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Didgeridoo Sound Meditation for Stress Reduction and Mood Enhancement in Undergraduates: A Randomized Controlled Trial

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Abstract

Background: College students report feeling frequently stressed, which adversely impacts health. Meditation is one effective method for reducing stress, but program length and required effort are potential obstacles. Research on sound meditation, involving focused listening to sounds, is nascent but may appeal to undergraduates. The effects of listening to didgeridoo, an Australian wind instrument producing a low, resonant, droning sound, have not been studied.

Objective: This study compared the effect of a 30-minute didgeridoo sound meditation versus silent meditation with focus on one's breath on acute self-perceived stress and mood in undergraduates without prior meditation experience.

Methods: Seventy-four undergraduates were randomized to 2 interventions: (1) didgeridoo meditation (n = 40) performed live by a musician or (2) silent meditation (n = 34) taught by a meditation instructor. Immediate pre–post effects of the session were examined using the 4-Dimension Mood Scale and an item assessing acute self-perceived stress. Intervention acceptability was assessed postintervention.

Results: Two-way mixed analyses of variance were performed. Both groups reported significantly increased relaxation after meditation (Group D, $P = .0001$ and Group S, $P = .0005$). Both groups reported decreased negative arousal (Group D, $P = .02$ and Group S, $P = .02$), energy (Group D, $P = .0001$ and Group S, $P = .003$), tiredness (Group D, $P = .0001$ and Group S, $P = .005$), and acute stress (Group D, $P = .0001$ and Group S, $P = .0007$). Group Didgeridoo experienced significantly more relaxation ($P = .01$) and less acute stress ($P = .03$) than Group Silent. Fifty-three percent of silent participants and 80% of didgeridoo participants agreed that they would attend that type of meditation again. Forty-seven percent of silent participants and 80% of didgeridoo participants enjoyed the meditation.

Conclusion: Didgeridoo sound meditation is as effective as silent meditation for decreasing self-perceived negative arousal, tiredness, and energy and more effective than silent meditation for relaxation and acute stress in undergraduates. Didgeridoo meditation participants reported higher levels of enjoyment and higher likelihood of attending another session. Further investigation into didgeridoo and sound meditation is warranted.

Keywords

didgeridoo, sound meditation, sound healing, sound therapy, meditation, stress, stress reduction, mood, undergraduates, college students

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Background

College students are a healthy adult population prone to stress. Over 50% of undergraduate college students report feeling frequent stress,[1] which can adversely affect mental and physical health.[2] In 2015, 30% of students reported that their academic performance was impacted by stress.[3] Meditation has been shown to reduce stress in college students and is one proposed,

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effective method of ameliorating stress and improving mood.[4–6] However, the best types and length of meditation interventions for stress management in students are unknown.

Meditation, defined as "the act of engaging in mental exercise to reach a heightened level of spiritual awareness or mindfulness,"[7] is a popular holistic self-care practice most commonly sought for stress management, emotional regulation, and overall wellness.[8] According to the Centers for Disease Control and Prevention (CDC), meditation is 1 of the top 3 most commonly used wellness activities in America and its use has increased more than threefold among US adults within the last 5 years.[7]

Meditation is practiced in many cultures and traditions and includes a variety of techniques and approaches, including Zen Meditation, Mantra Meditation, Transcendental Meditation, Mindfulness Meditation, Vipassana Meditation, Loving Kindness Meditation, and Contemplative Meditation, to name a few.[7,8] Techniques share a common theme of paying attention to a specific object (eg, one's breath, thoughts, feelings, sensory stimuli, repeated word or phrase).[8] This core meditation characteristic, with or without spiritual or religious association, has also been referred to as practicing present-centered awareness, attending, and mindfulness.[8] Research has shown benefit from various forms of meditation, including lowered perceived stress,[9] and decreased pain,[10] anxiety,[11] and depression.[10]

Traditionally, meditation involves lengthy sessions of disciplined practice, often over many weeks, months, or years. For example, 1 popular standardized meditation program, Mindfulness-Based Stress Reduction (MBSR), is typically taught as an 8-week, 2.5 hour per week course, plus a Saturday retreat, with at least 45 minutes of daily practice recommended.[4] Multiple studies have shown benefits from intensive, substantial amounts of meditation practice. For example, training in MBSR has been shown to lower stress,[12] enhance mood,[13] and ameliorate chronic pain.[10]

