid user (Dodge et al., 2012). These results show that not only do many college students not view misusing stimulants as cheating, but they also believe it to be necessary at times. Although many of these participants did not report misusing stimulants themselves, some of them still believed that NPSU in order to achieve greater academic success is not cheating. These attitudes toward academic NPSU could be related to personal usage of stimulants for academic purposes.

Not all studies have found perceptions of NPSU to be as ethically ambiguous. Other research has suggested that some students view NPSU as a form of academic dishonesty. In a study that reported on a hypothetical situation of a girl taking Ritalin in order to stay awake to study during finals because of high grade pressure put on her by her parents, approximately 56% of student respondents considered this act of NPSU to be academic dishonesty (Bossaer et al., 2013). Although not all students view NPSU as cheating (Dodge et al., 2012), almost 69% of college students believe NPSU gives its consumers an unfair advantage in an academic setting (Bossaer et al., 2013). NPSU, therefore, could be an academic shortcut some students use to obtain success, whether motivated by personal desire or social pressure. Further research is needed to clarify the relationship between actual NPSU and perceptions of the ethicality of academic NPSU.

**Extrinsic Motivation**

**Affecting Cheating and NPSU**

Because NPSU might be considered a form of cheating, some of the factors associated with academic dishonesty may also be associated with NPSU. Many of these factors appear to be related to extrinsic motivation, which is finding motivating factors for a particular action from external resources. There is a direct relationship between extrinsic motivation and a student’s tendency to cheat (Alt & Geiger, 2012), which could mean that there is a direct relationship between extrinsic motivation and NPSU, when NPSU is considered a form of academic dishonesty. Family and situational pressures, both extrinsic motivators, might be related to cheating, and by extension, NPSU. In a study of third- and fourth-year college women, the greatest predictor of academic cheating was the combination of the goals of achieving high grades alongside the pressure of desiring to please one’s parents—both extrinsically motivated goals (Alt & Geiger, 2012). Furthermore, in a study comparing misusers to nonusers, those who misused stimulants reported higher levels of perceived parental pressures in comparison to those who did not use (Hartung et al., 2013). Students who admitted to cheating generally described themselves as more performance-oriented and less mastery-oriented than their noncheating peers (Anderman, Griesinger, & Westerfield, 1998). This result shows that students are more likely to cheat if they have an external goal that they are trying to reach instead of trying to achieve for the sake of what they are learning, illustrating their extrinsic motivation for success. A student who is performance-oriented may strive for a good grade in a class because it is what the student’s parents want, but a student who is mastery-oriented may strive for a good grade because the student wants to fully understand the topic, and the grade itself is just an unintentional beneficial outcome. If cheating and academic NPSU are both extrinsically motivated, it follows that some students reported that, because of large external pressures for academic success, their NPSU was permissible as well as defensible (Kerley, Copes, & Griffin, 2015). Staying awake to study or to increase concentration and the spike of NPSU around midterms and finals are both actions driven by desiring good grades, which is derived from external goals and rewards (Garnier-Dykstra et al., 2012). If college students were more intrinsically motivated, or eager to do well because they want to fully understand and master the class material, it is possible that students’ chances of misusing stimulants would decrease.

**Environmental Factors**

**Affecting Cheating and NPSU**

A student’s academic and peer environments also play a large part in cheating prevalence, and, in turn, possibly play a role in academic NPSU. When students perceive their classes or schools to put a greater emphasis on extrinsic goals such as good grades, and try to foster competitive environments, they believe cheating to be more acceptable (Anderman et al., 1998). When students perceive a course as putting a larger emphasis on
Nonprescribed Stimulant Use in a College Setting

Nonprescribed stimulant use (NPSU) may be more common on college campuses perceived to be more competitive. This means that, when students believe that cheating is not unethical, a more cheating-prone environment may be created. Just as cheating is more common in cheating-prone environments, when students reported a higher perceived approval and higher perceived use by other students in regard to NPSU, they were more likely to misuse stimulants (Silvestri & Correia, 2016). This finding suggests that, if students believe that NPSU is commonplace, or that NPSU is not viewed negatively by others, they will be significantly more likely to misuse stimulants. NPSU is more common with students involved in Greek life, but those students also perceive a higher rate of nonmedical stimulant use among their peers compared to those not in Greek life (Dussault & Weyandt, 2013). This finding could mean that being around a group of people who one perceives to misuse stimulants may increase one’s likelihood of misusing stimulants. The prevalence of NPSU in the Greek community may be caused more by the misperception of NPSU popularity instead of the actual dominance of its usage. So, in reality, the perceived commonality of NPSU may be a more accurate predictive factor of academic NPSU than actual commonality.

Purpose of the Current Study
If NPSU for academic purposes is a type of cheating, extrinsic motivation, perceived environmental competitiveness, and perceived commonality could lead to NPSU. In the literature on academic cheating, students with extrinsically oriented goals were more likely to cheat, just like students who were more extrinsically motivated were more likely to misuse stimulants (Anderman et al., 1998; Garnier-Dykstra et al., 2012; Hartung et al., 2013). External pressures were higher in students who reported cheating and NPSU (Alt & Geiger, 2012; Hartung et al., 2013). Peer commonality of cheating and NPSU influenced students’ likelihood of partaking in it (Alt & Geiger, 2012; Silvestri & Correia, 2016), but potentially because of the perception of commonality itself. Furthermore, considering that competitive environments lead students to cheat (Anderman et al., 1998), they may also lead students to misuse stimulants.

Although a variety of research has been conducted on the prevalence of NPSU in college students, there is still a large gap in the research on identifying factors that lead some students and not others to misuse stimulants during their academic journeys. The purpose of the current study was to further understand and explore the extrinsic motivations behind college students’ misuse of stimulants in an academic setting. In addition, the current study attempted to examine how extrinsic motivation in particular, and various specific extrinsic motivators, are related to NPSU. We hypothesized that NPSU would be positively associated with (a) perceiving NPSU to be safe, (b) perceiving NPSU to be ethical, (c) possessing extrinsic motivation in an academic setting, (d) perceiving the academic environment to be competitive, and, finally, (e) perceiving NPSU to be common.

Method
Participants
Participants included 314 undergraduate students at a small, Christian, liberal arts university in Southern California. Participants were recruited from an online research participation management system that included students enrolled in a foundational psychology course. Participants were excluded from the data analyses if they had a stimulant prescription for ADHD or did not respond whether or not they had a prescription (n = 19), if they did not respond affirmatively to a data validity question included in the survey (n = 14), if they were younger than 18 years of age (n = 3), if they did not respond to two or more measures within the survey (n = 7), or if they did not respond to any of the questions from the Stimulant Use Questionnaire (n = 1). The final sample therefore included 270 participants.

Of these participants, 111 reported being
men (41.1%), and 159 reported being women (58.9%). The average age of participants was 18.88 years ($SD = 1.09$), with ages ranging from 18 to 24 years. The sample included primarily first-year students (65.9%) who predominantly represented Euro-American or White race/ethnicity (51.1%). Other participants self-identified as Asian American or Asian (18.5%); Mixed Race (11.1%); Latino/a or Hispanic (9.3%); African American, Africa, or Black (3.7%); Middle Eastern or North African (2.6%); Hawaiian or Pacific Islander (0.4%); Native American (0.4%); and Other (2.6%); missing (0.4%). Most participants reported living in on-campus housing (86.3%).

With regard to NPSU, 31 participants reported having misused stimulants at least once in their lives (11.5%), 21 reported NPSU in the past year (7.8%), 15 reported NPSU in the previous semester (5.6%), and seven participants reported NPSU in the past month (2.6%). For the students who reported use during the previous semester, responses ranged from one time to 10 times, with a mean usage of 3.01 ($SD = 3.21$). For the seven students who reported NPSU within the past month, four participants reported having misused stimulants once, two participants reported having misused stimulants twice, and one did not respond. Each of the participants who reported NPSU more recently also reported NPSU for the time frame prior, meaning if a participant reported past semester NPSU, they also reported past year NPSU.

**Measures**

**Demographic form.** Participants completed the demographic form to assess various demographic characteristics of the sample including sex, ethnicity, year in school, parents’ annual income, state of employment, on- or off-campus housing status, religious affiliation, GPA, age, and involvement in a fraternity or sorority. Most items required categorical responses with the exception of age and GPA, which were free responses.

**Academic Extrinsic Motivation score.** The Academic Motivation Scale is a 28-item questionnaire that measures both extrinsic motivation and intrinsic motivation, which are defined as finding motivation from an external source and finding motivation from an internal source, respectively (Vallerand et al., 1992). For the purpose of the current study, only the 12 items measuring extrinsic motivation were utilized. Items were measured on a 7-point Likert-type scale, with responses ranging from 1 (does not correspond at all) to 7 (corresponds exactly). Participants rated each item in terms of how well they felt each item answered the question, “Why do you go to college?” A sample item is: “In order to obtain a more prestigious job later on.” Three subscales measure extrinsic motivation: identified, introjected, and external regulation. For the purpose of the current study, the three extrinsic motivation subscale scores were summed to create an overall extrinsic motivation score. A high score for each subscale marked a high identification with extrinsic motivation. Previous research found strong internal consistency, with Cronbach’s α ranging from .70 to .86 for the various subscales (Cokley, Bernard, Cunningham, & Motoike, 2001). The Academic Extrinsic Motivation (AEM) score showed strong reliability for the present study’s data (Cronbach’s α = .91).

**Perceived Campus Competitiveness score.** We used 10 items from the Twenty Items Value Inventory (Sandy, Gosling, Schwartz, & Koelkebeck, 2016) to assess participants’ perceptions of the typical student’s competitiveness on campus. For the purpose of the current study, we used two of these items to measure perceived campus competitiveness. The items were, “Getting ahead in life is important to them. They strive to do better than others,” and “Being very successful is important to them. They like to impress other people.” The other eight items were included in the survey so participants would not be able to gauge what was being measured, but responses to these items were not used in any analyses. The items were rated using a 7-point Likert-type scale ranging from 1 (No one at Pepperdine University fits this description) to 7 (Everyone at Pepperdine University fits this description). The scores for these two items were combined, with higher scores indicating perceptions of a highly competitive campus. In previous research, these two items had a Cronbach’s α coefficient of .79, showing strong internal consistency (Sandy et al., 2016). For the current study, the Perceived Campus Competitiveness (PCC) score had an α = .72.

**Stimulant Use Questionnaire.** The Stimulant Use Questionnaire was developed by the authors for the current study (see Appendix A). This questionnaire was used to evaluate frequency of stimulant use. The first question required a dichotomous response regarding whether or not the students were prescribed an ADHD stimulant prescription. The next three questions also required a dichotomous response and asked if the participants had ever used stimulants, if they had used them in the past year, or if they had used
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them in the past month. Positive responses identified past Nonprescribed stimulant users. The final question required a ratio response and asked about the frequency of the participants’ stimulant use in the past month. Higher numbered ratio responses identified more frequent NPSU. Responses to each item were considered independently in the data analysis.

**Perception of Nonprescribed Stimulant Use Commonality score.** The perceived frequency of NPSU on participants’ college campus was measured using a modified version of the Perception of Prevalence of Prescription Use Among Peers subscale from Weyandt et al.’s (2009) Stimulant Survey Questionnaire. We modified the scale from its original 10 items measured with yes or no responses, to a three item 7-point Likert-type scale with responses ranging from 1 (No one at Pepperdine University does this) to 7 (Everyone at Pepperdine University does this). Participants responded to the items, “use prescription stimulants while studying,” “use prescription stimulants during midterms,” and “use prescription stimulants during tests.” The responses to each question were summed, with higher scores indicating greater perceived NPSU among peers. The Perception of Nonprescribed Stimulant Use Commonality (PSUC) score had strong reliability (Cronbach’s $\alpha = .93$).

**Perception of Nonprescribed Stimulant Use Safety score.** The perceived safety of NPSU was measured using the Perception of Safety of Stimulants scale from Weyandt et al.’s (2009) Stimulant Survey Questionnaire. Three items were excluded from the original 7-item scale because they measured participants’ own perceptions of how much they knew about stimulants, not how safe they viewed stimulants to be. Following this modification, the scale included four items measured on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The measure included items such as “Prescription stimulants are safer than marijuana” and “Using prescriptions stimulants daily is harmless.” The responses to each question were summed, with higher scores indicating perceptions of greater safety in using. In previous research, the unedited scale had a Cronbach’s $\alpha$ coefficient of .61 (Dussault & Weyandt, 2013). For the current sample, the Perception of Non-Prescribed Stimulant Use Safety (PSUS) score had a moderately high level of reliability (Cronbach’s $\alpha = .73$).

**Perceptions of Nonprescribed Stimulant Use Ethicality scale.** Perceptions of whether the participant viewed NPSU to be ethical was measured by a single item response to a hypothetical situation about a student named Jeff taking Adderall to increase performance for a midterm (Dodge et al., 2012; see Appendix B). Participants were asked to respond to a revised Likert-type response scale ranging from 1 (strongly disagree) to 7 (strongly agree) with the statement, “Jeff is a cheater for using Adderall.” Higher scores on the Perception of Nonprescribed Stimulant Use Ethicality (PSUE) scale indicated greater perception of NPSU as unethical, and lower scores indicated less perception of NPSU as unethical.

**Validity Question.** At the end of the study, participants answered the question, “Are your responses true and accurate, and if so, should they be included in the data being collected for this survey?” Their responses were measured using a yes or no categorical response. Only participants who affirmed their responses should be used were included in the following analyses.

**Procedure**
Pepperdine University’s institutional review board approved the study (IRB Approval Code: 17-04-548), and students completed an online informed consent form prior to participating. Participants volunteered to participate in the study using an online research participation management system. The survey questionnaires were administered online in the following order: the demographic form, the AEM scale, the PCC scale, the Stimulant Use Questionnaire, the PSUC scale, the PSUS scale, the PSUE scale, and the Validity Question. The survey was anonymous and took approximately 15 minutes to complete. Participants received one credit toward their psychology course research participation requirement as an incentive to participate.

**Results**

**Descriptive Statistics**
Scores on the PSUS scale ranged from 4 to 20, with the average score indicating that people generally feel NPSU is not safe ($M = 9.71, SD = 3.16$). Scores on the PSUE scale ranged from 1 to 7, with the average score depicting a general neutrality toward perceptions of NPSU as cheating ($M = 3.60, SD = 1.86$). Scores on the AEM scale ranged from 13 to 84, with the average score depicting high academic extrinsic motivation ($M = 60.97, SD = 13.65$). Scores on the PCC scale ranged from 3 to 14, with the average score indicating that participants perceived the campus to be generally...
competitive ($M = 10.20, SD = 1.95$). Scores on the PSUC scale ranged from 3 to 20, with the average score indicating that students perceived approximately half of the university’s students as participating in NPSU behaviors ($M = 8.87, SD = 3.18$). This information can also be found in Table 1.

### Demographic Differences for Independent and Dependent Measures

We conducted preliminary analyses to determine relationships between each of the demographic variables and the independent variable of lifetime NPSU as well as the dependent variables. Chi-square tests were conducted to examine the relationship between categorical demographic variables and lifetime NPSU. Lifetime NPSU was related to whether the participant lived on- or off-campus ($\chi^2 = 18.31, df = 1, \phi = .262, p < .001$), with those living off-campus being significantly more likely to report NPSU. Lifetime NPSU was also related to being in one’s first or second year of college versus being in one’s third or fourth year of college ($\chi^2 = 7.81, df = 1, \phi = .171, p = .005$), with those in the second half of their college experience being significantly more likely to report lifetime NPSU. An independent-samples t test was conducted to examine the relationship between age and lifetime NPSU. The average age of those who reported lifetime NPSU ($M = 19.57, SD = 1.50$) was significantly higher than those who did not ($M = 18.78, SD = 0.97; t = -3.90; df = 262; d = 0.63, p < .001$). The difference between the mean scores of those who did not report lifetime NPSU and those who did report lifetime NPSU was -.79 with a 95% confidence interval of -1.19 to -0.39. No significant differences were found between sorority/fraternity involvement, religious affiliation, sex, ethnicity, parents’ annual income, or state of employment. Because many of the participants were in their first semester of college, we were unable to evaluate the relationship between college GPA and NPSU. Lastly, we conducted t tests between sex and the dependent measures, and significant differences were only found for sex and academic extrinsic motivation ($t = -2.95, df = 266; d = 0.36, p = .02$), with women ($M = 63.01, SD = 12.21$) scoring higher on it than men ($M = 58.05, SD = 15.01$).

### Perceptions of Safety, Ethicality, and Commonality

The frequency distributions of PSUS, PSUE, and PSUC were examined. These findings are displayed in Figures 1, 2, and 3, respectively.

In regard to PSUS, 45.2% of participants viewed occasional NPSU as harmful, and 74.8% of participants viewed daily NPSU as harmful. When comparing stimulants with marijuana and alcohol, 54.4% of students viewed marijuana as safer, and 46.7% of students viewed alcohol as safer than stimulants. Overall, students had a split view of NPSU safety except for their opinions on daily use of it, which a majority considered unsafe.

When evaluating PSUE, 49.9% of participants did not consider Jeff as cheating for taking Adderall to improve his performance on his midterm. Furthermore, 10.4% of participants felt neutral to the scenario. Finally, only 38.9% of participants actually considered Jeff to be a cheater for misusing

<p>| TABLE 1 |
| --- | --- | --- | --- | --- | --- | --- |</p>
<table>
<thead>
<tr>
<th><strong>Means and Standard Deviations of and Correlations Between Dependent Variables and Lifetime and Past Year Nonprescribed Stimulant Use (NPSU)</strong></th>
<th>1.</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
<th>6.</th>
<th>7.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lifetime NPSU</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2. Past Year NPSU</td>
<td>.81***</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3. Academic Extrinsic Motivation</td>
<td>.03</td>
<td>-.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4. Perceived Campus Competitiveness</td>
<td>-.02</td>
<td>-.06</td>
<td>.30***</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>5. Perceived NPSU Commonality</td>
<td>.18***</td>
<td>.35***</td>
<td>-.08</td>
<td>.08</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6. Perceived NPSU Safety</td>
<td>.05</td>
<td>.06</td>
<td>-.04</td>
<td>.04</td>
<td>.16</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7. Perceived NPSU Ethicality</td>
<td>-.20***</td>
<td>-.22***</td>
<td>.09</td>
<td>.06</td>
<td>-.12</td>
<td>-.24***</td>
<td>-</td>
</tr>
<tr>
<td>Scale Range</td>
<td>-</td>
<td>-</td>
<td>12–84</td>
<td>2–14</td>
<td>3–21</td>
<td>4–20</td>
<td>1–7</td>
</tr>
<tr>
<td>M</td>
<td>-</td>
<td>-</td>
<td>60.97</td>
<td>10.24</td>
<td>8.87</td>
<td>9.71</td>
<td>3.60</td>
</tr>
<tr>
<td>SD</td>
<td>-</td>
<td>-</td>
<td>13.65</td>
<td>1.95</td>
<td>3.18</td>
<td>3.16</td>
<td>1.86</td>
</tr>
</tbody>
</table>

*Note. n is between 237 to 268 for all of the relationships. *p < .05. **p < .01. ***p < .001.*
stimulants to enhance his academic performance. Based on these findings, about half of participants did not consider NPSU for academic purposes as a form of cheating.

Lastly, students’ PSUC was much higher than actual reported NPSU. Although only 11.5% of participants reported lifetime NPSU, 29.9% of participants thought that at least half the students on campus misused stimulants during finals. Contrarily, 23.3% of participants thought that no one or almost no one misused stimulants during finals. Even though only 11.5% of students reported lifetime NPSU, 33% reported that at least half of the campus misused stimulants in contrast with a small proportion of respondents who perceived that no students or almost no students misused stimulants.

**Correlates of NPSU**

Spearman Rho correlation analyses were conducted to analyze the relationships between the dependent variables and lifetime NPSU as well as past year NPSU (see Table 1). No analyses were conducted to analyze past semester NPSU or past month NPSU because of the low number of participants who reported any of these behaviors.

