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Healing minds, moving bodies: measuring the mental health effects of online dance during the COVID-19 pandemic

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ABSTRACT

Use of breath, close physical proximity, and tactile cues are some of the unique facets of dance training. In March of 2020, as COVID-19 lockdowns occurred, these aspects were removed from the lexicon of dance educators as virtual learning took the place of in-person training. This data-driven project explores the benefits and challenges of virtual dance, examining whether online dance can acutely improve mental health and enhance social connectivity. We explore our findings from an education perspective, focusing on learning style, class experience, and dance history. Our findings suggest that online dance can improve mood and increase community connectedness in healthy adults. Importantly, we found that an individual's trait learning style can influence the effectiveness of online learning, with tactile learners benefitting the most in terms of mood state and visual learners benefitting the most in terms of social connectivity. Additionally, we found that greater levels of experienced enjoyment provided the greatest benefits to mood state, whereas greater levels of perceived difficulty may have detrimental effects. We suggest best practices for online dance learning, provide future areas of research, and highlight the importance of using online learning to increase dance accessibility to diverse populations.

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INTRODUCTION

Use of breath, close physical proximity, and tactile cues are some of the unique facets that draw many individuals to seek out and explore a dance training practice, both on an amateur and a professional level. In March of 2020, these aspects were abruptly removed from the lexicon of dance educators worldwide as lockdowns became necessary to curb the spread of COVID-19. Dance artists and educators have utilized the creativity, resilience and adaptability that are markers of their chosen profession to rapidly create an explosion of online and virtual content in the field of dance education and

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performance. Many of these online platforms, such as the website Dancing Alone Together (<https://dancingalonetogether.org/>), have stepped in to fill the void that dancers have experienced due to the acute loss of connection during lockdown and quarantine. Many prominent professional companies (e.g., Límon, Cunningham, Graham) have shifted to social media platforms such as Instagram for daily broadcast of classes and physical practice.

The transition to virtual teaching has presented a unique challenge as dance educators learn how to use a two-dimensional format for a skill that is three-dimensional in nature. Several obstacles exist in virtual dance instruction, such as an inability to either provide tactile cues or see the whole body in motion due to screen restrictions (Gingrasso 2020). Therefore, when it comes to dance, the question emerges whether or not online learning can take the place of in-person learning, since the art involves extensive physical and emotional connection.

While there are significant limitations to the practice of online dance learning, some surprising benefits have emerged. For example, when travel restrictions were in place, many studios and organizations offered successful summer intensives that opened up access to individuals who might not have had the financial means to travel long distances for such training. Additionally, large and geographically diverse audiences can be reached through these online platforms. Dancers can train on their own time, working physical practice into their existing daily schedule. Dance training has also become available in a new and supportive format to many adult beginners and intermediate dancers who may have felt uncomfortable trying out a class in person. These online offerings have provided a new opportunity for wellness and health maintenance to many individuals who may be struggling with new and existing mental health challenges as a direct result of the COVID-19 pandemic (Rajkumar 2020).

Pandemics and mental health

COVID-19 has affected the world in an unprecedented way, primarily because of the swift nature in which the virus swept across the globe. When the World Health Organization declared pandemic status in early March 2020, governments and health officials everywhere rapidly encouraged or enforced stay-at-home measures, introduced 'isolation' and 'quarantine' into common conversations, and promoted teleworking and virtual interactions whenever possible.

While pandemics are not new to our world, the attention to mental health during pandemics has only recently been explored. Before COVID-19, few peer-reviewed articles were published regarding the mental health effects of widespread illness. However, starting in 2010, the number of mental health studies involving pandemics increased steadily, with the majority of these studies occurring in 2020 or thereafter (15,124 out of 15,307 on pubmed.gov). In fact, more research into mental health consequences of pandemics has been performed for COVID-19 in the last few years than the combined research on Ebola and H1N1 (Maalouf, Bernadette Mdawar, and Akl 2021). These studies reveal several startling revelations on how COVID-19 has impacted mental health, including increased symptoms of anxiety, depression, stress, avoidance behaviors (Talevi et al. 2020), insomnia, anger, and fear (Torales et al. 2020). Further, worsened symptoms of post-traumatic stress and psychiatric symptoms have been found in clinical

and non-clinical populations alike (Vindegaard and Benros 2020). Across the board, during times of widespread illness, we see worsening mental health conditions in all populations, not just those with diagnosed psychiatric disorders.

Dance and mental health

We speculated that online dance may help mitigate the mental health effects and sense of social isolation that individuals experienced during the pandemic. While there is no shortage of online class material from private studios, professional companies, and academia, a scientific investigation on the tangible mental health effects of online dance learning has yet to be conducted.

Recent research indicates that in-person dance training positively impacts mental health. For example, a recent meta-analysis including eight studies (n = 351 patients with depression) found that dance movement therapy (DMT) in addition to usual care leads to significantly greater improvements in depression symptoms compared to usual care only (Karkou et al. 2019). Additionally, an intervention providing six weeks of tango lessons has also proven effective to decrease symptoms of depression and levels of stress in a group of individuals with depression (Pinniger et al. 2012). Interestingly, a qualitative study of older, underserved adults completing a 12-week moderate-intensity dance intervention found that dance reduced self-reported symptoms of depression, with participants providing four primary reasons for the beneficial effects including dancing for their own health, social acceptance, connection with others, and not wanting to stop due to unexpected benefits (Murrock and Graor 2016). Finally, dance and DMT have also proven effective for the treatment of schizophrenia, emotional eating in obese individuals, and symptoms of anxiety in clinical and non-clinical populations (H.-J. Lee et al. 2015; Vaverniece et al. 2012; Koch et al. 2014). These studies indicate that long-term dance training enhances mental wellness; however, very few studies have investigated the impact of a single session of dance on mental health.