Although lengthy meditation sessions and years of practice are known to be beneficial, there is also evidence of benefits from shorter periods of meditation.[14,15] For example, 1 study found that four 1-h mantra meditation sessions improved negative mood and stress.[14] Zeidan and colleagues found that brief mindfulness training (20 min per day for 3 consecutive days) was effective in reducing negative mood, depression, fatigue, confusion, and heart rate.[5]

An important consideration for would-be or beginning meditators is the potential obstacles to meditation, in terms of time limitations, as well as feelings of frustration and irritation, which may lead to their abandoning the practice before they have learned how to handle difficulties or to integrate their meditation practice into their daily lives.[16,17] In fact, it is possible that the demands of lengthy meditation sessions or programs may themselves become a stressor to participants.

Sound Healing and Sound Meditation

Music and sound have been used since time immemorial for therapeutic, sociocultural, and spiritual purposes. Historically, traditional healers or shamans have used sound, particularly repetitive sounds, to enter a trance or state of altered consciousness.[18,19] Tibetan monks have been known to use sound in their personal meditation practices.[20] Moreover, music therapy is a widely researched modality that has shown benefit for various mental and physical health conditions.[21–23] However, a thorough review of music therapy is outside the scope of this article. This study focuses on sound meditation, for which research is still nascent.

Sound meditation is a form of meditation that involves focused concentration on repetitive sounds. The source of the sound can be internal (eg, one's voice) or external (eg, another voice or instrument). There is a paucity of research in this area.[15] A study by Milbury et al. describes Tibetan sound meditation as the practice of producing meditative sounds while maintaining focused concentration and engaging in cognitive tasks.[24] It appears that this form of sound meditation uses sound that is produced with one's own voice. Another sound meditation study found reductions in tension and anxiety after subjects listened to a combination of instruments including singing bowls, gongs, bells, cymbals, and didgeridoo.[15] Singing bowls are a type of bowl-shaped bell that can be played by tapping or rubbing a mallet on the bowl, which is made from materials such as crystal or metal alloy.[15] Didgeridoo is an Australian instrument, which will be discussed later.

Certain sonic characteristics have been associated with inducing a trance-like state, including repetition[25] (eg, of pitch, rhythm, and/or motif), slower tempo, lower pitch or low frequency,[26] and tonal sound.[18,19] Perceived relaxation has also been elicited by sedative music described as "melodious, delicate, harmonic, and romantic" as well as "self-selected music,"[27] which means one's personal sound or musical preference based on background and experiences. Studies have shown that relaxing, sedative music can affect heart rate and heart rate variability by activating the parasympathetic nervous system.[27,28] Meditation that involves listening to relaxing sound may prove to be a holistic, low-cost, non-invasive therapy for stress management.[7,28]

What Is Didgeridoo?

Didgeridoo, also known as didjeridu or yidaki, is an ancient tribal instrument from Australia (Figure 1).

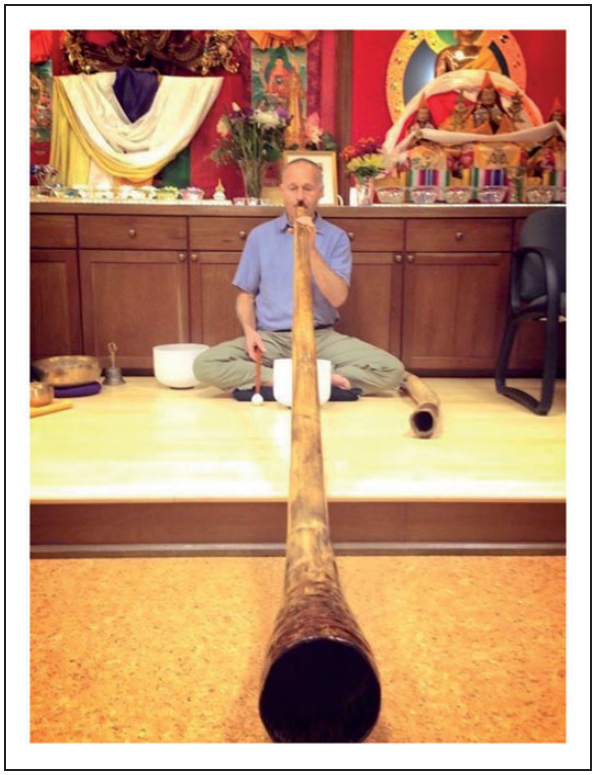

Figure 1. Musician Daran Wallman Playing Didgeridoo Instrument (Used With Permission From Daran Wallman).