No significant correlations were observed between lifetime NPSU and AEM, PCC, and PSUS. However, significant correlations were observed between lifetime NPSU and PSUE, \( r(267) = -.198, p = .001 \), as well as PSUC, \( r(238) = .177, p = .006 \). Significant correlations were also observed between past year NPSU and PSUE, \( r(268) = -.216, p < .001 \), and PSUC, \( r(239) = .147, p = .02 \). Participants were more likely to report NPSU if they did not view it as cheating or if they viewed it to be common. Although age was not significantly related to PSUE, \( r(263) = -.073, p = .24 \), it was the one demographic variable significantly related to both lifetime NPSU, \( r(264) = .181, p = .003 \), and PSUC, \( r(264) = .234, p < .001 \). To determine the extent to which age was confounding these significant relations, we conducted partial correlations controlling for age between the independent and dependent variables. When controlling for age, lifetime NPSU was still significantly associated with both PSUE, \( r(226) = -.14, p = .04 \), and PSUC, \( r(226) = .15, p = .03 \).

**Discussion**

The current study examined potential factors related to NPSU in order to increase understanding surrounding academic NPSU in college settings. It is important to identify and understand the various elements associated with NPSU in college students.
because of the serious consequences associated with NPSU such as state fines (Weyandt et al., 2016), potential jail time (Weyandt et al., 2016), and negative impact on academic performance (Weyandt et al., 2014). Furthermore, because 54% of NPSU is related to improving academic performance (Benson et al., 2015), it is important to look more specifically at the contributors to academic NPSU among college students. The findings from the present study were difficult to interpret given the small number of nonprescribed stimulant users in the current sample but do provide some important preliminary information about the relationship between lifetime NPSU and various extrinsic factors that affect it.

Because there are peaks in NPSU surrounding midterm and finals season (Garnier-Dykstra et al., 2012), perceptions of occasional NPSU as harmless would appear to be more common than everyday NPSU. Our findings support this idea because 24.8% of participants considered occasional use to be harmless, and 10% considered daily use to be harmless. Furthermore, only 45.2% of participants considered occasional use to be harmful, and 74.8% of participants considered daily use to be harmful. These findings illustrate that attitudes toward temporal safety may have some relevance to NPSU. Because past findings point to perceptions of safety as a possible predictor for NPSU, future research needs to evaluate the various degrees of safety to see how that relates to actual behaviors.

Similarly, the perceptions of the ethicality of taking Adderall to perform better on midterms were not consistent. Of participants in the current study, 49.9% reported that they disagreed to some extent that Jeff’s actions were cheating, but only 38.9% of the sample agreed to some extent that his actions were cheating, and 10.4% did not have an opinion. A large portion of students did not consider this behavior as a form of academic dishonesty, which could be a contributor to campus usage of stimulants.

An important element to review in regard to perceived commonality is the discrepancy between the amount of people who reported NPSU and how common participants perceived academic NPSU on campus. Of all of the participants, 47.4% stated that less than half or about half of their student peers took stimulants to study, and 51.1% stated that less than half or about half took them during finals week. If our sample is truly representative of the university itself, and only 11.5% of students have ever misused stimulants, the unique disparity between how many people misuse stimulants and how many how many people that participants believed misuse stimulants needs to be more fully understood and addressed.

We hypothesized that NPSU would be positively associated with (a) perceptions of NPSU as safe, (b) perceptions of NPSU as ethical, (c) extrinsic motivation in an academic setting, (d) perceptions of academic environment competitiveness, and, finally, if (e) perceptions of NPSU are seen as common. Of our five hypotheses, lifetime NPSU and past year NPSU were both found to be related to perceptions of NPSU ethicality and NPSU commonality, with people more likely to misuse stimulants if they did not perceive it to be cheating or if they viewed it as common.

Our first hypothesis stated that there would be a relationship between lifetime NPSU and perception of NPSU safety. This hypothesis was not supported, but past research has found that people who view NPSU as safe are more likely to report misuse (Dussault & Weyandt, 2013). Furthermore, the PSMS scale had some items that elicited vastly different responses such as the harmlessness of occasional NPSU and daily NPSU. If the scale were to measure more specific attitudes about NPSU, we might have been able to support previous research findings demonstrating a relationship between perceptions of safety and NPSU.

One significant relationship found in this study was between perceptions of NPSU ethicality and lifetime NPSU as well as past year NPSU. In the previous research conducted to evaluate ethicality of academic Adderall misuse using the same vignette as the current study, Dodge et al. (2012) found that most participants did not view the student's NPSU behavior as cheating, even though they believed the Adderall to be giving the student an unfair advantage. In our study, people were more likely to report lifetime and past year NPSU if they did not perceive the vignette character’s Adderall use to be cheating. People perceiving NPSU as unethical may be a factor that could prevent their engagement in NPSU for academic purposes. Another interesting but almost contrary finding is that common opinion participants had on Adderall use as cheating. Although nonprescribed stimulant users were less likely to interpret NPSU as cheating, about half of all participants did not consider it to be cheating either.

Some of the nonsignificant relationships observed in the current study could be based on the framework utilized from previous cheating
Nonprescribed Stimulant Use in a College Setting

This study had multiple limitations that should be addressed in future research. First, the population of participants who misused stimulants was a smaller proportion of our sample than we predicted it would be based on previous research. Previous researchers have found that 31% of undergraduate students have used stimulants at some point during their college experience (Garnier-Dykstra et al., 2012), although only 2% to 8% of undergraduate college students report having ADHD (Benson et al., 2015). Because of our reduced analytical power, we were unable to analyze the quantitative differences in NPSU (using frequencies of once last semester versus 10 times) or conduct binary logistic regressions that would have more fully explained the relationship between our independent variables and NPSU.

Furthermore, because our population of reported nonprescribed stimulant users was so small, we were only able to analyze lifetime NPSU, which means that most of our analyses were based on individuals who have tried stimulants at one point throughout their lives. Because this leaves a lot of room for variability such as someone trying once in high school or someone trying several years ago, we recommend that NPSU questionnaires focus specifically on the college student years by asking “Have you used stimulants at any point during college?” to represent a more precise measure of college use rather than lifetime use. Participants’ responses to the measure used in the current study might have reflected their current state compared to the state in which they misused stimulants, causing potential confounding. If we had a larger population of people reporting past semester or past month use in the current study, we would have been able to focus on recent NPSU, thereby reducing this confounding factor.

Finally, the characteristics of participants in the current study could have potentially been limiting. Lifetime NPSU and older age were significantly related, which might have affected our analyses because the majority of respondents were first-year students, and previous research as well as our own findings show that older students are more likely to report NPSU (Garnier-Dykstra et al., 2012). Furthermore, the time of the semester in which the majority of participants were completing the survey was prior to midterm season and Greek life recruitment had begun. Past research has found significant relationships between NPSU and midterms as well as being involved in Greek life (Dussault & Weyandt, 2013; Garnier-Dykstra et al., 2012), so some of the potential NPSU influences had yet to occur. Because participants attended a
Christian university, some students might have been deterred from accurately reporting NPSU for fear of potential repercussions, and the population itself might be less likely to misuse stimulants compared to a secular campus.

**Future Research**

With these limitations in mind, future research should include a larger sample size in order to test variations in NPSU frequency such as the difference in perceptions of safety for occasional NPSU or daily NPSU and those associations with actual NPSU. Also, with a larger sample size, the relationship between reasons behind one’s major choice (i.e., for one’s one academic desire versus one’s parents’ desire) could be examined and analyzed, which would provide information about more specific aspects of extrinsic motivation (Alt & Grieger, 2012). Because this study was the first to examine the relationship between extrinsic academic motivation and NPSU, through the eyes of NPSU as academic dishonesty, a longitudinal study could be conducted in order to evaluate if the perception of NPSU as cheating may mediate the relationship between academic extrinsic motivation and NPSU. Furthermore, because the majority of the sample did not perceive NPSU to be a form of cheating, future research should further gauge attitudes behind the conceptualization of academic dishonesty in relation to NPSU. Although some may not view NPSU as ethical, students may have an internal hierarchy of cheating behaviors, with NPSU ranking lower because it does not involve mimicking someone else’s work or inappropriately collaborating with others.

Future research should also more thoroughly examine perceptions of NPSU commonality. The current sample perceived NPSU to be more common than it actually was, and the relationship between perception of commonality and lifetime NPSU was not significant. Previous research has found that Greek life members were more prone to misuse stimulants than non-Greek life members (Dussault & Weyandt, 2013). Although we originally predicted that this finding was because of the perceived commonality within the environment, this study did not evaluate this situation exactly. Instead of testing perceived commonality within the participants’ social circle, we evaluated perceived commonality across the university campus as a whole. The perception of campus-wide commonality may matter to a certain degree, but commonality within one’s social circle could be much more predictive. Future research should examine perceptions of NPSU campus-wide as well as within participants’ social circles in order to evaluate the possible differences between these influences and participants’ NPSU.

**Implications**

Even though only two of the five relationships we predicted in our hypotheses were significant, three main issues emerged from our findings that universities should work to address: (a) most participants did not view NPSU as unsafe, (b) most participants did not view NPSU for academic purposes as unethical, and (c) most participants perceived NPSU to be much more common than was reported.

Universities should educate their college students to combat NPSU. First, universities should counter the inconsistent opinions of NPSU safety, especially in regard to occasional use. Although many of the participants recognized that everyday NPSU would be harmful, a majority did not consider occasional NPSU to be harmful. Universities could implement programs or educational seminars to alter inaccurate student perceptions of safety. Furthermore, because NPSU was correlated with perceptions of NPSU as cheating, it is possible that the gray area surrounding the academic dishonesty of abusing medications could contribute to the growing popularity of academic NPSU at colleges. With greater clarity about the ethicality of NPSU, more college students might avoid taking these illegal academic shortcuts. Instead of ignoring the issue, it is important for universities to acknowledge that misusing stimulants is actually a form of academic dishonesty and will not be permitted nor tolerated. Beyond expressing the expectations of their students’ behaviors, universities should also address students with accurate information. They should highlight how NPSU is not actually associated with academic improvements (Weyandt et al., 2014), and according to our findings, that NPSU is much less common than they think. Such interventions might reduce the prevalence of NPSU.

Although the information we have on academic NPSU is still lacking, the understanding surrounding it is slowly becoming more complete. Through the continuous attempts of research to evaluate factors associated with academic NPSU, researchers might then be able to more comprehensively and empirically combat it.
Nonprescribed Stimulant Use in a College Setting | Pfund, Miller-Perrin, and Rouse

References


Author Note. Gabrielle N. Pfund, O https://orcid.org/0000-0003-2929-752X, Department of Psychology, Pepperdine University; Cindy Miller-Perrin, O https://orcid.org/0000-0002-0095-8037, Social Sciences Division, Pepperdine University; Steven V. Rouse, O https://orcid.org/0000-0002-1080-5502, Social Sciences Division, Pepperdine University.

Gabrielle N. Pfund is now at the Department of Psychological & Brain Sciences at Washington University in St. Louis, MO.

This manuscript qualifies for Open Materials, Open Data, and Preregistration badges. The materials, data, and preregistered data collection and data analysis plans are available at https://osf.io/2g77t/.

Special thanks to Psi Chi Journal reviewers for their support. Correspondence concerning this article should be addressed to Gabrielle N. Pfund, Department of Psychological & Brain Sciences, Washington University in St. Louis, St. Louis, MO, 63130.

E-mail: gabrielle.pfund@wustl.edu.
### APPENDIX A

**Stimulant Use Questionnaire**

Stimulants in the following questions refer to legal, prescription stimulants often used to treat ADHD, such as Ritalin, Adderall, Vyvanse.

1. Do you have a doctor’s prescription for stimulants?
   a. Yes
   b. No

2. Have you used stimulants before?
   a. Yes
   b. No

3. Have you used stimulants in the past year?
   a. Yes
   b. No

4. Did you use stimulants last semester?
   a. Yes
   b. No

5. About how many times did you use stimulants last semester?  
   ________ (fill in with number)

6. Have you used stimulants in the past month?
   a. Yes
   b. No

7. About how many times have you used stimulants in the last month?  
   ________ (fill in with number)

8. If you have used stimulants, please list which kinds:

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### APPENDIX B

**Using Adderall for Midterms Scenario**

It is midterm exam time… Jeff wants to do well on his exams but is concerned that his grades may be low. He does not have much time and is worried that he will have trouble focusing on his work when studying. Last night Jeff went to the library and had trouble focusing. Jeff’s friend Paul has a prescription for Adderall pills. Jeff decides to ask Paul for a few of the Adderall pills because Jeff has heard the pills help people focus. Jeff takes the pills and several days later, receives his midterm grades. They are higher than expected.

Indicate how strongly you agree or disagree that Jeff is a cheater for using Adderall.

1. Strongly disagree
2. Disagree
3. Slightly disagree
4. Neutral
5. Slightly agree
6. Agree
7. Strongly agree
Mass Murder in the News: How Religion Influences Perception of Terrorism
Katie Keegan and Wendy L. Morris
McDaniel College

ABSTRACT. When a mass murder occurs in the United States, people may assume the crime is an act of terror or an act of a person with mental illness. Given the way that Muslims are presented in the media, the availability heuristic may cause people to assume that a Muslim perpetrator is a terrorist (Ciftci, 2012; Nagar, 2010; Tversky & Kahneman, 1974). Furthermore, if a Muslim uses a bomb, the representativeness heuristic may cause people to assume the Muslim is a terrorist rather than a mentally ill person. In the present study, participants read a mock news story about a mass murder committed by a perpetrator described as either Christian or Muslim who used either a bomb or a gun. Three hundred twenty college students participated (224 women, 92 men, 4 other). For the same crime, participants thought the Muslim perpetrator was more likely to be in an extremist group and more religious than the Christian, and they thought the Christian was more likely to be mentally unstable and depressed than the Muslim. Furthermore, when a bomb was used, participants thought the Muslim perpetrator was more typical for the crime than the Christian. These findings suggest that mass murder is perceived differently depending upon perpetrator religion and weapon in ways that are consistent with stereotypes.
terrorism includes the following specific qualifications to warrant its legal use: activities must (a) involve acts that endanger human life or break U.S. civilian laws; (b) appear to be intended either to intimidate the civilian population, influence government policy by means of intimidation, or influence government conduct through the use of mass destruction, assassination, or kidnapping; and (c) occur within U.S. territory (18 U.S.C. § 2331). One could argue that the mass shooting in Las Vegas was driven by a desire to intimidate the civilian population and would classify as domestic terrorism by this definition (even if the Islamic State’s claim to the incident had been false). However, prosecutors may not choose to add domestic terrorism charges to capital murder cases because the label may not increase the punishment (Brown, 2015). Although domestic terrorism charges may not influence punishment in mass murder cases, labelling a perpetrator as “mentally ill” certainly can. A mental illness label can lead to a not guilty by reason of insanity (NGRI) ruling, and thus result in time in a mental institution rather than prison time or a death sentence as a potential consequence. NGRI patients may end up with longer sentences than those who are given prison time, and in most states, are automatically committed to a psychiatric facility for an indefinite period of time (McClelland, M. 2017). In a study in which participants were given various descriptions of violent attacks, 80% of participants believed the perpetrator was mostly or entirely responsible for the attack when he was described as a “political fanatic,” and only 58% believed the perpetrator was mostly or entirely responsible when described as a “possibly schizophrenic crazy man.” Participants were also more likely to label the attack as terrorism when it was committed by the political fanatic than by the man with mental illness (Simmons & Mitch, 1985). People hold terrorists responsible for their actions but are less likely to hold people with mental illness responsible for their actions.

Islam in the Media
News articles refer to Muslim mass murderers as terrorists more frequently than their Judeo-Christian counterparts (Nagar, 2010). A content analysis conducted by Hoewe (2012) found that, out of the 144 Washington Post and New York Times articles published between 2005 and 2010 which both had the word terrorism in the title and mentioned religion, 93.8% mentioned Islam. It is possible that the prevalence of news articles linking terrorism and Islam is correlated with anti-Muslim beliefs given that 45% of people in the United States believe that Muslims are violent, 46% believe that Muslims are fanatical, and 54% believe that Muslims in the United States support terrorist organizations like Al-Qaeda (Ciftci, 2012). People in the United States perceive Muslims as violent and untrustworthy and often do not differentiate between their attitudes toward American Muslims and Muslims in general (Sides & Gross, 2013). Commercials, television shows, and movies also continue to give Judeo-Christian characters the most important and complex roles, while negatively portraying Muslims as violent terrorists, sexists, and homophobes (Entman & Rojecki, 2000; Jhally, Earp, & Shaheen, 2006). Whether U.S. media influences attitudes toward Islam, or vice versa, research has documented that the term Islam is strongly associated with terrorism (Smalarz, Madon, Yang, Guyl, & Buck, 2016).

Crime Stereotypicality by Race
Research shows that people not only develop group stereotypes, but develop stereotypes about which groups of people are most likely to commit a specific type of crime (Gordon, Michels, & Nelson, 1996; Skorinko & Spellman, 2013). The stereotypes of White European Americans include an association with crimes such as arson, credit fraud, and driving under the influence, whereas the stereotypes of African Americans include an association with crimes such as arson, credit fraud, and burglary (Skorinko & Spellman, 2013). Another study found people associate European Americans with white collar crime, but they associate Black Americans and Hispanic Americans with violent crime (Esqueda, 1997). People are more likely to misidentify a suspect as Black when they read about a violent crime than a nonviolent crime (Oliver & Fonash, 2002). When selecting a murder suspect from a line-up, people are more likely to misidentify a suspect as a Black person than misidentify a suspect as a White person (Oliver, 1999). These patterns are likely due to the perceived typicality of a Black suspect for the violent crime of murder. There is not a great deal of research about the associations between religion and various types of crime unlike research about the associations between race and crime types. However, people often perceive Muslims as a racial group and hold negative attitudes toward Muslims as they would toward ethnic minorities (Kalkan, Layman, & Uslaner, 2009). Thus, crime stereotypicality for Muslims may mirror the pattern...
of crime stereotypicality for race. This may account for why people associate Islam with terrorism (Smalarz et al., 2016).

**Crime Stereotypicality by Weapon**

People may also associate certain weapons with certain crimes. For example, on April 19, 1995, an explosion destroyed the Murrah Federal Office Building in Oklahoma City and the event was quickly dubbed the “Oklahoma City Bombing.” As reporters awaited results from investigators regarding who committed such a horrible act, columnist Georgie Anne Geyer of the *Chicago Tribune* wrote, “It has every single earmark of the Islamic car-bombers of the Middle East” (Geyer, 1995, para. 4). Geyer was not alone in her assumption that Islamic terrorists from the Middle East were responsible for the bombing solely based upon the fact that it was a bombing. The culprits, Timothy McVeigh and Terry Nichols, were neither Muslims nor foreigners (Naureckas, 1995). Not only does the media associate Muslims with the use of bombs, but also the use of bombs with the act of terrorism. A 2013 *Daily News* headline about the terror attack committed by the Tsarnaev brothers read, “Boston Marathon Terror Blast Kills 3, Injures Over 144 Including 8 Kids” (Ford, Goldstein, Adams Otis, & Coffey, 2013). A 2016 *New York Times* headline about the terror attack committed by Omar Mateen read, “Orlando Gunman Attacks Gay Nightclub, Leaving 50 Dead” (Alvarez & Pérez-Peña, 2016). In both attacks, the terrorists had connections to the Islamic State in some manner and identified as Muslim. However, only the attack that used a bomb had the word *terror* directly in the headline. It is possible that people associate bombs with terrorist attacks more than guns, especially when the perpetrators are Muslims. One study found that negative attitudes toward people with serious mental health issues increased in participants who read a news story about a mass shooting (McInty, Webster, & Barry, 2013). This supports an association between mass shootings and mental illness. Unfortunately, there is little other research available regarding how people perceive perpetrators based upon weapon choice alone. One study found that people with negative attitudes toward Muslims believe Muslim mass shooters are less mentally ill and more motivated by religion than non-Muslim shooters (Mercier, Norris, & Shariff, 2018). The above media examples indicate possible associations between weapon-type, perpetrator religion, and terrorism labels for acts of mass murder.