In light of the mandated social isolation and mental health issues emerging as a result of the COVID-19 crisis, we explored whether offering a single session of online dance education to both rural and urban communities across the United States could improve mental health outcomes and a sense of community connectedness. We detail the results of a four-week pilot study conducted as a partnership between the Embodied Brain Lab at Virginia Polytechnic Institute & State University and New River Moving Arts, a local dance studio based in Blacksburg, Virginia. During the Summer of 2020, we collected data from a group of n = 47 adults with diverse learning styles and dance backgrounds. The data presented in this manuscript focus on the educational aspects of the online dance experience. Specifically, we examined the hypothesis that learning style, dance history, and experience of the dance class significantly impact the mental health and social connectivity benefits of the dance class. Methods and findings are discussed, as well as suggestions for best practices in the emerging field of online dance education. Finally, we summarize some directions for future research in this area of study, including the potential for focus on special populations such as individuals with Autism Spectrum Disorder (ASD), veterans, and elders. Our research is an attempt to document and measure the mental health effects of online dance in an effort to provide one step forward for future research into the brain-body connection present in virtual dance training.

MATERIALS AND METHODS

Merging of artistic and scientific pursuits

The current research study was conceived and conducted through the merging of artistic and scientific interests. Rugh's interests in alternative and collaborative art-making processes and examination of best practices in dance teaching for a variety of learning styles met Basso's interests in understanding the body-brain connection and pursuing a career studying the neuroscience of dance. The field of neuroscience has been interested in gaining an understanding of ways to optimize mental health without pharmacology. In fact, Professor Kirk Erickson in the Department of Psychology at the University of Pittsburgh founded the field of Health Neuroscience in 2014, with the goal of examining the 'interplay between the brain and physical health over the lifespan' (Erickson et al. 2014). Dr. Erickson notes that, '[Health Neuroscience] is a new and interdisciplinary field of work, offering both great potential but also, as with any new approach in science, challenges to be overcome in maximizing its potential application.' One challenge is the breadth of this area of research; that is, the necessity to know and understand two or more academic fields. For example, if one is interested in studying the effects of dance on brain health, then one must know not only how to implement an appropriate dance intervention, but effectively examine the resulting outcomes through neurobehavioral testing or other approaches. Therefore, Rugh and Basso teamed together as dancer and neuroscientist, respectively, to conduct the current study to examine whether online dance could improve mental wellness during the COVID-19 crisis.

Designing an online dance education program

Between March and July of 2020, the instructors at New River Moving Arts (<https://www.newrivermovingarts.com/>) designed and implemented virtual dance class material, which was presented through the video conferencing platform, Zoom (zoom.us). The following guidelines helped inform our curriculum design process.

Repetition/scaffolding of movement material: While novelty is important in retaining the interest and attention of students of all ages (Mather 2013), we found that especially during the initial stages of the pandemic, the familiarity of repetitive material was comforting and encouraging to adult students. As dancers were already familiarizing themselves with a new virtual learning modality, adding extensive new or complex material frustrated and discouraged students more than it inspired them. As such, classes were kept relatively similar from week to week so that people would know what to expect and could feel successful navigating the subject matter. For instance, in the regular weekly modern dance technique class aimed at beginner-intermediate level movers, we performed a set floor warmup, repeated at least one standing technique combination, and added only one new technique combination per week. In the latter part of class, we built on larger, increasingly complex phrase work from week to week so that dancers would have time to practice and integrate between classes.

Simplicity/clarity of movement material and verbal directives: Additionally, keeping movements and directions as simple and clear as possible was imperative when teaching. Good verbal cueing skills became indispensable once tactile cues were eliminated as a teaching technique. We found that multiple directional changes were frustrating for

our beginner-level students. As such, we avoided teaching movement phrases that asked the dancers to turn their backs away from their computers, as it was difficult for students to mirror or follow along with the instructor.

Tending to both individual experience and group connection: We alternated between individual somatic-based improvisation exercises in which dancers were asked to focus on an internal experience, and group exercises in which dancers directed their energy towards the screen to connect with other dancers in the class. For instance, an online modern dance class might start with an internal breathing/sensing exercise, followed by a mirroring activity that allowed the group to tune in and engage with one another. At some point during every class, we provided dancers the opportunity to individually explore an improvisational prompt or manipulate phrasework, guided by the voice of the instructor. At the end of class, we invited the dancers to take turns witnessing the other participants performing the phrase work, in order to give participants a chance to see and appreciate the movement quality of the other individuals in the class. This type of ‘performing in small groups’ is a classic element of in-person technique classes that has been difficult to replicate in an online context; however, many of the participants specifically reported feeling more connected with the group when they had a chance to take turns watching each other perform.

Certainly, all of the techniques mentioned above are important to keep in mind for in-person instruction as well. However, they became invaluable when physical interaction with students was mitigated by a screen. We speculate that these skills will elevate dance teaching practices to a higher level of refinement and pedagogical mastery once we are able to fully resume in-person instruction without physical restrictions.