It is a long, hollow, usually wooden tube that is blown into like a horn.[29] It produces a distinctive and continuous low-pitched drone (frequency range 55 to 80 Hz).[30] Its sound is resonant, vibratory, and meditative in nature. Variations of rhythm can be produced by manipulation of the player's oral cavity.[31]

Traditional didgeridoos are made of Eucalyptus tree trunks or branches, hollowed by termites.[29,32] Indigenous Australian people or Aborigines are said to have used this wind instrument for sound healing and ceremonial purposes for tens of thousands of years.[20,29] Didgeridoo has become symbolic of spirituality and nature due to its simplistic design yet wealth of sonic possibilities.[33] Within recent decades, didgeridoo use has spread across the globe due to tourism and instrument popularity.[34]

Research has shown that playing didgeridoo is therapeutic for obstructive sleep apnea[35] and asthma.[29] In addition, playing the didgeridoo was found to be enjoyable among high school students.[29] However, the effects of listening to didgeridoo have not previously been studied.

Studies have shown that meditation is more effective for well-being than sitting in silence.[36,37] Given the relaxing nature of sound therapy, it is likely that listening to sound in meditation is more relaxing than meditation alone. This study examined the effect of sound meditation as compared to silent meditation (control) on acute stress and mood in undergraduate students. The sound meditation involved participants listening to the sounds of the didgeridoo instrument. The authors hypothesized that didgeridoo sound meditation would be at least as effective as silent meditation in lowering acute stress and improving mood, and that sound meditation would induce a more relaxed state than silent meditation in inexperienced meditators.

Methods

Design

The Institutional Review Board at the University of North Carolina provided approval for this study (IRB 15-3138). Undergraduates were recruited via flyers, listserv, and social media to take a Qualtrics screening survey where participants provided informed consent. Participants were told that the study was investigating the effects of different types of meditation on stress management in undergraduate students, and that they would be randomly placed in either a sound meditation or a silent meditation group and would be asked to attend one 30-minute meditation session. Criteria for inclusion included the following: (1) enrolled undergraduate at the University of North Carolina, (2) 18 years or older, and (3) having no current meditation practice (defined as less than 15 min a week). Participants were excluded if they failed to meet these criteria as well as if they met these criteria but were unable to attend the group intervention.

Eligible subjects' information was entered into an encrypted Excel file and deidentified by a coinvestigator. Deidentified subjects were assigned study IDs and randomized by the coinvestigator using an online random number generator to one of the following groups: (1) Group D (Didgeridoo Sound Meditation) or (2) Group S (Silent Meditation, control group). Email confirmation and reminders were sent, but the participants were blinded to group assignment. Students were informed of their group assignment immediately before giving written informed consent and participating in the intervention. Only the coinvestigator who performed the randomization had access to the randomization list and all data to be analyzed were deidentified. All investigators conducting data analysis were blinded to group assignment.

The study was conducted at 1 location: the University of North Carolina at Chapel Hill. The study was conducted on 3 occasions (Groups 1, 2, and 3), in order to recruit sufficient participants. The 2 forms of meditation were administered simultaneously in 2 separate rooms located in the Student Center based on group. Other than 1 investigator who acted as the facilitator for the silent meditation intervention, the investigators were not present in the room during the intervention.

Paper and pencil questionnaires were given to participants by research assistants both before and after the

intervention. Two questionnaires were completed immediately before and after each 30-minute meditation intervention, including the 4-Dimension Mood Scale (4DMS)[13,38–40] and a single-item assessment of acute self-perceived stress. Immediately postintervention, participants were asked to complete 2 additional single-item measures to assess intervention acceptability. These measures are described later in greater detail.