**Xenophobia**

*Xenophobia* is defined as the fear of people from other countries (Xenophobia, n.d.). In general, people in the United States are more xenophobic toward immigrants from Islamic countries than immigrants from Asian, European, or sub-Saharan countries (Braun, Behr, & Kacmirek, 2013). Xenophobia may influence sentencing of immigrant offenders; data from the U.S. Sentencing Commission from 1992 to 2009 indicates that non-U.S. citizens are over three times more likely to be incarcerated compared to similarly charged U.S. citizens and that noncitizens’ prison terms are 8.5 percent longer on average than prison terms for U.S. citizens (Light, 2014). When people view images of terrorist attacks and experience death-related thoughts, they increase their prejudice toward immigrants of all backgrounds (Kastenmüller, Greitemeyer, Ai, Winter, & Fischer, 2011). Prejudice toward Muslims could be two forms of outgroup prejudice combined: outgroup prejudice based on religion and outgroup prejudice based on country of origin.

**Cognitive Heuristics**

Two cognitive heuristics can explain stereotype development and may explain prejudiced attitudes toward immigrants, especially Muslims: the availability heuristic and the representative heuristic. According to the availability heuristic, people assess the frequency of a class or probability of an object based on how readily available examples of the class or object can be drawn from their memory. For example, people may overestimate the frequency of heart attacks in middle-aged people by recalling instances of heart attack in their acquaintances. People perceive things as being more common if they can retrieve instances more easily from memory (Tversky & Kahneman, 1974). The availability heuristic is partially due to the “egocentric bias,” a bias in which people do not take into account their limited knowledge of the world outside of their experiences. People remember vivid, interesting information more easily than credible, but boring, information. Thus, people may be more likely to recall instances in which immigrants were on the news for breaking the law, rather than instances in which immigrants were not on the news for breaking the law. This recall may lead to stereotype development about immigrants and the formation of negative attitudes toward the group as a whole (Rydgren, 2004). With regard to the stereotype that Muslim people are terrorists, it is likely that
exposure to just a few news articles about Muslim terrorists could lead to the availability heuristic that would make people think that Muslim terrorists are more common than they actually are.

According to the representative heuristic, the assumed likelihood that Object A belongs to Class B is determined by the degree to which Object A appears representative of Class B or is similar to Class B. Stereotypes may assist in determining similarity between an object and a class. For example, if a man is described as quiet and shy and others are asked to guess whether he is a librarian, their guess may be determined by the perceived stereotype of librarians and whether the man's personality fits that stereotype (Tversky & Kahneman, 1974). The representativeness heuristic may relate to the assumption that Muslim people are terrorists because being Muslim may be part of the stereotype of a terrorist. If that is the case, then when a Muslim person commits a mass murder, people will be more likely to assume it is due to terrorist motives rather than mental illness.

The Current Study
The research experiment tested whether there is a bias in the way people perceive mass murder depending upon the depicted religion of the perpetrator. Three independent variables were manipulated: perpetrator religion, weapon-type, and perpetrator country of origin. The dependent variables included several items assessing whether the crime was perceived as a terrorist attack, several items assessing whether the crime was perceived as being due to mental illness, and a question assessing how typical participants thought the crime was for that perpetrator. A main effect of perpetrator religion was expected such that people would be more likely to perceive the same description of a mass murder as a terrorist attack if the perpetrator was Muslim than Christian and more likely to assume it is due to terrorist motives rather than mental illness.

An interaction between perpetrator religion and weapon-type on typicality was expected such that people would perceive a Muslim perpetrator as being more typical when a bomb is used than a gun, and a Christian perpetrator as more typical when a gun is used than a bomb. In the current study, a semiautomatic pistol (specifically a Glock-22) was selected because Glocks have been used in at least five mass shootings in the United States in the last nine years, including the infamous 2015 mass murder conducted by Dylann Roof in Charleston, South Carolina (Alvarado, 2016).

Finally, the potential main effect of country of origin was also predicted such that people would be more likely to perceive the same description of a mass murder as a terrorist attack if the perpetrator is a dual citizen than U.S. citizen and as an act of a person with mental illness if the perpetrator is a U.S. citizen than dual citizen. Foreign citizenship status of criminal offenders is associated with anti-Muslim prejudice and harsher punishment (Braun et al., 2013; Light, 2014). In the current study, the perpetrator of the mass murder is described as either a U.S. citizen or a dual citizen originally from Turkey. Turkey was selected as the country of origin because its population is majority Muslim. However, the country itself was assumed to be less strongly associated with terrorism than other majority-Islamic nations such as Iraq or Iran, which were temporarily banned from entering the United States by President Donald Trump in 2017. By selecting an Islamic country that is not as strongly associated with terrorism, this study tested the main effects of country of origin (and thus immigrant status and xenophobia) rather than conflating immigrant status with a country known to have active terrorist groups.

Method
Participants
Three hundred twenty-five people began the study and 320 people completed it. The 320 participants were undergraduate students from a small mid-Atlantic college (92 men, 224 women, and 4 who identified as other). In the sample of participants, 76.6% identified as European American, 5.48% as Hispanic/Latino, 4.41% as African American, 4.03% as Asian, 0.58% as Middle Eastern or Northern African, 0.86% as American Indian or Alaskan Native, 1.73% as biracial, and 0.86% as other. Participants heard about the study through their Introduction to Psychology course or through weekly campus e-mail announcements. Students taking Introduction to Psychology received credit toward a course requirement for completing the study, and all participants were eligible to enter a lottery to win a $100 gift prize.

Design
Participants read a mock news story about an attempted mass murder. The religion of the perpetrator, his weapon, and his citizenship status were manipulated in a 2 x 2 x 2 between-participants factorial design. The perpetrator religion was...
either Christian or Muslim, the weapon was either a semiautomatic pistol or homemade bomb, and the perpetrator was either a United States citizen or dual citizen originally from Turkey. Participants were randomly assigned to read one of the eight possible news stories. After reading the news story, participants answered questions about their perceptions of the perpetrator and the crime. The dependent variables were perceptions that the perpetrator was a terrorist (4 items), perceptions of the perpetrator’s mental health (3 items), the perceived typicality of the crime, and whether participants would label the crime an act of terror or an act of a person with mental illness.

Materials and Procedure
The institutional review board of McDaniel College approved this study. Participants accessed the online experiment through a link provided by the researchers. After providing consent to participate in the study, participants answered demographic questions about their gender, ethnicity, citizenship status, level of religiousness, and religion. Participants then read the following trigger warning: “On the next page of this survey, you will read a hypothetical news story about a violent mass shooting. If you would prefer to opt out of this study at this point, please do so now.” Five participants opted out of the study.

Participants were randomly assigned to read one of the eight possible mock news stories. Below is an example news story in which the italicized font represents the manipulated text:

**BREAKING NEWS:** 17 reported dead and another 9 wounded following a violent incident at a nearby mall. Here is what we know: Around approximately 3pm this afternoon, David Anderson/Ibrahim Abboud entered the mall. He walked steadily toward the center of the food court on the second floor before he pulled out a *Glock-22* and opened fire on the crowd/homemade bomb and threw it into the crowd. Masses of people ran toward the front doors of the mall, blocking the exit. Anderson/Abboud had ammunition hidden under his clothes and was able to fire dozens of rounds/Anderson/Abboud had another bomb hidden in his pocket and was able to throw it before being tackled by mall security. It has been reported by a family member that he is a practicing Christian/Muslim and has frequented a local *church/mosque* for years. Government sources confirm that Anderson is a U.S. citizen/dual citizen originally from Turkey. Jennifer, age 33, was at the mall when the incident occurred. She told us that “people were running in all directions” and added that she was terrified for her and her children’s lives.

After reading the news story, participants responded to the first part of the survey, which included statements about the likelihood that the perpetrator was a terrorist and the perpetrator’s mental health. Statements about terrorism included “This crime was an act of terror,” “It is likely that the perpetrator is part of an extremist group,” “It is likely that the crime was premeditated,” and “The perpetrator is religious.” Statements about mental health included “The perpetrator is schizophrenic,” “The perpetrator is mentally stable,” and “The perpetrator is schizophrenic.”

The order of these statements was randomized and the statements were rated using a 7-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). The second part of the survey included statements about the perceived typicality of the crime (7-point scale) and whether the violent incident should be labeled an act of terrorism or an act of a person with mental illness (participants had to choose one of two options).

Filler items not related to mental health or terrorism were included in an attempt to distract participants from the true purpose of the study; the following statements were not analyzed: “It is likely the perpetrator is employed,” “The perpetrator is intelligent,” “It is likely the perpetrator is married,” and “This crime is severe.” The following filler questions were also not analyzed because they were not about perceptions that lay people would immediately consider upon reading a newspaper article and the purpose of the research was to measure immediate perceptions: “If the perpetrator is sent to prison, how long should his sentence be?” “If the perpetrator is sent to a mental institution, how long should he spend there?” “Should the perpetrator go to prison or a mental institution?”

Results
Perceptions of Terrorism
A three-way Multivariate Analysis of Variance (MANOVA) tested the effects of perpetrator religion, weapon type, and citizenship status on perceptions of terrorism as measured by four dependent
variables. The dependent variables were perceptions of terrorism, extremism, premeditation, and religiosity (see Table 1). Because a reliability analysis of these variables indicated low reliability (α = .49), these variables were not averaged together. The MANOVA found a significant main effect of religion, \( F(4, 308) = 4.05, p = .003, \eta^2 = .05 \), and a significant main effect of weapon, \( F(4, 308) = 4.95, p = .001, \eta^2 = .06 \), but no main effect of citizenship status, \( F(4, 308) = 0.66, p = .62, \eta^2 = .008 \). There were no significant two-way or three-way interactions.

The univariate analyses showed a main effect of religion on perceptions of extremism, \( F(1, 312) = 11.85, p = .001, \eta^2 = .021 \), and perception of religiosity, \( F(1, 312) = 5.38, p = .02, \eta^2 = .017 \). Muslim perpetrators (\( M = 4.38, SD = 1.40 \)) were perceived as more likely to be part of an extremist group than were Christian perpetrators (\( M = 3.88, SD = 1.21 \)), and Muslim perpetrators (\( M = 5.12, SD = 1.23 \)) were perceived to be more religious than Christian perpetrators (\( M = 4.78, SD = 1.38 \)). See Table 2.

A main effect of weapon was found to influence perception of terrorism, \( F(1, 311) = 6.63, p = .01, \eta^2 = .021 \), and perception of extremism, \( F(1, 311) = 10.44, p = .001, \eta^2 = .032 \). Participants agreed more strongly that the crime was an act of terror when a bomb was used (\( M = 5.45, SD = 1.43 \)) than when a gun was used (\( M = 5.03, SD = 1.52 \)), and participants were more likely to perceive the perpetrator to be part of an extremist group when a bomb was used (\( M = 4.36, SD = 1.33 \)) than when a gun was used (\( M = 3.89, SD = 1.29 \)). See Table 3.

Perceptions of Mental Health
A three-way MANOVA tested the effects perpetrator religion, weapon type, and citizenship status on perceptions of mental health as measured by 3 dependent variables. The dependent variables were perceptions of depression, mental stability, and schizophrenia (see Table 1). Because a reliability analysis of these variables indicated low reliability (α = .50), these variables were not averaged together. The MANOVA found a significant main effect of religion, \( F(3, 310) = 5.06, p = .002, \eta^2 = .05 \), but no effect of weapon, \( F(3, 310) = 1.25, p = .29, \eta^2 = .01 \), or citizenship status, \( F(3, 310) = .58, p = .63, \eta^2 = .006 \). There were no significant two-way or three-way interactions.

The univariate analyses found a main effect of religion on perception of mental stability, \( F(1, 312) = 6.13, p = .01, \eta^2 = .019 \), as well as perception of depression, \( F(1, 312) = 11.15, p = .001, \eta^2 = .055 \). Christian perpetrators (\( M = 2.46, SD = 1.33 \)) were thought to be less mentally stable than Muslim perpetrators (\( M = 2.85, SD = 1.45 \)), and Christian perpetrators (\( M = 4.57, SD = 1.15 \)) were thought to be more depressed than Muslim perpetrators (\( M = 4.17, SD = 1.05 \)). See Table 2.

### TABLE 1
**Correlations Between Dependent Variables**

<table>
<thead>
<tr>
<th></th>
<th>Extremism</th>
<th>Act of Terror</th>
<th>Premeditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>-.24**</td>
<td>-.04**</td>
<td>-.23**</td>
</tr>
<tr>
<td>Mental Stability</td>
<td>.00**</td>
<td>.21**</td>
<td>.15**</td>
</tr>
<tr>
<td>Schizophrenia</td>
<td>.40**</td>
<td>.14**</td>
<td>.06**</td>
</tr>
</tbody>
</table>

Note. *p < .05, **p < .01, “diff.” represents difference of Christian minus Muslim.

### TABLE 2
**Main Effect of Religion**

<table>
<thead>
<tr>
<th></th>
<th>Christian</th>
<th>Muslim</th>
<th>diff.</th>
<th>F</th>
<th>p</th>
<th>( \eta^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrorism</td>
<td>3.88</td>
<td>4.38</td>
<td>.50</td>
<td>11.85</td>
<td>.001**</td>
<td>.037</td>
</tr>
<tr>
<td>Extremism</td>
<td>5.16</td>
<td>5.31</td>
<td>.15</td>
<td>0.83</td>
<td>.361</td>
<td>.003</td>
</tr>
<tr>
<td>Act of terror</td>
<td>5.93</td>
<td>5.93</td>
<td>.00</td>
<td>0.00</td>
<td>.969</td>
<td>.000</td>
</tr>
<tr>
<td>Premeditation</td>
<td>4.78</td>
<td>5.12</td>
<td>.34</td>
<td>5.38</td>
<td>.021*</td>
<td>.017</td>
</tr>
<tr>
<td>Religiosity</td>
<td>3.61</td>
<td>3.54</td>
<td>-.07</td>
<td>.29</td>
<td>.592</td>
<td>.001</td>
</tr>
</tbody>
</table>

Note. *p < .05, **p < .01, “diff.” represents difference of Christian minus Muslim.

### TABLE 3
**Main Effect of Weapon**

<table>
<thead>
<tr>
<th></th>
<th>Gun</th>
<th>Bomb</th>
<th>diff.</th>
<th>F</th>
<th>p</th>
<th>( \eta^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrorism</td>
<td>3.89</td>
<td>4.36</td>
<td>.47</td>
<td>10.44</td>
<td>.001**</td>
<td>.032</td>
</tr>
<tr>
<td>Extremism</td>
<td>5.03</td>
<td>5.45</td>
<td>.42</td>
<td>6.63</td>
<td>.011*</td>
<td>.021</td>
</tr>
<tr>
<td>Act of terror</td>
<td>5.81</td>
<td>6.05</td>
<td>.24</td>
<td>3.31</td>
<td>.070</td>
<td>.011</td>
</tr>
<tr>
<td>Premeditation</td>
<td>5.04</td>
<td>4.86</td>
<td>-.18</td>
<td>1.49</td>
<td>.224</td>
<td>.005</td>
</tr>
<tr>
<td>Religiosity</td>
<td>3.62</td>
<td>3.53</td>
<td>-.09</td>
<td>0.46</td>
<td>.500</td>
<td>.001</td>
</tr>
</tbody>
</table>

Note. *p < .05, **p < .01, “diff.” represents difference of Christian minus Muslim.
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**Judgements of Terrorism vs. Mental Illness**

A chi-square test for independence indicated that when a bomb was used, participants were far more likely to label the incident as an act of terrorism (77.1%) than an act of a person with mental illness (28.9%), $\chi^2(1, N = 321) = 7.09$, $p = .008$. On the other hand, when a gun was used, there was a smaller difference between the percentages of people labeling the incident an act of terrorism (56.8%) and those who labeled it an act of a person with mental illness (43.2%). Labeling the crime as an act of terror or an act of a person with a mental illness did not vary with the religion of the perpetrator though, $\chi^2(1, N = 321) = 2.51$, $p = .11$, nor did it vary with the citizenship status of the perpetrator, $\chi^2(1, N = 321) = .03$, $p = .86$.

**Typicality**

The analysis of a three-way ANOVA, which studied the effect perpetrator religion, weapon, and citizenship status had on perceptions of typicality, found a two-way interaction between perpetrator religion and type of weapon, $F(1, 314) = 10.60$, $p = .001$, $\eta^2 = .033$. When a bomb was used, Muslims were perceived to be more typical than Christians ($p < .001$), but when a gun was used, there was no statistically significant difference in perceived typicality between Christians and Muslims ($p > .10$). There were no other significant main effects, two-way interactions, or three-way interactions.

**Discussion**

The goal of this study was to investigate the potential biasing effects of perpetrator religion, weapon-type, and perpetrator country of origin on perceptions of mass murder. Results indicated that people were more likely to perceive Muslim perpetrators than Christian perpetrators of the same mass murder as extremist and more religious, two characteristics related to terrorism. These findings are consistent with other research which has found that people view Muslims as violent and untrustworthy (Sides & Gross, 2013), believe Islam is associated with terrorism (Smalarz et al., 2016), and assume that Muslim mass shooters are more motivated by religion than Christian mass shooters (Mercier et al., 2018). Contrary to the hypothesis, participants were not more likely to view or label the crime as an act of terror if the perpetrator was Muslim than Christian. This is somewhat surprising given that, in the media, mass murderers who are identified as Muslim are more often referred to as terrorists than those who are identified as Judeo-Christian (Nagar, 2010). It is possible, however, that participants might have wanted to appear unprejudiced and so avoided labeling the Muslim as a terrorist, but ascribed terrorist-related qualities to the Muslim which were less explicitly prejudiced. Also, contrary to the hypothesis, participants did not think the crime was more premeditated if the perpetrator was Muslim than Christian. It is possible that participants might not have associated "premeditation" with terrorism as strongly as expected given that premeditation is frequently used to describe other types of crime such as assault or burglary.

As hypothesized, results indicated that people were more likely to perceive Christian perpetrators than Muslim perpetrators of the same murder as more mentally unstable and more depressed, two characteristics of mental illness. This result is consistent with other research, which has found that Muslim perpetrators of mass shootings are perceived as less mentally ill than Christian perpetrators of the same crime by people who harbor negative attitudes toward Muslims (Mercier et al., 2018). Although perpetrator religion influenced the degree to which participants thought the perpetrator was mentally unstable and depressed, it did not influence the likelihood of perceiving the perpetrator as schizophrenic. This may be because mental instability fits the narrative of the perpetrator “snapping” and committing a heinous crime and depression could indicate a level of suicidality which might allow someone to commit a crime that is likely to get themselves killed by law enforcement; schizophrenia may not be considered as stereotypical of mass murderers.

Participants rated the crime as more typical for Muslim perpetrators than Christian perpetrators only when the weapon was a bomb. The hypothesis that the crime would be rated as more typical for Christian perpetrators than Muslim perpetrators when the weapon was a gun was not supported. This seemingly inconsistent result could be explained by the availability heuristic (Tversky & Kahneman, 1974); participants might have thought Muslim perpetrators were more typical for the crime when a bomb was used because there are numerous examples of this scenario in the media. Outside of these examples in the media, participants may not be exposed to many Muslims in their daily interactions or positive news stories about Muslims which can lead to an easily retrievable image of a Muslim bomber. The same is not true for Christians who are portrayed in more complex and varied ways in entertainment media than Muslims (Entman...
Therefore, the image of a Christian shooter might have been less easily retrievable and thus perceived as less typical for the crime. There were a few other unexamined results related to weapon-type: participants were more likely to view and label a mass murder performed by bomb as an example of terrorism and extremism than mass murder performed by gun. However, the crime was not more likely to be labeled an act of mental illness than an act of terror when a gun was used. This is surprising given that McGinty, Webster, and Barry’s (2013) research found an association between mass shootings and mental illness. Notably, their research did not compare mass shootings to other forms of mass murder such as bombings. There is little other research regarding weapon-type and typicality by demographic, and so these results may call for future research.