Participants and data collection

Participants were recruited using a variety of online methods, including social media postings, Virginia Tech’s listserv, Dancing Alone Together, and email communication from New River Moving Arts. Participants were eligible to complete the study if they were age 18 or older, capable of engaging in physical activity, living within the United States, and English speaking. Participants also needed to pass the Physical Activity Readiness Questionnaire (PAR-Q) (Thomas, Reading, and Shephard 1992) before participating. Additional exclusionary criteria included non-ambulatory or intellectual impairment that would impact psychological assessment or intervention participation. Participants were screened for former or current psychiatric diagnoses and medication intake, but these did not serve as exclusionary criteria; rather, this information provided researchers with a broader picture of the mental and physical health of the individual.

Once a potential participant expressed interest in study participation, they received email instructions on how to sign up for a dance class and a link to the pre-intervention study survey. A reminder email was sent to each participant within 24 hours of their dance class time along with a Zoom link to their chosen class. Dance classes offered by New River Moving Arts included jazz, ballet, and contemporary styles. Each class was 60 minutes in length and featured instruction geared towards the beginner-level dancer. Each class was designed at the liberty of the instructor, but included a warm up, technique, and choreography. Thirty minutes into the class, the post-intervention survey was sent to the participants’ emails with instructions to complete the survey within two

hours of the end of class. At the end of class, dance teachers reminded the participants to complete the survey within two hours after the Zoom meeting ended. This interval was selected because the acute physiological effects of exercise are most prominent up to 120 minutes after cessation of activity (Basso and Suzuki 2017).

All data were collected in four weeks. Participants who did not complete both surveys were excluded from the final analysis. The data from both the pre- and post-intervention surveys were collected and stored using Qualtrics. The pre-intervention survey contained questions about dance history and learning style, whereas the post-intervention survey contained questions about perceived level of enjoyment and perceived difficulty level of the dance class. If a participant self-identified as a beginner and reported no formal dance training, simply ‘dancing in my house/home’, we coded this information as zero years of dance experience. All primary endpoint measures were assessed at both the pre- and the post-intervention survey as part of the repeated measures study design.

Our primary study endpoints included mental health measures, which were assessed using the following scales: 1) self-esteem as assessed by the Rosenberg Self-Esteem Scale (Rosenberg, 1965); 2) positive and negative affect as assessed by the Positive and Negative Affect Schedule – Short Form (Watson, Clark, and Tellegen 1988); 3) anxiety as assessed by the Beck Anxiety Inventory (Steer and Beck 1997); and 4) depression as assessed by the Beck Depression Inventory (Beck et al. 1961). Social measures, another primary endpoint, included the following: 1) social connectedness as assessed by the Social Connectedness Scale (R. M. Lee and Robbins 1995); 2) loneliness as assessed by the UCLA Loneliness Scale (Russell 1996); and 3) community inclusion as assessed by the Inclusion of Community in Self Scale (Mashek, Cannaday, and Tangney 2007). Finally, learning style was assessed by the Barsch Learning Styles Inventory (Barsch 1991).

Zoom etiquette

At their scheduled time, participants logged into Zoom and engaged in a 60-minute dance class. Participants were asked to activate their cameras (to ensure similar levels of engagement with the movement class), but had the option to mute their microphones. Additionally, at the beginning of every class, participants were reminded to clear a space of approximately 8 by 10 feet to minimize any risks associated with dancing in their home.

Power and statistical analysis

To determine the sample size to sufficiently power our study, an a-priori power analysis was conducted using the UCSF Clinical and Translational Science Institute correlation sample size calculator (Hulley et al. 2001). The power analysis was based on a correlation with an alpha (α) of 0.05, a beta (β) of 0.20, and a correlation coefficient (r) of 0.4, with results indicating a sample size of $n = 47$. All data were analyzed using SPSS Statistics 26.0 (George and Mallery 2019). Change scores were calculated by subtracting the pre-intervention from the post-intervention measures. To examine the relationship between dance measures (e.g., dance experience, learning style, or years of dance experience) and acute dance-induced mental health outcomes, Pearson’s product-moment correlations were utilized. Additionally, we present qualitative data regarding participants’ response

to the question, ‘Please share with us any additional comments, questions, or concerns about the study’. Qualitative data analysis was conducted to identify prominent themes in the data.

RESULTS

Here we report the results of a single session of online dance on mental well-being and social connectivity from an educational perspective, focusing on measures of dance history, learning style, and class experience.

Participant population

We collected data from $n = 59$ participants; however, after excluding those who did not complete both surveys, the final number of participants who completed the study was $n = 47$. The mean age was 32.47 years, ranging from 18 to 70. Of these participants, 92% had college degrees, 68% had an annual household income in middle- or high-income categories, and 76% worked full or part time. Male participants ($n = 4$) and female participants ($n = 43$) were primarily of Caucasian descent (77%) and most were non-hispanic (98%). Urban and rural communities were well represented at 49% and 51%,

Table 1. Demographics A. frequency table b. contingency table.