Intervention

Group D: A professional musician played the didgeridoo for 30 minutes to participants, who were briefly instructed to sit upright in a chair and maintain a comfortable yet attentive position. The following instructions were given: "Now we will begin the meditation. Close your eyes. Gently begin to focus on the sounds and vibrations of the didgeridoo and continue to focus only on the sounds and vibrations of the didgeridoo." The musician read these instructions from a script and verbally reminded participants at the 5-minute, 10-minute, and 20-minute mark with the following prompt: "Now continue to focus on the sounds and vibrations of the didgeridoo; if your mind has wandered, gently bring it back to the present moment to focus only on the sounds and vibrations of the didgeridoo." There was only ambient light in the room and participants were verbally instructed when the meditation concluded.

Group S: An experienced meditation instructor led a silent meditation for 30 minutes. Participants were briefly instructed to sit upright in a chair and maintain a comfortable yet attentive position. The following instructions were given: "Now we will begin the meditation. Close your eyes. Gently begin to focus on your breathing, noticing how it feels when you breathe in and then how it feels when you breathe out." (*Pause*) "Now, continue to focus only on your breathing." The meditation instructor read these instructions from a script and verbally reminded the participants at the 5-minute, 10-minute, and 20-minute mark with the following prompt: "Now continue to focus on your breathing; if your mind has wandered, gently bring it back to the present moment to focus on your breathing." There was only ambient light in the room, and participants were verbally instructed when the meditation concluded.

Measures

4-Dimension Mood Scale. The 20-item total 4DMS is a validated scale measuring 4 indices of mood, which has been used in previous studies on well-being in college students.[13,38,40] The mood dimensions were grouped according to the following: "Relaxation" (eg, Peaceful and Tranquil); "Tiredness" (eg, Exhausted and Weary); "Negative Arousal" (eg, Irritable and Upset); "Energy" (eg, Lively and Active). The 4DMS asks subjects "Please indicate to what extent each adjective describes *how you feel right now*, that is, *at this present moment*. For each adjective, please *circle* your response" (eg, Peaceful: Not at all, A little, Moderately, Quite a bit, or Extremely). Responses were quantified as follows: Not at all = 0, A little = 1, Moderately = 2, Quite a bit = 3 and Extremely = 4). Scores were computed by summing the items within each dimension and calculating the average. Thus, possible scores for each dimension ranged from 0 to 4.

Single-Item Self-Assessment of Acute Stress

Students were given a 1-item question assessing their acute stress following a Likert-type scale format (ie, "How stressed do you feel *right now* (*at this present moment*)?" 0 = Not stressed at all to 6 = Extremely stressed). The item was devised by the authors for use in this study.

Postintervention Measures of Intervention Acceptability

An item was administered at the postsurvey to assess likelihood of attending again (ie, "I would attend a didgeridoo meditation again" versus "I would attend a silent meditation again." Likert-type scale responses ranged from 1 = Strongly Agree to 7 = Strongly Disagree. Strongly Agree, Agree, and Somewhat Agree were combined and labeled "Agree," while Strongly Disagree, Disagree, and Somewhat Disagree were combined and labeled as "Disagree," creating a dichotomous variable.

A second item was administered at the postsurvey to assess enjoyment of the intervention (ie, "I enjoyed the didgeridoo meditation" versus "I enjoyed the silent meditation"). Likert-type scale responses ranged from 1 = Strongly Agree to 7 = Strongly Disagree. Strongly Agree, Agree, and Somewhat Agree were combined labeled "Agree" while Strongly Disagree, Disagree and Somewhat Disagree were combined and labeled as "Disagree," creating a dichotomous variable.

Data Analysis

Statistical analyses were performed using SAS (SAS Institute Inc., Cary, NC, USA; v 9.4). Mixed 2-way analyses of variance (ANOVAs) were performed for each dimension of the 4DMS and the acute stress item to test the within-group effects of time (preintervention to postintervention) and the interaction effect of time and group (Didgeridoo and Silent Meditation), while adjusting for age, race, and sex.

Independent t tests and χ^2 tests were performed to evaluate differences between the groups on intervention acceptability items (ie, likelihood of attending again and enjoyment of the intervention).

In exploratory post-hoc analyses conducted to help generate future hypotheses, the 4DMS Relaxation dimension was then stratified for sex, class year, and major area. Sex is defined as Female or Male, class year is defined as Underclassman (ie, Freshman and Sophomore) or Upperclassman (ie, Junior and Senior), and major area was grouped into 6 classes: Arts (includes Dramatic Art, English); STEM/Pre-Health (Biology, Chemistry, Biochemistry, Physics, Biophysics, Geophysics, Molecular Genetics; Computer Science, Biomedical Engineering, Math; Pre-Nursing, Pre-Pharmacy, Exercise and Sport Science, Public Health); Social Sciences (Economics, Environmental Studies, Communications, Psychology, Political Science, Latin American Studies); Business (Business, Business Administration); Double Major; and Undecided. Mixed ANOVAs were performed after stratification to test the within-group effects of time (preintervention to postintervention) and the interaction effect of time and group (Didgeridoo and Silent Meditation).