The results did not support the hypothesis that people would be more likely to label the murder an act of terror when the perpetrator was a dual citizen, but an act of a person with mental illness when the perpetrator was a U.S. citizen. It is possible that the hypothesis might have been supported had the independent variable manipulation of citizenship been more extreme. Instead of comparing a U.S. citizen to a dual citizen of the United States and another country, future research could compare a U.S. citizen to a person who is only a citizen of a foreign country. Future research should further explore how country of origin influences associations between terrorism, immigration, and xenophobia.

**Implications**

The results of the present study indicate that the religion of a perpetrator and type of weapon used may influence how mass murder is labeled and perceived. However, because many of these effect sizes are small, these associations are not particularly strong. Even though the majority of American Muslims do not partake in any terrorist activity (Smalarz et al., 2016), Islam is associated with characteristics of terrorism. The perceptual differences between Muslim and Christian perpetrators of mass murder may be influenced by how mass murder is reported in the media. There is a correlation between news exposure and greater anger toward Muslims (Shaver, Sibley, Osborne, & Bulbulia, 2017). This anger and stereotyping of Muslims as terrorists may be perpetuated by the media when early breaking headlines assume Muslim mass murderers are terrorists and Christian mass murderers are mentally ill. If early breaking headlines were to use the term mass murder equally across all cases and explore terrorism ties and mental health history with caution, the stereotyping of Muslims as terrorists and Christians as mentally ill could possibly be attenuated. Similarly, if media representations of Muslims were more varied, this could decrease the strength of the availability heuristic.

**Limitations**

Given the results indicating different perceptions of Muslim and Christian perpetrators of mass murder, it is important to address one confounding variable that may influence how these results are interpreted. The name of the perpetrator differed depending upon his identified religion; the Muslim perpetrator was always named Ibrahim Abboud and the Christian perpetrator was always named David Anderson. Although the purpose of including a name along with an identified religion was to increase the strength and noticeability of the religion manipulation by making the perpetrator appear stereotypical for his religion, instead it might have influenced participants to associate a race or ethnicity with the name. Thus, the perceptions of the Christian perpetrator may be associated with participants’ stereotypes of White individuals, and the perceptions of the Muslim perpetrator may be associated with participants’ stereotypes of Arab individuals. Instead, perpetrator name should have been controlled so that it was clear that the perpetrator’s religion, not perpetrator name, influenced participants’ perceptions. This confounding variable is a limitation to this study and should be remedied in future studies.

Another limitation included the sample demographics. Most participants identified as White, Christian, and women, and the sample was recruited from one liberal arts college. This likely limited the external validity of the study. Age was not included as a demographic question, but future studies should include this demographic information as well. Finally, a manipulation check for perpetrator religion was not conducted. It is possible that, if a manipulation check had been conducted and only the data from participants who remembered the religion of the perpetrator were analyzed, perhaps the effect sizes would have been larger.

**Future Directions**

Although this study found evidence that people associate Muslim perpetrators of mass murder
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with terrorism characteristics, this study did not test why this association occurs. According to terror-management theory (TMT), reminders of death lead to reminders of mortality, which may cause feelings of terror (Greenberg, Pyszczynski, & Solomon, 1986). To combat this terror, people cling to cultural worldviews that support their beliefs that they are leading a good and moral life. Outgroups that lead different lifestyles may threaten the sanctity of these worldviews. Thus, according to TMT, reminders of death may result in outgroup prejudice as a way to protect a person’s worldview (Greenberg et al., 1986). Not surprisingly, people infer that terrorist groups are more opposed to their personal values than the values of others (Combs & Collisson, 2016). Various studies have supported the argument that reminders of mortality are associated with outgroup prejudice, even specifically prejudice toward Arab-Muslims. Death-related thoughts mediate the effect that reminders of terrorism have on prejudice toward Muslims. Among White Europeans, watching news stories about an act of terror committed by an Arab man leads to death-related thoughts, which are in turn associated with anti-Arab prejudice (Das, Bushman, Bezemer, Kerkhof, & Vermeulen, 2009). Even when terror attacks are not committed by an Arab or Muslim, exposure to reminders of such attacks are associated with death-related thoughts, which are associated with prejudice toward Muslims (Kastenmüller et al., 2011). Furthermore, death anxiety in general, not just due to terrorism, is associated with anti-Muslim prejudice (Lopes & Jaspal, 2015). In accordance with TMT, death-related thoughts most likely act as a mediator between reminders of terrorism and Islamic prejudice. By using a targeted questionnaire developed by Greenberg, Pyszczynski, Solomon, Simon, and Breus (1994), future studies could test the presence of death-related thoughts in participants after reading the mock news story to test that mediational explanation.

Alternatively, beliefs in pure evil (BPE) may be another avenue to explore when researching anti-Muslim prejudice in relation to perceptions of terrorism. BPE is defined as having some or all of the following beliefs: pure evil involves intentionally inflicting harm for the purpose of pleasure, victims of evil are always innocent, evil is the opposite of order, and evil is brought by outsiders dissimilar to the victims (Baumeister, 1999). People who score higher in BPE score higher in measures of aggression including anti-Black and anti-Muslim prejudice (Webster & Saucier, 2013). People who score higher in BPE are also more likely to give harsh punishments to perpetrators of gun violence, regardless of whether the perpetrator is portrayed as having a brain tumor (mental illness) or as purely evil (Vasturia, Webster, & Saucier, 2018). Future research should assess participants’ BPE to see if this variable moderates how the crime is labeled as well as perceptions of typicality for the Muslim perpetrator.

Conclusion

When the same mass murder is committed by a Muslim and a Christian, people perceive it somewhat differently; they are more likely to ascribe characteristics associated with terrorism to the Muslim and characteristics associated with mental illness to the Christian. These assumptions are most likely based on the availability and representativeness heuristics. When the news media presents a mass murder differently depending upon the religion of the perpetrator, a probable consequence is that the negative stereotypes about Muslims in America are further strengthened.

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Author Note. Katie Keegan. ❖ https://orcid.org/0000-0001-5631-5058, Department of Psychology, McDaniel College; Wendy Morris, Department of Psychology, McDaniel College. This research was supported by a Student Research and Creativity Grant from McDaniel College. Special thanks to Psi Chi Journal reviewers for their support. Correspondence concerning this article should be addressed to Katie Keegan, 800 Grand Champion Drive APT#203 Rockville, Maryland 20850. E-mail: kek012@mcdaniel.edu

WINTER 2018

PSI CHI JOURNAL OF PSYCHOLOGICAL RESEARCH

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Nagar, N. (2010). Who is afraid of the T-word? Labeling terror in the media...
Many undergraduate students—particularly from nonmath majors such as psychology, nursing, social work, and the social sciences (Sesé, Jiménez, Montaño, & Palmer, 2015)—shudder at the mention of the word statistics and at the thought of enrolling in a statistics course (Chew & Dillon, 2014). Statistics and research methods are mandatory courses in these majors, yet many students tend to underperform in these courses (Chew & Dillon, 2014; Lester, 2016). Motivated by staggering figures documenting these underperforming behaviors in universities throughout the United States (Chew & Dillon, 2014; Lester, 2016), researchers have investigated the role of statistics anxiety on various performance measures in undergraduate statistics courses (Cruise, Cash, & Bolton, 1985; Griffith et al., 2014; Macher, Paechter, Papousek, & Ruggeri, 2012; Onwuegbuzie & Wilson, 2003). Statistics anxiety has been defined as “a negative state of emotional arousal experienced by individuals as a result of encountering statistics in any form and at any level” (Chew & Dillon, 2014, p. 9), which can significantly impair student learning during a statistics course (Macher, Papousek, Ruggeri, & Paechter, 2015; Onwuegbuzie, 2004).

Although some researchers have argued that lower performing students tend to have significantly greater levels of statistics anxiety than their high-performing classmates (Onwuegbuzie & Seaman, 2003).
1995), there are inconsistencies in the literature with respect to how, exactly, statistics anxiety is related to course outcomes (Chew & Dillon, 2014). However, if statistics anxiety has the capacity to debilitate students, then educators need to know exactly how it works so as to circumvent or at least reduce its negative impact. Although researchers such as Chew and Dillon (2014) have expressed the need to uncover exactly how statistics anxiety impacts academic performance, few empirical studies have involved a description of the mechanisms underlying statistics anxiety. Yet, there are at least two models, proposed by Macher et al. (2015), by which statistics anxiety is theorized to impact performance: the cognitive interference model and the deficit model.

According to the cognitive interference model, statistics anxiety directly affects a student’s performance on a statistics exam (Macher et al., 2015). This model says that anxiety overloads a student’s working memory during the exam and effectively disrupts the student’s performance on the exam. Both Macher et al. (2015) and Onweugbuzie (2004) stated that students often cite their high levels of anxiety as an explanation for why they did not perform as well as they anticipated. In support of this model, some researchers have reported that, as statistics anxiety increases, statistics performance decreases, illustrating a direct relationship between statistics anxiety and performance (Griffith et al., 2014). Although the results of this research support a direct negative effect of anxiety, according to Paechter, Macher, Martskvishvili, Wimmer, and Papousek (2017), “various studies have found no or only low, nonsignificant correlations between statistics anxiety and academic performance” (p. 2); these studies include Hamid and Sulaiman (2014) and de Vink (2017). One explanation for these inconsistencies may be due to the questionnaire used to measure anxiety. Hamid and Sulaiman (2014) and de Vink (2017) measured anxiety using the Statistics Anxiety Rating Scale (STARS; Cruise et al., 1985), and Griffith et al. (2014) used a different instrument, the Statistics Comprehensive Anxiety Response Evaluation (SCARE). Nonetheless, these inconsistencies still raise two questions: Does anxiety influence performance? If it does, is the relationship between anxiety and performance direct or indirect?

Although the cognitive interference model proposes a direct effect of anxiety, an alternative model, the deficit model, suggests that the negative effect of statistics anxiety on performance is primarily indirect (Macher et al., 2015). In the deficit model, students come into an exam ill-prepared because their anxiety prevented them from sufficiently studying for the exam. As Paechter et al., (2017) argued, statistics anxiety’s negative, indirect effects “mostly concern difficulties in time-management and procrastination during the preparation phase” of the learning process (p. 2). This model proposes that statistics anxiety inhibits learning before the exam by first prompting students to avoid the course material, leading to a decrease in appropriate studying behavior and diminished motivation (Macher et al., 2015). Paechter et al. (2017) and Sesé et al. (2015) also supported this argument with empirical evidence: These researchers found that anxiety had an indirect negative effect on academic performance. Macher et al. (2015), Paechter et al. (2017), and Sesé et al. (2015) provided support for the deficit model, each showing that statistics anxiety had an indirect negative effect on academic performance. These results suggest that statistics anxiety impairs the learning process, which in turn, impedes performance. That is, statistics anxiety may have a direct effect on learning behaviors, but an indirect effect on exam performance on statistics exams.

Several studies have provided additional support for the deficit model. For instance, researchers have reported that higher statistics anxiety was positively related to the utilization of maladaptive learning strategies (Onweugbuzie & Wilson, 2003), procrastination (Macher et al., 2012; Onweugbuzie, 2004; Paechter et al., 2017), low levels of statistics self-efficacy (McGrath, Ferns, Greiner, Wanamaker, & Brown, 2015), and was negatively related to the use of self-regulated learning strategies (Kesici, Baloglu, & Deniz, 2011). Each of these preceding variables were, in turn, related to statistics performance. These findings provide tentative evidence that statistics anxiety may have a negative, indirect effect on academic performance.

The cognitive interference model is a somewhat straightforward model because it focuses primarily on the direct effect of statistics anxiety on performance. Conversely, because the deficit model involves slightly more complex relationships between these variables, it seems there may be other variables and behaviors involved in this model, such as a students’ learning strategies, levels of procrastination, or self-efficacy. As such, it is necessary to examine the deficit model more closely and identify which variables are key components in the learning process. To identify other
relevant variables, it is important to first establish a theoretical framework in which anxiety operates to influence performance, so as to help explain how and why statistics anxiety may disrupt the learning process in statistics courses.

Researchers have posited that anxiety may influence performance by preventing students from becoming active and self-regulating learners (Zimmerman, 2002). The results of several studies have shown that students with high levels of statistics anxiety were more likely to adopt maladaptive learning strategies (Onwuegbuzie & Wilson, 2003) and less likely to adopt more effective self-regulated learning strategies (Kesici et al., 2011). Self-regulated learning is one of the theoretical frameworks often used to explain the learning process (Bandura, 1986); it is described in three phases: forethought, performance, and self-reflection (Zimmerman, 2002). Self-regulation theorists such as Bandura (1991) and Zimmerman and Schunk (2004) have argued that anxiety can impair students during the early stages of learning by reducing their self-efficacy (e.g., during the forethought phase). Anxious students tend to have maladaptive beliefs about their statistics abilities that frequently lead them to struggle to keep up with class work from the beginning of the course (Onwuegbuzie & Wilson, 2003). They tend to procrastinate and avoid completing their homework because it gives them anxiety, and they often do not know how to help themselves to view the course material in a less threatening way so that they can study more productively (Onwuegbuzie, 2004; Paechter et al., 2017). Moreover, these students often are afraid of asking a professor for help (Cruise et al., 1985). Anxious students often find themselves experiencing repeated failures on exams, yet they cannot find a way to generate success out of their underperformance. This is due to the fact that students with heightened anxiety tend to have low levels of self-efficacy (Perepizcka, Chandler, & Becerra 2011).

To be successful in their statistics courses, researchers argue that students must possess high levels of self-efficacy (McGrath et al., 2015). Having high self-efficacy helps students to feel that they can develop the skills they need to master a given concept, even if they have to work through setbacks (Bandura, 1986). These beliefs, in turn, prompt students to engage in effective studying and learning behaviors. For example, a self-efficacious student is one who approaches a statistics course with an analytical mindset, deciphers which skills are needed to meet a given learning objective, and knows that, with effort, the necessary skills can be achieved (Bandura, 1993). This student can set clear, challenging, but realistic goals that lead the student toward mastery of the learning objective through acquiring these needed skill sets (Artino, 2012). A self-efficacious student is, furthermore, able to use any underperformance as feedback, changing study strategies as needed, rather than seeing failure as final. Researchers have provided evidence that self-efficacy has a significant impact on students’ course performance (Byrne, Floor, & Griffin, 2014). For instance, Nelson, Gee, and Hoegler (2016) found that students’ statistics self-efficacy beliefs significantly predicted an additional 7% of the variability in their final exam scores, after controlling for prior GPA. Other researchers have similarly found self-efficacy to be a significant predictor of course performance in statistics (Byrne et al., 2014; McGrath et al., 2015).

On the contrary, when students do not develop self-efficacy beliefs, they often adopt maladaptive patterns of behavior that impair their ability to learn (Artino, 2012; Bandura, 1993). For instance, they are often unable to determine how to address an assignment or objective, leading to diminished motivation (Artino, 2012) and decreased performance (Nelson et al., 2016). This is often the case for students with high levels of statistics anxiety: They lack self-efficacy and fail to develop the skills they need to succeed in the course (McGrath et al., 2015). These students tend to internalize their failures and interpret their current situation as inescapable and overwhelming (Onwuegbuzie & Seaman, 1995), further raising their anxiety and decreasing their sense of self-efficacy (Schneider, 2011).

In many studies, researchers have reported a significant negative relationship between anxiety and self-efficacy (Chou, 2018; McGrath et al., 2015; Onwuegbuzie & Seaman, 1995; Perepizcka et al., 2011; Schneider, 2011). Bandura and Adams (1977) argued that anxiety contributes to the development of self-efficacy. They stated that one of the sources of self-efficacy is the “state of physiological arousal from which people judge their level of anxiety” (p. 288) and that stressful, anxiety-inducing, and otherwise emotionally arousing scenarios are “source[s] of information that can affect perceived self-efficacy in coping with threatening situations.” On the converse, Bandura (1993) has also argued that self-efficacy can predict the development of anxiety, remarking that one’s efficacy beliefs can influence one’s perception of stressors. According
to Bandura (1993), those who have high levels of self-efficacy tend to have low levels of anxiety because they believe they are in control of how they manage stressful situations.

However, theorists such as Pintrich and DeGroot (1990), Tremblay and Gardner (1995), and Zimmerman and Shunk (2004) argued for the former explanation—that anxiety primarily affects self-efficacy, not the other way around. Empirical studies have provided support for this argument (Chou, 2018; Perepiczka et al., 2011; Schneider, 2011). Perepiczka et al. (2011) showed that statistics anxiety was a significant predictor of statistics self-efficacy. Chou (2018) indicated that anxiety was a significant predictor of self-efficacy, although self-efficacy (but not anxiety) was a significant predictor of academic performance. Schneider (2011) revealed that, although self-efficacy and anxiety were significantly related to one another, anxiety had no significant relationship with performance. However, whether it is students’ self-efficacy that influences their anxiety, or vice versa, still remains to be further addressed.

In summary, statistics anxiety seems to play a role in student achievement in statistics, and thus appears to be an important variable for statistics educators to understand. If statistics anxiety is detrimental to student learning, then educators need to understand the mechanism by which anxiety impacts performance, either directly (in the case of the cognitive interference model) or indirectly (in the case of the deficit model). Although some researchers have identified a direct effect of anxiety on academic performance (Griffith et al., 2014), others have suggested that anxiety may instead impede performance indirectly (Macher et al., 2015; Paechter et al., 2017). One mechanism through which anxiety may be exerting its effect is by first influencing students’ self-efficacy beliefs, which then directly impact academic performance (Chou, 2018; Perepiczka et al., 2011; Schneider, 2011). In other words, anxiety may have a negative indirect effect on performance during the early stages of the learning process (Paechter et al., 2017; Zimmerman & Schunk, 2004). To date, few researchers have formally compared and analyzed models of how statistics anxiety affects learning and performance (Macher et al., 2015; Paechter et al., 2017).

The Current Study

Researchers have yet to identify the mechanism by which statistics anxiety influences course performance, as demonstrated by the conflicting evidence presented earlier. Yet, identifying this mechanism has important implications for statistics educators. If statistics anxiety directly impairs performance, then educational interventions should strive to directly reduce anxiety before exams. Conversely, if statistics anxiety works through other variables—namely self-efficacy—to exert an impact on academic performance, then it is important to examine how these other variables such as self-efficacy operate with anxiety to influence performance. Therefore, the current study aimed to fill in these gaps in the previous literature in order to help educators meet the needs of low-performing students in statistics courses. First, we investigated whether statistics self-efficacy could predict final exam performance, after controlling for prior GPA. Second, we compared which of the two models could best explain the role of statistics anxiety in final exam performance:

(a) the cognitive interference model, in which prior GPA, self-efficacy, and anxiety would each have a direct effect on final exam performance; or

(b) the deficit model, in which only prior GPA and self-efficacy would have a direct effect on final exam performance, but anxiety would have an indirect effect by working through students’ self-efficacy.

Method

Participants

Undergraduate psychology majors at a public university in the Northeast were recruited via e-mailed flyers as a convenience sample of students enrolled in two sequential statistics courses: Principles of Research Methods (covering descriptive statistics, the basics of hypothesis testing, and research design issues) or Psychological Statistics (focusing on inferential statistics from a one-sample t test through regression). Students were recruited from three sections of Psychological Statistics (n = 52) and two sections of Research Methods (n = 49). These courses were taught by the same two professors, who both used the same curriculum, teaching approach, and cumulative final exam questions and grading criteria for the sections of each course. A total of 101 students from both courses were asked to participate. Seventy-two students (71% of the initial sample) provided complete responses. Of these 72 respondents, nine were transfer students (all enrolled in psychological statistics) who did not have a prior semester cumulative GPA. Because prior GPA was a key variable for the study, these nine students were excluded from all analyses,
The Influence of Anxiety and Self-Efficacy

by Hoegler and Nelson

Materials and Variables

Prior GPA. The university research office provided students’ cumulative GPAs from the semester prior to their enrollment in the Research Methods or Psychological Statistics courses; prior GPAs ranged from 1.59 to 4.00 (M = 2.93, SD = 0.58).