Mean age = 32.47		$n = 47$	
Household income		Household income	
% Low income	32%	Low income	15
% Middle income	47%	Middle income	22
% High income	21%	High income	10
Education		Education	
% High school/GED or lower	4%	High school/GED or lower	2
% Some college	4%	Some college	2
% College degree	43%	College degree	20
% Advanced degree	49%	Advanced degree	23
Employment Status		Employment Status	
% Working full time	38%	Working full time	18
% Working part time	38%	Working part time	18
% Not working	23%	Not working	11
Sex		Sex	
% Female	91%	Female	43
% Male	9%	Male	4
Race		Race	
% White/Caucasian	77%	White/Caucasian	36
% Black/African American	6%	Black/African American	3
% Asian	13%	Asian	6
% Other	4%	Other	2
Ethnicity		Ethnicity	
% Hispanic	2%	Hispanic	1
% Non-hispanic	98%	Non-hispanic	46
Urban vs Rural Community		Urban vs Rural Community	
% Urban	49%	Urban	23
% Rural	51%	Rural	24
BMI		BMI	
% Underweight (<18.5)	2%	Underweight (<18.5)	1
% Normal Weight (18.5–24.9)	55%	Normal Weight (18.5–24.9)	26
% Overweight (25–29.9)	23%	Overweight (25–29.9)	11
% Obese (>30)	19%	Obese (>30)	9

respectively (Table 1). The majority of participants (55%) were in the BMI range for normal weight (BMI of 18.5–24.9), compared to the national obesity prevalence of 42.4% in adults (Hales et al. 2020).

Effect of learning style

We first examined whether an individual's preferred learning style would influence mental health and social connectedness outcomes in a virtual setting. Using the Barsch Learning Styles Inventory, we divided participants into visual, auditory, and tactile learners (or a combination if they had an equivalent score in two categories; no individual scored evenly in all three areas). Interestingly, the predominant learning style was visual (42% of participants), followed by tactile (17%), visual/auditory (13%), auditory (9%), visual/tactile (9%), and auditory/tactile (4%).

Our findings show two prominent effects. First, visual learning scores showed a significant positive association to the change in the Inclusion in Community in Self score (Figure 1(A)) $p=.007$, $r = .389$, showing that visual learners experience more social connectedness from an online dance learning experience. Second, tactile learning scores showed a significant negative association to the change in negative affect scores from the Positive and Negative Affect Schedule (Figure 1(B)) $p=0.028$, $r = -.320$, demonstrating that tactile learners experienced the most significant mood improvements from an online dance learning experience. No significant associations were seen between auditory learning score and primary mental health and social connectedness outcome measures.

Effect of class experience

At the end of class, participants were queried on their overall experience of the class in terms of both enjoyment and difficulty level. Overall, participants reported the class as moderately to highly enjoyable, with an average of 8.4 (± 0.32 SEM) on a 0 to 10 point scale. In terms of the relationship to primary outcome measures, we found that class enjoyment was significantly positively associated with the change in positive affect as

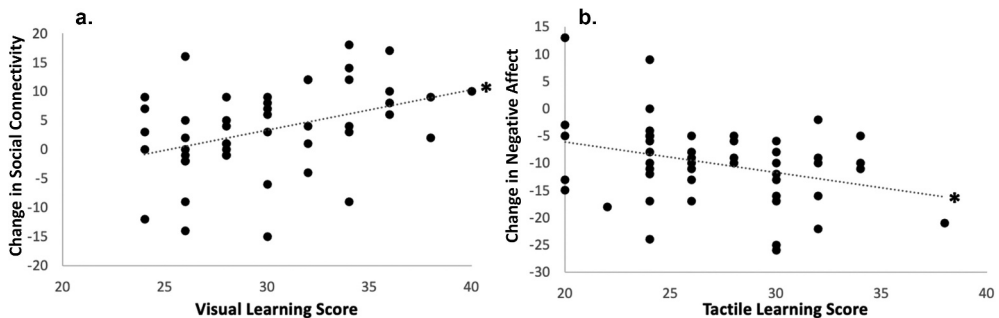


Figure 1. Relationship of learning styles to primary outcomes. A. The Barsch visual learning score showed a significant positive association to the change in social connectivity as measured by the Inclusion of Community in Self Scale. B. The Barsch tactile learning score showed a significant negative association to the change in negative affect score as measured by the Positive and Negative Affect Schedule. Statistically significant at $p<0.05$.

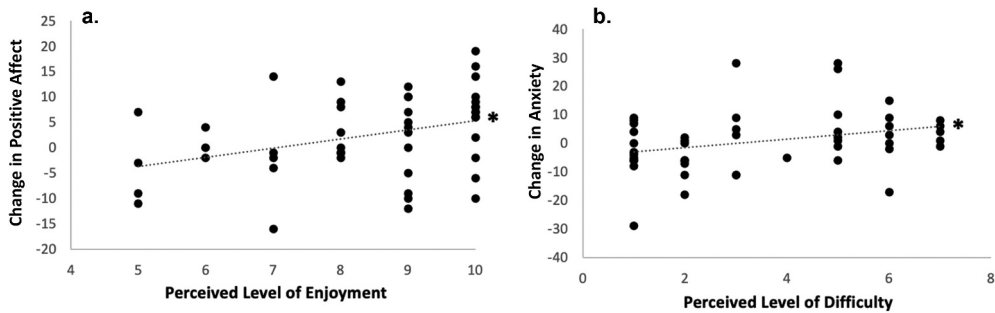


Figure 2. Relationship of class experience to primary outcomes. A. Perceived level of enjoyment showed a significant positive association to the change in positive affect score as measured by the Positive and Negative Affect Schedule. B. Perceived level of difficulty showed a significant positive association to the change in anxiety as measured by the Beck Anxiety Inventory. Statistically significant at $p < 0.05$.

measured by the Positive and Negative Affect Schedule (Figure 2(A)) $p = .015$, $r = .351$. Additionally, participants reported the class as low to moderately difficult, with an average of $3.6 (\pm 0.23 \text{ SEM})$ on a 0 to 10 point scale. Perceived level of difficulty was significantly positively associated with the change in anxiety as measured by the Beck Anxiety Inventory (Figure 2(B)) $p = .037$, $r = .305$, which revealed that those individuals who perceived the class as most difficult had the greatest increases in anxiety from before to after class.