Effect sizes were calculated examining differences between pre and postintervention for each group (Didgeridoo v Silent Meditation).[41] A post hoc power calculation was determined for the "Relaxation" dimension of the 4DMS (n = 74). This was done by considering the difference in "Relaxation" for pre and posttreatment for the didgeridoo and silent meditation groups. A power calculation with 2 independent sample means was used for this medium effect size. We found the "Relaxation" dimension was underpowered at 49.6%.

Results

Participants

Out of the 266 students who were screened, 133 were ineligible and 133 were eligible and agreed to participate. Of the eligible subjects who agreed to participate, 59 were no-shows, leaving 74 eligible, enrolled participants in this study (age range = 18–29 years; mean age = 19.7 years; 58 females and 16 males; group assignment: Group D n = 40 and Group S n = 34). Demographic information was compared and the groups did not appear to differ at baseline (Table 1). The groups did not differ at baseline for Relaxation ($P = .47$; analysis not shown), Tiredness ($P = .71$; analysis not shown), Negative Arousal ($P = .29$; analysis not shown), and Energy ($P = .13$; analysis not shown) (Table 2). In addition, both groups had similar levels of acute self-perceived stress at baseline ($P = .35$; analysis not shown).

Table 1. Participant Demographics by Group.

	Didgeridoo	Silent	*P*
Mean (SD) age	19.7 (2.1)	19.7 (1.4)	.90
Female	30 (52%)	28 (48%)	.44
Male	10 (63%)	6 (38%)	
African American	3 (60%)	2 (40%)	.79
Caucasian	28 (56%)	22 (44%)	
Other	8 (47%)	9 (53%)	
Freshman	18 (60%)	12 (40%)	.07
Sophomore	10 (67%)	5 (33%)	
Junior	4 (25%)	12 (75%)	
Senior	8 (62%)	5 (38%)	

Demographic information organized by age, sex, race, and class year for undergraduate students who participated in a 30-minute Didgeridoo Sound Meditation or Silent Meditation (Control).

Table 2. Mean (SE) 4-Dimension Mood Scale (4DMS) Adjusting for Age, Race, Sex (N = 74).

4DMS	Pretest	Posttest	Within-TX, *P*	D vs S, *P*	Interaction Cohen's effect size
Relaxation					
D	1.3 (0.2)	2.4 (0.2)	<.0001		
S	1.1 (0.2)	1.9 (0.2)	.0005	.01	0.55
Tiredness					
D	2.0 (0.2)	1.2 (0.02)	.0001		
S	2.2 (0.2)	1.5 (0.02)	.005	.14	−0.33
Negative arousal					
D	0.8 (0.1)	0.3 (0.1)	.009		
S	1.0 (0.2)	0.5 (0.2)	.01	.20	−0.23
Energy					
D	1.2 (0.1)	0.8 (0.1)	.009		
S	1.0 (0.1)	0.7 (0.1)	.03	.27	0.16

Subjects' mean responses (including standard error) to each of the 4 indices of mood tested by the 4DMS. Subjects responded before (pretest) and after (posttest) one of the following treatment (TX) interventions: Didgeridoo Sound Meditation (D) or Silent Meditation (S) (control). The 4DMS uses 5 adjectives to determine each of these 4 mood states: Relaxation, Tiredness, Negative Arousal, and Energy. 4DMS, 4-Dimension Mood Scale; D, Didgeridoo; S, Silent.

4-Dimension Mood Scale

Both groups experienced significantly increased relaxation after a meditation intervention (Group D, $P = .0001$ and Group S, $P = .0005$) (Table 2). Participants in didgeridoo sound meditation experienced a significantly greater increase in relaxation than participants in the silent meditation group (adjusted $P = .01$; moderate pre to post effect size of $d = 0.55$; Table 2). Both groups reported significantly reduced tiredness after a meditation intervention (Group D, $P = .0001$ and Group S, $P = .005$), but the group-by-time interaction was not significant. Both groups reported significantly reduced negative arousal after a meditation intervention (Group D, $P = .009$ and Group S, $P = .01$), but the interaction was not significant (Table 2). Both groups reported

significantly less energy after a meditation intervention (Group D, $P = .009$ and Group S, $P = .03$), but the interaction was not significant (Table 2).