Statistics Anxiety Rating Scale (STARS). The STARS (Cruise et al., 1985) contains 51 items, comprising six subscales. The first three of these subscales measure statistics anxiety and the last three measure attitudes toward statistics (Baloglu, 2002). For the purposes of this study, we utilized only the three subscales measuring statistics anxiety: Interpretation Anxiety (11 items), Test and Class Anxiety (8 items), and Fear of Asking for Help (4 items), totaling 23 items. Participants responded to these questions on a 6-point Likert-type scale, with higher scores indicative of greater anxiety. In keeping with previous studies that have used this instrument (Baloglu, 2002; de Vink, 2017), we combined students’ scores on the three anxiety subscales into a total anxiety score. Researchers have previously demonstrated the construct and concurrent validity of this survey (Baloglu, 2002; Cruise et al., 1985). Cronbach’s α coefficients reported for the anxiety scale have ranged from .68 to .89 (Baloglu, 2002; Cruise et al., 1985). For the current sample, Cronbach’s α = .95.

Statistics self-efficacy. Statistics self-efficacy was measured using the eight-item Self-Efficacy subscale of Pintrich, Smith, Garcia, and McKeachie’s (1991) Motivated Strategies for Learning Questionnaire (MSLQ). This scale originally contained general wording (e.g., it referred to students’ beliefs about their college courses in general), but was adapted for the specific domain of statistics courses, in keeping with Nelson et al. (2016). Students responded to these items on a 6-point Likert-type scale, with higher scores indicative of greater self-efficacy. Researchers have established the construct and concurrent validity of this instrument (Ilker, Arslan, & Demirhan, 2014; Pintrich et al., 1991). Cronbach’s α for this instrument was reported as .93 by Pintrich et al. (1991) and was reported as .92 for the adapted version by Nelson et al. (2016). For the current sample, Cronbach’s α = .94.

Exam grade. Students’ scores on the final exam in their Research Methods or Psychological Statistics course were collected. The final exams for both professors’ courses and sections were cumulative and identical in format. All exams were cumulative, used a short answer format, were graded all-or-nothing (e.g., no partial credit was given for partially correct answers), and were graded out of a maximum score of 200 points. The content covered in the Research Methods final included descriptive statistics, introductory inferential statistics, and hypothesis testing concepts, and the content covered in the Psychological Statistics final covered descriptive and inferential statistics, focusing on a greater use of SPSS, while also including research methodology questions. Although the exams in these two sequential courses were not identical, there were similar numbers of statistics-related and research-related questions contained in each exam. After course grades were submitted, final exam scores were compiled by the supervising faculty member, and all identifying information was removed before any data was given to the student researcher. Final exam scores were converted to percentages before any analyses were conducted; in the literature, exam grades are often discussed in the form of percentages, so that the reader can more easily interpret the performance of students (Brookheart et al., 2016). Although these two required courses were sequential in nature, no student’s data was in both courses because data was collected during only a single semester.

Procedure

Before beginning this study, institutional review board approval was given by the Western Connecticut State University Institutional Review Board (#1617-138). Exploratory in nature, this study did not involve any experimental manipulation. As previously stated, students were recruited from two statistics courses for psychology majors. Several days before their final exam, students in both courses were recruited, via e-mailed flyers, to respond to a survey via Qualtrics® online survey platform. The survey included 40 questions (nine demographic and 31 items representing the self-efficacy and anxiety scales) and took approximately 10–15 minutes to complete. The flyers sent by e-mail contained a link to the survey website. If students decided to participate, they electronically signed the consent form on the survey website and then provided demographic information including age, sex, and the course and section in which they were enrolled. The survey questions were presented.
to consenting participants one at a time and in a randomized order on Qualtrics. The presentation of the questions in a randomized order is a practice that has been investigated in prior literature (Schell & Oswald, 2013; Siminski, 2008). According to these sources, the order in which questions are presented can bias a respondent’s answers (e.g., the answer to one question is influenced by a previous answer) (Choi & Pak, 2005). To circumvent this potential bias, the current study followed the advice of these studies and randomized the order of the self-efficacy and anxiety questions. However, this practice has not been formally evaluated with these specific survey instruments, a potential limitation that is examined at length in the discussion.

Planned Analyses and Power
The current exploratory study was designed to answer two research questions: (a) Can statistics self-efficacy predict final exam performance, after controlling for prior GPA, and (b) Which model best explains the role of statistics anxiety in final exam performance: cognitive interference or deficit? Based on these research questions, the planned analyses chosen for this study were hierarchical multiple regression and path analysis, for the first and second research questions, respectively. An a priori power analysis was performed using G*Power 3.1.9.2. Prior researchers have identified both large (McGrath et al., 2015; Perepicka et al., 2011) and medium effects (Chou, 2018; Schneider, 2011; Sesé et al., 2015) when investigating the relationships between these variables using these analyses; to err on the conservative side, a medium effect was used when conducting power analyses. Power analysis indicated that, to have power of .80 to detect a medium effect at the .05 level of alpha in a hierarchical multiple regression, the analysis required 68 people. For the path analysis, power analysis indicated that 77 people were required to detect a medium effect. Although we originally anticipated being able to utilize data from between 72 and 101 people (see participant section), the final sample was $n = 63$, slightly under the recommended minimum sample size. The fact that this study was slightly underpowered will be addressed in the discussion section.

Results

Preliminary Comparisons
Eighty-three percent ($n = 52$) of the sample was women, with women outnumbering men in the sample five to one, thereby making interpretation of comparisons between sexes tenuous at best. Nonetheless, these comparisons were conducted (see Appendix). Several comparisons between the two courses (Research Methods and Psychological Statistics) were also conducted. There were no significant differences between the two courses in terms of self-efficacy, anxiety, final exam performance, or prior GPA (see Appendix). The lack of significant differences between the two statistics courses justified combining the data into one sample for the remaining analyses.

Main Analyses
The assumptions of hierarchical multiple regression and path analysis were assessed and verified (see Appendix). Before the research questions were examined, correlations among the four variables were calculated. Anxiety ($M = 2.96, SD = 1.09$) and self-efficacy ($M = 4.61, SD = 0.87$) were significantly and negatively related, $r(61) = -.65, p < .001$. Final exam performance ($M = 82.83, SD = 13.20$) was also significantly and positively related to both self-efficacy, $r(61) = .45, p < .001$, and to prior GPA ($M = 2.93, SD = 0.58$), $r(61) = .27, p = .04$. In other words, final exam scores increased with an increase in self-efficacy, as well as an increase in prior GPA. However, prior GPA was not related to self-efficacy, $r(61) = .004, p = .98$, or anxiety, $r(61) = .01, p = .91$, and there was no relationship between anxiety and exam performance, $r(61) = -.16, p = .21$.

Research Question 1. Hierarchical multiple regression was conducted using SPSS 22 to assess the first research question: Can statistics self-efficacy predict final exam performance, after controlling for prior GPA? Because the correlations between prior GPA and final exam performance, and between self-efficacy and final exam performance were significant, a hierarchical multiple regression was performed to examine whether self-efficacy was a significant predictor of final exam performance, after accounting for prior GPA (see Table 1 for

### Table 1

| Prior GPA and Self-Efficacy as Predictors of Final Exam Performance |
|------------------|-------|------|--------|--------|--------|
|                | $\beta$ | $t$  | $p$    | $R^2$  | $\Delta R^2$ |
| **Step 1**     |        |      |        |        |        |
| Prior GPA      | .27    | 2.15 | .035   | .27    | .07    |
| Self-Efficacy  | .26    | 4.50 | .019   | .53    | .28    | .21    |
| **Step 2**     |        |      |        |        |        |
| Prior GPA      | .45    | 4.14 | .001   |        |        |

Note. $N = 63$. 

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results summary). Students’ prior cumulative GPA was entered into Step 1 of the model, so as to control for past performance; prior GPA explained 7% of the variance in exam performance. Self-efficacy was entered into Step 2 of the model, accounting for an additional 21% of the variability. The entire model was significant, accounting for 27.7% of the variability in final exam grades. This analysis replicated the results of a previous study (Nelson et al., 2016), which also found that self-efficacy was a significant predictor of exam performance, even after controlling for prior GPA.

**Research Question 2.** Path analysis was performed using the AMOS 22 plug-in for SPSS 22 in order to assess the second research question. Model fit was assessed by using the Chi-Square, Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Normed Fit Index (NFI), and Incremental Fit Index (IFI) following the suggestions of McDonald and Ho (2002) and Schreiber, Nora, Stage, Barlow, and King (2006). A nonsignificant chi-square value indicates that the current model is not a bad fit for the data (Sheskin, 2011). CFI, NFI, and IFI values greater than or equal to .95 are considered representative of a “good” fit; an RMSEA value less than or equal to .05 is indicative of a “good” model fit (Sheskin, 2011).

The results of the path analysis including standardized path coefficients are depicted in Figure 1. The model was a good fit, as evidenced by $\chi^2(2, N = 63) = .032, p = .98$, RMSEA = .00, CFI = 1.00, NFI = .99, and IFI = 1.04. Prior GPA ($\hat{\beta} = .26, p = .006$) and self-efficacy ($\hat{\beta} = .60, p < .001$) each had a significant direct effect on final exam performance. As evidenced by the standardized path coefficients, self-efficacy had a medium effect on exam performance, and prior GPA had a small effect. There was also a significant inverse relationship between anxiety and self-efficacy ($\hat{\beta} = -.65, p < .001$). However, contrary to the hypothesized model, there was no significant direct effect of anxiety on exam performance ($\hat{\beta} = .23, p = .102$). The entire model accounted for 30% of the variability in final exam scores ($R^2 = .30$).

Because no direct effect of anxiety on final exam performance was identified, resulting in a nonsignificant path, the second proposed model was subsequently evaluated using path analysis. Model fit was again assessed with the Chi-Square, RMSEA, CFI, NFI, and IFI. The path analysis including standardized path coefficients is shown in Figure 2. Good model fit was evidenced by $\chi^2(2, N = 63) = 2.64, p = .45$, RMSEA = .00, CFI = 1.00, NFI = .95, and IFI = 1.01. As shown in Figure 2, both self-efficacy ($\hat{\beta} = .45, p = .001$) and prior GPA ($\hat{\beta} = .26, p = .008$) had significant direct effects on final exam performance. The standardized path coefficients indicate that self-efficacy had a medium effect on exam performance, and prior GPA had a small effect. There was also a significant large direct effect of anxiety on self-efficacy ($\hat{\beta} = -.65, p = .001$, $R^2 = .42$). Finally, there was a significant indirect
Research Question 1

Using a sample that was almost twice as large as the previous study ($N = 63$ vs. $N = 39$), we replicated Nelson et al.’s (2016) finding that self-efficacy is a significant predictor of final exam performance in a psychological statistics course, after accounting for prior GPA. These findings again revealed that self-efficacy could explain more of the variability (21%) in final exam performance than prior GPA (which explained 7.1% of the variance), suggesting that students’ beliefs in their ability to succeed may actually play a larger role in influencing their exam performance than their prior GPAs. This finding is particularly noteworthy because it suggests that students do have the potential to succeed if given the correct learning tools, even if they lack a strong academic history (Artino, 2012; Bandura, 1993; Nelson et al., 2016).

Research Question 2

The primary focus of this study was to identify a model that best explains the relationships between prior GPA, self-efficacy, anxiety, and statistics performance. Findings from both path analyses demonstrated that, although prior GPA played a small direct role in exam performance, it was not related to anxiety or self-efficacy. This is interesting considering the prior literature, as prior successes (i.e. a high prior GPA) are theorized to be related to increased self-efficacy, while prior failures (i.e. a low previous GPA) are theorized to be related to increased anxiety (Artino, 2012). However, prior literature has also remarked on the importance of keeping domain-specificity in mind when examining the role of non-cognitive variables in performance (Nelson et al., 2016; Pacheter et al., 2017). As such, it may be that one’s domain-specific statistics anxiety and statistics self-efficacy are not related to one’s general, nondomain-specific GPA (Pacheter et al., 2017).

The main concern of this study was to use path analysis to evaluate the two different proposed models: the cognitive interference model (in which prior GPA, self-efficacy, and anxiety directly affect performance) and the deficit model (in which prior GPA and self-efficacy directly affect performance, and anxiety has an indirect effect). The analysis of the first model revealed that anxiety had no direct effect on performance. However, the analysis of the second model revealed that anxiety had a significant indirect effect on performance by altering students’ levels of self-efficacy. Evaluation of an alternative model, which proposed that

effect of anxiety on exam performance ($\beta = -.30, p = .001$), in that anxiety appeared to indirectly affect exam performance by first influencing self-efficacy. This indirect effect was medium in size. The entire path model explained 28% of the variability in final exam performance ($R^2 = .28$). Because the direct effect of anxiety on final exam was nonsignificant in the previous model, this second model seems to best explain the role of anxiety in statistics performance. It not only was a good fit for the data and explained a large portion of the variability in final exam performance, but it also did not have any nonsignificant paths. Jöreskog and Sörbom (1996) argued that, when comparing models that both are a good fit for the data, the model that significantly explains all or most of the effects (e.g., paths) should be chosen to interpret the findings.

Upon further consideration, we also decided to analyze and report an alternative model, in which statistics self-efficacy is proposed to directly affect statistics anxiety, which in turn influences performance. Although this alternative model does not exemplify either a cognitive interference or deficit model, it was tested as a means of examining an alternative explanation for the relationship between self-efficacy and anxiety (as described in some of Bandura’s (1993) work). The purpose in proposing this model was to assess any alternative explanations for the finding that Model 2, the deficit model, was the best explanation for the relationship between self-efficacy, anxiety, and exam performance. The alternative model was analyzed using path analysis. The chi square value, $\chi^2$ (3, $N = 63$) = 16.36, $p = .001$, suggested that the data was not a good fit for the model; this was substantiated by RMSEA = .27, CFI = .74, NFI = .71, and IFI = .75. Therefore, this alternative model was eliminated as a potential alternative explanation for the finding that Model 2, the deficit model, appeared to be the best explanation for the relationship between self-efficacy, anxiety, and performance.

Discussion

The purpose of this study was to investigate the relationships between students’ prior academic performance, self-efficacy beliefs, levels of anxiety, and their performance in statistics courses. Framed within this overall purpose, this study had two specific aims: to replicate the results of a previous study (Nelson et al., 2016) and to identify which model best explained the relationships between prior GPA, statistics anxiety, statistics self-efficacy, and final exam performance.

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self-efficacy indirectly influenced statistics anxiety, and that anxiety in turn influenced performance, was not a good fit for the data. The results of the analyses of the two primary models, as well as the alternative model, provide evidence that anxiety may have an indirect influence on statistics achievement. This is vital information for any statistics instructor because it provides tentative evidence for the idea that, no matter how anxious statistics can make students, their anxiety may not have the final say in performance in the course.

These results contradict the cognitive interference model (Macher et al., 2015), which suggests that anxiety directly interrupts performance by disrupting and distracting students in the midst of their exams. The results of this study align with other studies, including Hamid and Sulaiman (2014) and de Vink (2017), which found that students’ anxiety, measured via their responses to Cruise et al.’s (1985) STARS scale, were not significantly related to their performance. Some previous studies, namely Griffith et al. (2014), identified a direct relationship between performance and anxiety. They measured anxiety with an instrument called the SCARE, which could have contributed to the differences in findings. The STARS was utilized in this study because it appears to be the most commonly used instrument to measure statistics anxiety (de Vink, 2017; Hamid & Sulaiman, 2014; Onwegbuzie, 2004; Paechter et al., 2017; Schneider, 2011), and a search of the literature shows that SCARE has only yet been utilized by Griffith et al. (2014).

The results of the current study lend support for Macher et al.’s (2015) deficit model, which says that anxiety indirectly impedes performance by first impacting students’ learning and motivational behaviors. In other words, statistics anxiety may prompt students to avoid the course material (Onwegbuzie & Wilson, 2003), which may lead them to not engage in effective, distributed study strategies (Zimmerman, 2002): it may prevent students from learning the material in the first place (Macher et al., 2015).

These results also provide insight into one of the potential mechanisms through which anxiety may indirectly influence performance. These findings contribute tentative evidence that supports explanations in the existing literature that anxiety during learning may prevent students from developing the self-efficacy they need to persist as they continue through the learning process (Perepiczka et al., 2011; Schneider, 2011), leading to an indirect effect of anxiety on exam performance (Macher et al., 2015). To more precisely examine what stage of the learning process is affected by anxiety, future research should focus on the relationship between anxiety and smaller, local assessments such as quiz, activity, and test performance over the semester. These smaller assessments may better reflect students’ learning progress throughout the course.

The results provide support for the argument that self-efficacy explains more of students’ statistics performance than prior GPA or anxiety alone. The extent to which students believe that they have the skills to master statistics seems to be a major predictor of their final exam performance. These findings are in line with existing literature, which suggests that high levels of self-efficacy can help motivate students during the early phases of learning (Zimmerman & Schunk, 2004) and help prevent them from succumbing to hardships or failures (Artino, 2012). Self-efficacy may specifically do so by instilling in students the “belief that failure is not permanent and that with effort and resilience they can succeed” (Nelson et al., 2016, p. 8).

Limitations and Suggestions for Future Research

This study was not without its limitations. First, some researchers have posited that the order in which the questions in a survey are presented can influence responses (Choi & Pak, 2005). In this study, we randomized the order of the items in the two survey instruments, as a means of guarding against learning bias (Choi & Pak, 2005, p. 9). These researchers have suggested “completing a questionnaire can be a learning experience for the respondent about the hypotheses and expected answers in a study” (p. 9), such that a participant’s response to one question may shape their responses to the questions that follow. Choi and Pak (2005) argued that, to prevent this type of bias, “it may be necessary to randomize the order of the questions” (p. 9). Several researchers assessed this type of randomization as a means of guarding against learning bias (Schell & Oswald, 2013; Siminski, 2008). These researchers found that randomizing the surveys items did not reduce the reliability of their instruments. However, no researchers have formally assessed the effects of this practice on the reliability of the Statistics Anxiety Rating Scale (STARS) or the Self-Efficacy subscale of the MSLQ. In our own prior research, we found no significant differences in reliability for these scales when the items were presented in their original order (Nelson, Gee, Heath, & McAndrew, 2015).
as compared to a randomized order (Nelson et al., 2016). Nonetheless, further research is needed to determine whether randomization of survey items reduces the reliability of these survey instruments.

Additionally, the a priori power analyses described in the Method section indicated that this study was slightly underpowered. As such, it is important to interpret these findings with caution until they can be replicated with a larger sample. Likewise, for this study, data was only collected during one semester, and it may be instructive to establish whether the effect of anxiety on academic performance is replicable over multiple semesters (Simons, Shoda, & Lindsay, 2017). Another study, currently in progress, is directed toward addressing the need for increased power and data collection over multiple semesters. Another limitation was the fact that two courses were used in this study, meaning that final exams were not identical in format. Despite the fact that both exams contained similar percentages of research methods-related and statistics-related concepts, a goal of future research should be to analyze each course individually to see if the present findings hold true. Furthermore, it is important to note the “constraints of generality” (Simons et al., 2017, p. 1124) that are present when interpreting these findings. Specifically, this study took place at a public university with open enrollment policies. As such, these findings may only be relevant to similar populations. Additional research at different types of institutions is necessary to determine whether the observed statistical relationships in this study are relevant to students at other types of institutions. Finally, we collected demographic information on participant age and sex, but not on race/ethnicity. In future studies, researchers should expand the collected demographic data to provide more information on the generality of these findings.