Effect of dance history

Participants were additionally queried on their dance experience, both in terms of years of dance as well as a self-reported categorization measure of dance experience (i.e., beginning, intermediate, advanced, or professional). Beginner dancers comprised 36% of participants, with intermediate dancers at 38%, advanced dancers at 17%, and professional dancers at 9%. We found that dance experience was negatively associated with the change in positive affect (Figure 3) $p = 0.006$, $r = -0.396$. That is, the more advanced the dancer, the less positive affective change they received from the class. Surprisingly, neither level of class enjoyment nor perceived difficulty were significantly related to years of dance experience.

Testimonials of class experience

During the post-intervention survey, we asked participants to provide feedback on their experience. In Table 2, we present both positive and negative or other feedback from participants. The feedback includes comments regarding the need and interest in such online movement opportunities as well as the difficulties and challenges associated with the virtual experience. We further identified themes from these comments (Figure 4). Participants noted that they enjoyed the spirit/energy of the class ($n = 5$), ability to move ($n = 4$), and their reconnection with movement ($n = 3$). Negative comments referred to technical issues and limitations associated with online dance instruction ($n = 3$), limited social engagement through online learning ($n = 2$), and choice of choreography ($n = 2$).

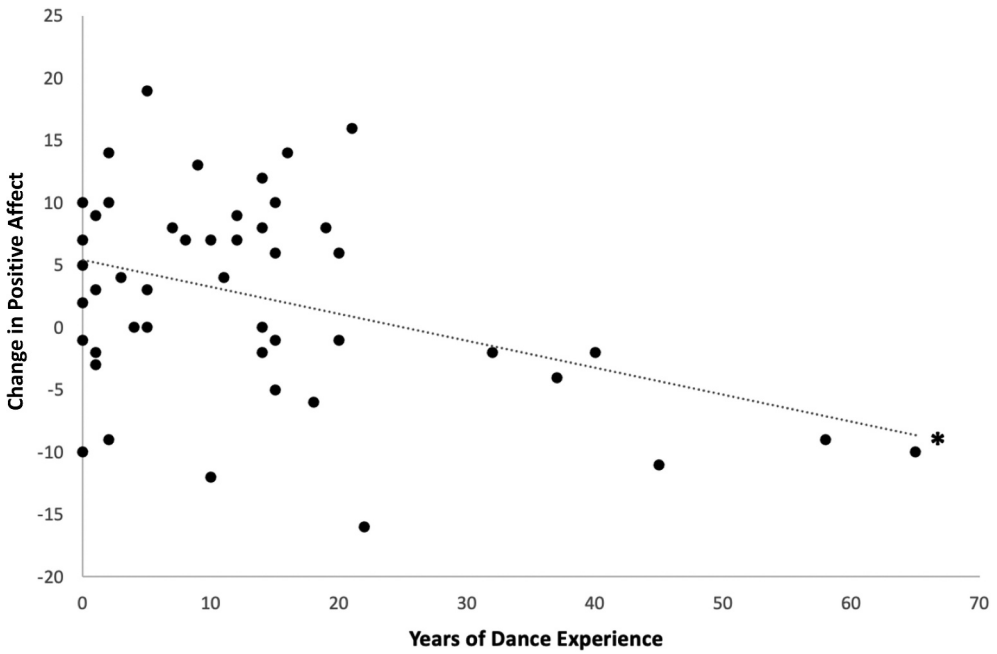


Figure 3. Relationship of dance history to primary outcomes. Years of dance experience showed a significant negative association to the change in positive affect. Statistically significant at $p < 0.05$.



Figure 4. Common themes identified from participant testimonials.

Table 2. Participant feedback regarding their online dance class experience.