4DMS "Relaxation"—Stratified by Sex, Class Year, Major Area

Exploratory post hoc analyses were carried out on the subgroup of participants in terms of the relaxation component of the 4DMS instrument. We are aware of the limitation in adequate power in these analyses; nevertheless, we wished to explore whether there were differences between males and females with regard to relaxation, to gather information for future possible research. Relaxation increased significantly among females following both types of meditation (Group D, $P = .0001$ and Group S, $P = .001$) (Table 3). Didgeridoo sound meditation helped females relax significantly more than silent meditation ($P = .0001$). The pre- to postinteraction effect size was strong ($d = 0.81$; analysis not shown).

Didgeridoo sound meditation significantly increased relaxation among males ($P = .02$). Silent meditation also increased relaxation among males but was not significant ($P = .30$). However, since there were only 16 male participants, with 10 in the Didgeridoo group and only 6 in the Silent Meditation group, there was insufficient power and thus limited veracity to this finding (Table 3). Didgeridoo sound meditation was beneficial in both underclassmen and upperclassmen, but it was significantly more relaxing than silent meditation only in underclassmen ($P = .001$) (Table 3). The pre- to postinteraction effect size was strong ($d = 0.84$; analysis not shown). With regard to students' major, didgeridoo sound meditation significantly increased relaxation more than silent meditation only among STEM/Pre-Health majors ($P = .04$) (Table 3). A significant interaction was not observed for Social Science majors and Double majors. No difference between groups was noted for the other majors but sample sizes were small.

Table 3. Mean (SE) 4-Dimension Mood Scale (4DMS) "Relaxation" Stratified by Sex, Class, and Major Area.

4DMS relaxation	Pretest	Posttest	Within-TX, *P*	D vs S, *P*
Sex				
Female				
D (n = 30)	1.3 (0.1)	2.5 (0.1)	<.0001	
S (n = 28)	1.0 (0.2)	1.7 (0.2)	.001	.0001
Male				
D (n = 10)	1.1 (0.3)	2.3 (0.3)	.02	
S (n = 6)	1.9 (0.4)	2.6 (0.4)	.30	.59
Class				
Underclassmen				
D (n = 28)	1.4 (0.2)	2.5 (0.2)	<.0001	
S (n = 17)	1.0 (0.2)	1.6 (0.2)	.04	.001
Upperclassmen				
D (n = 12)	1.0 (0.3)	2.4 (0.3)	.001	
S (n = 17)	1.2 (0.2)	2.1 (0.2)	.02	.41
Major area				
Double major				
D (n = 6)	1.2 (0.4)	2.5 (0.4)	.04	
S (n = 5)	0.7 (0.4)	1.8 (0.4)	.10	.23
STEM/prehealth				
D (n = 16)	1.2 (0.2)	2.5 (0.2)	<.0001	
S (n = 16)	1.1 (0.2)	1.8 (0.2)	.01	.04
Social sciences				
D (n = 12)	1.3 (0.3)	2.2 (0.3)	.07	
S (n = 10)	1.7 (0.3)	1.7 (0.3)	.39	.25

Subjects' mean responses (including standard error) to Relaxation, 1 of the 4 indices of mood tested by the 4DMS. Subjects responded before (pretest) and after (posttest) one of the following treatment (TX) interventions: Didgeridoo Sound Meditation (D) or Silent Meditation (S) (control). Responses are stratified by Sex, Class, and Major Area. Sex includes Female and Male, Class includes Underclassmen (Freshman and Sophomore) and Upperclassmen (Junior and Senior), and Major Area includes Arts (not shown), Business (not shown), Undecided (not shown), Double Major, Science, Technology, Engineering and Mathematics (STEM/Pre-Health), and Social Sciences. 4DMS, 4-Dimension Mood Scale; D, Didgeridoo; S, Silent.