Implications for Intervention

Despite the need for further research, the current study can provide several important, albeit tentative implications for interventions. The results of this study, in addition to others, provide evidence that students’ anxiety may primarily inhibit their performance by working through self-efficacy (Chou, 2018; Perepiczka et al., 2011; Schneider, 2011). These findings are aligned with Bandura’s (1993) argument that students’ self-efficacy is one of the best predictors of whether or not they succeed academically, while students’ “level[s] of scholastic anxiety bear little or no [direct relationship to their academic performance” (pp. 133–134). Accordingly, Bandura suggests that educational interventions should focus on promoting students’ self-efficacy, rather than on creating “anxiety palliatives” (p. 134). In other words, it might be more effective for classroom interventions, activities, and general structure to focus primarily on promoting self-efficacy, rather than decreasing student anxiety.

An example of an intervention that can be used to improve self-efficacy is the exam wrapper (Achacoso, 2004). Exam wrappers are post-exam reflection exercises that help students to reflect on their exam performance, distinguish between the concepts they mastered and those they did not, and between which study methods were and were not effective (Achacoso, 2004; Nelson et al., 2015). When used in our statistics courses, exam wrappers help students to view their errors as an opportunity for growth, better preparing them to identify the concepts about which they need to develop a deeper understanding. This is one intervention that has been shown to raise students’ levels of self-efficacy over the course of a semester (Nelson et al., 2015). Another relevant classroom intervention is the preclass activity, assigned with readings from the textbook. These low-stakes activities are short learning exercises that teach the basic, factual information for a given topic. The preactivities have students answer mostly low-level (i.e., remembering and understanding from Bloom’s Revised Taxonomy) practice problems. These activities were designed to teach students that they have the capability to master the basic concepts—reinforcing their self-efficacy.

Although it seems reasonable to design interventions directed at promoting self-efficacy, researchers must begin by replicating the current study with a larger and more diverse sample. If replicated, these results would support the continued evaluation of interventions such as the exam wrapper or the preactivity, and the design and development of similarly structured interventions. Although additional research is needed, two practical pieces of advice can be gained from this study and the related literature. First, statistics instructors must instill in their students an understanding that they will likely experience mistakes and suffer setbacks as they work through a statistics course. Second, and perhaps more importantly, statistics instructors must emphasize that, with effort and
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http://dx.doi.org/10.5206/cjsol-rcacea.2015.1.5


Author Note. Sarah Hoegler, BA, https://orcid.org/0000-0001-8765-4450, Department of Psychology, Western Connecticut State University; Mary Nelson, PhD, https://orcid.org/0000-0003-2866-7640, Department of Psychology, Western Connecticut State University.

Special thanks to *Psi Chi Journal* reviewers for their support. We would like to express our gratitude to Dr. Tara Kuther-Martell for all the time and effort she spent as a reader for this research. Her feedback was invaluable—thank you! We would additionally like to thank Dr. Jessica Kraybill for allowing us to recruit students from her courses to participate in this research.

Correspondence concerning this article should be addressed to Sarah Hoegler, Department of Psychology, Western Connecticut State University.

E-mail: hoeglers@wcsu.edu

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### APPENDIX

#### Course Comparisons, Gender Comparisons, and Evaluation of Assumptions

The two courses did not differ in prior GPA, \( t(61) = -1.00, p = .32, d = 0.26 \), self-efficacy, \( t(61) = -1.38, p = .19, d = 0.40 \), anxiety, \( t(60.93) = 0.58, p = .56, d = 0.15 \), or final exam scores, \( t(61) = -0.32, p = .75, d = 0.08 \).

Men and women did not differ in self-efficacy, \( t(61) = 0.27, p = .79, d = 0.08 \), anxiety, \( t(29.20) = 1.11, p = .28, d = 0.29 \), or final exam scores, \( t(61) = -0.32, p = .75, d = 0.10 \). Women had significantly higher prior GPAs than men, \( t(61) = 3.14, p = .003, d = 1.08 \); this finding is likely due to the fact that female participants \( (N = 52) \) outnumbered male participants \( (N = 11) \) five to one.

The assumptions of hierarchical multiple regression and path analysis were assessed (Field, 2017; Laerd, 2017). Independence of observations/residuals was verified for each model, as all Durbin-Watson statistics were near 2.00. There was no evidence of multicollinearity (tolerance values were greater than 0.1). Studentized deleted residuals fell between -3 and +3, no leverage values exceeded 0.2, and no values for Cook’s distance exceeded 1.0. The Shapiro-Wilk test indicated that prior GPA \( (p = .54) \), self-efficacy \( (p = .13) \), and statistics anxiety \( (p = .10) \) were normally distributed; the distribution of final exam scores violated normality \( (p = .001) \). Probability-probability (P-P) plots suggested that final exam scores were positively skewed, which is often the case for final course exams. These two analyses are considered robust to some violations of normality (Field, 2017). Visual inspection of P-P plots and scatterplots of each dependent variable and of studentized residuals plotted against predicted values for each dependent variable did not suggest any violations of linearity. Visual inspection of plotted studentized residuals and unstandardized predicted values suggested some small violations of homoscedasticity; these analyses are robust to minor violations of this assumption (Field, 2017).
Individuals under chronic stress suffer anxiety and depression at higher rates than sex- and age-matched controls (O’Donovan et al., 2010; Slavich & Irwin, 2014). In modern society, some of the primary sources of chronic stress are social in nature, relating to relationships and conflicts with other people (McEwen, 2003, 2004; Slavich & Irwin, 2014). As such, the development of appropriate animal models could provide insights into the behavioral, physiological, and neurological consequences associated with chronic social stressors. In addition, using these models to demonstrate how individuals respond to the termination of those same stressors may provide insight into potential therapeutic applications to mitigate symptoms associated with chronic stress with specific implications for anxiety and depressive disorders.
Historically, the most common rodent model that has been utilized to investigate chronic social stress is the social defeat model (a.k.a. “resident-intruder” model; Golden, Covington, Berton, & Russo, 2011; Hollis & Kabbaj, 2014; Iniguez et al., 2014; Kinsey, Bailey, Sheridan, Padgett, & Avitsur, 2007; Watt, Burke, Renner, & Forster, 2009). This model involves a male rodent subject (i.e., the “intruder”) being introduced to a larger and more aggressive male’s cage (i.e., the “resident”). The subject is often attacked repeatedly by the aggressive resident, eventually resulting in the subject expressing behavioral and physiological symptoms that resemble human populations experiencing clinical anxiety and depression (e.g., social withdrawal, anhedonia; Hollis and Kabbaj, 2014; Iniguez et al., 2014; Kinsey et al., 2007; Watt et al., 2009; Zhang, Yuan, Shao, & Wang, 2016).

For at least two reasons, the social defeat paradigm has been insufficient for providing a complete picture of the neuroendocrine correlates of depression and anxiety. First, the social defeat model involves both physical (i.e., attacks by resident male) and psychological (i.e., being placed into an unfamiliar cage) stressors, whereas the most common sources of social stress in modern human populations are psychological. Physical stressors certainly exist, even in Western societies (e.g., malnutrition, infectious diseases), but psychosocial stressors are recognized as frequent precursors to onset of depressive and anxiety disorders (Juster, McEwen, & Lupien, 2010; McEwen, 2004, 2005; Slavich & Irwin, 2014). Second, the social defeat model is typically only effective with male rodents (although, see Harris et al., 2018; Takahashi et al., 2017; Williams et al., 2018) because males tend to be more aggressive than females (Solomon, 2017). However, women report experiencing depressive or anxiety symptoms two times more frequently than men (McLean, Asnaani, Litz, & Hofmann, 2011; Silverstein, 2002). Therefore, a rodent model that involves a primarily psychosocial stress and is effective with females might provide insights that have been missed when using the social defeat paradigm.

One alternative model has been developed in which male mice either experience or witness social defeat (Warren et al., 2013). Although this testing paradigm allows for the assessment of distinctly psychological stress (in the witnesses), it still employs male subjects. Recently, a social instability paradigm was developed and found to be effective at eliciting the predicted behavioral and hypothalamic-pituitary-adrenal (HPA) responses in female subjects (Herzog et al., 2009; Jarcho, Massner, Eggert, & Wichelt, 2016). This paradigm is characterized by frequent and unpredictable changes to the subjects’ social environments including social isolation and social crowding.

The social instability model described above was designed to accurately translate to frequent and substantial changes to one’s social environment in humans. Given that social stressors may last for weeks to months (e.g., family disagreements, feeling excluded from a group), or longer (e.g., end of a marriage, loss of a loved one), assessing glucocorticoid responses over a comparable timeline is ideal. Common methods of sampling glucocorticoids involve the collection of either blood plasma or saliva. Additionally, urinary and fecal samples provide insight to HPA functioning over the preceding hours (Harper & Austad, 2015; Shamim, Yousufuddin, Bakhai, Coats, & Honour, 2000). These methods give “point” values that are highly variable within the same individual, and within a given day. A number of variables are known to affect plasma and salivary samples in particular (e.g., food intake, exercise, time of day/year) and need to be controlled for or taken into account, and repeated samples are required for an accurate understanding of HPA regulation (Davenport, Tiefenbacher, Lutz, Novak, & Meyer, 2006). Sampling glucocorticoids (i.e., corticosterone in rodents, cortisol in primates) in hair, however, is a newer method that allows for the noninvasive assessment of glucocorticoids over a longer period of time with a single sample and has been shown to accurately reflect individual responses to various social stressors in rhesus macaques (Davenport et al., 2006; Dettmer, Novak, Meyer, & Suomi, 2014; Dettmer, Novak, Novak, Meyer, & Suomi, 2009; Dettmer, Novak, Suomi, & Meyer, 2012). Further, because the hair samples reflect HPA activity over the entire period that the hair has been growing (5 weeks in the current study), variables like stage of estrous cycle and time of day are inherently controlled.

Previous work in this lab (Jarcho et al., 2016) has shown that female mice exposed to social instability experience an increase in hair corticosterone, indicating that HPA activity is elevated in these animals throughout the time that they experience social instability. However, we were unable to determine whether our effects were unique to social instability stress itself, or whether they would be common across other social stressors. In addition, previous work by this lab was limited because we did
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not include a measure of neuronal consequences of the stressor, an important measure possibly linking physiological and behavioral patterns. The current study attempted to address both of those questions by incorporating both social instability and social isolation stressors, and by quantifying mRNA concentrations in hippocampal tissue samples in an attempt to elucidate the mechanisms that underlie stress-related alterations in behavior and brain function. Social isolation is characterized by being isolated from social contact (but not, visual, auditory, or olfactory isolation), whereas social instability is characterized by frequent shifts in the social environment including periods of isolation and social crowding.

Although the hippocampus is widely known to be involved in memory and cognition (Squire, 1992), anxiety behavior in rodents requires synchronized activity between the hippocampus and medial prefrontal cortex (Adhikari, Topiwala, & Gordon, 2010) and intrahippocampal kainite injection has been shown to decrease amygdalar volume and increase anxiety-like behavior (O’Loughlin, Pakan, McDermott, & Yilmazer-Hanke, 2014). Thus, we investigated the hippocampus, a region known to respond to social stress (Chang, Hsiao, Chen, Yu, & Gean, 2015; Cheryl M. McCormick et al., 2012) and directly regulate anxiety-like behavior (Mineur et al., 2013), to determine the effect of chronic social stress on mRNA expression. We specifically looked at the involvement of tumor necrosis factor alpha (TNF-α), interleukin 1 receptor beta receptor (IL-1βR), and glial fibrillary acidic protein (GFAP). Expression of proinflammatory cytokines including TNF-α and IL-1βR have been found to increase following chronic stress (Badowska-Szalewska et al., 2013; Liu et al., 2015), and increased levels of these markers have been implicated in the etiology of stress-associated disorders like depression and posttraumatic stress disorder in rat models (Jones, Lebonville, Barrus, & Lysle, 2015; Şahin et al., 2015). Because IL-1β is thought to be a key mediator in a variety of behavioral actions of stress, its receptor has emerged as an attractive target for the treatment of stress-related disorders like depression (Koo & Duman, 2009a, 2009b). Although increased cytokine levels following stress have been demonstrated using chronic variable stress and forced-swim stress models (Badowska-Szalewska et al., 2013; Liu et al., 2015), brain cytokine expression resulting from social instability and social isolation stress has not been investigated. Thus, for the current study, we investigated whether

Our third marker, GFAP, is an intermediate filament component of astrocytes and is often used as an indicator of astrocyte activity and function (Hol & Pekny, 2015). In relation to stress, decreased GFAP expression has been shown to occur in the brains of stressed animals (Araña-Callís, Hiemke, Abumaria, & Flugge, 2012; Imbe, Kimura, Donishi, & Kaneoke, 2013) indicating astrocyte dysfunction. Considering that astrocytes are critical in supporting neuronal functioning, astrocyte dysfunction may lead to neuronal dysfunction, particularly in stress sensitive brain regions, leading to anxiety-like and depressive behaviors (Li, Yang, Ma, & Qu, 2013; Rahati, Nozari, Eslami, Shabani, & Basiri, 2016). Because GFAP expression has been found to be an important stress-related endpoint and indicator of astrocyte function, we wanted to determine how its expression would change in response to our social stress paradigm(s).

Our overall prediction for the current study was that both forms of chronic social stress would induce behavioral, physiological, and neuronal changes when compared to controls, and that social instability would be a more potent chronic social stressor than social isolation. The predicted difference between forms of chronic social stress was based on the fact that social instability is more unpredictable than social isolation, and level of unpredictability is known to enhance the response to the stressor (Thakur, Patel, Gulati, Anand, & Ray, 2015). Behaviorally, based on previous findings (Baranyi, Bakos, & Haller, 2005; Haller, Baranay, Bakos, & Halász, 2004; Haller, Fuchs, Halász, & Makara, 1999; Herzog et al., 2009), we predicted that females experiencing either social stress would be characterized by increases in expression of anxiety-like and depression-like behaviors when compared to baseline and when compared to control animals not experiencing social stress. We further predicted that animals experiencing social instability would show greater increases in anxiety-like behavioral expression when compared to those experiencing social isolation. However, based on previous results in similar studies, we were cautious with these behavioral predictions (see Jarcho et al., 2016). From the brain tissue samples, we expected to see differences in messenger RNA profiles between those animals that experienced a social stressor and those that did not. Specifically, because neuroinflammation is considered to be a major etiological factor in the development of
stress-associated depression and anxiety (Lehmann et al., 2016; Weber, Godbout, & Sheridan, 2017), we expected markers of inflammation to be expressed at higher levels in those animals that had experienced chronic social stress (i.e., either isolation or instability), and that animals experiencing instability would express these markers at the highest levels. Given that chronic stress can be accompanied by a proinflammatory profile due to glucocorticoid resistance (Avitsur, Stark, & Sheridan, 2001; Cacioppo, Cacioppo, Capitanio, & Cole, 2015; Hawkley, Cole, Capitanio, Norman, & Cacioppo, 2012), we predicted that subjects showing increased expression of proinflammatory markers would also have elevated hair corticosterone following the stress period. Therefore, we predicted that both groups of animals experiencing social stress would show elevated hair corticosterone levels, and that those experiencing social instability would have the highest hair corticosterone levels.

Method

Subjects and Study Outline

Adult (Age in weeks, M = 12.33, SE = 0.45 at start of baseline, M = 22.33, SE = 0.45 at end of Stress period, and M = 27.24, SE = 0.78 weeks at end of Recovery) female CD-1 mice (N = 27) that were bred in our facility at Loras College were housed in clear plastic cages (10.5” x 19” x 6”, Allentown, Inc., Allentown, NJ) in a temperature- and humidity-controlled animal facility on a 12-hour light-dark cycle with food and water available ad libitum. All behavioral testing occurred within the first 4 hours of the dark (i.e., active) period. Mice were randomly assigned to either the control (n = 9), social instability (n = 9), or social isolation (n = 9) groups, similar to the experimental groups in previous work (Maslova, Bulygina, & Amstislavskaya, 2010). Animals in the control group remained with two familiar females throughout the study, and all animals in the cage were used for the study. Animals in the social instability and social isolation groups spent the first 5 weeks of the study (i.e., “Baseline”) housed with two other females. During the “Stress” period of the experiment, animals in the social instability group experienced an unpredictable and unstable social environment. At varying times of day, these animals were moved every 24–48 hours between social isolation (i.e., housed by themselves) and social crowding (i.e., housed with six female conspecifics in the same cage dimensions) for 5 weeks. This social instability model was based on previous work in rats (Herzog et al., 2009) and mice (Jarcho et al., 2016). For social crowding, animals were returned to the same cage and same cohabitants for each exposure. This housing paradigm is considered stressful because the animals have no control over their social environment, nor are they able to predict exactly how long they will remain in either isolated or crowded social conditions (Baranyi et al., 2005; Haller et al., 1999; Herzog et al., 2009). During this time, animals in the social isolation group were housed continuously in isolation. To control for any handling effects, control and isolated animals were handled on all days that animals in the social instability group were moved. Animals in all experimental groups were returned to their original housing groups (i.e., same subjects housed together as were housed together during baseline) for the final five weeks of the study (i.e., “Recovery”; see Table 1). Adequate measures were taken to minimize pain or discomfort, and all experiments were conducted in accordance with international standards on animal welfare, were compliant with local and national regulations, and were approved by the Institutional Animal Care and Use Committee at Loras College.

Behavioral Testing

All animals were weighed and assessed for behavioral expressions of anxiety and depression once per week throughout the 15-week study in an open field maze and an elevated plus maze (n = 9 per group during the baseline and stress periods, n = 6 per group during the recovery period). Mice were tested for 5 minutes on each maze and were video recorded under dim red lighting. Video recordings were scored using Behavior Tracker 1.5 (www.behaviortracker.com) by observers blind to the experimental manipulations. In the open field, the duration of time spent in the center or perimeter of the open field, and frequency of rearing were quantified. In the elevated plus maze, the time spent in the “open” and “closed” arms were quantified.

Brain Tissue Collection

One third of the animals for each group (n = 3 per group) were randomly selected to be euthanized at the same time for brain tissue collection 24 hours after the end of the stress period at approximately 1300 hours. Animals were euthanized by CO₂ asphyxiation. Brains were extracted and the entire hippocampus, both dorsal and ventral aspects, was collected from each mouse. Tissue was placed in tubes containing RNAlater (ThermoFisher,
Waltham, MA) and stored at 4°C until mRNA analyses were conducted.

**Gene Expression Analyses**

mRNA from mouse hippocampus was isolated using Pure Link spin columns (ThermoFisher, Waltham, MA), and cDNA was synthesized using Verso cDNA synthesis kit (ThermoFisher, Waltham, MA). Real-time polymerase chain reaction (RT-PCR) was performed using PowerUp SYBR Green Master Mix (ThermoFisher, Waltham, MA) and gene specific primers (see Table 2; Integrated DNA Technologies, Coralville, IA). Samples were run in triplicate using a StepOnePlus RT-PCR System (Applied Biosystems, Inc., Foster City, CA). Data were analyzed using the $2^{\Delta\Delta Ct}$ method (Livak & Schmittgen, 2001), and mRNA expression of target genes was normalized to that of the housekeeping gene glyceraldehyde 3-phosphate dehydrogenase (GAPDH). Data are expressed as fold change of levels compared to control mice.