Positive Feedback	Negative/Other Feedback
'I have been aching for a way to start moving my body especially since the pandemic hit. Thank you so much for this opportunity.'	'As much as I love the spirit of these classes . . . zoom is so HARD. I miss getting to chat with people before, during, and after class. They don't feel as social on Zoom.'
'I really enjoyed doing this study. I felt nervous about turning the camera on for the individual groups but I did it and just decided to do my best. Thank you!'	'I expected to do more choreography in the class than just ballet and movement exercises.'
'I was diagnosed with minor depression and go through good and bad days. Dance always helps me out and when I first took the survey, I was not having the best day but today (post dance) has been a very good and happy day.'	'The only comment I have is that I had some difficulty following because I could see everyone in small boxes instead of just [the instructor].'
'This has motivated me to be involved in more classes like this after remembering and recognizing how movement, exercise, and class unity makes me feel!'	'The current pandemic has affected us all in isolation from friends, family and general social interactions. I was surprised the survey did not ask us to consider answering the questions from a time from before or currently during the pandemic isolation. It clearly has some impact on my answers.'
'The class was fantastic and the instructor was so lovely and cheerful. Please tell her she was a ray of sunshine in my day!'	' . . . A lot of time during the class, I couldn't see the instructor's feet. I could see the feet of the other person she had with her, but it was hard to split attention between looking at that person's feet and listening to the instructor . . . I finally figured out how to pin the instructor's video because here and there someone would do something and their video would come up instead, which was annoying. It would be good if instructions on how to do that were shared at the beginning.'
'I'm not a dancer, but I really enjoyed the class! Now that I've got my workout clothes on, I'm going to do some yoga (my true love) after finishing this survey.'	'A concern on wording it that the questionnaire asks about how "often" you feel something "right now." This wording can lend itself to multiple interpretations, and I may have been back and forth on the two while taking it; thanks for the fun class!'
'This was fun! Thanks! It gave me and my husband a fun activity to do together.'	'Will there be any follow up to participants with the results from the study? I think this is an awesome study and I was glad I could participate, I'm very curious to see what results you receive. Thank you for the opportunity to get my body moving during this hard time for me. Keep being awesome and teaching positive classes!'
' . . . I was preparing for my coming qualifying exam. I really enjoyed the engagement with other people during the dance class. Thanks a lot for the class!'	'Not sure why, but I had a bit of nausea (bad lunch?), and a lot of emotional release nearing [the] end of class, and so I didn't feel super positive after exercise/dance as I might normally. Thanks for class anyhow!'

DISCUSSION

Using dance as a way to promote well-being has been a staple in societies for centuries and engaging in such performance arts practices enhances mental wellness (Jensen and Bonde 2018). Here, we explored in this new era of online learning whether virtual dance could confer similar mental health benefits. Overall, our findings suggest that an online dance education experience is effective at improving mood states and increasing sense of community connectedness in a group of healthy adults. This has important implications for educational opportunities that need to be online, for example, during stay at home orders during a pandemic or during distance learning where in person learning is not feasible. Importantly, we found that an individual's trait learning style can influence the effectiveness of online learning, with tactile learners benefitting the most in terms of mood state and visual learners benefitting the most in terms of social

connectivity. Additionally, an individual's experience of the class may impact the beneficial mental and social outcomes they experience. Greater levels of experienced enjoyment will provide the greatest benefits to mood state, whereas greater levels of perceived difficulty may have detrimental effects on mood state (i.e., increased anxiety). Finally, we found that dance history is an important consideration, as novice dancers experienced the largest mental health gains. Collectively, this work suggests that dance educators can provide effective movement experiences in an online platform to both improve mood and increase social connectivity, but attention to the individual learning styles, level of enjoyment, and difficulty of the class are imperative. Below, we offer implications for each of our findings as well as discuss recommendations for future researchers and dance educators working with online platforms.

Individual learning style impacts online dance-induced mental health effects

Our findings suggest that an individual's learning style influences the benefits they receive from an online dance course. First, we found that visual learners experience the biggest gains in their sense of community connectedness. This suggests that the visual platform of Zoom, in the absence of in-person interaction, can be an effective medium to build community. Visual learners are those who learn best through images, pictures, computers or other visual media. We hypothesize that visual learners may be more focused on the visual aspect of the Zoom class and perhaps more engaged with the instructor or the other members of the class. Elements of the online class can be developed to specifically target visual learners and interactions that promote social connectivity. For example, exercises can be developed where students are instructed to follow or mimic the movements of the instructor or to move in synchrony with one another. Alternatively, choreographic exercises could be developed whereby students use the 'break out' feature of Zoom to choreograph a movement phrase together (e.g., in pairs) and then share their work with the remainder of the group. Previous research has shown that both moving in synchrony with others as well as working in collaboration (as in the experience of choreographing together) increases the sense of social bonding as well as inter-brain synchrony between individuals (Behrends, Müller, and Dziobek 2012; Valencia and Froese 2020; Basso, Satyal, Rugh 2021). Additionally, mirroring practices in dance and DMT are thought to drive empathic enhancements, with this ability being linked to increased activation in the mirror neuron system (McGarry and Russo 2011). We hypothesize that types of online movement experiences that focus on direct visual interactions with others on the computer screen may be especially beneficial for visual learners.

Second, we found that tactile learners experience the biggest gains in their affective state. Tactile learners are those who prefer learning through the sense of touch and hands-on activities. This may make online learning difficult for tactile learners, especially in movement practices where the instructor would typically provide tactile cues or sensory-based activities, either with another student or directly with the instructor. In the absence of person-to-person contact, exercises can be developed to support the tactile learner. For example, a guided movement practice could be conducted that focuses on

internal felt states. Specifically, as the individual moves their body through space, they can be instructed to attend to bodily sensation as they make contact with the floor, an object in the room, other parts of the body, or even a friend or family member at home.

Other work has identified that learning styles should be taken into consideration when designing and developing online learning classes (Zapalska and Brozik 2006). The authors of this work suggest that, 'the achievement of online learning can be improved by instruction in a manner consistent with each student's learning style. However, it is important to keep in mind that, even if a specific student learns best in a certain way, he or she should be exposed to a variety of learning experiences to become a more versatile online learner' (Zapalska and Brozik 2006). Of course, both assessing students' learning styles and crafting classes geared at an individual level proves challenging on many levels. Therefore, we recommend incorporating a variety of movement experiences geared towards a range of learning styles (i.e., visual, tactile, and auditory). Interestingly, research shows that auditory learners prefer other methods of educational experiences over online learning (Zapalska and Brozik 2006). This is in line with our findings, first showing that we had a low percentage of auditory-dominant learners (9%) and second that auditory learners did not benefit as much from the online dance experience as visual or tactile learners.