Acute Self-Perceived Stress

For the 1-item acute self-perceived stress measure, responses were obtained only for Groups 2 and 3 (n = 54). Didgeridoo participants experienced mean [standard error] self-perceived stress preintervention of 3.8[0.2] and postintervention of 1.9[0.2], while silent meditation participants experienced mean self-perceived stress preintervention of 4.1[0.3] and post-intervention of 2.7[0.3]. Participants in both groups had significantly reduced acute self-perceived stress after their respective interventions (Group D, $P = .0001$ and Group S, $P = .0007$; Table 4). However, participants in didgeridoo sound meditation had significantly reduced acute self-perceived stress compared to the silent meditation group ($P = .03$). The pre- to postinteraction effect size was moderate ($d = 0.53$).

Table 4. Mean (SE) 1-Item Acute Stress Scale Adjusting for Age, Race, and Sex (N = 54).

	Pre	Post	TX, *P*	D vs S, *P*	Interaction Cohen's effect size
D	3.8 (0.2)	1.9 (0.2)	<.0001		
S	4.1 (0.3)	2.7 (0.3)	.0007	.03	0.53

Subjects' mean responses (including standard error) to the 1-item acute stress scale. Subjects responded before (pretest) and after (posttest) one of the following treatment (TX) interventions: Didgeridoo Sound Meditation (D) or Silent Meditation (S) (control).

Intervention Acceptability

An independent t test demonstrated that students are significantly more likely to attend a didgeridoo meditation again versus a silent meditation ($P = .04$; analysis not shown). In a χ^2 test (Table 5), 80% of participants agreed they would attend a didgeridoo meditation again as opposed to 53% of silent participants (P, by $\chi^2 = .01$).

Students enjoyed didgeridoo meditation significantly more than silent meditation ($P = .03$; analysis not shown). In a χ^2 test (Table 5), 80% of surveyed participants enjoyed the didgeridoo meditation as opposed to 47% who enjoyed the silent meditation (P, by $\chi^2 = .003$).

Discussion

This study demonstrated that both a 30-minute silent meditation and a 30-minute didgeridoo sound meditation resulted in significant self-assessed positive changes in mood and stress in undergraduates without prior meditation experience. Immediately following either type of meditation, each group experienced statistically significant increases in relaxation and decreases in tiredness, negative arousal, energy, and acute self-perceived stress. To our knowledge, this is the first study demonstrating that didgeridoo sound meditation could be effective for acute stress management in undergraduates.

Results from this study confirmed our hypothesis that didgeridoo sound meditation induced a more relaxed state than silent meditation in novice undergraduate meditators. Subjects randomized to didgeridoo sound meditation experienced significantly more relaxation and decreased acute perceived stress than those in the silent meditation group, adjusting for age, race, and sex. The primary differences between these interventions were the sound of the didgeridoo instrument and focus on an external object versus silence and focus on the breath. The difference in levels of relaxation may have been because focusing on an external stimulus like ambient sound required less effort or was easier to pay attention to than an internal stimulus like one's breath. From the outside, silent meditators may appear to be inactive; however, what is actually taking place is an active cognitive process—a form of mental exercise focused on training the brain.[42] Thus, although silent meditation may at times produce a state of relaxation, it is not always the intention of the practice. The difference in levels of relaxation could also be because the activity of focused sound-listening was more familiar[26] or comfortable to inexperienced meditators than focusing on one's breathing. Distracting thoughts or daydreaming are more likely to occur in those without prior meditation experience,[16] so external stimuli (eg, reminders from an instructor and/or ambient sound) may be helpful to keep one's attention focused in the present. In addition, relaxation could have been due to unknown psychophysiological effects of the sound waves themselves, or because the process of experiencing the didgeridoo was more pleasurable.

Furthermore, relaxation among subjects in the didgeridoo group was significantly increased especially among females, underclassmen, and STEM/Pre-Health majors. Although sample sizes were small and thus power was limited, this information may generate further hypotheses about specific demographic groups that could most benefit from these types of interventions. A study by de Vibe et al.[43] of medical and psychology students who participated in a 7-week mindfulness training program found significant improvements for women but not men on stress and subjective well-being. Another study by Rojiani et al (2017), which compared outcomes for men versus women who participated in a college course that included mindfulness training, found that only women demonstrated decreased negative affect.[44] Although there are limitations to both of these studies, including lack of active control groups, findings suggest that male and female students may respond differently to this form of meditation. If male students do experience less benefit than females from silent meditation, they may still benefit from other stress-management approaches.[43] For males in our study, both groups experienced increased relaxation, but we detected a significant increase only in the didgeridoo sound meditation group. Thus, didgeridoo sound meditation may be a

Table 5. χ^2 Test of Intervention Acceptability Questions.