**Hair Sample Collection and Preparation**

To ensure that hair corticosterone samples represented HPA activity during the study, mice were shaved at the start of the baseline period. This hair was not collected or analyzed for corticosterone. Mice were shaved again at the end of the 5-week baseline ($n = 9$ per group), stress ($n = 9$ per group), and recovery ($n = 6$) periods. Hair was collected from the posterior dorsal portion of the animals (see Figure 1) in order to minimize auto-grooming of the shaved area. Collection was conducted without anesthesia by two trained technicians, one to immobilize the mouse and one to operate the hair clippers (Wahl Clipper Corporation, Sterling, IL). Animals were shaved using the same protocol regardless of experimental group to eliminate any handling effects on hair corticosterone. Hair samples were collected, weighed (mean weight 13.9 ± 0.3 mg), and stored in a -20°C freezer until assay. Samples were prepared following a modified previously published protocol (Davenport et al., 2006). Briefly, samples were washed with isopropanol to remove debris and external corticosterone while minimally affecting corticosterone levels inside the hair (Davenport et al., 2006; Gow, Thomson, Rieder, Van Uum, & Koren, 2010). Washing involved adding 1 ml of isopropanol to each sample for a 5-minute incubation, followed by centrifugation at 13,000 rpm at room temperature prior to removing the solution. Washing was repeated two additional times for all samples. Washed samples were allowed to dry by leaving them in a laminar flow hood for 24 hours. Samples were then chopped into fine pieces with a razor blade to facilitate steroid extraction (Yu et al., 2015). To obtain a holistic measure of HPA activity throughout a given period of the study (e.g., throughout the Baseline period), the entire sample was processed. Steroids were then

### TABLE 1

<table>
<thead>
<tr>
<th>Description of Social Instability Methodology</th>
<th>Housing</th>
<th>Isolation</th>
<th>Body weight measured</th>
<th>Behavioral testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>3/cage</td>
<td>3/cage</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>Shave: sample not assayed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 1–5</td>
<td>3/cage</td>
<td>3/cage</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>Shave: baseline sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 6 Stress</td>
<td>3/cage</td>
<td>Single</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>S/cage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 7 Stress</td>
<td>3/cage</td>
<td>Single</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>S/cage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 8 Stress</td>
<td>3/cage</td>
<td>Single</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>S/cage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 9 Stress</td>
<td>3/cage</td>
<td>Single</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>S/cage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 10 Stress</td>
<td>3/cage</td>
<td>Single</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>S/cage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shave: stress sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain tissue collection ($n = 3$/experimental group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 11–15</td>
<td>3/cage</td>
<td>3/cage</td>
<td>1x/wk</td>
<td>1x/wk</td>
</tr>
<tr>
<td>Shave: recovery sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: All animals were shaved initially to ensure corticosterone concentrations reflected only the study period. The study was comprised of three 5-week phases: (a) baseline, (b) stress, and (c) recovery. During each phase, mice were weighed and assayed behaviorally once per week. At the end of each phase, mice were shaved and hair was collected to assess corticosterone production. All mice were housed three mice per cage for 5 weeks leading up to the study. Controls remained in these groups for the duration of the study. Mice in the isolation group were isolated for 5 weeks, and then returned to the same groups of 3 for 5 weeks. Mice in the instability experienced multiple changes in their housing environment for 5 weeks prior to returning to a stable housing environment of three mice per cage for the final 5-weeks of the study. All mice were weighed and tested behaviorally once per week, and hair samples were collected for corticosterone analyses from all mice at the time points indicated. Three animals from each experimental group were sacrificed at the end of the stress period for collection of brain tissue samples.*
extracted from the chopped hair by incubating the samples in methanol for 24 hours. Samples were centrifuged for 5 minutes at 13,000 rpm at room temperature and the steroid-containing methanol solution supernatant was collected. This solution was purified by passing it through Supelco-select HLB SPE tubes (Sigma-Aldrich). Purified extracts were reconstituted with assay buffer (Arbor Assays, Ann Arbor, MI).

Corticosterone Assays
Reconstituted samples were assayed in duplicate(s) for corticosterone via commercially available enzyme immunoassay kits (Arbor Assays, Ann Arbor, MI). The detectable range of corticosterone for these kits was 78.125–10,000 pg/ml, and the intra-assay and inter-assay coefficients of variance were 16.43 and 6.59, respectively. Corticosterone concentrations as detected by enzyme immunoassay were then matched with the original weight of the hair collected in order to account for minor variations in hair quantity collected. Corticosterone concentrations are, therefore, expressed in pg/mg of hair.

Statistical Analyses
Physiological and behavioral patterns were evaluated with a 3 x 3 repeated-measures Analysis of Variance (ANOVA) with group (i.e., social instability vs. social isolation vs. control) and time (i.e., baseline vs. stress vs. recovery) included as main factors, a group by time interaction term, and individual subject identity as a within subject factor. For behavioral trials that were conducted every week (i.e., five trials per mouse per period of the study), averages were calculated for each individual for each period of the study. That is, each subject had three averages for each behavioral measure—one at baseline, one at stress, and one at recovery. Post-hoc t tests were used to compare social instability values to controls, to compare social isolation values to controls, and to compare baseline to stress to recovery levels within groups. Analyses of mRNA expression levels was assessed with ANOVA. An α of .05 was used in all statistical analyses, and Bonferroni adjustment was used to correct for multiple tests. Effect sizes were calculated as partial eta-squared ($\eta^2$) for ANOVA and as Cohen’s $d$ for t tests. Post-hoc power analyses were conducted using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007) with an α level of .05. Power values are reported following estimates of effect size as 1-beta (1-β).

**Results**

**Effect of Social Stress on Body Mass**
Animals were weighed once per week throughout the study, and weights were averaged across individuals within experimental groups. Repeated-measures ANOVA with main effects of time and group did not yield significant differences for either main effect, nor was there a Group x Time interaction (all $p$s > .05).

<table>
<thead>
<tr>
<th>TABLE 2</th>
</tr>
</thead>
</table>

**List of Primers Used in Reverse Transcription Polymerase Chain Reaction**

<table>
<thead>
<tr>
<th>Gene</th>
<th>Species</th>
<th>Accession</th>
<th>Forward</th>
<th>Reverse</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFAP</td>
<td>Mouse</td>
<td>NM_010277.2</td>
<td>TGGCCGGGGGCCCTCAATGCTGCC</td>
<td>GGGCGACTCCCGGCGATGCCCTC</td>
</tr>
<tr>
<td>IL-1Beta R</td>
<td>Mouse</td>
<td>NM_010555.2</td>
<td>GGGCCGCTAAAGGAAATC</td>
<td>TACCAGTTGGGAACCTCTGC</td>
</tr>
<tr>
<td>TNF alpha</td>
<td>Mouse</td>
<td>NM_013693.2</td>
<td>GAACTGGCAGAAGGCACT</td>
<td>AGGGCTTGGGGCATAGAACT</td>
</tr>
<tr>
<td>GAPDH</td>
<td>Mouse</td>
<td>NM_008084</td>
<td>AACTTTGCGATTGTGGAAGG</td>
<td>GGATCGAGGGATGATGTTCT</td>
</tr>
</tbody>
</table>

*Note. GFAP = glial fibrillary acidic protein. IL-1Beta R = interleukin 1 receptor alpha receptor. TNF alpha = tumor necrosis factor alpha. GAPDH = glyceraldehyde 3-phosphate dehydrogenase.*

FIGURE 1
Area of fur collected for corticosterone assays. Following each period of the study (i.e., Baseline, Stress, Recovery) hair samples were collected for corticosterone quantification. Hair was collected from the posterior dorsal surface of the mice, between the tail and hind legs. Shaded area represents target area to be shaved.
Effect of Social Stressors on Expression of Anxiety-Like Behaviors

No group differences were seen in the amount of time spent in either the open arms of the elevated plus maze or the center of the open field (all \( p < .1 \)). The only behavior that showed group differences was rearing in the open field maze. This indicator of anxiety remained relatively constant in control mice, but increased during the stress period in the isolation and instability animals (see Figure 2). Rearing frequency was predicted by experimental group, \( F(2, 351) = 6.91, p = .001, \eta^2 = .04, (1-\beta) = .94 \), and post-hoc tests revealed that this effect was primarily driven by differences between rearing patterns of mice in the instability group: compared to controls, \( t(238) = 2.37, p = .018, d = .10, (1-\beta) = .90 \); compared to isolated animals, \( t(238) = 3.87, p < .001, d = .14, (1-\beta) = .92 \), whereas isolated animals did not show different rearing patterns from controls (\( p > .1 \)).

Effect of Social Stressors on RNA Expression Patterns in the Brain

In hippocampal samples, IL-1\( \beta \)R mRNA levels differed across experimental groups, \( F(2, 6) = 5.65, p = .045, \eta^2 = .85, (1-\beta) = .99 \) (see Figure 3a), and post-hoc tests revealed significant differences when any two groups were compared, with expression levels being lowest in controls, higher in isolated animals, and highest in instability animals: control vs. isolation, \( t(4) = 5.21, p = .032, d = 2.53, (1-\beta) = .64 \); control vs. instability, \( t(4) = 11.89, p < .01, d = 4.12, (1-\beta) = .96 \); isolation vs. instability, \( t(4) = 5.93, p = .031, d = 2.28, (1-\beta) = .57 \). A similar pattern was observed for TNF\( \alpha \) mRNA with differences in expression across experimental groups, \( F(2, 6) = 8.89, p = .042, \eta^2 = .86, (1-\beta) = .99 \) (see Figure 3b). Post-hoc analyses revealed differences between all groups, again with expression levels being lowest in controls, higher in isolated animals, and highest in instability animals: control vs. isolation, \( t(4) = 8.29, p = .01, d = 3.37, (1-\beta) = .87 \); control vs. instability, \( t(4) = 12.12, p < .01, d = 4.22, (1-\beta) = .96 \); isolation vs. instability, \( t(4) = 5.96, p = .03, d = 2.44, (1-\beta) = .60 \). Hippocampal mRNA levels for GFAP showed a similar pattern of group differences in expression, but in the opposite direction, \( F(2, 6) = 13.37, p = .006, \eta^2 = .82, (1-\beta) = .99 \). Post-hoc analyses revealed lower and lowest expression patterns in isolated and instability animals, respectively: control vs. isolation, \( t(4) = 7.51, p = .02, d = 2.91, (1-\beta) = .76 \); control vs. instability, \( t(4) = 9.48, p = .01, d = 3.58, (1-\beta) = .90 \); isolation vs. instability, \( t(4) = 4.09, p = .05, d = 1.79, (1-\beta) = .39 \) (see Figure 3c).

Effect of Social Stressors on Hair Corticosterone

Hair corticosterone concentrations were assessed by repeated-measures ANOVA, which revealed a significant group by time interaction, \( F(4, 63) = 3.47, p = .013, \eta^2 = .18, (1-\beta) = .89 \) (see Figure 4), indicating different patterns of corticosterone production over time between the three groups. In addition, the phase of the study predicted corticosterone concentrations, \( F(2, 63) = 15.41, p < .001, \eta^2 = .35, (1-\beta) = .99 \). However, the experimental group was not a significant predictor of corticosterone concentrations, \( F(2, 63) = 0.85, p = .42, \eta^2 = .03, (1-\beta) = .17 \). Post-hoc analyses revealed group differences in corticosterone concentrations during the stress period: control vs. isolation, \( t(16) = 2.76, p = .025, d = 1.08, (1-\beta) = .58 \); control vs. instability, \( t(16) = 3.98, p = .004, d = 1.49, (1-\beta) = .84 \), but no differences between groups during either the baseline or recovery periods, and no differences between instability and isolation animals at any period (all \( p > .25 \)).

Discussion

We predicted that both social instability and social isolation would have behavioral, physiological, and neural consequences in adult female mice, and that social instability would have amplified...
consequences. Specifically, we predicted that either social stressor would be associated with increases in hippocampal expression of proinflammatory mRNA, increases in the expression of certain anxiety-like behaviors, and increases in hair corticosterone. We further predicted that social instability would have more potent effects on each of these measures, as a result of being less predictable for the animals experiencing this social stressor. We observed significant increases in markers of neuroinflammation and reduced glial health in animals that experienced both social stressors, and significantly greater changes in animals that experienced social instability. We observed increased rearing behavior only in animals that experienced social instability. Lastly, we observed increased hair corticosterone concentrations in all animals that experienced chronic social stress.

Differences in hippocampal mRNA expression were observed between experimental groups and were greatest between animals that had experienced social instability and controls. Females that experienced social instability were characterized by decreases in a marker of astrocyte structural stability (i.e., GFAP) and increases in markers of neural inflammation (i.e., IL-1βR and TNFα). The decrease in hippocampal GFAP is consistent with other studies showing that chronic stress, and elevated glucocorticoids in particular, leads to a reduction of GFAP within the hippocampus and other areas of the brain (Liu et al., 2011; Tynan et al., 2013; Zhang, Zhao, & Wang, 2015). Glucocorticoids are known to modulate GFAP expression throughout the brain (O’Callaghan, Brinton, & McEwen, 1989), with prolonged corticosterone treatments causing a decrease in GFAP mRNA expression in the hippocampus and cerebral cortex (Nichols et al., 1990). Corticosterone treatment to adult rats also decreases GFAP protein levels in several brain regions whereas adrenalectomy increases the GFAP protein levels (O’Callaghan et al., 1989). Thus, glucocorticoids may be involved in the suppression of GFAP. Although the exact cause of astrocyte atrophy under stressful conditions is poorly understood, there is evidence to suggest that changes in astrocyte morphology and viability is a consequence of immune activation (Lee et al., 2013), specifically attributed to the cytokines TNF-alpha and IL-1beta (van Kralingen, Kho, Costa, Angel, & Graham, 2013), which are likely produced by glucocorticoid-activated microglia.
Comparing Chronic Social Stressors | Jarcho, Avery, Kornacker, Hollingshead, and Lo

Hippocampal inflammation, driven by the cytokines TNF-alpha and IL-1β, has been shown to play a key role in the pathogenesis of depression and anxiety (Abbott et al., 2015; Goshen et al., 2008). In our work, we detected an increase in hippocampal TNF-alpha and IL-1βR mRNA expression in mice subjected to psychosocial stressors. Consistent with previous reports, social defeat stress has been shown to elevate the expression of cytokines and their receptors in the hippocampus (Joana et al., 2016; McQuaid, Audet, Jacobson-Pick, & Anisman, 2015). Differences in stressor, strain, and sex can all independently vary brain cytokines levels (Deak et al., 2015; Gibb, Hayley, Poulter, & Anisman, 2011; Razzoli, Carboni, Andreoli, Ballottari, & Arban, 2011). Therefore, it is difficult to put the scale of our observations—a 35-fold increase in hippocampal IL-1βR expression and 62-fold increase in hippocampal TNF-alpha mRNA expression in social instability-stressed mice compared to controls—in the context of other social stressor studies that did not utilize the exact same variables. Although, to the best of our knowledge, there is no direct correlate for our present study, our observed numbers are comparable to the elevation in hippocampal cytokine expression that follows lipopolysaccharide (LPS) administration (Browne, O’Brien, Connor, Dinan, & Cryan, 2012; Czapski, Gajkowska, & Strosznajder, 2010; Henry et al., 2008; Shin et al., 2014).

Given these comparisons, the current study supported previous findings indicating the power of social stressors to promote inflammation in the hippocampus. Our mRNA results indicate that chronic social stress induces an unfavorable neural environment characterized by astrocyte dysfunction and increased neuroinflammation, both of which are implicated in the development of neurological dysfunction and behavioral symptoms associated with stress-related disorders like depression (Bortolato, Carvalho, Soczynska, Perini, & McIntyre, 2015; Cobb et al., 2016).

Importantly, differences in expression patterns were present not just between control and stressed animals, but also between animals experiencing the two types of social stress. This suggests that social instability and social isolation result in distinguishable hippocampal consequences. Coupled with the group differences in rearing behavior, these results indicate that isolation and instability are not experienced in the same way and that instability induces more substantial behavioral and neural consequences than isolation (Maslova, Bulygina, & Amstislavskaya, 2010).

Rearing behavior in the open field, a behavior typically associated with elevated anxiety in mice (Heisler et al., 1998), was exhibited differently between experimental groups. Females subjected to social instability displayed elevated rearing behavior when compared to either isolated animals or controls. A similar pattern was previously observed following social instability stress in this lab, also without other group differences in behavior (Jarcho et al., 2016). It is possible that rearing behavior in the open field is an anxiety-like behavior that is particularly sensitive to the unpredictable nature of social instability stress.

We observed increases in hair corticosterone in animals that experienced either form of social stress, in line with previous work investigating the effects of social stress on the production of glucocorticoids (McCormick, Merrick, Secen, & Helmreich, 2007; Saavedra-Rodríguez & Feig, 2013). Plasma levels of corticosterone consistently show 3- to 4-fold increases in response to acute social stressors, whereas hair corticosterone increases are less substantial, even in response to repeated social defeat (Yu et al., 2015). However, we did not find a difference in the degree of increase between animals experiencing social instability as
compared to those experiencing social isolation. We predicted a more substantial increase in hair corticosterone in animals that had experienced social instability than those that had experienced isolation, but observed nearly equal increases in both groups.

The hair corticosterone results combined with the group differences in behavioral and neural markers begs the question of why the experimental groups differed on certain measures of stress and not on the primary measure of HPA activity. One possible explanation might be that there is a ceiling effect of corticosterone deposition in the hair. However, previous work in rats suggest that this is not the case (Scorrano et al., 2015). Another explanation is that, although the HPA response was nearly equivalent in these two groups, other physiological systems are impacted by chronic stress, and may have varying sensitivities to specific chronic stress paradigms (Capitanio & Cole, 2015). That is, chronic social stress, in any form, might increase HPA activity, but the added unpredictability or lack of control associated with social instability (as opposed to isolation, which is unchanging) may more potently increase inflammation in the brain and may be more likely to affect behavior. An additional possibility is that, although the cumulative HPA activity did not differ between the two stress groups, the specific pattern of HPA activity and corticosterone production did. That is, perhaps diurnal patterns were flatter in subjects experiencing social instability than in those experiencing social isolation.

In humans, flattened diurnal cortisol release was observed in individuals who previously experienced anxiety or major depressive disorder (Doane et al., 2013; Jarcho, Slavich, Tylorova-Stein, Wolkowitz, & Burke, 2013), who are battling metastatic breast cancer (Abercrombie et al., 2004), or who endorse higher ratings of loneliness (Doane & Adam, 2010). Similar consequences of diurnal rhythmicity have been observed in rodents. Experimentally flattening the diurnal corticosterone rhythm in mice results in increased expression of anxiety and depression like behaviors in mice (Murray, Smith, & Hutson, 2008), and a similar manipulation in rats resulted in altered hippocampal mRNA expression, demonstrating a possible link between HPA activity, anxiety- and depression-like behaviors, and hippocampal protein expression (Cacioppo et al., 2015; Gartside, Leitch, McQuade, & Swarbrick, 2003; Miller, Maletic, & Raison, 2009). We are unable to assess glucocorticoid reactivity or diurnal patterns in hair samples, but future work will add plasma sampling of corticosterone to address these questions directly.

An alternative explanation for the hair corticosterone patterns that we observed is that the elevations in corticosterone were not a result of the housing paradigms being perceived as stressful, but instead that the two experimental conditions (i.e., isolation and instability) were associated with elevated physical activity patterns. It is certainly true that increased physical activity can increase plasma glucocorticoid concentrations (Few, 1974; Girard & Garland, 2002; Stupnicki & Obminski, 1992), although voluntary exercise has also been shown to mitigate the expected increase in plasma glucocorticoids and downstream health consequences in animals and humans experiencing chronic stress (Adlard & Cotman, 2004; Puterman et al., 2010; Sasse et al., 2008). We cannot rule this possibility out because we did not collect behavioral data on the mice while they were in their home cages. However, it seems highly unlikely that both of these housing paradigms would be associated with increases in physical activity. It should also be noted that, although we did not quantify behavior in the home cages, previous observations in female rats did not detect changes in home-cage behaviors as a result of prolonged isolation stress (McCormick et al., 2007).

Based on previous work investigating the effect of social stressors on behavioral expression of anxiety and depression (Kaushal, Nair, Gozal, & Ramesh, 2012; Kinn Rød et al., 2012; Liu et al., 2013; Reiss, Wolter-Sutter, Krezel, & Ouagazzal, 2007; Treit, 1985; Watt et al., 2009), we expected, but did not observe group differences in the open field and elevated plus maze in the amount of time spent in the center/perimeter or open/closed arms, respectively. Our findings indicate that, although physiological and neural responses were elicited, the primary behavioral measures associated with anxiety (i.e., time in the perimeter of the open field and the closed arms of the elevated plus maze) were not significantly affected by these forms of social stress. It should be noted that previous work in this lab demonstrated a similar lack of group differences on these measures (Jarcho et al., 2016), and other authors did not detect group differences on the forced swim test (Herzog et al., 2009). It is possible that, given the social nature of these stressors, behavioral expressions of anxiety would only have been observable in a more social setting. That is, this lack of observable differences may reflect the nature of the testing apparatuses used.
Comparing Chronic Social Stressors

not the actual anxiety levels of the mice (Ennaceur & Chazot, 2016). Despite this possibility, group differences on these apparatuses were expected. It is possible that more socially relevant behavioral measures (e.g., social withdrawal) might have revealed significant group differences.