Class experience impacts online dance-induced mental health effects

Regarding class experience, those individuals who received the most enjoyment from class received the greatest mental health benefits as assessed by the change in positive affect. The positive effects of exercise on mental health are well established in the field of exercise science and physiology, both in terms of acute and long-term exercise (Basso and Suzuki 2017; Vivar and van Praag 2017; Mikkelsen et al. 2017). In fact, a single bout of exercise has been shown to increase positive affective states and decrease negative affective states, with improvements lasting up to 24 hours. Additionally, exercise-induced mood improvements appear to be most beneficial when the type of exercise is self-selected, as was the case in the current study (Zervas et al. 1993). Our results show for the first time that the greatest online dance-induced mental health benefits come when the student experiences a high level of enjoyment. Other studies have revealed similar results with in-person group fitness classes. Specifically, a study in female undergraduate students using a single session of aerobic exercise found that enjoyment levels were positively associated with exercise-induced increases in positive affect (Raedeke 2007). Though the underlying effects of exercise-induced improvements are still under investigation, studies have shown that increases in neurotransmitters such as serotonin and dopamine as well as increases in endogenous opioids and endocannabinoids may be involved (Lubans et al. 2016; Mikkelsen et al. 2017).

Additionally, we found that the perceived level of difficulty was positively associated with the change in anxiety level, meaning that participants who found the class too difficult experienced greater levels of anxiety after class as compared to before. Though these classes were taught at a beginner level, some students, perhaps new to dance or the online learning platform, found the dance experience challenging, which resulted in an unanticipated increase in anxiety. Previous research has shown that the perception of task difficulty can influence the psychological response to the task. For example, if the

task is experienced as difficult, the individual will likely experience negative feelings of intimidation in response to task participation (Nunan and Keobke 1995). A lack of familiarity with the task can cause the participant to disengage from the learning process, and therefore, a dance class setting where learning is expected, can result in an increased anxiety level. To combat these effects, we suggest that dance instructors adapt the learning environment to include a variety of dance levels within an online program, offering movement options that may accommodate the novice to advanced dancer. Alternatively, an approach that accommodates unique skill levels (such as offering separate classes divided into beginning, intermediate, and advanced levels) could be a suitable solution.

Our findings have implications for educators interested in positively impacting students' mental states. In the realm of virtual dance learning, dance educators should focus on creating an enjoyable experience for their students, taking into consideration the challenging nature of the online movement experience. Offerings that may be considered at a beginner or intermediate level in the in-person format may be more challenging when presented in an online format.

Dance history impacts online dance-induced mental health effects

Regarding dance history, our data revealed that the most novice dancers (i.e., those with the fewest years of dance experience) experienced the largest gains in positive affective state. This is one of the first reports to examine the association between dance history and changes in mental health after a single session of online dance. Limited investigations have explored the relationship between exercise habits or cardiopulmonary fitness levels and change in mood states after a single session of exercise. The work that has been done indicates findings in opposition to ours. That is, individuals who have a regular exercise regimen, compared to those who do not, report the greatest mental health benefits after an acute bout of aerobic exercise (e.g., decreases in anxiety and fatigue) (Hoffman and Hoffman 2008; Hallgren, Moss, and Gustin 2010; Chen et al. 2019). These studies, however, utilized a standard, aerobic exercise protocol on a cycle ergometer or treadmill, where the participants engaged in similar moderate- or vigorous-intensity exercise regimens. One limitation of the current study was that we did not record participants' heart rate and therefore were unable to measure or standardize the level of aerobic activity achieved. We hypothesize that our advanced dancers did not obtain an equally high heart rate as our beginner dancers, which may contribute to the lack of mental health benefits seen in our advanced dancers. That is, advanced dancers may need a more intense or vigorous dance experience to achieve the same effects as our beginner dancers.

The effect we see in our data could also rely heavily on the fact that our dance classes were taught at the beginner level, and while that was sufficient to elicit a psychological response in less experienced dancers, more advanced dancers did not find the classes challenging or engaging enough to see the same increases in positive affect. Novice dancers may have found the class more exciting due to its novel nature, which could have contributed to greater mental health gains. This hypothesis has important implications for dance instructors; that is, for the greatest benefits in a dancer's mental health to be achieved with a single dance class, they should be instructed at an optimum difficulty

level based on their current skill set. A class that is too easy will not be as beneficial for advanced dancers, while a difficult class will hinder a novice dancer's ability to enjoy the movement experience. The selection of technique, pace, and choreography phrases are vital to a dancer's enjoyment levels. Our findings suggest that online dance classes could be offered separately for beginners versus advanced dancers. Alternatively, within a mixed skill-level class, the instructor can provide multiple scaffolded movement options for beginning, intermediate and advanced learners.

Lessons learned and best practice recommendations

One of our goals for this study was to compile best practices and suggestions for other dance instructors teaching in an online classroom. We used Zoom as our platform, but many of these principles can be applied to a variety of online video conferencing methods.