	Neutral-Disagree	Agree	P
"I enjoyed the [silent or didgeridoo] meditation"			
D	8 (20%)	32 (80%)	
S	18 (53%)	16 (47%)	.003[a]
"I would attend a [didgeridoo or silent] meditation again"			
D	8 (20%)	32 (80%)	
S	16 (47%)	18 (53%)	.01[a]

Results from χ^2 tests of 2 questions assessing acceptability of each intervention. Intervention acceptability was identified by enjoyment of and willingness to attend the intervention again. Interventions were either a Didgeridoo Sound Meditation (D) or a Silent Meditation (S) (control). For intervention enjoyment, group D subjects were asked "I enjoyed the didgeridoo sound meditation" and group S subjects were asked "I enjoyed the silent meditation." For willingness to attend, group D subjects were asked "I would attend a didgeridoo meditation again" and group S subjects were asked "I would attend a silent meditation again." Subjects responded on a Likert-type scale of 1 to 7 with 1 = Strongly Agree, 2 = Agree, 3 = Somewhat Agree, 4 = Neutral, 5 = Somewhat Disagree, 6 = Disagree and 7 = Strongly Disagree. Strongly Agree, Agree, and Somewhat Agree were grouped as "Agree," whereas Neutral, Somewhat Disagree, Disagree, and Strongly Disagree were grouped as "Neutral-Disagree." D, Didgeridoo; S, Silent.

[a]χ^2 test.

beneficial stress management technique for male college students.

In addition, STEM/Pre-Health students may suffer from higher levels of stress, as significant distress and burnout have been reported in this group.[43,45,46] A 2017 systematic review by McConville, McAleer, and Hahne argues that universities should place more emphasis on providing mindfulness-based interventions to reduce stress and support well-being in health professional students.[46] More well-powered research trials are needed to better understand how undergraduates' demographic and educational characteristics impact their responses to brief meditation interventions.

This study found that participants in both meditation groups experienced decreases in tiredness and energy. Although there may seem to be a paradox between being less tired but also having less energy following both 30-minute meditations, the positive correlation is likely due to the questions covered by the term "energy" in the 4DMS scale, such as being active and lively; since both listening to the Didgeridoo and practicing silent meditation focused on the breath involved relatively physically passive activities (eg, being seated in chairs and not talking to others in the room), it would be reasonable that students would report being less lively and active than at the start of the session. These types of issues may have affected participants' responses.

Participants reported that didgeridoo sound meditation was more enjoyable than silent meditation, with subjects also reporting significantly greater likelihood of attending didgeridoo sound meditation again. It is important to emphasize that mindfulness meditation with focus on the breath can be challenging for inexperienced meditators, that it requires effort to return to the breath after becoming distracted by thoughts, and that it is not typically known for being enjoyable or relaxing. More experienced student meditators may report less effort and greater enjoyment in silent meditation, as they learn to stay in the present moment.

Didgeridoo sound meditation is a highly acceptable intervention that may be more appealing than some traditional meditation styles. In addition, this study used didgeridoo sounds that were produced in person by a professional musician. Future studies should examine whether there are differences in outcomes between a live musician versus recorded sounds. Studies should also examine and compare other types of music or sound used in meditation in terms of their ability to evoke relaxation.

A limitation of this study is small sample size for males and nonscience majors. Other limitations of this study are that validated measures of acute stress could not be obtained so the authors devised the 1-item acute stress scale themselves. Moreover, only Groups 2 and 3 were assessed as to self-perceived stress. We also created the 2 single-item postintervention measures of intervention acceptability to specifically address this unique intervention. Neither of these measures is validated and they should be interpreted with caution.

Conclusion

Didgeridoo sound meditation is as effective as silent meditation for decreasing self-perceived negative arousal, tiredness, and energy and more effective than silent meditation for relaxation and acute stress reduction in undergraduate students. Didgeridoo meditation participants reported higher levels of enjoyment and higher likelihood of attending this type of meditation again. Further investigation into didgeridoo sound meditation is warranted.

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