The implications of these findings are limited by certain aspects of the current study. Primarily, the number of animals (n = 9 per experimental group) used in the study was rather small, particularly in our investigation of hippocampal mRNA expression, because only three animals were sacrificed from each group. Future investigations should attempt to increase sample sizes, even if elimination of certain measures that were collected in the present study is necessary for feasibility. A second limitation of the current study is that it focused exclusively on female mice. Females were used in the current study because they show a greater response to psychosocial stress (Haller et al., 1999) and women report higher rates of anxiety disorders than men (Bangasser & Valentino, 2014; McLean et al., 2011).

However, to increase the translational value of these findings, future investigations should include both females and males in order to directly observe sex differences that may be relevant to differential rates of stress-induced anxiety disorders in humans. A third limitation is the limited behavioral measures we quantified. Future studies should include additional behavioral tests, particularly those that specifically target indicators of social anxiety (e.g., social withdrawal tests). Lastly, we are unable to determine causality across our dependent variables. For example, it is possible that the changes in hippocampal mRNA were a direct result of social stress. However, it is equally possible that the mRNA effect was mediated by changes in HPA activity. Future studies should attempt to disentangle these variables to determine causality in order to better inform treatment strategies.

These findings support previous work indicating that social stressors are potent enough to elicit behavioral, physiological, and neural responses in adult female mice. In addition, they further support the initial findings that these stressors can induce physiological changes that are detectable in mouse hair, and that the corticosterone concentrations are responsive to the onset and termination of a social stressor. These data also indicate that, although the hair corticosterone responses to both social isolation and instability were similar, the behavioral and neural consequences of these two forms of social stress were quite different. These subtle differences in the form of social stress and the consequences associated with them may be translatable to different sources of social stress in humans and the multitude of mood disorders and other psychological consequences that may result. Additional work is needed to establish a more concrete causal relationship between types of social stress and behavioral, physiological, and neural consequences.

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Comparing Chronic Social Stressors | Jarcho, Avery, Kornacker, Hollingshead, and Lo


Mobile Phones and Physical Pain
Monica N. Van Wilpe and Marc A. Sestir*, University of Central Arkansas; Lindsay A. Kennedy*, Hendrix College

ABSTRACT. Mobile phones and their psychological effects have been a point of interest for researchers in recent years. Although research has assessed the effects of active mobile phone use on pain management (e.g., Wiederhold, Gao, Kong, & Wiederhold, 2014), most mobile phone interaction is passive. If personal phones are associated with social support, the mere presence/absence of a mobile phone may influence pain responses. Our study aimed to test this effect. A sample of 100 were randomly assigned to hold a mobile phone or television remote control while a cold pressor task was used to ethically induce acute pain. During the task, pain threshold and tolerance were recorded. Afterward, subjective pain, social support, current emotions, perceived mobile phone attachment, and mobile phone usage were also measured. The mobile phone group reported marginally higher pain thresholds, $F(4, 95) = 0.47, p = .76, R^2 = .02$, and showed marginally greater pain tolerance, $F(4, 95) = 1.98, p = .10, R^2 = .08$, than the remote control group. The effects did not rise to the level of statistical significance. Interestingly, the remote control group scored marginally higher in some negative emotions compared to the mobile phone group. This research lays the groundwork for future research on the effects that increasingly routine interactions with mobile phones have on people, often without their knowledge.
can be seen between social and physical pain. The pain overlap theory (Eisenberger & Lieberman, 2004) suggests that there is a shared processing system between physical and social pain due to evolutionary processes, developed in order to prevent social separation that could be detrimental to developing mammals that require a mother’s care for survival. Furthermore, social and physical pain can cause shared psychological consequences of feeling ignored and excluded (ostracism), and increase desire to aggress (Riva, Wirth, & Williams, 2011). In turn, satisfying social needs could increase pain tolerance because some of the negative psychological effects of physical pain would be counteracted (Riva et al., 2011). Due to their built-in social capabilities, mobile phones may pose as a good tool to increase pain tolerance.

Mobile phones have been useful in previous studies to aid in physical pain and stress management via different applications such as virtual reality (Wiederhold, Gao, Kong, & Wiederhold, 2014), mobile-delivered narratives (Grassi, Gaggioli, & Riva, 2011), and smartphone diaries (Garcia-Palacios et al., 2013). However, little research has been conducted to test the effects of the mere presence of mobile phones on physical pain. If mobile phones can elicit the feeling of social inclusion (Barlott et al., 2014), and if social inclusion can offset physical pain (Riva et al., 2011), then the presence of a mobile phone during a physically painful situation could potentially increase pain threshold and tolerance. In our study, we tested whether the presence of a mobile phone would affect pain tolerance and threshold during participation in a cold pressor task. We hypothesized that participants in the presence of their personal mobile phone would show a reduction in the severity of pain experiences, with both higher thresholds of pain onset and tolerance for pain than participants not in the presence of their mobile phone. We also predicted that the presence of mobile phones would decrease self-reported pain intensity and degree of negative emotional experience, relative to their absence. Finally, we predicted that these differences in pain experiences between groups would be mediated by differences in current perceptions of social support.

Method

Participants
The participants in this study were 100 students, 24 men and 76 women at a university in the Southern United States. Nearly all (95%) were between 18–24 years of age, with no participant older than 30 (Mage = 20.18 years, SD = 2.41). Participants were told the study assessed the effects of wireless electronic signals on various tasks, and they received course credit and $10 in exchange for their participation in the study. To assure participant safety, individuals who answered “yes” to having a history of cardiovascular disorders, fainting or seizure disorders, Raynaud’s syndrome, or frostbite were not permitted to participate in the study. Similarly, any individuals with injuries such as an open cut, sore, or fracture to their nondominant hand were ineligible to participate. No individuals were excluded due to reported health issues.

Materials

Cold pressor task. The cold pressor immersion task has been repeatedly used in psychological research as means to produce acute pain in a safe manner (e.g., Mitchell, MacDonald, & Brodie, 2004; Uysal & Lu, 2011). During the task, participants placed their nondominant hand, palm up, in a cold bath of circulating water maintained at a temperature of 5.5°C. The water temperature was controlled by a refrigeration unit (Techne RU-200 Dip Cooler) and a thermo regulator (Techne Model TE10D). Participants were instructed to keep their hand in the water for as long as they could, with a maximum time of 5 minutes. The procedure used to administer the cold pressor task was mirrored after the procedures reported by Uysal and Lu (2011).

Pain measures. During the cold pressor task, participants were instructed to indicate when they first felt pain by saying, “now.” They were also instructed to keep their hand in the water as long as they could before removing it. The time between immersion of the participants’ hands and when they said, “now” was recorded as their pain threshold score; time between immersion of the participants’ hands and when they removed their hands was recorded as their pain tolerance score (Uysal & Lu, 2011). After immersion, participants were also asked to rate their overall pain experience during the cold pressor task on a 10-point scale, ranging from 0 (no pain) to 10 (severe pain).

Social support. To assess current feelings of social support, participants completed the Multidimensional Scale of Perceived Social Support (Zimet, Dahlem, Zimet, & Farley, 1988). This scale consists of 12 statements such as “My friends really try to help me.” Participants indicated their agreement with each statement on a 7-point scale, ranging from 1 (very strongly disagree) to 7 (very strongly agree). The measure had strong internal reliability,
Mobile Phones and Pain | Van Wilpe, Sestir, and Kennedy

Participants

Participants completed the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) to report on their current feelings. The measure consists of 20 emotion items (e.g., interested, afraid, alert), 10 positive, and 10 negative. Participants chose a number between 1 (very slightly or not at all) to 5 (extremely) that indicated the extent to which they currently felt each emotion. The measure also showed good internal reliability for each subscale, with a Cronbach’s $\alpha = .863$ for positive emotion items and .746 for negative emotion items for the sample.

Mobile phone attachment. Participants responded to five items to measure the amount of attachment they feel toward their mobile phones. This scale includes statements such as, “I would feel lost if I didn’t have a cell phone” (Weller, Dieckmann, Mauro, & Slovic, 2010; Weller, Shackelford, Dieckmann, & Slovic, 2013). Participants were instructed to rate how much they agreed with each statement, ranging from 1 (strongly disagree) to 5 (strongly agree). The measure also showed strong good internal reliability, with a Cronbach’s $\alpha = .808$ for the sample.

Mobile phone usage. Participants were asked to supply information about the make and model of their mobile phone, how long they have owned that mobile phone, and how they typically use their mobile phone (making phone calls, sending text messages, e-mailing, social media, and/or keeping track of their schedule).

Procedure

Experimentation commenced following institutional review board approval (Protocol #16-248). Upon entering the lab, participation eligibility was confirmed. Mobile phone participants were then reminded that the study assessed the effects of wireless electronic signals and that they had been reminded that the study assessed the effects of wireless electronic signals and that they had been randomly assigned to either hold their mobile phone or a television remote control during the first part of the experiment. Those in the remote control group were instructed to place their mobile phones in an envelope that was moved to an adjoining research room for the duration of the study.

The experimenter then provided instructions for the cold pressor task and had the participant restate them in order to make sure that the procedure was clearly understood. During the cold pressor task, the participant placed his/her dominant hand inside of a sheet protector next to the water bath that contained either their personal mobile phone (experimental condition) or a remote control (control condition). The participant was instructed to keep a hand on the assigned device during the entirety of the cold pressor task. Participants then completed the cold pressor task.

After the cold pressor task, participants were given 2 minutes to relax before the questionnaire packet was presented. Participants in the mobile phone condition were instructed to leave their mobile phones in the sleeve next to the water bath for the remainder of the study. After resting, participants first rated their overall pain before completing the measures of social support, current affect, perceived mobile phone attachment, and mobile phone usage. Participants were then asked to provide their sex and age in an open-response format. Participants in the remote control condition were then given back their mobile phones. Finally, all participants were debriefed and paid $10 for their participation.

Results

Descriptive statistics for all dependent measures—both overall and by mobile phone condition—are presented in Table 1. We hypothesized that individuals with their mobile phone present would have higher pain threshold and pain tolerance scores, and lower overall pain ratings, than individuals without their mobile phone present. We used three multiple regression models to test these hypotheses, controlling for mobile phone, sex, age (mean centered), and level of mobile phone attachment (mean centered). The overall models did not explain a significant amount of variance in pain threshold scores, $F(4, 95) = 0.47, p = .76, R^2 = .02$, pain tolerance scores, $F(4, 95) = 1.98, p = .10, R^2 = .08$, or self-reported pain, $F(4, 91) = 0.27, p = .90, R^2 = .01$. The full results of each model are presented in Table 2. Across all models, the only significant effect to emerge was a main effect of sex on pain tolerance scores, such that men showed a greater tolerance for pain than women, $b = .4732, SE = 21.52, p = .03$.

Importantly, mobile phone condition did not significantly predict any of the three focal dependent measures: threshold, $b = 10.67, SE = 8.48, p = .21$; tolerance, $b = 16.9, SE = 18.2, p = .36$; self-reported pain, $b = -1.45, SE = 0.32, p = .05$. Independent-samples $t$ tests were also used to test the simple relationships between mobile phone condition and our three focal dependent measures, but no significant differences emerged.
between groups: threshold, $t(98) = -1.23, p = .22$; tolerance, $t(98) = -1.12, p = .27$; self-reported pain, $t(94) = 0.51, p = .61$.

A model was also tested that predicted perceived social support from mobile phone condition, mobile phone attachment, sex, and age. Again, the overall model did not explain a significant amount of variance in perceived social support scores, $R(4, 95) = 0.86, p = .49$, $R^2 = .04$, with no significant main effect of mobile phone condition ($p = .76$). The full results from this analysis are also presented in Table 2. Because no significant relationships emerged between the independent variable and any pain measure, tests for mediation by social support were not conducted.

For exploratory purposes, independent-samples $t$ tests were conducted to compare feelings of negative emotions and positive emotions across mobile phone conditions. The two conditions did not significantly differ on overall levels of negative emotions, $t(97) = 1.47, p = .15, d = 0.29, 95\% CI = [-0.04, 0.26]$, or positive emotions, $t(98) = -0.43, p = .67, d = 0.09, 95\% CI = [-0.41, 0.26]$. Mean overall levels of negative and positive emotions are presented in Table 1.

Additional mobile phone exploratory analyses were also conducted on individual PANAS items, which revealed marginal mobile phone group differences on four individual negative emotion items. The mobile phone absent group reported feeling marginally more scared ($M = 1.28, SD = 0.54$) than the mobile phone present group ($M = 1.12, SD = 0.33$), $t(98) = 1.80, p = .08, d = 0.36, 95\% CI = [-0.02, 0.34]$; marginally more hostile ($M = 1.28, SD = 0.61$) than the mobile phone present group ($M = 1.10, SD = 0.36$), $t(98) = 1.80, p = .08, d = 0.36, 95\% CI = [-0.02, 0.38]$; marginally more ashamed ($M = 1.20, SD = 0.50$) than the mobile phone present group ($M = 1.06, SD = 0.24$), $t(98) = 1.80, p = .08, d = 0.36, 95\% CI = [-0.01, 0.29]$; and marginally more afraid ($M = 1.26, SD = 0.49$) than the mobile phone present group ($M = 1.10, SD = 0.36$), $t(98) = 1.86, p = .07, d = 0.37, 95\% CI = [-0.01, 0.33]$. No other individual PANAS items differed significantly across groups.

### Discussion

The primary purpose of this study was to test the effects of mobile phone presence and absence on the intensity of physical pain experiences. Additionally, we examined the perceived social support and current emotions experienced by participants during the trial. Our hypothesis that individuals with mobile phones present would have higher pain threshold and pain tolerance scores than individuals without their mobile phone present was not supported by the data. However, the condition means consistently differed in the predicted directions, with the mobile phone present condition displaying higher pain threshold and tolerance scores and lower overall pain scores than the mobile phone absent condition. These trends, however, were combined with a large amount of variability in both pain threshold and pain tolerance scores, suggesting that individual differences in pain experiences need to be better accounted for in future work.

The study also produced interesting findings on the emotion measures that could lead to useful insight. Participants in the mobile phone absent group scored marginally higher in the negative emotions scared (a state of fear), afraid (the feeling of fear), hostile, and ashamed compared to the mobile phone present group. These emotions could have been due to the fact that participants felt exposed and anxious without their mobile phones (Cheever, Rosen, Carrier, & Chavez, 2014). Similarly, Hoffner and Lee (2015) found that mobile phone use could lead to alleviation of...
negative emotions; stripping people of their mobile phones could, in turn, evoke those negative emotions. It could also be argued that having a mobile phone present could serve as a safeguard against such negative emotions. In order to test this in future studies, a control group that performs a neutral, nonpain inducing task with phones removed could be added to the two original pain conditions. Such a condition could help isolate and identify the independent effect of phone removal on negative emotions.

Another interesting, but secondary, finding involved the relationship between pain tolerance and sex. Consistent with previous research on pain tolerance (Schmitz, Vierhaus, & Lohaus, 2012; Snyder et al., 2005), men were found to be more tolerant to pain. This provides additional support for sex differences on physical pain measures and reinforces the need to statistically control for this difference in future research.

A possible reason why the results did not come out as predicted is that the participants’ mobile phones remained in the plastic sleeve during the questionnaire portion of the experiment. This could have influenced questionnaire results due to the phones not being as easily accessible as they were during the cold pressor task. The lack of accessibility could have affected how participants responded to the questionnaire because any social comfort provided by physical contact with the phone during the cold pressor task was removed while the measures were completed. However, this would not account for the lack of group differences on the two initial pain measures, which were assessed before participants withdrew their hands from the sleeve containing either the phone or the remote. In the future, it may be beneficial to conduct a similar study wherein the participants’ phones remain accessible throughout the entire study, provided they are in the cell phone present group.

Another possible limitation is that, due to an equipment issue, the water temperature used was 5.5 degrees Celsius, instead of the originally intended 5 degrees Celsius (as was used by Uysal & Lu, 2011). Prior protocols (e.g., Mitchell et al., 2004) have used temperatures as low as 1 degree Celsius for similar cold pressor tasks. Using a lower temperature might have produced more physical discomfort, reduced variability in tolerance, and increased the likelihood of a significant difference between conditions. A lower water temperature should be utilized in possible replication studies.

In addition to addressing these methodological concerns, future research should also measure anxiety in regard to mobile phone presence and absence. We made an assumption that anxiety played a role in the negative behaviors displayed by participants in the mobile phone absent condition, but a specific measure for anxiety would be needed to support this claim. There is potential for mobile phones to serve as a mild anxiolytic if these findings are supportive of our prediction. Future research could also move in the direction of testing the relationship between mobile phones and chronic pain. Our study and many others

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**TABLE 2**

Full Results for Regression Analyses

<table>
<thead>
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<td>Age</td>
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</tr>
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</table>

*Note: Condition was coded as 0 = mobile phone absent and 1 = mobile phone present. Attachment refers to level of attachment to one’s mobile phone. Sex was coded as 0 = men and 1 = women. Both attachment and age were mean centered.*

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1Because a cell phone manipulation may differentially impact individuals based on level of cell phone attachment, models were also tested that included the interaction term between cell phone condition and cell phone attachment. However, inclusion of this term did not significantly improve any models (all changes in $R^2 < .015$, all $F < .021$). Therefore, cell phone attachment was only included as a covariate in the presented models.

2Dropping outliers present for pain threshold and pain tolerance did not change the pattern of findings presented in this paragraph.
measured acute pain, and although knowledge about acute pain is valuable, according to the 2012 National Health Interview Survey, around 25.3 million Americans suffer from chronic pain (National Institutes of Health National Center for Complementary and Integrative Health, 2015). Studying how mobile phones affect chronic pain, whether positively or negatively, could potentially benefit these millions of Americans. For future tests of these specific relationships, efforts to increase sample size (particularly of men) and adequately control for individual differences in pain responses could reveal statistically significant effects related to mobile phones. Having a larger sample of men would allow for between- and within-sex comparisons, and a pretet of initial pain tolerance could help control for individual differences in pain sensitivity. Additionally, race/ethnicity of participants was not measured, leaving open the possibility of meaningful racial or ethnicity differences. Future research should also measure and assess this demographic factor. Moreover, due to the fact that this information is not widely studied yet, effect size and power are difficult to calculate. If the effect size is small to moderate the study may be underpowered and this poses another limitation.

In a world that is becoming increasingly reliant on mobile phone technologies, this study is a stepping-stone in understanding more about how mobile devices are affecting the general population, sometimes even without people’s knowledge. This research adds to the ever-growing literature of coping mechanisms underlying mobile phone use. This study shows that mobile phones can yield psychological consequences when taken away (i.e., fear, hostility, etc.), but future research should further explore their potential psychological benefits. With their vast capabilities and universal nature, mobile phones could be an extremely useful tool in the pursuit of a collective well-being.

References

Author Note. Monica N. Van Wilpe, University of Central Arkansas; Marc. A. Sestir, University of Central Arkansas; Lindsay A. Kennedy, University of Central Arkansas. Special thanks toPsi Chi journal reviewers for their support.
Correspondence concerning this article should be addressed to Monica N. Van Wilpe, University of Central Arkansas, 1222 S. 55th St., Rogers, AR 72758. E-mail: nvanwilpe@gmail.com
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DR. NAHID AZIZ
Associate Professor at the American School of Professional Psychology at Argosy University | Northern Virginia

Dr. Aziz is committed to mentorship, training, and addressing issues relevant to the ethnic and racial diversity.

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