In regard to technology, troubleshooting sound issues is one of the most important aspects of online teaching. First, students need to clearly hear your feedback and instruction. Second, they need to hear the music you are using, often simultaneously while you are speaking; otherwise, following the beats or counts of music will be challenging or impossible. For this purpose, we recommend using the 'share sound' feature in Zoom to help music come through clearly while also allowing participants to hear human voices. Keep in mind that the volume levels may need to be adjusted for each song choice. Visually, we recommend that students alternate between speaker and gallery view during various parts of the class. When movement material is taught, speaker view enables participants to see the instructors more clearly. Gallery view works well to increase social connectivity during group improvisation and informal performance times.

In regard to the class itself, we recommend using the spatial framework, of both the virtual and physical space, to your advantage. We also recommend keeping in mind the space in which the students are dancing, as most participants did not have more than a small space in their bedroom or living room. Therefore, we limited large movements in choreography, developing movement material within a smaller physical area or utilizing gestural movement rather than relying on large amounts of floorwork or traveling movements. While we limited movement space, we created room for more emotional processing during the class. Sometimes this came in the form of a water break with time to verbally reflect on movement material or the dancers' emotional states on a given day; at other times, it involved providing moments for contemplative movement while the dancers focused on their breath or bodily sensations. We also took time to slow down and clarify our methods. Finally, we found that online classes can be shorter than in-person classes; both participants and instructors faced 'Zoom fatigue' as teleworking and virtual meeting hours were prominent during the day. Moving forward, we recommend considering quality over quantity when it comes to online dance learning. 45 to 60 minutes of movement, reflection, and group connection may be more effective at positively influencing mood states than the 75 to 90 minutes of pure movement that might be expected in an in-person class experience.

Finally, we found that utilizing the spatial framing of the Zoom screen proved to be an aesthetically engaging and effective teaching tool. Drawing on dance film techniques such as perspective, proximity/distance, angles and framing allowed us to capitalize on the unique and novel role of the camera in online learning versus trying to make the experience exactly like an in-person class.

Qualitative themes of importance

Based on our qualitative analysis, we found that our participants were appreciative of the social and physical aspects of the online class. The COVID-19 pandemic limited our ability to engage in meaningful in-person social interactions and our online dance class served as a social outlet for our participants. Dance studios were closed during the pandemic, but our online class helped participants reconnect with movement. Of course, the online dance experience could not recapitulate the experience of being in a dance studio and brought forth technical limitations that made it difficult to connect with others and follow dance instruction.

Limitations and future directions

We acknowledge several limitations of the current study. First, as females tend to self-select dance experiences, and our sample was made of primarily females (91.5%), more males will need to be intentionally incorporated in future research studies. Second, though this study was sufficiently powered for its cross-sectional nature, future studies should increase the sample size, perhaps including comparisons between sexes or other demographic factors. Additionally, only three dance styles were represented based on the expertise of the instructors (ballet, jazz and contemporary/modern); we see potential for future expansion of the project into non-Western forms or social dances.

Based on the current findings, we suggest some potential directions for future research. First, future work will need to investigate the neural mechanisms underlying the beneficial mental health effects of online dance. Second, the findings from this work suggest that online dance may be beneficial for individuals with mental health disorders or neuroatypical populations. For example, we plan to expand this study to focus on a cohort of adults with ASD. Since the beginning of the pandemic, research has shown some benefits to synchronous online learning for adults with ASD. Because of the clear communication structure and rules of social engagement on Zoom and other virtual platforms, individuals with ASD may feel more comfortable and supported developing a new skill in an online learning environment than they might via in-person classes (Sallafrance-St-Louis and Normand 2017). As well, previous findings on the effectiveness of DMT in special populations lead us to speculate that this work could be tailored to the specific needs of trauma survivors and veterans.

In addition, considering that auditory learners were the smallest sample of our cohort, and they showed negligible positive effects from this study, we are additionally interested to explore whether there may be ways to help meet the needs of auditory learners in an online context. Could we incorporate specific parts of class

in which members of the group are instructed to turn off cameras and simply listen to verbal directions from the instructor? Are there additional aural cues that could be incorporated in classes to help auditory learners feel more successful? We plan to investigate these questions further in order to provide multiple opportunities for various learning styles to achieve the wellness benefits of online dance classes.

CONCLUSION

While we acknowledge that holistic dance learning is most ideally achieved through in-person instruction, the results of the present study suggest that online dance can be beneficial to both the body and mind. When in-person learning is not available due to health risks or various other accessibility issues, we have demonstrated that measurable mental health and social connectivity benefits can be gained via online dance education.

Best practices for online dance learning include: repetition and scaffolding of movement material; simplicity and clarity of movement material and verbal directives; tending to both individual experience and group connection; and incorporating a variety of movement experiences geared towards various learning styles. In the future, we look forward to engaging in further study regarding potential applications of this research for special populations such as adults with ASD, trauma survivors, and veterans.

Perhaps most importantly, even when we can safely resume in-person learning, online classes may still play a significant role in increasing dance accessibility across a wide array of populations. Online learning has the capacity to meet various schedules, financial situations, physical limitations, learning styles, and comfort levels. Online learning can never replace the intimacy of in-person dance education, but it can and should be considered as an important element in the field of dance education at large, and future study is warranted to continue developing its efficacy as one of many tools that can be employed to deliver the mental health and physical wellness benefits of dance and movement to larger and more diverse populations.

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Co-author Rugh is both an adjunct faculty member at Virginia Tech and director of the dance studio, New River Moving Arts. The studio was compensated by the university in order to provide classes at no cost to the 47 study participants; however, no additional financial compensation was received.

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